

Unit 4: Pest Management Options

Learning Objectives

After studying this unit, the learner will be able to:

- Define Integrated Pest Management (IPM).
- Describe the advantages and disadvantages of fumigants.
- Evaluate several nonfumigant pest management methods for food and stored commodities.
- Use several methods simultaneously or sequentially to solve a pest problem.

This unit describes the principles of Integrated Pest Management (IPM). It explains how you can use fumigation as one aspect of a well-planned IPM program. You will learn several advantages and disadvantages of fumigants. You will also learn several ways to manage pest problems without fumigation. These “alternatives to fumigation” may be cultural, biological, or chemical. By using a combination of methods, you may often achieve the best control.

Terms to Know

Action Threshold – A pest population level that triggers a management response. Sampling and regular observation are necessary to assess threshold levels.

Aeration – *Fumigant application*: The process of replacing fumigant-containing air or water with fresh air and/or water that contains little or no fumigant. Aeration must follow all fumigation operations.

Aeration – *Grain storage*: The process of passing air through a stored product such as grain to regulate temperature and moisture content.

Auger – A grain transfer tool used to load and unload grain and other stored products.

Binning – Placing grain or another raw product into a storage bin.

Biological Control – The use of natural enemies (predators, parasites, or pathogens) to control pests and pest populations.

Cultivar – An agriculturally derived plant variety with unique characteristics. For example, there are several cultivars of corn. Each one has a unique flavor, color, or pest resistance.

Cultural Control – A pest control method that involves changing one or more crop production practices (sanitation, cultivation, crop rotation, use of resistant plant varieties, etc.) to create an uninviting or unfavorable environment for pests.

Cuticle – The protective outer covering of an insect.

Fines – Broken kernels and pieces of small foreign material within a load of grain.

Harborage – Shelter, a home or refuge for an organism.

Headspace – The open area between the stored product and the ceiling of the storage facility.

Hot Spot – An area in stored grain that is much warmer (10°F or more) than the surrounding grain. A hot spot indicates that the grain has a higher than normal moisture content, possibly caused by insect or fungus activity.

Insecticide – A pesticide used to control or repel insects or to reduce the unwanted or harmful effects of insects.

Integrated Pest Management (IPM) – A pest management system that uses all appropriate strategies to reduce pest populations.

Multipurpose Fumigant – A fumigant that controls more than one type of pest.

Pathogen – An organism that causes diseases.

Pesticide Resistance – The ability of an organism to tolerate a specific pesticide. There are levels of resistance. For example, some insects may be sensitive, weakly resistant, or strongly resistant to a specific insecticide. Total resistance is immunity.

Plenum – An enclosure in which air or other gases are at a pressure greater than the atmospheric pressure outside the enclosure.

Rodenticide – Any substance used to control or repel rodents or to reduce the unwanted or harmful effects of rodents.

Skinning – Superficial injury, such as to the surface of a grain kernel during harvesting, transport, and storage.

Topdressing – A material such as a pesticide applied to or mixed into the upper surface of grain or soil.

IPM and Decision Making

There are many ways to control pests of food and stored commodities. Your job is to select the best method for the situation at hand. Pesticides and other control methods often provide good to excellent control temporarily. However, for consistent, reliable, long-term control, you will need to use Integrated Pest Management (IPM).

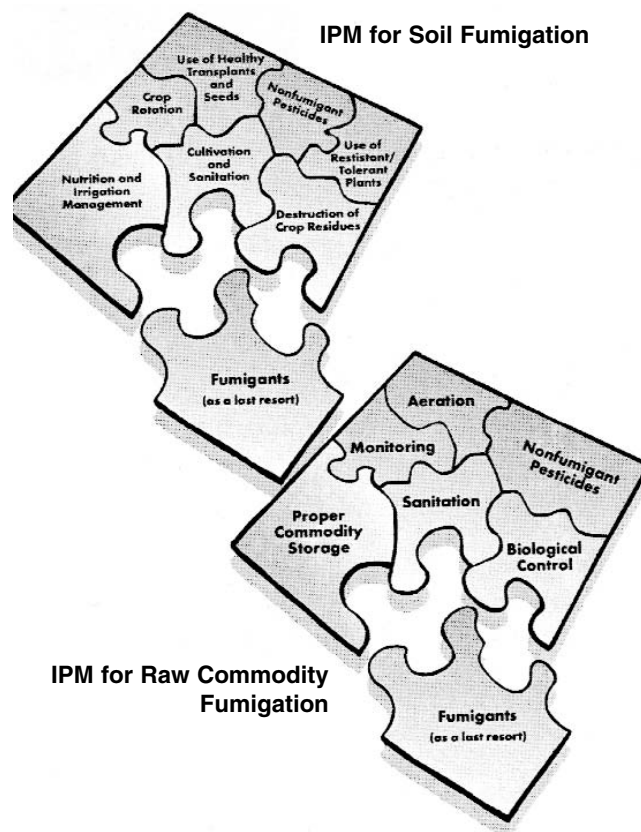
IPM is an ecological approach to pest control. It is based on the habitat and life cycle of the pest. It combines all of the most appropriate pest control strategies into a unified, site-specific plan. IPM plans may include both nonchemical and chemical management methods. IPM is dedicated to managing causes rather than simply treating symptoms. IPM balances the level of control needed with any associated risks. The goal of an IPM program is to reduce pest numbers to an acceptable level in a way that is practical, cost-effective, and safe for people and the environment.

