

# Rodent control will reduce post-harvest food losses

*Structure design, sanitation and direct control examined*

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**R**ats, mice, birds and other vertebrate pests cause annual losses amounting to millions of tonnes of stored foods in developing countries. Many of these pest losses are directly associated with poor and inadequate storage conditions, a lack of sanitation and good housekeeping and improper food handling practices.

A great diversity of food storage methods are practiced around the world. These range from storing grains in modern grain elevators in Saudi Arabia or underground in Ethiopia, to storing groundnuts in open heaps on the ground in parts of Asia and Africa. These open heaps of grains and bagged foods can be protected from damage by rodents fairly easily if common sense and good structural conditions are used.

The magnitude of losses of stored foods depends on their vulnerability to attack by pests.

In addition to the direct losses of stored foods due to rodent consumption, indirect losses occur due to wastage and contamination. Rodents shed hundreds of hairs and excrete an average of 35 fecal droppings and a half ounce of urine nightly.

These contaminate grains and many other stored commodities. Rodents spread bacterial, protozoal and parasitic diseases to humans and domestic animals through their feces and urine. House mice (*Mus musculus*) nibble at grains, often eating only a portion or taking only the endosperm. This direct loss, in addition to the contamination, greatly reduces the quality of the stored food.

Rodents gnaw holes in bags, causing grains to be spilled onto the floor or ground. This grain is often swept up with dirt, mold and feces, rebagged and sent on for milling.

Storing commodities in jute bags is a common practice in many countries lacking bulk-grain handling facilities. This is an acceptable method when storage structures are reasonably pest-proof, clean and in good condition. Unfortunately, these simple conditions are rarely maintained.

This summary of post-harvest food losses to rodents is based on several consultancies we have made to countries such as Pakistan, Bangladesh, Bhutan, Kenya, Yemen and Chad. We have had firsthand experiences with most of the

problem rodent species and many of the storage practices used at government-owned storage facilities, in town and city markets, and on farms and in villages. Some practices have been excellent; others have been very poor or nonexistent.

**THE CULPRITS.** The most common rodents infesting stored foods are those known as commensals, meaning literally "sharing our table and eating our foods." These species include the well-known Norway rat (*Rattus norvegicus*), the roof rat (*Rattus rattus*), and the house mouse. Several other species infest food stores in Asia and Africa, most notably the lesser bandicoot rat (*Bandicota bengalensis*), important in India, Bangladesh, and parts of Southeast Asia. Another species that may occur in food stores in Africa is the multimammate rat (*Mastomys natalensis*).

The roof rat and the house mouse are widely distributed throughout the world and are the important storage pest rodent species in most countries in the tropics and subtropics. The Norway rat is usually confined to seaports in these regions or may follow rivers into inland areas. But, in most cases, the Norway rat is

not abundant in storage facilities away from seaports.

The roof rat is a nimble climber, weighs about 150 to 250 grams, and can eat 10 to 16 grams of stored foods nightly. The Norway rat is a larger rat, weighing between 200 to 400 grams, and prefers to live in soil burrows. It can consume between 15 and 25 grams of grain nightly. The house mouse is small, weighing only about 20 grams when fully grown. Like the roof rat, it is a nimble climber. It probably is the most widely distributed mammal, except for man himself, in the world. Mice eat only a small quantity of food daily, usually 2 to 4 grams, but are known to nibble and foul at least three to four times as much as they eat.

**STORAGE TYPES.** *Pakistan:* Provincial (public sector) storage facilities store wheat in bags in house-type warehouses (godowns). Despite some structural defects (loose-fitting doors, missing screens on ventilators) and poor maintenance, rodent pest infestations and consequent grain losses were minimal, primarily due to a fairly rigorous insect control fumigation schedule. Overall losses due to rodents and birds



To remove rodents from storage areas, traps must be placed in areas of major rodent activity, such as on sacks of stored grain or on rafters.

were estimated as only 0.2 % to 0.4% of the 4 million tonnes of wheat in storage each year.

In many wholesale grain markets in towns and cities in the Punjab Province, heavy infestations by roof rats caused losses of grains and other commodities estimated at 0.25% to 0.5% of the 1.25 million tonnes at risk annually. Contamination and waste of stored grains and other foods was also evident.

Farms and villages store about 60% of the harvested wheat crop each year in Pakistan. Storage losses in this situation were estimated at about 30 kg per family per year, or an average of 1% to 2% of the annual production of 14 million tonnes of wheat.

