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Storage of wheat (*Triticum aestivum*) in jute (*Corchorus* sp.) bags: An Indian storage system case study

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ABSTRACT

Jute (*Corchorus* sp.) is bio-degradable whereas synthetics are not environment-friendly. The disposal of unserviceable jute bag is not as big a problem as may be for synthetic bags.It is true that HDPE bags are not a good option for storing wheat (*Triticum aestivum* L.) because they do not breathe but for rice they are the best option. Jute bags for rice need very heavy fumigation, which is not eco-friendly. Usually, each jute bag undergoes 10 handlings from the stage of procurement to its final stage of distribution. As foodgrain handling is largely manual, the handling labour takes support of 6-inch (approx. 150 mm) hooks to lift the bags. Owing to multiple uses of hooks at each handling, leakages, bursting, spillages are frequent. No wonder then that Food Corporation of India (FCI) percentage of transit shortages is almost three times of the storage shortages.

Key words: Jute bags, Gunny bags, Synthetic bags, JPM (Jute packaging materials), High-density polyethylene (HDPE)

The history of jute manufacturing is lost in the narrow passage of time. Jute (*Corchorus capsularis* L. and *Corchorus olitorius* L.) is believed to have been cultivated around 800 BC. In these environmentally conscious times, jute contributes lasting solution to the universal problem of pollution. It is environment friendly as its contents, cellulose and lignin, are biodegradable. Like most synthetic products, it does not generate toxic gases when burnt. The jute fiber is available in inexhaustible quantities and at comparatively low prices. It also has the potential to replace several expensive fibers and scarce forest resources. As per the government decision, at least 90% of foodgrains produced and 20% of the sugar production is reserved for packaging in jute. This is by Revoking a previous decision, the government has now made it mandatory for all foodgrains sold in the domestic markets to be packed only in jute bags. This order will hit the jute industry employing 0.25 million workers and 4 million jute growers, mostly in West Bengal and Bihar. But though jute farmers benefit, gunny bags are expensive. The cost of a jute bag is around ₹ 10 for 50-kg bag size, whereas the cost of a HDPE bag is virtually half. As HDPE bags also last longer, they are preferred over jute. In other words, instead of the cheaper and more resilient polypropyelene (PP) bags, local millers, processors and even wholesalers will now have to switch to jute bags. Hence, sales of companies producing PP bags are likely to fall. FCI alone buys jute bags worth several thousand million annually.Moreover, consumer packs of quantity of above 10 kg and up to 25 kg for packing of foodgrains should be done in jute bags for distribution of foodgrains under the Food Grains Security Act subject to such bags being cost competitive compared to HDPE/PP bags considering the subsidy/reimbursement provided by Government of India. More importantly, even the popular 15-kg consumer packs of cleaned wheat and rice, especially basmati and sugar will now have to be retailed by grocers and supermarkets in jute bags only. With a view to reducing the cost of jute bags all future orders of the government shall be for lighter weight bags of 580 and 600g subject to conformity with relevant Bureau of Indian Standards (BIS). Wheat and rice, the two major staple food commodities, are stored

