

drinking water exists, moist baits may be more readily accepted than dry baits. However, moist baits usually have a tendency toward rapid spoilage and must be replaced frequently. A meat type bait is generally taken well by Norway rats. Poisons suitable for use in water solution are usually readily accepted in this form by both mice and rats.

Detailed discussions of the proper use of both red squill and warfarin in grain storage areas follow.

Red squill

Red squill, when properly used, is quite effective against rats and is one of the safest rodenticides currently available. If accidentally eaten by man or domestic animals, it induces vomiting, thus acting as its own emetic. Since rats and mice cannot vomit, red squill is fatal to them when eaten in sufficient amounts. This poison is best used where a quick reduction of a heavy rat population is desired. Maximum control is achieved on the first baiting. Subsequent use of squill in the same area will not generally produce a satisfactory cleanup as rats quickly become bait shy, and any animals that have received a sublethal dose will seldom again take red squill poisoned baits. Red squill is not recommended as a mouse poison.

Following the initial kill, warfarin, which produces no bait shyness in rodents, should be used as a follow-up in permanent type bait stations.

Red squill is generally sold in powdered form and is mixed with bait in the proportion of one part poison by weight to nine parts bait. The following bait formula is suggested for use around grain storage areas:

Ground fresh meat.....	5 pounds
Bread crumbs, rolled barley, rolled oats, or combination.....	4 pounds
Red squill powder.....	1 pound

Mix the red squill powder with the meat, then add cereal and mix thoroughly. Put out baits in teaspoon quantities or in balls about $\frac{1}{2}$ inch in diameter. Complete coverage of the area with baits is desirable—both inside and outside buildings.

Warfarin

Warfarin has proved a very effective rodenticide for both rats and mice, used either by experts or by persons unskilled in rodent control methods. Warfarin kills by causing internal bleeding or hemorrhage after several days of ingesting small amounts of bait containing the chemical. Warfarin *will not* give effective control when used as a single dose or baiting. Dead animals are usually not found until from 5 to 15 days after continuous exposure to warfarin

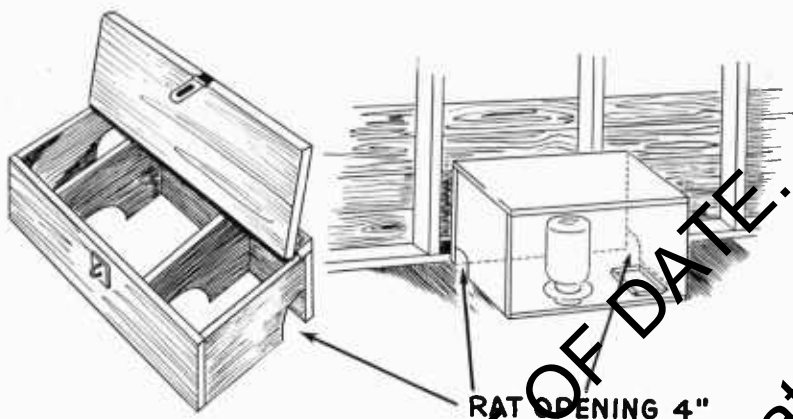


Figure 3. Permanent enclosed type bait stations prevent spillage and dusting over and keep bait away from domestic animals and children.

baits. Warfarin does not cause "bait shyness" in rodents, and no "prebaiting" with unpoisoned bait is necessary.

Warfarin products are now generally available in three forms:

- ▶ Warfarin dry concentrates in powder form, containing 0.5% active warfarin and 99.5% starch base or filler. This concentrate should be mixed in the ratio of 1 pound of concentrate to 19 pounds of bait for rats or mice.

- ▶ Finished dry warfarin baits ready for use. These baits contain .25% warfarin on a ratio of 1 part warfarin to 4,000 parts bait.

- ▶ Water-soluble warfarin (sodium salt) to be dissolved and used as a water bait. (The above two forms of warfarin are relatively insoluble in water.)

Use of different types of warfarin baits in the following sequence is suggested, depending upon efficiency of control achieved:

1. Dry, cereal-type warfarin baits
2. Moist meat, fish, or vegetable warfarin baits
3. Water baits.

To achieve satisfactory control, warfarin baits of any type must be exposed continuously for at least 15 days. However, maximum control efficiency will be attained only by *continuous* exposure of baits in *permanent enclosed* bait stations (as illustrated). Such permanent stations not only will destroy rodents already present on the premises, but also will control any rodents moving in from surrounding areas.