Prevention

The first strategy of an IPM program is prevention. Prevention of pests in food and stored commodities relies on sanitation, proper storage, and monitoring the condition of the commodity before and during storage. Prevention may help you exclude pests or provide them with unsuitable living conditions. Stopping a pest problem before it occurs saves time and money.

Sampling and Observation

IPM also relies on sampling and regular observation. Sampling and observation will help you determine if treatment is needed and/or if previous control measures were effective. Check commodity storage areas regularly. When sampling and observing stored products, check their physical condition. Look for signs of new infestations. Determine what pests are present, how many of each kind are in the area, and how much damage they are causing.



Thresholds

Use information from sampling and observation to make management decisions. Follow the action thresholds that indicate at what point pests need to be controlled.

Thresholds are the basis for IPM. "Damage thresholds" indicate how many pests must be present to cause a problem, such as economic damage or a safety threat. "Action thresholds" indicate the number of pests that must be present for a problem to be severe enough to warrant a control action.

When an Infestation Occurs

When an infestation does occur, identify the pest. Learn how it causes damage and when it is most vulnerable. Then, develop a control plan. Consider all appropriate control options. Your strategy should be economical and effective, while minimizing harm to people and the environment. Follow-up site inspections are critical. Did the control tactic work? Is re-treatment needed? Continue to monitor areas for long-term control.

Fumigation is only one option of an IPM program. Use it only as a last resort when nothing else works. For stored products, sanitation, proper grain storage, and nonfumigant pesticides can often control pests without the help of fumigants.

When deciding whether to fumigate stored products, weigh these advantages and disadvantages.

Advantages of Fumigants

- Depending on the specific situation and fumigant, fumigants are effective against insects, mites, and most other living things.
- Most fumigants are fast acting. They are the quickest way of controlling many pests.
- In some cases, they can provide total eradication.
- Human exposure is limited. Areas are evacuated during treatment and must be aerated before reentry.
- Most fumigants, when used properly, do not leave residues on surfaces.
- There are several ways to apply fumigants.
- They penetrate and treat spaces in food and commodities like grain that cannot otherwise be reached.

- When treating raw products, you can apply them without disturbing the commodity.
- They are usually readily available.
- You can use some fumigants in or near food without leaving harmful residues, tastes, or odors.

Disadvantages of Fumigants

- They are highly toxic to most living things, including humans. Breathing even small amounts of some fumigants can be fatal.
- They may require special protective equipment, such as a self-contained breathing apparatus (SCBA) and gas detectors.
- They require highly trained applicators.
- They offer no residual control. Once an area, item, or field is aerated, traces of fumigant do not remain to help control future pests.
- They must be confined in a tightly sealed area to be effective.
- Some may injure seeds and reduce germination. Others may leave toxic residues, tastes, or odors if used incorrectly.
- Because they are fast acting, response to problems and emergencies must be quick. Spills, leaks, and equipment failures usually call for immediate action.
- They usually require warm temperatures to be effective. Temperature requirements may be hard to meet, especially in the winter.
- Some are expensive.
- Some are corrosive.
- Some are flammable and explosive.
- Some fumigants are hard to remove from treated material.