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and handled in jute bags. The bags containing the grains undergo at least 10 handlings from the start of procurement to reaching retail stores. Government agencies and the co-operatives keep the grain-stocks in their warehouses and the surplus stocks are stored in the open in Cover and Plinth (CAP) storages. Outdoor storage involves wheat and paddy only. Although improved storage structures and modern chemical and physical control techniques are now employed for the safe storage of produce, in many countries 70-90% of foodgrain is still stored for 6 months to a year at farmer's level in traditional storage structures made of locally available material, such as paddy straw, split bamboos, reeds, mud, bricks, etc., which are not insect-proof (Semple, 1990). In some countries, grains are sometimes mixed with sand, limestone, or ash to provide physical obstacles to movement of insects through the grain and reduce deposition of eggs. In Nigeria, both local herbs and smoke from small fires are also used as insect repellents and fumigants to deter insect establishment in stored food grain (Ezueh 1983). The size of on-farm storage may range from a few hundred kilograms to a few tonnes. Gunny bag storage, as practiced widely in some countries, is not the most efficient way of storing foodgrains and is vulnerable to pest attacks. Prophylactic chemical and physical treatments, such as aeration, radiation, refrigeration, heating, or hermetic storage in controlled nitrogen or carbon dioxide gaseous environments, are not only prohibitively expensive but not always feasible, because in villages the foodgrain is generally stored within the confines of human dwellings. Also, widespread resistance to insecticides, including the juvenoidmethoprene, among populations of major post-harvest insect pest species (Benezet and Helms 1994; Champ and Dyte, 1976; Muggleton, 1987) and concerns about health hazards associated with the use of chemicals are other limitations of chemical control at village levels. Although methyl bromide is used as a fumigant for more than 70 years for controlling insect pests in durable and perishable commodities, concerns of its role in ozone depletion indicated that it will eventually be removed from the list of few remaining products capable of preventing the damage in food and other commodities (Taylor, 1994). This situation demands alternative control measures that reduce the dependence on contact insecticides. It has been an age-old practice in India to mix dried neem leaves with grains meant for storage. The practice of mixing neem materials with stored products became rooted as part of traditional wisdom and culture. Pruthi and Singh (1944) recorded that neem leaves were spread in 5-7 inches thick layers in grains and neem fruits were crushed on the inner surfaces of grain containers. Mixing of neem leaves (2-5%) with wheat, rice, or other grains is even now practiced in many villages in India and Pakistan. Other common practices include mixing of neem leaf paste with the mud that is used for making earthen bins and overnight soaking of gunny bags in boiled neem leaf extract (2-10%), which are then used for storing grain.The traditional uses of neem may differ in different regions or with farmers of different cultural backgrounds. For example in southern Sind, Pakistan, farmers mix dried neem leaves with grains stored in jute sacks, or they apply crushed neem leaves on the inner surfaces of mud bins before filling them with grains (Jilani and Amir, 1987). In central Sind, where *"palli"* (a giant basket) made of plant materials is a common storage structure, crushed neem leaves mixed with mud are used as plaster for its inner sidewalls and top. In southern Punjab, Pakistan, neem leaf extract is sprinkled on wheat straw packed at the bottom of *"palli"* 2 to 3 days before filling with grain. A survey of various types of on-farm storage practices revealed that a combination of two or three control measures, including the use of neem leaves, was used by 29% of the farmers in Punjab and 47% of the farmers in Sind (Borsdorf et al., 1983). In Sri Lanka, farmers' burn neem leaves to generate smoke for fumigation against insect pests that attack stored paddy and pulses (Ranasinghe, 1984). Also, chopped green leaves are kept over the heap of paddy in a container; as leaves dry up, they are replaced periodically. Ahmed and Koppel (1987) conducted a survey of post-harvest control practices of 145 farmers in 11 districts of six provinces in India. They found that 30-60% of the farmers who stored wheat, rice, sorghum, and millet, used 4-10% neem leaves (wt/wt) for protection. The grain was stored in large, open straw baskets or in jute bags.In Nigeria, the traditional use of neem for protecting stored grains is well-documented (Bugundu, 1970; Prevett, 1962).

The traditional use of neem materials simply emerged from experience and understanding that relatively less damage occurred in the treated stored commodity than when stored in jute bags without neem. Little consideration was given to the large quantities of neem material needed for affording protection because of the ubiquity of neem tree in villages and on homesteads. The characteristic garlicky odor of neem materials permeating the closed storage environment presumably repelled insects and bitter compounds in neem materials mixed with the stored grain discouraged insect feeding. Probably, the oil present in neem seed or kernel also discouraged egg deposition on grains, particularly on leguminous seeds. There could also be other less visible but significant effects of neem on behaviour and physiology of stored product pests.

Practical experiences

The synthetic bags are becoming popular with both farmers and storage agencies, because these bags are perceived to be cheaper, lightweight, functional and hygienic. These synthetic bags are responsible for the environmental and agricultural land degradation that has used up precious resources of the earth, in particular, petroleum. In fact a synthetic bag can last up to 1,000 years in the soil inhibiting the breakdown of biodegradable materials around or in it. Commonly, jute bags are recommended as an environment friendly alternative to plastic bags because the bags are made from biodegradable material which comes from a plant fiber called jute, mostly consisting of cellulose. This is eco-friendly and has no harmful effects on the environment and agriculture. Some of the countries in the world are producing huge amount of jutes, such as, India and Bangladesh. These countries are in a much better position to lobby for the much sought global alternative of plastic bags.Jute bags preserve the quality of dry food items like rice and wheat as the bags have the inherent aeration property and are safe for storage purposes. They are stable and do not slide down when stacked. Jute bags are also easy to handle both manually and mechanically.