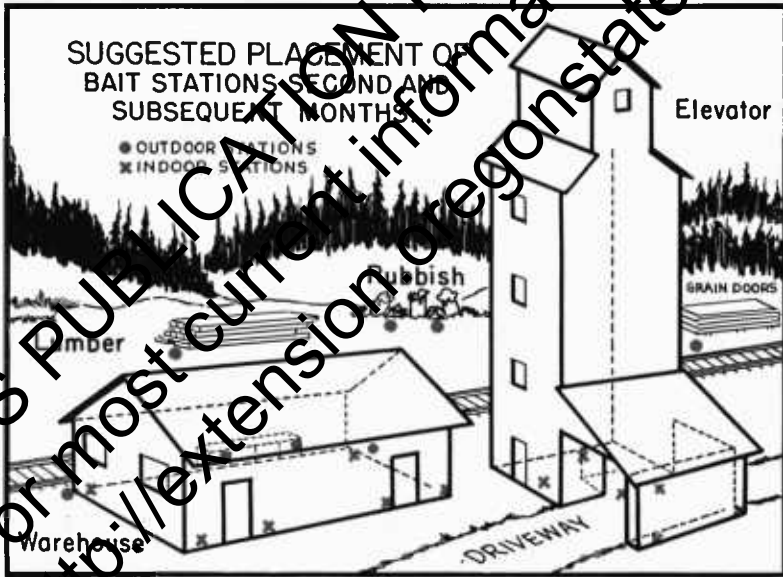
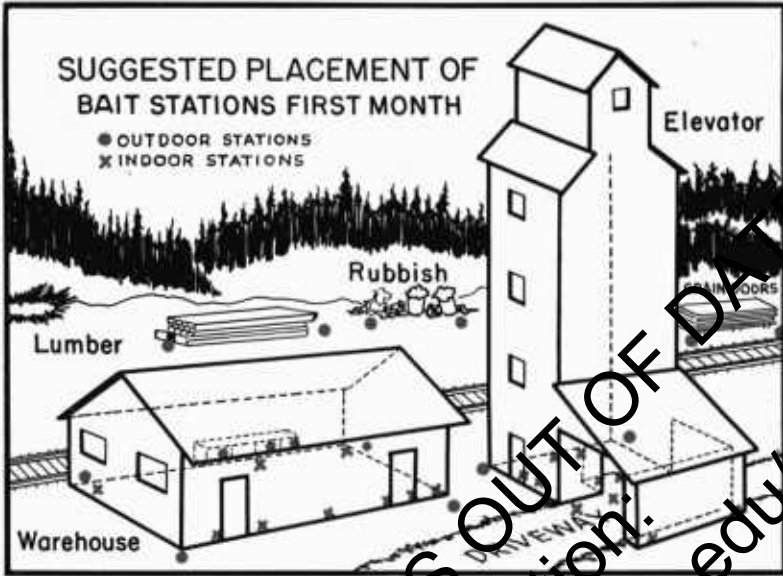


Figure 4. When rodents are present, complete coverage of the storage areas with warfarin bait stations is essential for adequate control.

Dry, cereal-type warfarin baits do not spoil rapidly and, if in permanent, enclosed bait stations, need be replaced only as eaten by rodents. Dry baits are convenient to use and require little effort on the part of the operator. Unfortunately, such baits do not always compete favorably with more palatable foods readily available to rodents. In such cases, moist baits or water baits may give satisfactory results. Moist baits or water baits are usually particularly effective since most grain storage areas provide no source of free drinking water to rats and mice.

Moist meat, fish, or vegetable warfarin baits should be replaced at two-day intervals. Water bait stations should be refilled as necessary. Chick watering stations (as illustrated) work satisfactorily as water-bait stations. Addition of a small amount of glycerin will prevent freezing of water bait stations in cold weather. The use of unpoisoned water as an attractant, at warfarin dry bait stations, appears to have some merit. Permanent-type, enclosed bait stations prevent spillage and dusting over of baits and keep them out of reach of pets, domestic animals, and children. To insure palatability, water bait containers should be washed before refilling.

A diagram suggesting general placement of bait stations in grain storage areas is found on page 7. Since mice have a much smaller travel range than rats, a larger number of bait stations placed closer together should be used when attempting control of this species.

The following bait formulas are suggested for use with warfarin:

1. Dry, cereal-type—yellow corn meal, rolled oats, rolled barley, chicken mash, or combination 19 pounds
Warfarin 1 pound
2. Fresh ground meat, fish, or vegetables 19 pounds
Warfarin 1 pound
3. Water bait—The only soluble form of warfarin now available is packaged in small envelopes, each containing enough warfarin to make one quart of bait. At present this form is sold under the name "Warficide."

