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Review on: Management of Stored Grain Pests in Storage Structure Systems

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INTRODUCTION:

The condition of stored grain is determined (Lacey, 1988) by a complex interaction between the grain, the macro- and micro-environment and a variety of organisms (including microorganisms, insects, mites, rodents and birds) which may attack it. Grain provides an abundant source of nutrients, and the natural consequence of the type of stable ecosystem described above will normally be spoilage (biodeterioration) of the grain, caused by the organisms.

Losses of grain in storage due to insects are the final components of the struggle to limit insect losses in agricultural production. These losses can exceed those incurred while growing the crop. Losses caused by insects include not only the direct consumption of kernels, but also include accumulations of frass, exuviae, webbing, and insect cadavers. High levels of this insect detritus may result in grain that is unfit for human consumption. Insect-induced changes in the storage environment may cause warm, moist 'hotspots' that are suitable for the development of storage fungi that cause further losses. Worldwide losses in stored products, caused by insects, have been estimated to be between five and ten percent. Heavier losses occurring in the tropics may reach 30%, and the net value of losses in storage in the United States has been placed at over $200 million annually David K. Weaver and A. Reeves Petroff, (2005).

Limiting insect infestation in grain storage must be a primary consideration beginning at the time of harvest. Economically speaking, storage insects and, to a lesser degree, fungi reduce the quality and value of grain, while losses due to rodents and birds are typically quite infrequent and minor. There are some points which could be used while managing and minimizing the stored grain pestsinvasion as follows.

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1. Cleaning bins, harvest and loading equipment prior to harvest and after bin emptying,
2. Applying "empty-bin" insecticides to the inside of the structures,
3. Sealing structures,
4. Cleaning up grain spills on the grounds,
5. Removing weeds close to structures.
6. Storing sufficiently dry wheat (less than 13%),
7. Aerating the stored grain with fans to cool the wheat thus slowing insect development,
8. Close monitoring of grain temperature and insect populations.

CRITICAL IPM ISSUES: (Preventive measures before binning)

The integrated pest management (IPM) approach that protects stored grain includes:

• Sanitation

• Frequent monitoring

• Aeration

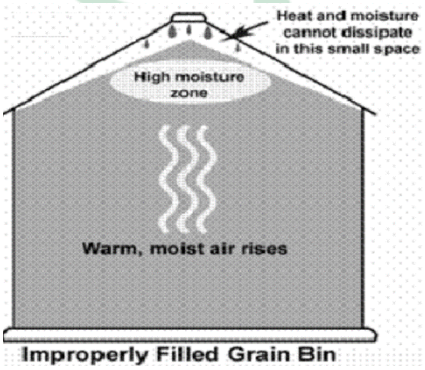
• Biological control

• Pesticide treatments IPM techniques should be considered as tools in a toolbox; not all of them are needed every time, such as pesticides, but still need to be available.

Sanitation:

The goal of sanitation is to eliminate insect eggs, pupae, and adults. Never put newly harvested grain into bins containing old grain. Empty the bins of all residual grain, and use shovels, brooms, and industrial vacuums to clear dust, webbing, and fines from around any cracks and crevices, doors, seams, vents, and especially under false floors. Floors and walls inside empty bins are swept of old grain and debris. Weeds around the bins are removed. Remove spilled grain outside the storage structure. All grain handling equipment is repaired and kept in good condition before harvest.

Monitoring Stored Grain and Levelling of Grains:



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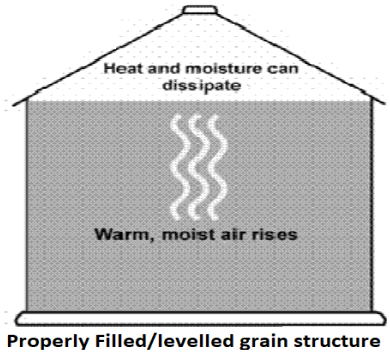
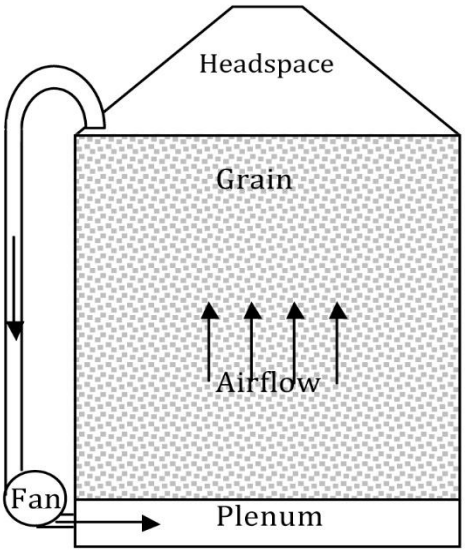