**Bangladesh:** Several species of rodents damage stored food in Bangladesh. Studies in farm and village houses have shown that in some areas of the country, rodents consume and contaminate about 47 kg of stored rice per farm family per year. The typical farmhouse storage container is a large woven basket, usually without any cover, so rodents can easily enter and eat. A compounding problem for Bangladesh house storage is that lesser bandicoot rats, one of the main pests, hoard more grain nightly than they consume. This can result in greatly increased losses.

**Bhutan:** The Food Corporation of Bhutan (F.C.B.), a government agency, stores about 33% of the country's cereal production. Grain and commodity storage structures owned by the F.C.B. are generally well constructed with cement walls and floors. But, since the Bhutanese have not practiced rodent control, these buildings are usually heavily infested by rodents. Small village market storage facilities are usually in poor condition and also heavily infested.

Several factors in the storage structures significantly influenced the magnitude of infestations and losses, including: 1 — the duration of the storage of a given lot, 2 — the amount of human activity in and around the stored products, 3 — the structural condition of the facility, and 4 — the sanitation conditions within and around the structure.

Grain consumption by rodents in F.C.B. storage structures visited during September-October 1988 was estimated at about 2.6%; an additional 25% to 50% of the stored grain was contaminated with feces, urine and hair.

**Kenya:** The traditional grain storage structure in western Kenya is a large, woven basket. Basket fibers vary with local availability. The baskets are about 1.5 meters in diameter, 2.0 meters high, with a capacity of about 1 tonne of cobbed maize. Baskets are raised off the ground on a low platform about 25 cm high. The base of the basket is frequently plastered with cow dung on both sides to a height of about 1 meter. Some farmers claim that the dung prevented rats from climbing into the basket. Although other on-farm storage structures such as wooden sheds are sometimes used, they are no better protected from rodent depredations than piles of grain on an open platform. On-farm storage losses and contaminated losses probably are at least 5% and 90%, respectively, in these situations.

**Yemen:** Large government storage and seed distribution structures in Yemen were well-constructed, but usually were heavily infested with rodents. Farm storage structures are small out-buildings (averaging 4 meters by 4 meters), often adjacent to sheep and goat holding areas. These buildings are usually in poor condition and are home to extremely high

rodent populations. The primary commensal rodent pest is the roof rat in all areas, except in the Tihamah or Red Sea coastal region, where the Norway rat is found.

Based on rodent densities estimated from sightings and signs in all Yemen storage facilities, consumption of grains and other commodities by rodents probably exceeded 5%. In addition to the direct losses of stored foods consumed by rodents, other losses including contamination, container damage, spillage and labor costs often exceed direct consumption losses. Also to be considered are costs associated with disease transmission from rodents to man and domestic animals, but this goes beyond the scope of the review.

**CONTROL MEASURES.** Rodent control in food storage facilities falls into three general categories: 1 — rodent-proofing structures to keep animals out, 2 — sanitation and good housekeeping to make the habitat unsuitable for rodents, and 3 — direct control through, for example, trapping, poisoning and fumigating.

**RODENT-PROOFING.** Many warehouses and godowns were never designed to keep rodents out. Doors usually have gaps large enough for rodents to enter through: 6 mm for house mice, 12 mm for some rats. Unless these gaps are closed, rodents can regularly enter and exit the structures.

In areas where doors must remain open most of the time, an inner door made of hardware cloth or expanded metal can be used. Wooden doors are easily gnawed by rodents and need to be edged with sheet metal. Because roof rats and house mice can climb, outside surfaces of storage structures need to be finished in some smooth material. All outside openings such as windows, ventilators, and drains, should be properly screened.

Some warehouse designs incorporate a rodent collar around the periphery. A collar is an extension of the floor and loading dock that extends outward from the building at least 30 cm, so that rats or mice cannot climb past the extension.

Permanent steps should be discouraged at loading docks. Instead, a temporary ramp or steps should be placed during the day and removed at night.

Rodent-proofing is the first line of defense in keeping rodents from damaging stored foods. Once rodent-proofing measures have been established, they must be maintained or the benefits will be lost. If rodents are still in the structure, lethal control measures should be used.

**SANITATION.** Piles of spilled grain should be swept up daily and, when possible, the grain cleaned and rebagged. Most contamination of grain occurs on the floor or on the top surfaces of grain stored in bulk inside warehouses.

