Using Improved Storage Technology to Reduce Food Insecurity and Postharvest Losses in India

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Summary

Can access to improved storage technology enhance food security for smallholder farmers in India? This study examines the impact of on-farm hermetic storage technology on four dimensions of food security – availability, access, utilization and stability. Postharvest losses during storage manifest in reduced quantity and quality of stored grain, resulting in decreased household incomes and reduced food availability. Improper storage undermines households' ability to delay sales in expectation of higher prices and compromises food safety. Through a randomized control trial in India, we find that access to hermetic storage bags led smallholder farmers to store for longer periods, sell at higher prices, shift consumption away from market sources to own stock, reduce aflatoxin contamination, and decrease postharvest losses. A cost-benefit analysis of improved storage technology shows that farmers recover the full, unsubsidized cost of hermetic storage bags in one agricultural season.

Background

Food security and postharvest losses are interrelated issues. The Food and Agriculture Organization (FAO) of the U.N. estimates that about 1.3 billion tons of food per year is lost after harvest and before reaching consumers. Put in perspective, a 50 percent decrease in losses would be equivalent to adding more than 550 million acres of agricultural land, which is greater than the total amount of arable land in the United States and Canada combined. Thus, reducing postharvest losses appears to be a promising way to increase the amount of food available for human consumption.

Poor postharvest management reduces the quantity of food available for consumption and compromises the quality of food grains for sale, adversely impacting sales prices and farmers' incomes. Lack of effective grain storage technology can lead to food contamination, as well as pest and rodent damage resulting in health hazards and reducing the farmers' ability to store grains for the lean season. These effects combine to undermine all four pillars of food security - availability, access, utilization and stability. As defined by the FAO, availability refers to the supply of food - not just in terms of quantity but also quality. Access is about the affordability of food, which can be promoted by lowering food prices and/or improving household income. Utilization refers to the use of safe food in a way that supports a healthy life. Finally, stability

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requires continued access to safe and healthy food at all times and the ability to smooth consumption over different income shocks. Our research shows that providing hermetic storage technology to smallholder farmers can address all four dimensions of food security.

Methodology and Theory of Change

To measure the food security impacts of improved on-farm storage, we conduct two randomized experiments with smallholder farmers in India. In the first experiment, we provide 1500 farmers in 42 villages in Bihar with the opportunity to purchase 50kg hermetic storage bags at highly subsidized prices to store wheat, rice, maize or lentils. When properly used, these bags form an air-tight (hermetic) seal which serves to maintain constant moisture content in the grain while suppressing insect populations and mycotoxin infestation. We compare the treatment group of farmers who received access to hermetic bags to those who did not and examine the impact of improved storage on physical quantity and quality of grain losses, aflatoxin contamination, storage quantity, grain use, and duration of storage. In the second experiment, we conduct a randomized storage and sales study to understand market price premia for grains stored in hermetic bags as compared to jute bags over a period of four months after harvest. In a sample of 200 farmers, each farmer is encouraged to store four bags of maize – two jute bags and two hermetic bags -- for four months after harvest. Two months after harvest, all farmers sold maize from one of each kind of bag and recorded the difference in price received.

