MANUAL ON THE PREVENTION OF POST-HARVEST GRAIN LOSSES

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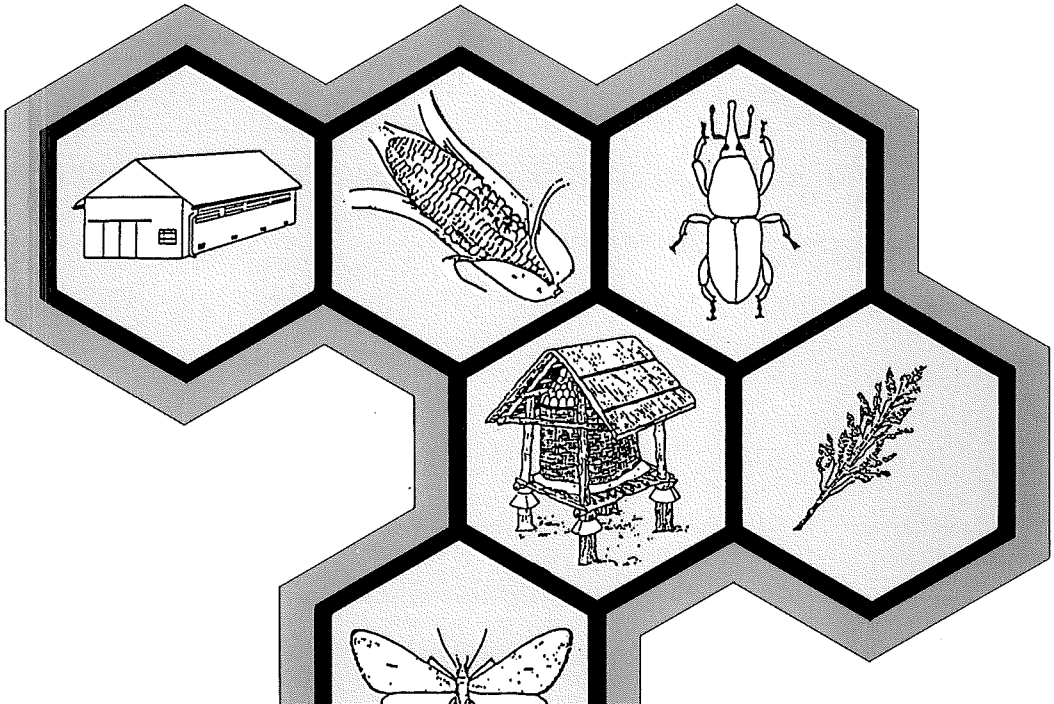

MANUAL ON THE PREVENTION OF POST-HARVEST GRAIN LOSSES

9.7 Further Literature

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10. Integrated Pest control

In order to prevent and control stored product pests, hygiene and chemical measures are generally used. There are also, however, biological and physical methods of control some of which are still at the research and development stage. Biological methods have little practical importance to date, but may well become a part of an integrated control concept in the future.

10.1 Mechanical Methods

These are generally methods which are aimed at separating the pests from the stored produce. While the main mechanical methods in small farm storage are sieving, picking out, or winnowing, use is made in larger scale storage of various cleaning installations. It is important to destroy any insects found in the by-products or left-overs immediately. Larvae living inside the grain are only inadequatly eliminated.

- Packaging

Pests can be prevented by packing the stored produce well. This is, however, only the case if the material used is strong enough to resist any attack by the pests. It will often be difficult to obtain packaging material which meets this demand.

Jute and artificial fabric sacks, plastic foil, paper or containers made of wood or cardboard are in general use. They often do not afford any mechanical protection against pests.

Packaging material can only be attacked by pests which have sufficiently strong mouthparts or teeth. This applies to the following pests:

- Rhizopertha dominica
- Sitophilus spp.
- Lasioderma serricorne
- Stegobium paniceum
- Plodia interpunctella
- Rodents

- Processing

Processing of grain or grain products, such as parboiling of rice or preparing bulgur, may make the stored produce unattractive for certain pests due to the change in the structure, density, hardness or other properties, and thus increase its storability.