Properly Filled/levelled grain structure

Several kinds of traps are commercially available to monitor facilities for the presence of stored grain pests. Reliant on the pest, lures may include female sex pheromones, male aggregation pheromones, or food attractants. Increased carbon dioxide concentration in the grain indicates the presence of insects in the storage bin during the development of the infestation. To determine if insects are present, inspect the top of the grain mass. A sour smell, grain clumped together, condensation on the inside surface of the bin roof, webbing on the grain surface, or the presence of insect larvae, adult beetles, or moths all indicate an insect infestation and the interior of the grain mass can be monitored through the side access panel by using plastic tube traps, probe traps, and sticky pheromone traps. These traps are inserted into the grain mass for a specified period of time and then retrieved. These types of traps will attract insects and help determine the kind and number of insects present. The process of levelling the grain requires the judicious use of the grain auger and a brief period of physical labor using a grain shovel. The level surface is well suited for monitoring with pitfall traps, and for the proper application of fumigants.

Aeration: (Temperature control)



The use of low volume airflow rates to cool stored grains (aeration) is an important component of stored grain pest management. Airflow rates are usually specified as 0.1 to 0.5 cubic feet per minute (cfm) per bushel. Clean grain contributes to uniform airflow and successful drying. Because many stored grain pests originated in the tropics, they are susceptible to cold temperatures. Most require temperatures above 60 o F to reach damaging populations; some need temperatures above 70°F. Therefore, storing grain in a cool place will slow pest development. Very cold temperatures can be used to kill pests; storage at 0°F for 4 days will destroy some species. Prevention of moisture migration by maintaining a uniform temperature throughout the grain mass greatly reduces the possibility of mold development as well as insect feeding and reproduction. Aeration will not kill insects, but will slow their growth and development. Aerated bins contain lower insect populations than non-aerated through the winter, thus aeration greatly reduces the requirement for fumigation. Aeration fans at the base of the bin move cool air through the mass, with warm air exhausting through vents in the roof. Airflow

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rates of 0.1 to 0.5 cfm/bu are historically recommended for wheat at normal moisture levels. However, higher airflow, night aeration is most effective during late summer and fall, when the air temperature is below 60°F.

Insecticides Treatments with usage:

Current usages for stored-grains pesticides, including fumigants and contact insecticides, constraints on their use and the ways in which chemical pest control may be integrated into storage systems are subjects which have received much attention. The following account may be usefully augmented by reference to various publications including, for example, Champ and Highley (Eds.) 1985.

(Table 1: Insecticides are labelled for use and empty bin treatment)

Sr No.	Active Ingredients (a.i.)	Use during
1	**Cyfluthrin**	**Most effective residual as compared with malathion and Chloripyrifos-methyl.**
2	**Malathion**	**No longer recommended for empty grain bins because of high insect resistance and rapid degradation in warm, relatively moist grain**
3	**Chlorpyrifos-methyl + cyfluthrin**	**Can only be applied from outside of bin and sprayed downward into the bin. Degrades on hot surfaces.**
4	**Chloropicrin**	**Empty bin fumigant, under false floor, aeration tubes, and tunnels.**
5	**Methyl bromide**	**Empty bin fumigant; rarely used.**
6	**Chlorpyrifos-methyl**	**Can only be applied from outside of bin and sprayed downward into bin. It is not recommended for grain intended for export.**
7	**Diatomaceous earth (DE)**	**Excellent empty bin treatment. Special grade required for grain use. Must use DE labelled for grain.**
8	**Phosphine**	**Empty bin fumigant**

(Note* Table recommended by *David K. Weaver and A. Reeves Petroff* Pest Management for grain Storage and Fumigation manual in 2005)

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Grain protectants are insecticides applied directly onto grain going into the storage or already in storage. Grain protectants do not kill insects inside the kernels. Following are insecticides labeled as protectants

Table 2: Liquid insecticide Labelled for Use of Grain Protectants.