Figure 1: Theory of Change

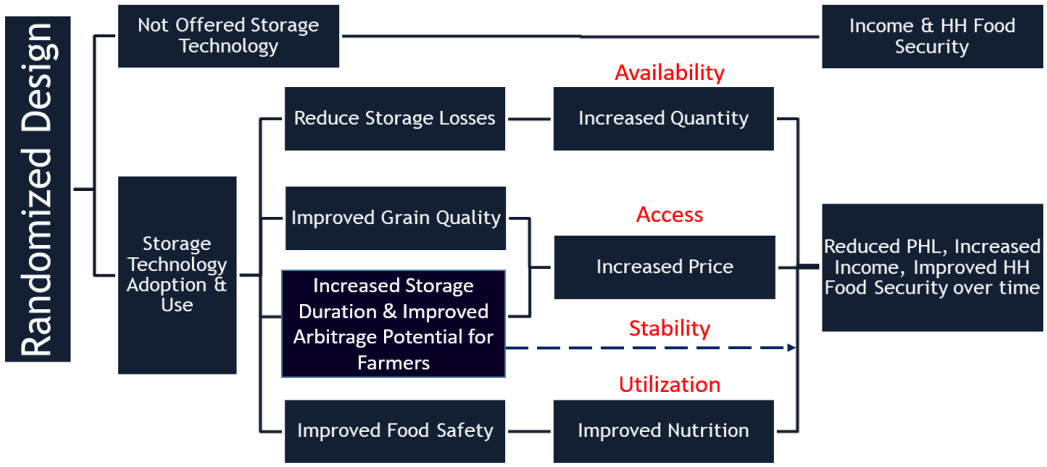


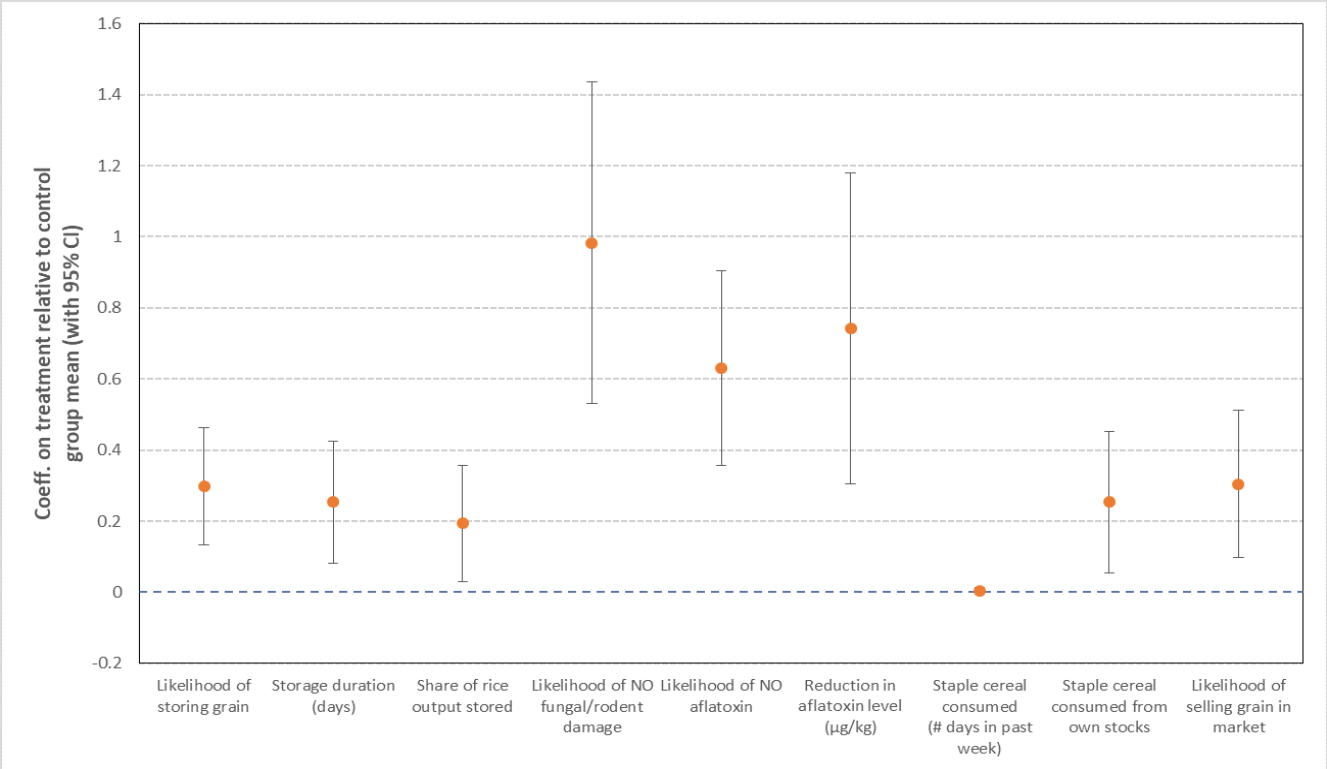
Figure 1 shows the channels through which we hypothesize improved storage technology will impact food security. The decrease in quantity lost increases the amount of grain available for sale and household consumption. Storage in hermetic bags maintains grain quality for longer and provides benefits that are twofold. First, it gives farmers the opportunity to sell at a later date when prices are higher; second, it provides them the option to store grains for their own consumption, diminishing the need to buy grain from the open market at higher prices during the lean season. Thus, improved storage can raise revenues and reduce costs for farm households. Another benefit of using improved storage could be enhanced food safety since research shows that hermetic

