

Review

Recent advances in cover and plinth (CAP) and on-farm storage

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ABSTRACT

Now a days storing grain for short duration in cover and plinth (CAP) storage is followed in India. These CAP storages were also used when insufficient indoor spaces were available. Various studies and research were conducted around the world to improve large scale grain storage for on-farm, open and short duration grain storage. Present study compiles important and relevant research in cover and plinth and on-farm storage. This paper discusses the suitability of hermetic bags in cover and plinth and on-farm storage for effective controlling the insect species for three to four months and for monitoring the system of storing grain in CAP storage. The studies demonstrate that the temporary grain storage in polyethylene bags does not lead to grain quality loss compared to the conventional storage.

Keywords: Cover and plinth storage; CAP; storage; grain; on-farm storage

INTRODUCTION

Farmers were seeing the positives of on-farm storage as tight profit margins and high yields have forced them to seek temporary storage structures in hopes of higher prices. The silo bags that are popular in South America have made their way to the US and these bags were an inexpensive way to store grain and these bags turn the grain into silage. So it is important for producers to keep the grain in good condition as it could damage the quality. Alternative storage structures are a risky proposition but if it is working according to

small farmers needs this can save lots of resources for small farmers (Pratt 2014). The cost of storage protection has a larger effect on storage profitability with low value commodities such as maize while the opportunity cost of capital has a larger effect on storage profitability of high value commodities such as cowpeas and common beans (Jones et al 2014).

Outdoor stacks of bagged grain covered with a waterproof material have been used in many countries. Cover and plinth storage became necessity as Indian harvests increased faster than storage

capacity (Garg 1985). But CAP storage is vulnerable to wind damage and the cover needs to be inspected frequently to detect damage. The system requires careful management if severe losses are to be avoided. Careful quality control is achieved with regular sampling. The advantage of CAP is its low establishment cost which is only one quarter the cost of godown storage. But security is a problem and extra fencing together with an extra watchman has been included in the cost calculation. The storage of grains in large polyethylene bags is not a new method for grain storage and preservation (Harrel et al 2007, Gaston et al 2009). As of 31 March 2010 nearly 176.83 lakh MT of food grain is in CAP with FCI and state agencies of India. (Writ Petition (civil) No. 196 of 2001 dated 10/08/2010)

Construction of CAP

For CAP construction a plinth with hooks to provide purchase for the ropes lashing the stack is constructed on a suitable site. Dunnage is provided and the covers are made of black polyethylene 250 micron thick shaped to suit the stack. The covers are held down by nets and nylon lashing. Condensation is prevented by placing a layer of paddy husk-filled sacks on top of the stack under the polyethylene.

For a typical 150 ton CAP storage the commonly constructed size is 8.55 m x 6.30 m for 3000 bags each of 50 kg capacity. It is generally provided on a raised

platform where grains are protected from rats and dampness of ground. The grain bags are stacked in a standard size wooden dunnage. The stacks are covered with 250-350 micron low density polyethylene (LDPE) sheets from the top and all four sides. Wheat grains are generally stored in such CAP storage for 6-12 months. It is the most economical storage structure and is being widely used by the Food Corporation of India for bagged grains (Jain and Patil 2012).

The main agencies involved in large quantities of storage of food grains for a longer period in India through CAP are:

- The Food Corporation of India (FCI)
- Central Warehousing Corporation (CWC)
- State Warehousing Corporation (SWC)
- Grain Marketing Corporation (GMC)
- Some state Government Agencies

These agencies use CAP storage for 6-12 months of storage.

Generally disinfection of traditional structures is difficult to achieve and infestation might have started from grain stored from the previous season (Zewdie et al 2010). Due to this reason for shorter duration grain storage CAP storage is suitable storage method in India.

Effect on quality of grains in CAP: Idler et al (2012) conducted a study on short term storage of food grains in large polyethylene bag silos with the conventional bulk storage of grains regarding quality parameter. Results demonstrated that there were no differences between the measuring points within a bag, between the two bags and no difference between the storage systems regarding the parameters dry matter, pH, starch, crude protein, contact of mesophilic microorganisms (bacteria, yeast and mould) and germination. The temperature in the polyethylene bag silos resembled rapidly to the ambient temperature. There was no local overheating due to microbiological activity. The results demonstrated that the temporary grain storage in polyethylene bags does not lead to grain quality loss compared to the conventional storage. Because of the very low cost the flexible bagging system represents an alternative to high investment in permanent storage structures for grain. The carbon dioxide atmosphere inside the bags brings advantages from the point of view of insect and mould avoidance but Muenzig (1988) concluded that high carbon dioxide level in a storage unit leads to reduced germination of wheat kernels, a loss of sensory quality and a lower baking volume. The results were found out by grain with moisture content higher than 14 per cent.