Sr No.	Active Ingredients (a.i.)	Use during
1	Pyrethrins	Expensive, short residual life.
2	Methoprene	Kills developing insects only, slow kill of larvae, no kill of adults though causes sterility. High cost and must use other products before sale. Newly marketed.
3	DDVP	also as strips. Used in the head space against Indian meal moth.
4	Malathion	Existing stocks are available but label has been withdrawn. Most stored grain insects are resistant.
5	Chlorpyrifos-methyl	Reldan does not control lesser grain borer. Can only be applied to the grain stream as it is moved (augured) into the bin. Use limited to existing stocks.
6	Chlorpyrifos-methyl + cyfluthrin	Can only be applied to the grain stream as it is moved (augured) into the bin. It is not recommended for grain intended for export.

(Note* Table recommended by *David K. Weaver and A. Reeves Petroff* Pest Management for grain Storage and Fumigation manual in 2005)

Table 3: Dusting insecticide Labelled for Use of Grain Protectants.

Sr No.	Active Ingredients (a.i.)	Use during
1	Malathion	Top-dress treatment. Insects are resistant in many areas. Millers resist purchasing grain with strong malathion odor.
2	Diatomaceous earth (DE)	Can lower the test weight of grain and is expensive if it is applied to entire grain mass, so is best applied to empty bins and to the top and bottom layers of the grain mass.

(Note* Table recommended by *David K. Weaver and A. Reeves Petroff* Pest Management for grain Storage and Fumigation manual in 2005)

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Table 4. Recommended insecticide application rates:

Insecticide	Dust admixture with cereals (ppm)	Surface treatments (g/m²)	
		Walls	Bags
Malathion	8-12	1-2	1-2
Pirimiphos methyl	4-10	0.5	0.5
Fenitrothion	4-12	0.5	0.5-1
Chlorpyrifos methyl	4-10	0.5-1	0.5-1
Dichlorvos	2-20*	0.5	
Methacrifos	5-15	0.2	0.4*
Lindane	0.5		
Pyrethrin/piperonyl butoxide (1:5)	3	0.1	
Bioresmethrin (resmethrin)	2		
Phenothrin	5		
Permethrin	0.05-0.1	0.05-0.1	
Carbaryl	5-10	1-2	
Bendiocarb	0.1-0.2	-	
Dioxacarb	0.4-0.8	-	
Propoxur	-	0.5	-

Notes: * Short persistence. '-' The insecticide is not normally used in that type of treatment.

Source: Pest Control for Food Security Plant Production and Protection Paper 63 (Prepared for FAO by ODNRI) FAO, Rome (1985).

Fumigation Management Plan:

• Seal all leaks and test the seal, plus monitor phosphine levels in adjacent occupied buildings to ensure safety.
• Review existing Fumigation Management Plans, Material Data Safety Sheets, the label/applicator's manual, and safety procedures before fumigating.
• Develop procedures and safety measures for other workers that will be in and around the fumigation area during application and aeration.
• Develop a monitoring plan that confirms that workers and bystanders are not exposed to levels above the allowed limits during application, fumigation, and aeration. This monitoring plan must also demonstrate that nearby residents are not exposed to unacceptable levels, as well. The levels for exposure are an 8 hour time-weighted average of 0.3 ppm or a 15 minute time-weighted short term exposure limit of 1.0 ppm.
• Develop a procedure with local authorities to notify nearby residents in the event of an

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emergency.
• Confirm the placement of placards to secure all entrances to any structure under fumigation.

CONCLUSION:

The regular and constant monitoring and sanitation practices and away the stored grain pest sway from the source (Exclusion) method. Time to time preparation with all hygienic practices and maintain the temperature inside while filling the structures with grains or levelling the storage Grain storage facilities lend themselves to the development of insecticide resistance by virtue of the enclosed, protected structures, limited immigration and emigration ofinsects, and the repeated use of the same chemicals without rotation between chemical classes and modes of action. Of particular concern are the organophosphate and pyrethroid protectants. The same fumigant, phosphine, is used with no rotation with other chemical classes. Methyl bromide is to be phased out, leaving phosphine as the only registered fumigant for application directly to stored grains.

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