storage limits the growth and spread of aflatoxin contamination in some cereals. The aggregate effect of increased quantity available for consumption and sale, higher sales prices, improved nutritional value, and longer storage duration is improved food security.

Quantified Impacts of Improved Storage Technology

As shown in figure 2, use of hermetic storage bags has a significant positive impact on a wide range of outcomes. Farmers who had access to hermetic storage were approximately 30 percent more likely to store and sell grain in the market at a later date. Moreover, the duration of storage for farmers with access to hermetic bags was around 25 percent longer. There is a significant increase in the share and quantity of output stored after harvest. Farmers with access to hermetic storage bags stored nearly 20 percent more of their grain (about 60kg more on average). The quantity of staple cereals consumed was not affected by access to improved storage, but consumption from own stocks increased by 26 percent while consumption from market sources decreased by 7 percent. The likelihood of fungal/rodent damage decreased by almost 98 percent and the level of aflatoxin contamination fell by almost 75 percent. While an average of 37 percent of the maize, wheat and rice samples from traditional bags had higher than permissible levels of aflatoxin, only 4 percent of samples from hermetic bags had this level of contamination. Finally, results from our storage and sales experiment show that on average, maize stored in hermetic bags received almost 11 percent higher prices than that stored in jute bags.

Figure 2: Impact of Improved Storage on Food Security Indicators



Cost-Benefit Analysis of Improved Storage Technology

A simple cost-benefit analysis demonstrates a high return to the use of on-farm hermetic storage bags as opposed to the storage methods in common use. We assume two potential scenarios – one, in which all the grain produced is sold in the market and the other in which all the grain produced is used for own consumption. Non-financial benefits of averting the negative health impacts of consuming aflatoxin-contaminated grain are not included in the calculation provided here, but contribute to the net benefit gained through use of hermetic storage.

Financial benefits

Table 1 presents a cost-benefit analysis of on-farm hermetic storage under two scenarios, including estimates with and without the premium from selling aflatoxin-free grains in high value markets. We use the following data and assumptions for our cost-benefit calculations.