10.2 Physical Methods

- Airtight storage

Airtight storage prevents any pests from entering and causes the death of insects left in store due to a lack of oxygen and an excess of carbon dioxide. Airtight storage needs absolutely gastight facilities such as pit stores, metal drums and fired clay pots. There is the danger of condensation, which often occurs under such storage conditions.

- Inert Gases

Storage in an atmosphere of inert gases (carbon dioxide and/or nitrogen) gives insects no chance of survival. When using nitrogen (N_2), a concentration of 97 - 99 % must be maintained if the treatment should be succesful.

In case of carbon dioxide (CO_2) a concentration of around 60 % gives good control.

Methane, which is produced in bio-gas plants, can also be used for this purpose.

The process using inert gases generally requires hermetically sealed storage facilities.

Storage of produce in an N_2 or CO_2 atmosphere is, however, also possible under fumigation sheets and is in practice in some places.

There are three important prerequirements when using inert gases:

- Availability of CO_2 (from flasks or as a product of the combustion of propane or butane).
- Gas-tight stores (or bag stack seal) which allow to maintain the concentration for several weeks.
- Low moisture content of stored produce, as otherwise condensation is likely to occur.

The use of inert gases can provide an alternative to the use of insecticides in the future for a number of developing countries.

- **Use of High Temperatures**

It is a general rule that temperatures of above 40°C are lethal for most stored food pests within a short time.

Distinction is made between heat treatments under wet and dry conditions. The considerable amount of energy and equipment required is a drawback.

This process cannot be used for seeds because it endangers the germination capacity.

- **Use of Low Temperatures**

The effect of low temperatures ranges from reducing feeding activity and mobility to complete stop of development and to death. Extensive technology is required in order to achieve low temperatures in the store and the costs of the energy are very high.

It may be necessary in individual cases to store valuable seeds in cold stores.

As grain has a low temperature conductivity it is difficult to cool large stacks or bulks of grain. In addition, there is the danger of condensation during cooling procedures.

- **Treatment using Short-Wave Radiation**

Stored food pests can be killed by short-wave (gamma) rays. Anyway, this method is registered only in some countries.

10.3 Biological Control Methods

Every living organism has natural enemies or diseases. They ensure the equilibrium of the population.

The main advantage of biological control methods lies in the fact that they are toxicologically safe. Before they are used, however, any ecological side-effects must be precisely investigated and taken into account.

Pests can be kept at a low level using biological methods but cannot be eradicated. As storage pests are tolerated up to a certain level in small farm storage, there are excellent possibilities for the use of such control methods.

- **Predators and Parasites**

Most predators or parasites are more or less specific. Natural enemies of stored food pests such as predator mites or bugs have not been used to date for control. Laboratory tests have shown some promising effects of certain beneficial insects.

- **Pathogenic Agents**

Pathogenic agents (bacteria, viruses, protozoa), which are specific to certain species, can provide satisfactory control of a pest population.

Among the insect pathogens Bacillus thuringiensis is of particular importance:

- it has a higly toxic effect on storage moths
- it remains effective for several months
- a surface treatment is sufficient

Although there are a large number of protozoa which are pathogenic to stored product pests, their use in biological control has not shown up to now any sufficient lethal effect.

10.4 Biotechnical Methods

These methods involve more than other control methods the pests to be controlled actively in their own destruction. Use is made of the natural reactions of storage pests to stimuli from the environment.

- Baiting

The use of baits has been in practice for centuries. Food is mixed with poison and offered to the target animals. Baiting is the best and environmentally safest method if all necessary precautions are taken.

Occasionally this technique is used to attract and control insects. The main use of baiting is, however, still in dealing with rodents.

