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Stored Grain Insect Pests and Their Strategic Management

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ARTICLE ID: 028

Introduction

Between harvesting and processing or direct eating of food grains, storage is one of the most critical processes. Storage is extremely important in developing nations since most small and medium-scale farmers rely on on-farm storage. In India, however, post-harvest insect damage results in an annual storage loss of 14 million tonnes worth around 7000 crores (https://igmri.dfpd.gov.in/). The quantity of contamination and spoiling caused by body parts, excreta, and hoarding are all factors that contribute to the economic loss caused by storage bugs. The major cause of massive losses is a lack of awareness about storage pests and their damage, as well as incorrect storage procedures.

On the one hand, the construction of appropriate storage structures that are well-equipped and well-managed, and on the other, the implementation of strict hygiene standards in stores, as well as effective pest control operations, are actions that must be carried out in tandem to limit storage losses.

Major insect pests of stored grains:

Storage insect pests are categorized into two types *viz.*

1. Primary storage pests : Internal and External feeders
2. Secondary storage pests

1. Primary storage pests: Insects that damages sound grains are primary storage pests.

Common name	Pest	Family	Order
Rice weevil	*Sitophilus oryzae, S. zeamais, S. granarius*	Curculionidae	Coleoptera
Lesser grain borer	*Rhyzoperthadominica*	Bostrychidae	Coleoptera
Angoumois grain moth	*Sitotrogacerealella*	Gelechiidae	Lepidoptera

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Pulse beetle	*Callosobruchuschinensis, C. maculatus*	Bruchidae	Coleoptera
Cigarette beetle	*Lasiodermasericorne*	Anobiidae	Coleoptera
Drug store beetle	*Stegobiumpaniceum*	Anobiidae	Coleoptera
Tamarind Beetle	*Pachymeresgonagra*	Bruchidae	Coleoptera
Sweet Potato weevil	*Cylasformicarius*	Apionidae	Coleoptera
Potato tuber moth	*Phthorimoeaoperculella*	Gelechiidae	Lepidoptera
Red flour beetle	*Triboliumcastaneum, Triboliumconfusum*	Tenebrionidae	Coleoptera
Indian meal moth	*Plodiainterpunctella*	Phycitidae	Lepidoptera
Rice moth	*Corcyra cephalonica*	Galleriidae	Lepidoptera
Khapra beetle	*Trogodermagranarium*	Dermestidae	Coleoptera

2. Secondary storage pest: Insects that damage broken or already damaged grains secondary storage pests.

Common name	Pest	Family	Order
Saw toothed grain beetle	*Oryzaephillissurinamensis*	Silvanidae:	Coleoptera
Long headed flour beetle	*Latheticusoryzae*	Tenebrionidae	Coleoptera
Flat grain beetle	*Cryptolestusminutas,*	Cucujidae	Coleoptera
Grain lice	*Liposcelisdivinitorius*	Liposcelidae	Psocoptera
Grain mite	*Acarussiro*		Acari

Management

Storage pests may be effectively managed by adequately drying grains before storage, storing new grains in clean godowns or receptacles, and fully covering any cracks, crevices, and holes in the godowns. If there has previously been a grain infestation, chemical treatment will be required. As a result, a well-thought-out Integrated Pest Management strategy should be used.

I. **Preventive measures, and**
II. **Curative measures**

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I. Preventive measures

a) Sanitation and handling of grains

Sanitation of the storage facility, both inside and out, as well as neighbouring habitats, to eliminate insect stages and pest habitats. Sanitation aids in the prevention of insect population growth and subsequent harm. It is recommended that old or infected grains be removed whenever fresh grains or storage commodities arrive in the facility.