1. *Quantity calculation (row a)* - Our experiment on physical loss measurement shows that an average of 10 percent of grain is lost to pest, fungal and rodent damage in traditional storage. We also find that nearly 100 percent of this damage is eliminated by using hermitic storage. Thus, the quantity available for consumption or sale in 45 kg from traditional bags and 50 kg from improved storage.
2. *Value calculation (row b)* - Maize stored for an average of two months after harvest in traditional storage fetched INR 1085 per quintal (or INR 10.85 per kg) while that stored in improved storage fetched INR 1202 per quintal (or INR 12.02 per kg) – an increase of 10.8 percent in price. We also know that the average price of medium quality grain purchased from local trader/retailer is INR 22 per kg.
3. *Cost of bag calculation (row d)* - The cost of a jute bag is INR 10 and the cost of the hermetic storage bags used for this experiment is INR 80 per bag. Our follow up survey found that the improved storage bags were being reused by nearly all farmers for four seasons. To take this into account, we spread the cost of storage technology over four agricultural seasons (or two years). However, to ensure longevity and effectiveness, improved (hermetic) storage bags are best used as an additional inner layer with traditional bags. Therefore, we add the cost of traditional bags to hermetic bags to calculate the full cost of using improved storage (i.e. the cost of improved storage per season: (80/4) + 10 = INR 30).
4. *Value calculation with potential aflatoxin-free premium (row g)* – Traders surveyed in high value markets (Hyderabad and Delhi) buy maize with low aflatoxin content at an average of INR 1300 per quintal (or INR 13 per kg). These traders reported not buying grains from Bihar due to high aflatoxin levels, particularly in maize. Improved storage reduces aflatoxin contamination by nearly 75 percent bringing it down to permissible levels and providing an opportunity to farmers to access high value markets. We assume that nearly 50 percent of the difference in maize price is attributable to factors like transaction costs and non-aflatoxin related unobservable grain quality, there is still a price premium for low aflatoxin grains for

farmers (INR ((13 – 12.02) * 0.5) = INR 0.49). Thus the price per kg with potential aflatoxin-free premium will be INR (12.02 + 0.49) = INR 12.51.

Table 1: Cost Benefit Analysis of On-Farm Hermetic Storage Technology

	For 50 kgs stored in one bag	**Traditional Storage**		**Improved Storage**	
		If all sold	***If all consumed***	***If all sold***	***If all consumed***
a.	Consumable or saleable quantity	45 kg	45 kg	50 kg	50 kg
b.	Value per kg (from local traders)	INR 10.85	INR 22	INR 12.02	INR 22
c.	Total value (a * b)	INR 488.25	INR 990	INR 601	INR 1100
d.	Cost of storage bags	INR 10	INR 10	INR 30	INR 30
e.	Revenue – Cost (net revenue)	INR 478.25	INR 980	INR 571	INR 1070
f.	Additional net revenue from using hermetic storage (for one season)	-	-	INR 92.75	INR 90
	Including potential aflatoxin control premium				
g.	Value per kg	INR 10.85	INR 22	INR 12.51	INR 22
h.	Total value (a * g)	INR 488.25	INR 990	INR 625.50	INR 1100
i.	Revenue – Cost	INR 478.25	INR 980	INR 595.50	INR 1070
j.	Additional benefit from using improved storage	-	-	INR 117.25	INR 90

Whether all of the grain produced is used for own consumption or sold in the market, using improved storage is profitable, with and without an aflatoxin-free price premium. The calculations in table one spread the cost of the improved bag over 4 seasons, but the additional revenues in one season are sufficient to cover the full cost of the bags (INR 80). The benefit of using improved storage would be even greater for farmers with access high value markets that pay a premium for reduced aflatoxin levels (row j).

Policy Implications

Providing access to hermetic grain bags, a simple and locally replicable storage technology, can be a sustainable way to enhance all four dimensions of food security – increasing physical availability, improving economic access, ensuring safe utilization and improving stability by providing continuous access to cereals. In developing countries where storage infrastructure is scarce, these findings suggest that policy interventions to accelerate the adoption of hermetic storage could constitute cost-effective ways to promote food security. A cost-benefit analysis shows that an average farmer recovers the full cost of a hermetic bag in one agricultural season, but in experimental auctions, farmers were not prepared to pay the full market price of INR 80. They were willing to pay INR 25 to INR 30 for hermetic bags compared to INR 10 for jute sacks. The research also revealed increases in farmer willingness to pay for hermetic bags as they learned more about food safety benefits and as they had experience with the bags. These findings suggest that policy support through endorsing hermetic storage, facilitating local production of lower-cost certified hermetic bags, and providing information about the benefits of hermetic storage could support technology adoption and enhance food security.

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