Pesticide Resistance

One of the biggest problems with pesticide use is “pesticide resistance.” Pesticide resistance develops when a group of insects are able to tolerate doses of a specific pesticide that would kill a normal population of the same species. Surviving pests reproduce and pass their resistant traits to their offspring. Preventing resistance is of great importance for the pests of stored commodities. New laws and regulations have drastically reduced the number of insecticides approved for use against food and stored product pests. As a pest control operator, you can protect the effectiveness of pesticides by:

- Using IPM
- Using alternative controls and nonchemical controls whenever possible
- Using pesticides only when necessary
- Avoiding repeated use of the same pesticide
- Doing a thorough job when applying a pesticide (do not leave behind pests that can develop resistance and reproduce), and
- Fumigating only when nothing else works

Alternatives to Fumigation

Many pests of raw commodities can be controlled without fumigants. The key is prevention. Prevention involves sanitation, proper grain storage, and maintaining before and after the raw commodity is placed into storage. In this way, you can keep pests away or reduce the number of pests that are able to develop. Other management strategies such as biological control, aeration, spot treatments, empty bin sprays, grain protectants, topdressing, pest strips, and rodenticides help to reduce existing pest populations.

Sanitation

The first step in preventing insect infestations is sanitation. By keeping bins and the areas around them clean, you can greatly reduce insect populations. Old grain and grain

products provide food and habitat for insects. These residues can occur inside and around bins, in combines, and in grain transfer equipment. Before storing fresh grain, clean the inside and outside of storage bins and buildings. Clean aeration ducts, augers, and sidewalks. Use both a broom and vacuum. Dispose of all spilled or leftover grains and grain dust. Open the aeration ducts and augers to be sure they are clean. Clean bins immediately after they are emptied and again at least two to three weeks before adding grain. You should also clean bins before applying “empty bin sprays.” (See “Empty Bin Sprays” later in this unit.) Always wear a dust mask when cleaning these and other storage areas. Mow regularly around bins to reduce harborage for rodents and insects.

Proper Grain Storage

Harvesting grain does not end the danger of pests. You must also store it properly. Good grain storage can prevent infestation and the need for fumigation. In Arkansas, producers may store grain for a few weeks to a few years. The profitability of such storage depends on grain quality and marketing. Grain is usually stored so that it can be sold when market prices are higher than they are during the harvest season.

Grain Condition

The physical condition of grain when it is placed into storage influences its susceptibility to pests. Only high-quality, undamaged grain with a low moisture content can be stored successfully for long periods. Never mix new grain with old grain in storage.

Drying Grain Before Storage

Grain is dried to prevent spoilage and to deter insect infestation. Most small grains are dried to 12 to 13 percent moisture. The moisture level may be 1 to 2 percent higher if the producer plans to hold the grain during the cooler part of the year only.

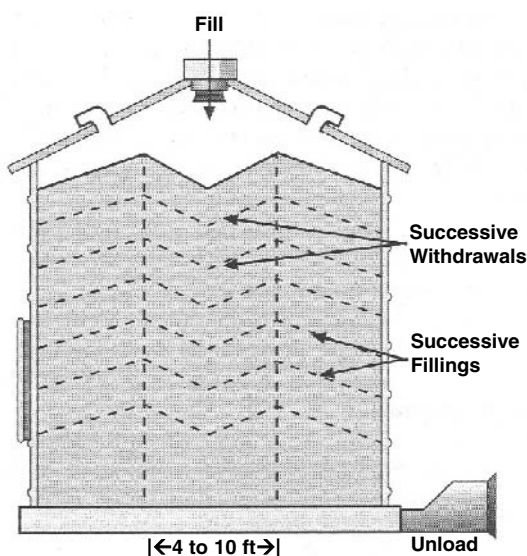
Drying methods may influence grain quality. High-speed, high-temperature drying produces more stress-cracked corn than low-temperature drying. Kernels with stress cracks break readily during handling. Broken kernels are more likely to spoil.

Table 4-1. Maximum moisture contents for safe aerated grain storage in Arkansas.

Grain Type and Storage Time	Maximum Moisture Content for Safe Storage (% Wet Basis)
Shelled corn and sorghum	
Sold as #2 grain by spring	14-15
Stored 6 to 12 months	13-14
Stored more than 1 year	12-13
Wheat, oats, and barley	
Stored up to 6 months	12-13
Stored 6 to 12 months	11-12
Stored more than 1 year	10-11

Broken Kernels and Fines

Many insects that infest stored grain are not able to penetrate the seedcoat of unbroken kernels. These pests depend on the presence of broken kernels and foreign material called “fines.” Broken kernels are also more likely to spoil and mold than are unbroken kernels. Fines decrease the airflow from aeration fans. This can increase aeration time up to 50 percent. Fines also tend to accumulate in the center of the bin. Fines hold moisture, further increasing the chance of insect and mold damage. This is especially true when fines are concentrated in certain parts of the storage.