- Keep the threshing floor/yard clean and free of bug illness, and keep it away from communities.
- Clean machinery such as harvesters and threshers, lorries, trolleys, and bullock carts before using them to avoid infection.
- Before storing grains, mud or cement the gaps, fissures, and holes located on walls and floors, and white wash the stores.
- To prevent rats, birds, and squirrels from entering, install a metal sheet up to a height of 25 cm at the bottom of the wood in doors and wire meshes on windows, ventilators, gutters, drains, and other areas.
- All of the rat holes discovered in the godown were sealed with a combination of broken glass and mud coated with mud/cement.
- Insect exposure can be reduced by properly managing grains and eliminating hooks on storage bags.
- To ensure appropriate storage conditions, provide dunnage with a 0.75-1 m gangway or alleyway all around. Bags should be arranged in rows with about 2-3m between them, with no more than 15 bags per row, leaving about 1/5 of the entire storage area from the ceiling.

b) Drying of grains

- Grains are harvested when the moisture content is between 20 and 28 percent. The moisture content should be between 12 and 13%.
- Before storing any food grains, the most usual approach is to sun dry them. Mold, discoloration, respiration, and insect damage reduce storage losses using this method.
- Moisture content may fluctuate depending on how long the product has been stored. Aeration inside the storage structure is ensured by adequate grain washing before to storage.

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- Grain washing removes undesired grains from other crops, weeds, and bugs contained in the grains, reducing the risks of fungal growth.
- Most significantly, grain washing improves the efficacy of management methods such as fumigation.
- Improper paddy grain drying during post-harvest activities increases not only insect infestation but also breakage during milling.
- Insect infestation is reduced by staggered sun drying with brief sun exposure spread over a wide number of days (9-11 am for 8 days).

c) Use of improved storage structures

- Gunny bags or jute bags with close weaves can reduce insect infestation.
- Impregnation of gunny bags with insecticides can prevent entry of insects.
- Use of Polythene lined gunny bags.
- Polyester- polythene 400 gauge lined canvas was found to be resistant to all types if insect attack.
- Improved and pest free storage structures namely aluminium bin, Pusa bin(Developed by ICAR-IARI), domestic Hapur bin (Indian grain storage institute),Pusa cubicle PAU(Punjab Agricultural University) bin, IGSI domestic bin and TNAU insect removal bins have been found very effective for bulk storage and reducing insect damage.
- Storage can be done indoors, outdoors or inside, or underground.

d) Dis-infestation of stores/receptacles

- Use a preventative spray to clean the godowns/storage buildings before storing the newly harvested crop to eliminate various bio stages of pest hiding and other pest harbouring areas to minimise pest population carryover.
- Insecticide treatment of bulk and bag storage structures is a critical step in preventing latent infestation in reused bags and bulk storage structures.
- Malathion and dichlorvos are two pesticides that are frequently prescribed.

- Legal procedure in 1914, India passed the Destructive Insects and Pests Act.

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- The Plant Quarantine Order of 2003 governs the regulation or limitation of insect migration into the nation and between various places within the country via commodities.
- At ports, grains and other goods are rigorously inspected and treated to prevent pest entrance.

e) Grain protectants

- Grain protectants are mostly contact insecticides that are used to eliminate insect pests in godowns and buildings. Insecticides can be used as a preventative or therapeutic strategy.
- To destroy cowling insect stages, pesticides such as Deltamethrin 2.5 percent WP and Malathion 50 percent EC are applied at appropriate concentrations to walls, floors, alleys, and surface grain sacks.
- After a 15-day interval, 3 litres of Malathion 50 percent EC emulsion is sprayed over a 100 sq. mtr. surface area, diluted 1:100 with water. Similarly, after 90 days, 40 gm of Deltamethrin 2.5 percent WP is dissolved in 1 litre of water and 3 litres of emulsion are sprayed on 100 sq. mtr. of surface area.
- One kilogramme of pulses may be combined with 200 g of common table salt and stored for 6-8 months.
- Combine red soil and water to make a paste, then transfer seeds to this container and well mix so that the dirt clings to the seeds. Seeds can be shaded and then moved to a gunny bag later.

