## General management of stored product insects

Although, insect management options like physical, mechanical, biological and chemical practices are available, in India fumigation was practiced since long time in storage. Some of the general preventive and curative management options are listed below.

1. Preventive measures
   * Drying of the grains to a moisture range of 10 to 14% based on grain type, avoid majority of the damage. Drying can be done under sunlight or using any developed dryers.
   * After harvesting of the grains before shifting to storage, certain measures have to take the initial infestation or inoculum of storages pests. Some of the preventive measures are listed below,
   * Sanitation of storage site is prerequisite, which involves removing of dirt, debris, foreign particles, other insects and infested grains that will reduce avoid initial infestation.
   * Handling of grains should be proper and the storage structure should not be damaged. Proper stacking size and wooden dunnage should be maintained to avoid from mechanical damage or to keep away from wall. Between each stacks a proper space should be maintained.



* + Sometimes the initial infestation observed in field can be managed with exposing the grains for sunlight for shorter period.
  + Using of improved storage structures. In Indian conditions grains are storing variedly from small metal bin to bulk storage in gunny bags under warehouses. Hermetic storage concept developing can be exploited for the future. Jute bags are generally using, which are additionally suggesting to amalgamate with polythene lining.
  + Newer lots have to store separately and should have isolated distance between old stocks.
  + Several improved bins are available, which are developed by different institutes for Indian conditions like, Pusa bin, PAU bin, TNAU bin, etc. can be used.
  + Disinfestation of bulk and bag storage structures using insecticides is also an important practice to be done prior to storage and a layer of insecticide spray can be suggested

immediately after storage. Since, dichlorvos was banned using in warehouses, presently deltamethrin and malathion are the available options for disinfectant and for surface sprays.

1. Curative measures

a. Physical methods

* + 1. Temperature management: Increasing or decreasing the temperature can alter the insect growth and metabolism. Optimal temperature for most of the storage insects is between 25 and 33º C. deviations from these points will slower down the growth and continuously to death. Passing of dry or wet heat in the storage system or refrigerated aeration yield better results. Even it can be achieved using high frequency waves.
    2. Mixing of inert dusts: Inert dusts like clays, sand, ash, minerals, silica (silicon dioxide) are effective in managing the insects by moisture loss of the insect body by abrasion. Dusts that contain natural silica, such as diatomaceous earth (DE), are commercially available and using in many developing countries either to manage or to improve fumigation efficiency .Activated clay (kaolin) has also been used in protecting grains from the attack of storage insects.
    3. Irradiation: Radiations in lower dose can able to kill or sterilizes the common grain pests, and even the eggs deposited inside the grains. Radiations like microwaves, x rays, etc. are utilizing in several forms to treat the grains before storage to disinfest them.
    4. Use of controlled atmosphere: A novel methodology where the storage atmosphere generally contains 78% Nitrogen (N2), 21% Oxygen (O2) and 0.03% carbon dioxide (CO2). This proportion can be altered mechanically by altered atmosphere which interfere with the normal insect metabolism which achieve mortality.
    5. Mechanical devices, traps, etc.: Devices developed for monitoring and mass trapping such as entoleters, which are using in flour mills.

Apart from these some other traps like Probe trap, Pulse Beetle Trap, Light traps, Sticky traps, Bait traps and Pheromone were also developed and tested in some of the countries.

* + 1. CHEMICAL

In empty bins, apply a coarse spray of an approved insecticide to run-off at least 2 weeks before binning (See Insecticides and Fumigants). Pay close attention to areas which might hide insects, such as under false floors and vents. Cracks around doors and vents may serve as sources of infestation.

A grain “protectant” is an insecticide that can be applied to the bulk grain as it goes into a storage bin (See Insecticides and Fumigants). The treatment offers protection for about one season and should be considered if the grain may be held for more than 6 months. Proper calibration of the application system is important to ensure even insecticide distribution throughout the grain. Protectants are effective against both beetle and caterpillar pests. A surface dressing (Cap Out) may be applied to prevent insects from entering the top of the grain mass and to control surface infestations of Indian meal moth, when a “protectant” is not used (See Insecticides and Fumigants). Though surface dressing may be useful if a grain protectant is not used, it will not reduce an established infestation within the grain mass. Producers anticipating problems with these pests should follow some specific steps:

**Infestation in the Grain Bulk**

Fumigants are gases that penetrate the grain and kill insects both on and in the grain. They are very toxic to man and animals and should be applied only by trained, experienced operators working in pairs. Once an insect infestation has become established, there are only two treatment options: (1) move the grain and apply a protectant during transfer or (2) fumigation. Both choices have good and bad points. Application of grain protectants during movement will provide some residual protection. But moving grain is costly, time consuming and requires additional bin space. Also, if good control is not achieved, movement will spread the insects throughout the grain mass. On the other hand, fumigation works very well and is relatively cheap. Fumigants are gases that penetrate the grain and kill insects both on and in the grain. They are very toxic to man and animals and should be applied only by trained, experienced operators working in pairs. But because it is very sensitive to poor technique, many failures occur. Also, it is dangerous and provides no residual protection.

**Fumigation**

Several factors are important in assuring successful fumigation. Grain should always be level in the bin to let the fumigant penetrate evenly. Any surface caking or crusting should be broken up and removed. Grain temperature should be 60°F or higher to ensure proper vaporization. Possible leak points such as cracks or holes in the bin should be closed before fumigation since leakage may result in under treatment and poor control.

**Causes of Fumigation Failures**

Fumigation failures can usually be attributed to one or more of the following: Insufficient fumigant--A fumigant's efficiency depends on its attaining a lethal concentration in the grain. Results will not be satisfactory if less than the recommended dosage is used or if the fumigant is applied under unfavorable conditions. Storage structure--Leaky bins will not retain fumigants long enough to kill the insects. The depth of grain also affects a fumigation's efficiency. In general, the greater the surface area of the grain in relation to bulk, the greater the difficulties in adequate fumigation. As a result, flat storage bins require higher dosages than do round silo bins. Also, storage structures with a large amount of space over the grain are difficult to fumigate effectively because large amounts of gas escape into that space.

**Moisture**--As moisture content increases above 12% a proportionately higher dosage of fumigant is required. It is difficult to effectively fumigate grain having a surface moisture content of 15 to 20% because the fumigant vapors will not penetrate the moist layer.

**Temperature**--During fumigation, the gas quickly assumes the temperature of the grain. In general, fumigant activity increases as temperature increases. However, if grain temperature reaches or exceeds 115 °F, the fumigant may vaporize very rapidly and escape from the bin before accomplishing the job. On the lower end of the spectrum, stored grain insects are inactive at temperatures below 60°F. Fumigation should be delayed until the grain temperature increases.

**Treatment**

Should fumigation become necessary, a variety of compounds are available for treatment (See Insecticides and Fumigants). Fumigants are inherently dangerous and should be applied only by trained operators. Operators should wear a full-face gas mask equipped with the proper canister, and have access to self-contained breathing apparatus, and another person should always be present during fumigation.