- Pheromones

Pheromones are natural stimulants emitted by insects to establish a kind of communication system. Sexual attractants (mostly issued by the female) as well as aggregation pheromones (which have an equal effect on both sexes) have been synthesized from storage food pests.

Up to now pheromones are not really used as control agents, but rather serve in the following tasks:

- Studies of the species composition
- Recognizing infestation (monitoring)
- Checking the success of control measures
- Estimating the population density

Pheromones can be excellently used in combination with traps.

Moth traps consist of a strip of adhesive (fly catcher) with a capsule containing the pheromone. The flying insects are attracted by the pheromone and become stuck to the adhesive strip.

For **beetles** (Prostephanus truncatus, Trogoderma granarium, Tribolium spp., Rhizopertha dominica) there are corrugated cardboard traps containing the pheromone capsule and treated with an insecticide.

- Attractants

Food attractants, which act on the sense of smell, draw storage pests over a greater or shorter distance. They can be used in practise like pheromones.

- Repellents

Some plant extracts have the effect of repelling stored product pests. This applies e.g. for Neem, which has been mentioned in section 4.4.1.2.2.

Tests results have shown that the application of these substances is limited under practical conditions.

- Growth Regulators

Attempts have been made to use substances which interfere with the insects' complicated mechanism of development and molting. By using these substances, it is possible to disturb development to such an extent that no progeny capable of reproduction are born.

In this context **juvenile hormones** are very common. Their application leads to the development of intermediate forms in the larval or pupal stages which cannot survive.

Growth regulators still cannot be used effectively enough to make them a viable alternative to insecticides.

- Use of Sterile Males

Chemical and physical treatment can produce sterility of insect pests.

With most species females only mate once before they lay their eggs. If the male insects involved in mating is sterile, there will be no progeny. Mass reared and sterilized males of the pest insect which are released will compete with the males of the natural population which will lead to a reduction of the offspring. A drawback of this method is that there is a need for a constant release of sterile males in order to maintain the rivalry.

This control method has gained little practical use because of technical difficulties and high costs involved in large scale application.

- Crop Varieties Resistant to Storage Pests

A larger number of high-yield varieties coming on the market in context with the "green revolution" have proved to be more susceptible to infestation by storage pests than the local varieties. The following criteria may be responsible:

- Hardness
- Compounds
- Smell
- Shape
- Husks

Making use of the differences between varieties can be seen as an excellent prophylactic means of control, providing the resistant varieties meet the necessary quality standard. Resistant varieties should therefore have priority in breeding programmes.

None of the methods listed in this chapter can at present be regarded as being a viable alternative to the use of insecticides. They may represent, however, a part of an integrated control of stored product pests and can contribute to a considerable reduction of chemicals in future.

10.5 Literature

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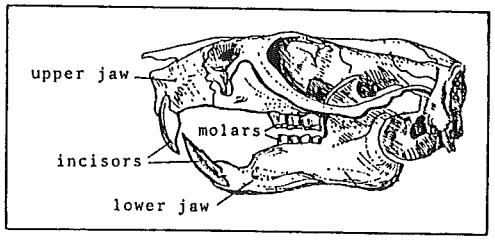
11 Rodent Pests

Rodents belong to the most important pests of stored produce. In a number of countries they cause as much if not more damage than insect pests.

Rodents have an exceptional ability to adapt themselves to different environmental conditions and an incredible potential for reproduction. One pair of rats can theoretically have 350 million offspring within the space of three years. Estimates state that over 3.5 million rats are being born daily.

11.1 Characteristic Features of Rodents

Rodents are characterised by their teeth. They have a pair of incisor teeth in the upper and lower jaws, separated from the molars by a large gap (diastema).



The incisors are curved inwards and have an extremely hard anterior coating. The softer inside layer is worn down much more rapidly than the hard, outer layer. This means that the teeth are continually kept sharp, enabling them to damage even materials such as masonry and electric cables. The incisors do not stop growing. This means that the animals are forced to gnaw steadily in order to wear them down.