Withdrawals during filling remove most fines from the core of fine material.

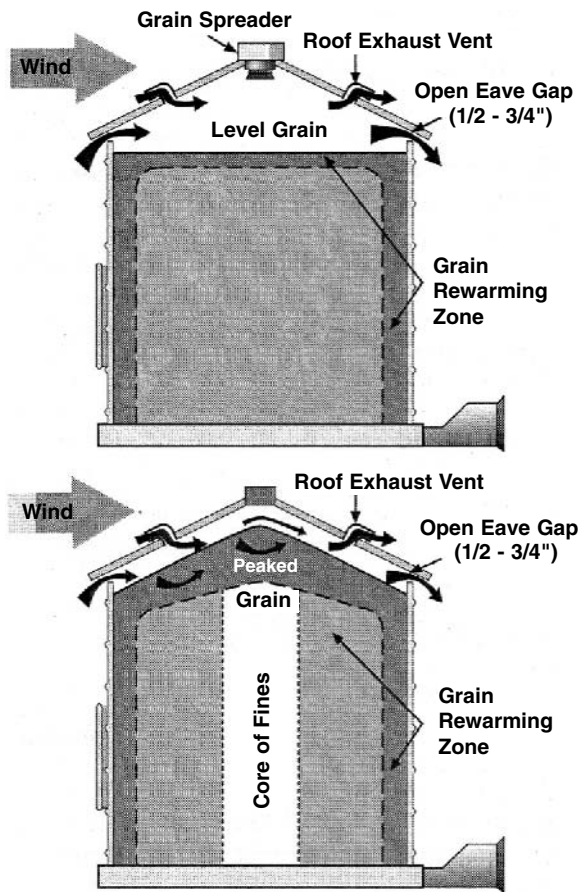
Grain Cleaning

Cleaning grain before “binning” is the best way to minimize problems with fines. Rotary screen and aspiration cleaners work best. Rotary screen cleaners use a rotating screen to remove foreign material from the grain as it is transferred to a dryer or storage bin. Avoid using perforated or screened sections in the auger. These usually do a poor job of cleaning the grain. They may even reduce grain quality by “skinning” or causing superficial damage to the kernels.

If you cannot clean the grain ahead of time, remove fines during bin loading. When grain is loaded into the center of a round bin, most of the fine material will collect in a center “core” under the spout. Eliminate this problem in one of two ways. First, try using a grain spreader. Grain spreaders distribute fines and grain evenly throughout the bin. This method retains the fines, which may have value as animal food. However, they tend to pack the grain, reducing airflow within the load. You can also remove the core of fine material periodically as the bin is filled. To do this, remove the grain from the bottom of the center core. Mix it with other grain and put it back in the bin.

Peaked Grain

Peaks occur at the top of a grain pile just below the loading spout. There are several problems with leaving grain peaked in a bin. First, it is impossible to achieve uniform aeration. This is because air moves toward the nearest open areas, the sides, leaving the center core unaerated. (See “Aeration” later in this unit for more information on how it affects stored grain.) Second, when grain is loaded without a spreader, the fines tend to accumulate in the center under the spout. Fines are particularly prone to insect and fungal attack. They are also difficult to aerate. (See “Broken Kernels and Fines” earlier in this unit for more information on how they affect stored grain.) In addition, it is very difficult to enter a bin to sample the grain or to apply a topdressing if the grain is peaked and filled to the top of the bin. It is easier to walk on level grain than on sloped grain. There may also be insufficient headspace. Be sure to level the surface of stored grain so that it is not peaked.



Peaked grain vs. level grain surface in storage bins.

Storage Facilities and Packaging

Grain should always be stored in a steel bin. Be sure the bin is weather-tight, rodent-proof, and mounted on a moisture-proof concrete base. It should have a grain spreader, a perforated floor-aeration system, an adequate fan, and a weather- and rodent-proof roof vent. Caulk the seams of older bins and inspect them annually for moisture leaks. Buildings used to store other types of commodities should be dry and designed to exclude rodents, birds, and flying insects. There should also be a minimum of harborages for pests. Move or eliminate unnecessary equipment, wood, rocks, and other popular pest hideouts in and around storage facilities.