II. Curative measures

a) Physical control measures

- Install a super heating system with infrared heaters in flour mills and food processing factories to achieve effective pest management, since most stored produce insects die at 55–600 degrees Celsius in 10–20 minutes.
- To manage the insects, modify the storage environment to produce low oxygen (2.4 percent) and high carbon di oxide (9.0–9.5) by adding CO2.
- The goal of the seed: For every 100 kg of seed, combine 1 kg of activated kaolin (or) lindane 1.3 D (or) Malathion 5 D and store/pack in gunny or polythene lined bags.

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- For grain, combine 1 kilogramme activated kaolin with 100 kg of grain and store. Mix 1 kilogramme of activated kaolin or any one of the edible oils for every 100 kg of grain or 1 kg of neem seed kernel for every 100 kg of cereal / pulse and store to preserve the pulse grains.
- Never combine synthetic pesticides with cereals intended for human consumption.

i. Use of low and high Temperatures

- Insects can be managed by raising or lowering the storage temperature.
- The ideal temperature for most storage insects is between 25 and 33 degrees Celsius.
- Temperatures of 13 to 25°C will impede growth, while temperatures of 35°C or Above will stop it.
- Insect reproduction and development are slowed by temperatures over 42°C and below 15°C.
- In order to disinfest grains, hot air grain driers, fluidized beds, spouted beds, pneumatic conveyors, a counter flow heat exchanger, high frequency waves microwaves, infrared waves, and sun radiations have been successfully employed.

ii. **Mixing of inert dust**

- There are four types of inert dusts utilised in stored-product protection.
- Clays, sand, paddy husk ash, volcanic ash, and wood ash make up the first group, whereas dolomite, magnesite copper oxy-chloride, rock phosphate, powdered sulphur, lime limestone, and common salt make up the second group.
- These minerals have been utilised in grain at amounts of more than 10g per kilogramme.
- The third category includes dusts containing synthetic silica (silicon dioxide). These materials are light and hygroscopic, and they're made by drying a sodium silicate aqueous solution.
- The fourth category includes dusts containing natural silica, such as diatomaceous earth (DE), which is made up of fossilised diatom skeletons.

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- Many DE dusts are now commercially accessible and are being utilised in many developing nations to control stored-product insects and mites, as well as to increase fumigation efficiency.

iii. **Activated clay and Prophylactic treatment of grains/seeds:**

Activated clay (kaolin) has been used to preserve wheat against storage bug infestation. This approach is highly successful against the majority of storage pests while also being harmless to larger animals. After a series of activation operations with acid and heat, kaolinite clay can be employed as a physical toxin.

- For every 100 kg of seed, combine 1 kilogramme of activated kaolin, 1 kg of lindane1.3 D, or 1 kg of malathion 5 D, and store/pack in gunny or polythene lined bags.
- If the produce is for grain, combine 1 kilogramme of activated kaolin with 100 kg of grain and storage.
- To preserve the pulse grains, use the aforesaid dose of activated kaolin or 1 kilogramme of edible oil per 100 kg of grains, or 1 kg of neem seed kernel powder per 100 kg of cereal or pulse and store.

iv. **Irradiation**

- Irradiation at low doses entirely kills or sterilises common grain pests, including the eggs laid within the grains.
- For disinfestations, a single radiation exposure of grains is sufficient.
- Ideally suited for large-scale operations, resulting in significant cost savings.
- Effective disinfestation technique for various pre-packaged cereal items.

v. **Use of controlled atmosphere**

- The typical storage atmosphere (also known as the earth's atmosphere) comprises 78 percent nitrogen (N2), 21% oxygen (O2), and 0.03 percent carbon dioxide (CO2).
- Insects can be managed in grain storage by reducing O2 or raising CO2 or N2 concentrations in the atmosphere, interfering with insects' natural respiration.
- This can be accomplished by modified atmospheric storage, controlled atmospheric storage, or airtight storage.

b) Cultural methods

- Split and save pulses to avoid being attacked by the pulse beetle, which likes to attack full pulses rather than split ones.