Bagged grain should be stored in piles on pallets, if possible. Piles should be not more than 12 or 14 bags high. Adequate space between piles is desirable so that grain can be easily inspected. Piles of bagged grain should be inspected for insect or rodent infestation at least weekly, and inspection records should be maintained. Grain bags should not be piled against the walls, but should stand at least 1 meter away. The longer grain remains in storage, the more apt it is to become infested with rodents, insects and mold. Rapid turnover of stocks will prevent rodent infestations from increasing.

When the warehouse is emptied between seasons, it should be thoroughly cleaned and all cracks and breaks in the walls and floors repaired before restocking with freshly harvested

grain. Vegetation should also be removed or kept short around warehouses for a distance of at least 30 meters to discourage rodents from burrowing or taking advantage of an inconspicuous entrance to the structure.

**KILLING.** Direct rodent control means killing the rodents with traps, poisons or fumigants. It should be practiced only after all other measures have been completed, not before.

Both snap and live-capture traps are suitable for rodent control inside food storage structures. The snap traps usually are of metal or wood construction, with a strong spring and bar that will break the rodent's back or skull when released. Traps should be baited with fruits, nuts, vegetables or meats.

The traps should be placed with the trigger or bait plate facing a wall or just off runways near the base of the grain bags. Traps should not be put on the runways, or the rodents will be frightened from them for several nights. Enough traps should be set to capture a major part of the population in the first three or four nights. This may mean setting 100 or more traps overnight, depending on the size of the warehouse. Traps for house mice should be set about every 1 meter because mice have a limited range of movement. Traps for roof rats or Norway rats can be set about every 10 meters. Traps should be placed on top of the grain stacks and on any roof beams where roof rats or house mice may climb. Traps should be checked daily and rebaited when necessary. Captured animals should be removed and disposed of by burial or incineration. Efforts should be made to avoid contact with fleas. One precaution is to wear gloves when handling rodents. Fleas can transmit murine typhus and plague.

Poison can be effective in situations where infestations are severe and trapping is difficult. Several kinds of poisons are available and include acute poisons and chronic toxicants. The major problem with poisoning in grain storage structures is finding baits that will compete well with the available grain to which the rodents are accustomed. This means using freshly made baits and incorporating sugars and 1% to 3% oils as attractants. In some situations, fresh vegetables or fruits may be more acceptable as baits. In storage structures where water is limited, water-soluble anticoagulant baits should be placed along with the usual food baits.

Safety and care in placing baits should be observed. Baits should be put into bait containers to prevent them from contaminating stored foods. Extreme care should be used with water baits so that they do no spill. They should be set near runways and dark corners of buildings. The water baits need to be checked two or three times a week and refilled as necessary. If evaporation is high, water baits should be discarded and filled with fresh liquid after each check to prevent the poison from becoming too concentrated.

Fumigation, a method usually used to control insect infestations, is also quite effective in killing rodents in structures. Experienced personnel using fumigation under gas-tight tarpaulins or plastic sheets is the most effective and economical method, but whole structures can also be fumigated. In this case, the windows, vents and doors need to be sealed. The fumigant is then introduced into the building, with enough being used to treat the entire cubic volume. Aluminum phosphide tablets generally are used in developing countries at an application rate of three to five tablets for each tonne of stored grain in instances where the whole structure is fumigated. The gas needs to stand at least seven days before

opening and airing out the structure.

Safety precautions should always be used when using poisons and fumigants. The bait applicator should wear gloves when placing or mixing baits. In addition, a dust mask or respirator should be worn when mixing baits. The bait mixer should be operated under a vent hood or in a well-ventilated area if no hood is available. Baits should not be used in any manner where they might contaminate the grain or other foods. This means they should be placed at floor level in bait containers that cannot be spilled. Fumigants should not be placed in burrows under buildings. As with all pesticides, the best guidance for safe acceptable use is the label. Again, all dead rodents should be picked up and disposed of by deep burial in the ground.

In conclusion, many post-harvest rodent losses can be significantly reduced by: 1 — minor modifications to the storage structures, 2 — improved sanitation methods, and 3 — the application of efficient rodent control measures. But, it should be remembered that many times in developing countries, changes in traditional food storage methods may require significant cultural changes and, also, that cultural change is a slow process because it involves other cultural practices that are often not readily apparent to outsiders. ■

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