Under anaerobic conditions some activity may continue and is more obvious

with grains at higher moisture content. Such an activity can lead to sour off-flavour and odour (Tipples 1992). Due to rapid anaerobic conditions during the process in the conventional storage of grains the low losses in a bag are a common advantage of the CAP (Weber 2006, Weber 2009). Despite decreasing ambient temperature no condensation was obtained which would influence the vitality of the grains. Condensation water was absorbed by the dry grain thereby the moisture content below the surface of the bag increased slightly without coming in a critical range over 14 per cent moisture content.

The storage of grain with 12.9 per cent moisture content in polyethylene bags is possible for 6 months. The carbon dioxide produced by respiration of the grain had no influence on the viability. The variable bag length allowed the farmers to adapt the storage capacity to the grain mass which must be stored (Idler et al 2012).

Infestation in CAP storage and its remedy: Grain borer (*Prostephanus truncatus*) is more damaging particularly in small scale and on farm storage. Polypropylene bags treated with Actellic Super are effective in controlling both insect species for upto four months. Actellic Super in the polypropylene bags also controls weevils relatively better than *P truncatus*. These bags may also be used in the CAP to prevent infestation in CAP storage.

The hermetic bags also known as super grain bags were effective in controlling the two insect species for three to four months. The effectiveness of hermetic containers against *P truncatus* has been reported earlier in Mexico with 100 per cent mortality of *P truncatus* after only a few days when storing grain in glass containers (Ouezada et al 2006). Improved storage technologies (hermetic storage bags as well as the use of Actellic Super) kept storage losses within acceptable levels. But hermetic bags can only be used for one season only while Actellic Super provides good control for up to four months at least when the product is not adulterated. The product is cheap, easy to use, has low toxicity and can therefore be recommended for the short term storage of small quantities with repeated application every four months (Dales and Glob 1997, Urono 1999).

Another type of storage bags which can be used are purdue improved cowpea storage bags (PICS). These are largely in use in west and central Africa on a large scale. These PICS consist of a woven polypropylene bag enclosing two high density polyethylene (HDPE) bags each 80 micron thick. Initially these bags were of 50 kg capacity which were later increased to 100 kg capacity on farmers demand in west and central Africa. These bags stored cowpeas for 5-7 months. PICS bags represent a form of hermetic storage. The two inner HDPE bags present substantial barriers for the movement of O₂ across the

bag wall. This barrier plus metabolism of the insects living in the grain in the bag quickly lead the airspace within the bags to have reduced O₂ (hypoxia) and elevated CO₂ (hypercarbia). This drop in O₂ concentration causes the insects to cease feeding and become inactive which in turn arrests population growth and grain damage caused by the cowpea bruchid *Callosobruchus maculatus* (F). The germination tests showed that storage of grain in the PICS bags (also known as triple bags) for subsequent use for planting is feasible (Baoua et al 2013).

Monitoring of grain bag environment in CAP: Ward and Davis (2013) designed and fabricated a sensor system to measure the internal environment of a grain bag. To apply this sensor system under field conditions instrumentation system of linearly mounted thermocouples and relative humidity (RH) sensors was developed. The linear sensor array had a sampling interval as low as 30 seconds. The system RMS error for measuring temperature (T) and RH were 0.6 AoC and 3.1 per cent respectively. To characterize the internal temperature of a grain bag temperature measurements needs to be taken at a minimum of three depths at the internal bag surface within the peripheral regions and within the core temperature regions. Collected T and RH data were used to describe the grain equilibrium moisture content. Researchers, producers and grain managers could use a similar system to monitor grains stored using

this alternative storage system and to make effective management decisions.

CONCLUSION

With the advent of new advances in grain storage bags particularly hermetic bags and triple storage bags hold promising prospect for cover and plinth storage. The loss in the quality of the grain in CAP storage was also minimal but keeping in view of the future challenges some modifications are required to stop different types of infestation in the storage bags. An attempt was also made by Jason and Jeremiah (2013) for monitoring the CAP storage health by measuring different environmental parameters of a grain bag. This work was found to be at their early stages further research is also required in terms of monitoring CAP storage health. Studies show that hermetic bags are effective in controlling the insect-pests for three to four months in cover and plinth storage and on farm storage. The studies demonstrate that the temporary grain storage in polyethylene bags does not lead to grain quality loss compared to the conventional storage.

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