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- To avoid pest infestation, store the food grains in airtight sealed structures.

c) Mechanical control measures

- Several mechanical devices for monitoring and mass capturing stored goods insects have been developed.
- Entoleters are mostly utilised in flour mills.
- Primary feeders such as *Sitophilus* sp. *R. dominica* infected kernels break apart and separate from uninjured kernels.
- Additional traps include the Probe trap, the Pulse Beetle Trap, Light traps, Sticky traps, Bait traps, Pheromone traps, and the TNAU Automatic Insect Removal Bin.
- Sieve and remove any broken grains to avoid creating an environment that encourages storage bugs.
- Before filling the grains, sew all ripped bags together.

d) **Use of plant products**

- Neem leaf powder, Nochi leaf powder, turmeric powder, and Sweet Flag (Vasambu) Rhizome powder have all been reported to be effective against storage pests at a concentration of 10g/kg.
- Experiments showed that mixing fresh Nochi leaves with paddy at a rate of 2% w/w for 9 months protected the grains against insect attack.
- Garlic extract is another harmless plant substance that has been demonstrated to preserve grains.
- A water extract (0.02%) of bulbs combined with grains at a rate of 2 litres per 100 kg grains will provide effective insect protection for paddy grains.

e) Chemical methods

- Spray Malathion 50 EC 10 ml/L (or) DDVP 76 WSC 7 ml/L at 3 L spray solution/10 m2 on the walls, dunnage materials, and ceilings of an empty godown.
- Spray Malathion 50 EC 10 ml/L or DDVP 76 WSC 7 ml/L (1 L of spray fluid/270 m3) in alleys and gangways.
- Spray Malathion 50 EC 10 ml/L over the bags using @ 3 L of spray fluid / 100 m2.
- Insecticides should not be sprayed directly on cereal grains.
- Kill flying insects and insects on surfaces, fissures, and crevices with knockdown chemicals such as lindane smoke generator or fumigant strips pyrethrum spray.

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- Mix seed protectants such as pyrethrum dust and carbaryl dust with grains intended just for seed.

f) **Fumigation**

To efficiently reduce stored produce pests, use fumigants such as ethylene dibromide (EDB), ethylene dichloride carbon tetra chloride (EDCT), and aluminium phosphide (ALP). With the use of an applicator, apply aluminium phosphide (available in 0.6 g and 3g tablets) at a rate of 3 tablets (3g each) per tonne of food grains lot. Choose the fumigant and calculate the required using the recommendations below.

- Determine if a shed fumigation (for the full storehouse or godown) or a cover fumigation is required (only selected blocks of bags).
- Inspect the storehouse/godown for holes and prepare the black polythene sheets or rubberized aluminium coverings for fumigation.
- Based on the following recommendations, select the fumigant and calculate the demand. 3 g aluminium phosphide tablets per tonne of grain, 21 g aluminium phosphide tablets per 28 cubic metres, 5 day fumigation period
- Have sand-snakes on hand in case of cover fumigation. Place the needed quantity of aluminium phosphide tablets in separate layers between the bags. Cover the bags with fumigation cover right away.
- Lift the cover in the corner to enable residual gas to escape, allow for aeration, and lift the cover after a few hours, and repeat the process if the shed is fumigated.
- Make a paste out of clay or red earth with water and keep it ready to plaster all over the fumigation cover or have sand snakes on hand.
- Arrange the needed number of aluminium phosphide tablets in layers between the bags.
- After the stipulated fumigation intervals, remove the mud plaster and lift the cover in the corner to enable the leftover gas to escape. After a few hours, lift the lid to allow for aeration.

Conclusion

To avoid post-harvest losses of food grains the proper care of storage facilities, continuous monitoring and use of proper prophylactic and curative measures are essential. From augmenting the existing storage capacities by construction of new ones through various means both public and private partnerships is need of the hour to revamp the existing storage pest

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management in the country. Use of new systems of grain storage including silo storage, controlled atmosphere storage and using integrated pest management techniques would greatly reduce the cost of preservations and increase the available food free from contaminations.