Storage Time

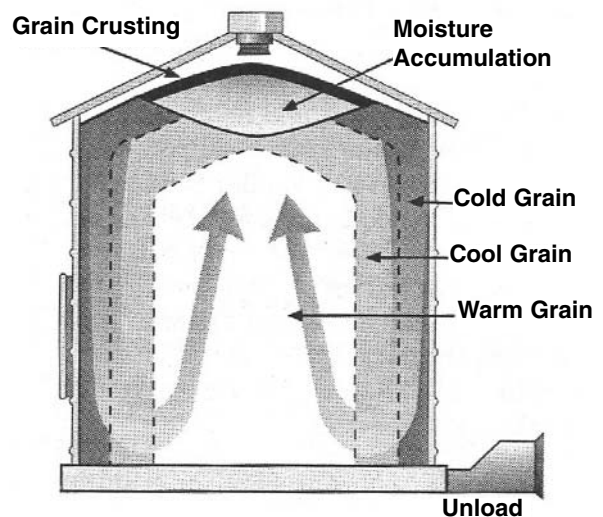
Storage pest problems tend to be seasonal. Grains harvested and stored in the heat of the summer are more susceptible to pests than

grains harvested in the fall when temperatures are cooler. As a rule, the longer a commodity is stored at 60°F to 90°F, the greater the chance of pest problems. If a producer needs to store a commodity for more than one year, or if conditions are more likely to be favorable to pests, he or she should increase monitoring and pest prevention efforts.

Aeration

Proper aeration can control insects in many ways. Aeration is the movement of air through grain to regulate moisture and temperature. By preventing moisture from building up and moving through a commodity, aeration helps to limit mold growth. This, in turn, reduces the food supply for fungus-feeding insects. Aeration also controls "hot spots." Hot spots are sites that are much warmer (10°F or more) than the grain in the rest of the storage bin. These areas indicate that the grain has a higher than normal moisture content and may harbor insects or fungi.

Aeration procedures are the same for all types of stored grains. In the fall, aerate to lower the grain temperature below 60°F. At this temperature, most insect and mold activity will decrease. In the fall, winter, and spring, aerate to control moisture migration and to create a uniform temperature throughout the grain mass. If you plan to store grain through the summer, you may need to aerate to control moisture during this season as well. However, most grain is sold before summer to make room for the next crop.



Example of moisture migration in grain stored several months without aeration.

Biological Control

Biological control is the use of natural enemies (predators, parasites, or pathogens) by humans to control pests and pest populations. These natural enemies, also called biocontrol agents, can sometimes reduce the number of pests in raw commodities. Predatory or parasitic insects are the most common biocontrol agents used to control insect pests of raw commodities.

Unfortunately, it may be difficult to effectively use biological control in an IPM program. This is because beneficial insects require some host insects to become established. It is difficult to keep these pest insects from reaching damaging levels. Stay informed about new developments in biocontrol that may help prevent infestation.

Nonfumigant Pesticides

Empty Bin Sprays

Another management strategy is to coat empty bins with insecticidal sprays. These pesticides will kill eggs and insects missed during cleaning. Treat bins as soon as they are clean. Try to delay treatment until the weather is warm and the insects are active. Insecticides are most effective at this time. If treatment occurs more than three months before the bin will be filled, repeat the application at least two weeks before storing the grain. Apply the spray to as many surfaces as possible. Be sure to hit all joints, seams, cracks, ledges, and corners. Spray the ceiling, walls, and floor to runoff. Spray beneath the bin and its supports. Treat the outside surfaces in a similar fashion. Then apply the insecticide in a six-foot border around the outside foundation. For increased protection, treat harvesting equipment, elevators, augers, trucks, and wagons. Be sure these items are thoroughly cleaned. Insecticides will kill most insects emerging from cracks and crevices.

Unfortunately, empty bin sprays do not work for every type of storage bin. More and more producers are using metal bins with perforated floors. These floors aid in grain drying and aeration. They also permit broken grain and grain dust to gather in the subfloor plenum. This is an ideal area for insects to thrive. Additionally, subfloors are often difficult to remove. It may be difficult to inspect, clean, or apply insecticides under them. In these cases, fumigation may be your only practical method of pest control.