Jute bags used in the agro-based products treated with vegetable oils to destroy the harmful effect of hydrocarbons are also called hydrocarbon free bags. Over the past three decades, neem, *Azadirachta indica* (A. Juss.), a botanical cousin of mahogany, has come under close scientific scrutiny as a source of natural pest control materials. The tropical tree is widespread in Asia and Africa and has long been known to be free from pests and diseases. The scientific name of neem is derived from *"azaddirakht-i-hind,"* which in Persian language means the "free or noble tree of India." Here, the traditional uses and the possible practical applications of neem materials for averting losses in foodgrains and other commodities caused by stored products insect pests are reviewed and evaluated on scientific bases.How neem materials, whether raw, enriched, or purified, including bi-active compounds, such as azadirachtin, affect behaviour, growth and development, and survival and reproduction of stored product insects was reviewed earlier (Jotwani and Srivastava, 1981; Mordue (Luntz) and Blackwell, 1993; Pascual et al*.,* 1990; Saxena et al*.,* 1989; Schmutterer, 1988). Although the sensitivity of stored product insect pests to neem materials varies, almost all the species are sensitive to neem. There are a few exceptions, such as *Oryzaephilus surinamensis* Linnaeus (Sarup and Srivastava, 1971) and *O. acuminatus* (Carle) (Thomas and Woodruff, 1983), which can infest old neem seed kernels.

Although seed damage is not always reduced by neem materials at par with synthetic insecticides (Sehgal and Ujagar, 1990), the advantage of neem treatment is that it does not impair the germination of stored seed (Gupta et al., 1989). In fact, rice seedlings raised from seed treated with 2.5% neem seed kernel extract or with 2% neem cake were more vigorous and had higher root and shoot growth indices and dry weights than those germinated from untreated seed (Abdul Kareem et al., 1989). India was the first to demonstrate that powdered neem kernel when mixed with wheat seed at a proportion of 1-2 to 100 (wt/wt) parts satisfactorily protected against *S. oryzae*, *R. dominica*, and *Trogoderma granarium* for 270, 320, and 380 days, respectively. Rahim (1997) found that an ethanolic neem kernel extract, containing azadirachtin, at 75mg/ kg protected stored wheat against *R. dominica* for up to 48 weeks. In warehouse trials, wheat grain treated with neem oil at a proportion of 8 ml to 1 kg grain, prior to storing for 8 months in gunny bags, had 50 to 70% less infestation by *S. oryzae* (L.), *R. dominica* (Fabricius), *T. castaneum* (Herbst), and *Cryptolestes* spp. (Ketkar 1976). Application of neem oil at a low concentration of 0.1% (wt/wt) to wheat grain reduced egg laying by *Sitotroga cerealella* as effectively as a 5% malathion dust treatment (Verma et al., 1985).

In commercial trials conducted in Pakistan, it was demonstrated that paper or cloth or jute grain storage bags treated with water extract of neem leaves at 20% (wt/vol) or water extract of neem seed at 5% (wt/vol) observed the penetration of stored grain pests into the bags for 6 months during storage (Malik et al., 1976; Jilani, 1981). In an on-farm trial conducted in Sind, Pakistan for 13 months, the application of ethanolic neem seed extract (600 $\mu g/cm^2$) to storage jute bags or directly to wheat grain controlled more than 80% of the population of *Tribolium castaneum*, *R. dominica*, *S. oryzae*, and *S. cerealella* (Olivier) and prevented grain damage up to 6 months (Jilani and Amir, 1987). The treatments remained effective up to 13 months, providing more than 70% protection; insect infestation and the percentage of weevil attacked grains was much lower than in the untreated control.

Paddy grain that had been fumigated and then treated with neem oil or, after fumigation, stored in neem oil-treated bags, also had fewer adults of *T. castaneum*, *R. dominica*, *S. oryzae*, and *O. surinamensis*, as compared with the fumigated or the untreated paddy grain. *C. cephalonica* infestation was found in the stored paddy only after 4 months and remained low throughout the trial in treated as well as untreated paddy.

CONCLUSION

There is a big scope globally for Indian Jute bags as an alternative to plastic bags. In the present scenario the jute industry is facing a stiff competition against the rising demand for plastic bags for storage and transportation purpose. This is because the present jute bag making process was not sophisticated and production of jute bags takes more time. Nevertheless, jute bags are preferred to plastic bags for packaging of agricultural products because plastic bags are not eco-friendly. Jute bags are being preferred to plastic bags for packaging of agricultural products like sugar, vegetable and fruits because of growing awareness about the harmful effects of plastic bags. In countries like India, petrochemical products especially plastic bags have become a menace to municipalities. Indiscriminate use of carry-bags made of plastic has wreaked havoc on the environmental front. Soil pollution, visual pollution, choking of drains, blocking natural water streams has all added to the plunder. The alternative may not come as cheap as its plastic counter parts, but the price paid will still be cheap for the cost of saving to the environment. Jute bags may be tailored as per customer's specifications in terms of size and to meet the ever-increasing demand for jute bags in the farm sector and agro-based industries. These are specifically used for the purpose of storing agro-based products, known as hydrocarbon free bags that have been treated with vegetable oils to destroy the harmful effect of hydrocarbons. The neem oil may be considered as an option for treatment of jute bags. India and Bangladesh must propagate jute bags for storage of foodgrains.

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