Grain Protectants

You can prevent or reduce insects by applying insecticides directly to the grain. These “grain protectants” are usually applied as grain is moved into storage. Grain protectants are intended to protect the grain, not to eradicate an existing infestation. For eradication, use a fumigant.

If a producer plans to hold grain for more than one month and the grain temperature is likely to be above 60°F, treat the grain with a protectant. To apply liquid protectants, use a gravity drip, compressed air, or wipe-on applicator to apply the insecticide as the grain is augured or elevated into the bin. Mixing of the insecticide and the grain will occur during the bin-filling process. Use the auger diameter, angle, and speed as well as the type of grain to determine the application rate.

Grain protectants are also formulated as dusts. You can apply dusts to grain in trucks before transfer. Spread the dust evenly over the surface of the grain and mix it in with a shovel. Complete mixing will occur as the grain is loaded into the bin.

Unfortunately, insecticides tend to break down faster in areas with high temperatures and moisture. If the moisture level of grain is greater than 13 percent and its temperature exceeds 90°F, a treatment may last for only a couple of weeks. When treating warm grain, be sure to aerate and cool it as soon as possible after it is introduced into the bin. Aeration will not remove the insecticide from the grain.

Most grain protectants are not registered for use on all types of grain. Be sure that you use the correct insecticide for the product you intend to treat. Consider all types of registered protectants including synthetic pesticides, naturally produced toxins, abrasives, and growth regulators.

Topdressing

Some areas of a grain bin, such as the headspace at the top, are likely to remain hot and humid. These conditions cause some grain protectants to break down quickly at the grain surface. The headspace is also the area where reinfestation tends to recur after fumigation. This is because chemical protectants break down more quickly, and the moisture content of the grain in this area makes it more favorable to

insect pests. Treat the surface of the grain beneath the headspace with an insecticide registered as a topdress treatment. Both sprays and dusts work well. Mix half of the treatment with the upper 3 to 6 inches of grain. Be sure the grain is dry and less than 90°F. The bin should be insect-tight below the treated surface. Once the insecticide is in place, do not disturb the treated surface. It acts as a protective barrier over the entire load of grain. Topdressings can be especially useful against moths, such as the Indianmeal moth, that tend to stay near the grain surface.

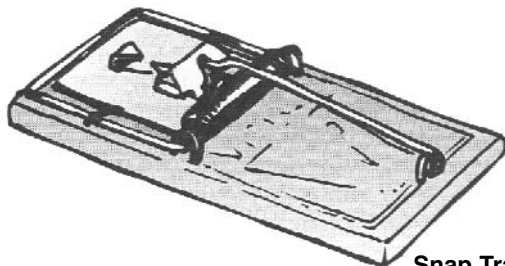
NOTE: Topdressings will kill insects on the surface and in the upper few inches of grain. They can also prevent new insects from entering the grain load from the top surface. However, they will not control existing infestations deeper in the bin.

Pest Strips

You can also hang resin strips in the headspace in the top of the bin to help control adult moths. Use one strip per 1,000 cubic feet of airspace. Replace them once every three months. For resin strips to be effective, you must temporarily seal the top of the bin, including the roof vent. Aeration will prevent this treatment from working.

Rodenticides

Rodents harm stored grain by eating it and contaminating it with feces and saliva. There are many rodenticides registered for the control of rats, mice, and other rodents. Before using rodenticides, fumigants, or nonfumigants to control vertebrate pests, develop an IPM program. Include prevention through structural exclusion and sanitation, sampling, and nonchemical controls such as snap traps. These methods may reduce or eliminate the need for rodenticides.



Snap Trap

When pesticides are necessary, try nonfumigant rodenticides first. Choose between anticoagulants and nonanticoagulants. Anticoagulants cause death by internal bleeding. These chemicals are normally placed with baits in bait stations. Nonanticoagulants cause death by stopping the heart, damaging the intestines or liver, or by attacking the central nervous system. These chemicals act quickly, and rodents are usually less resistant to them. However, rodents are more likely to reject non-anticoagulants as food. You may need to prebait with untreated food to encourage consumption.

If control with nonfumigant rodenticides is poor, it is usually due to:

- Insufficient or low-quality bait
- Low numbers of bait stations
- Failure to treat the entire infested area
- Invasion from untreated areas such as outside a structure
- Poor placement of the stations
- Other foods being more readily available, or
- Pesticide resistance

When possible, pinpoint the problem and correct it before resorting to fumigation.

Fumigation

Sanitation, proper grain storage, aeration, and nonfumigant pesticides can go a long way toward preventing or reducing pests in stored grain and other raw products. For some situations, however, fumigation may be the only answer. Fumigants control pests by diffusing through the spaces between grain kernels as well as into the kernels themselves. They often work better than nonfumigant pesticides because they can penetrate into places that are not accessible with insecticide sprays or dusts. They can also kill all stages in an insect's life cycle.

Before using a fumigant to control pests in stored grain and other raw products, make sure you need it. Monitor pest populations throughout the storage period. Do not hold grain or other raw products in storage for longer than necessary. Use all possible cultural and nonfumigant chemical controls to maintain pest populations below damaging levels. Before you decide to fumigate, make sure that pest populations are high enough to warrant fumigation.

Test Your Knowledge

Q. What is Integrated Pest Management (IPM)?

- A. IPM is an ecological approach to pest control. It is based on the habitat and life cycle of the pest. It combines all appropriate pest control strategies, including nonchemical and chemical management methods. IPM is dedicated to removing causes rather than simply treating symptoms. Prevention is key. IPM balances the level of control needed with any associated risks. The goal of an IPM program is to reduce pest numbers to an acceptable level in a way that is practical, cost-effective, and safe for people and the environment.

Q. How does fumigation fit into an IPM program?

- A. Fumigation is only one part of an IPM program. Because it is specialized, very toxic, and often expensive, fumigation is usually the last resort to a pest problem.

Q. Why is regular observation of food and stored products important in effective pest management programs?

- A. Sampling and regular observation allow you to check for pests in an area to determine what pests are present, how many of each kind are in the area, and how much damage they are causing. Sampling and observation will help you determine if treatment is needed and/or if previous control measures were effective.

Q. List some of the advantages of fumigants.

- A. 1. They are effective against insects, mites, and most other living things.
2. Most are fast acting.
3. They are capable of providing total eradication.
4. Human exposure is limited.
5. Most fumigants, when used properly, do not leave residues on surfaces.

6. There are several ways to apply fumigants.
7. They penetrate and treat hard-to-reach areas.
8. You can apply them without disturbing the commodity.
9. They are usually readily available.
10. You can use some fumigants in or near food without leaving harmful residues, tastes, or odors.

Q. List some problems with fumigants.

- A. 1. They are highly toxic to most living things.
2. They require special protective equipment.
3. They require highly trained applicators.
4. They offer no residual control.
5. They must be confined in a tightly sealed area to be effective.
6. Some may injure seeds and reduce germination. Others may leave toxic residues, tastes, or odors.
7. Response to problems and emergencies must be quick.
8. Temperature requirements may be hard to meet.
9. Some are expensive.
10. Some are corrosive.
11. Some are flammable and explosive.
12. Some fumigants are hard to remove from treated material.

Q. How can you prevent pesticide resistance?

- A. As a pest control operator, you can protect the effectiveness of pesticides by:
- Using IPM
 - Using alternative controls and nonchemical controls whenever possible
 - Using pesticides only when necessary
 - Avoiding repeated use of the same pesticide
 - Doing a thorough job when applying a pesticide (do not leave behind pests that can build up resistance and reproduce), and
 - By fumigating only when nothing else works

Q. How often should you clean grain storage bins to prevent insect infestations?

A. Clean bins immediately after they are emptied and again at least two to three weeks before adding grain. Before storing fresh grain, clean the inside and outside of storage bins and buildings. You should also clean bins before applying “empty bin sprays.”

Q. Name several things you can do to reduce stored grain’s susceptibility to insects and disease.

A. 1. Clean and dry the grain before placing it into bins.
2. Always store grain in a steel bin that is weather-tight, rodent-proof, and mounted on a moisture-proof concrete base.
3. Remove as much fine material as possible or spread out the fines throughout the load.

4. Level the surface of the grain so that it is not peaked.
5. When possible, store the grain in the fall when temperatures are cooler.

Q. What technique can you use to maintain ideal moisture levels and temperatures within a load of stored grain?

A. Aeration

Q. Why is it important to keep stored grain cool and dry when applying insecticides?

A. Insecticides tend to break down faster in areas with high temperatures and moisture.

Q. True or False: Topdressing will kill insects throughout a load of grain.

A. False