Warfarin ranks with red squill in safety. Most animals are highly resistant to single doses, and repeated small doses for several days are required to cause death. Dry, cereal-type baits are usually unattractive to pets or children. However, moist meat or fish baits and water baits should not be exposed to cats, dogs, and children. Dogs and cats may be killed either by eating baits or by eating a number of dead rodents over a period of several days. If a human being should eat warfarin bait, immediately induce vomiting and call a physician. Antidote for warfarin poisoning usually includes

giving massive doses of Vitamin K preparations intravenously, or by mouth, and by giving transfusions of whole blood. No known danger exists from external contact with warfarin on the skin.

Warfarin is one of the new anticoagulant materials that have proved to be very effective in rat and mouse control. At present, several more anticoagulant materials show promise of being equally effective and when available will provide additional tools in rodent control.

Trapping

Except for light rodent infestations, trapping is not usually an efficient control method in grain storage areas. Successful control by trapping requires the use of a large number of traps in relation to the numbers of animals present. The trapper must use considerable skill, persistence, and ingenuity, and a variety of bait materials and must keep traps freshly baited.

The common wooden base snap traps are efficient and may be obtained in large size for rats and small size for mice. The large size traps may be used for mice by releasing the tension spring on one side of the bail, allowing the trap to be sprung more easily.

Peanut butter combined with rolled oats makes an excellent bait for mice and a good one for rats. Near grain storage areas where cereal food is abundant, fresh meat, fish and bacon are often effective baits for attracting Norway rats. Both rats and mice may be trapped with unbaited traps set along burrows with the trigger end next to the wall. The efficiency of such traps is increased by enlarging the trigger surface with a two-inch square of cardboard.

Mice are more easily trapped than rats but seldom range more than 15 to 20 feet.

Placing baited, *unset traps* for several nights prior to the actual trapping often helps to overcome trap shyness.

Fumigating

Poison gas is effective for controlling rats in outside burrows or when burrows extend beneath concrete slabs or foundations. One of the most effective fumigants is calcium cyanide dust. This gas is extremely dangerous to animals and people when used in sufficient concentration. Because of the dangers involved, this method of rodent control should be used only by trained personnel or under the direct supervision of such personnel.

Calcium cyanide dust is forced into burrows with a portable dusting pump. A few strokes of the pump will fill burrows with the smokelike dust, which will emerge from all connecting openings and thus indicate the extent of the burrow system. The mouth of the burrow and any other openings through which dust escapes should immediately be closed with damp earth or sod.

On the following day, entrances to all rodent burrows should be broken and filled in with earth. The number of burrows reopened by rats will indicate the degree of control achieved.

Precautions to be taken and antidotes for accidental poisoning are listed on containers for calcium cyanide.

Good Housekeeping

One of the most economical and effective methods of controlling rats and mice is the elimination of available food and shelter by regular, systematic, and continuous good housekeeping. An effective plan of sanitation and good housekeeping for the entire plant and the surrounding territory is essential to rodent control. Regardless of the effectiveness of temporary rodent control measures such as poisoning, trapping, or gassing, populations will rapidly build up again unless rodents are deprived of food and shelter. Where living conditions are favorable, rats and mice will again reach population peaks within from 6 to 12 months after being successfully "controlled" by poisons and other direct methods. Regardless of how efficient exclusion measures are, rodents will usually manage to reinvade premises where careless housekeeping permits them to find food and harbors in or near the area.

Frequently, piles of lumber, machinery, screenings, old sacks, and other trash are conveniently located (for rodents) near the elevator or flat storage house. Often, trash is scattered throughout the basement, storage rooms, or odd corners within buildings. At such establishments, one can usually hear the operator complain, "Why can't I get rid of the rats? I've put out plenty of poisoned bait."

Sacked grain should be stored neatly, preferably on racks from 12 to 18 inches off the floor. Stacks should be kept from 12 to 24 inches away from walls and corners. Aisles between stacks should be kept clean and floors swept regularly. Lumber, pipes, posts, sacks, and all similar materials can be neatly stacked on racks above ground or floor levels. All trash, broken and discarded machinery, and other waste materials should be hauled to the dump ground. Whenever spillage of grain occurs, it should be immediately cleaned up.



Figure 5. Piles of lumber, machinery, sacks and other debris outside storage buildings make ideal living quarters for both rats and mice.



Figure 6. Piling lumber off of ground and removing trash from around grain storage buildings eliminates habitat and aids in rodent control.

Exclusion

Exclusion of rats and mice means blocking their points of entry by all ratproofing and mouseproofing methods. New grain storage buildings should be rodent proofed at the time of construction. Many older buildings can be made to exclude rodents with only a minimum of expense and effort. This is especially true of farm storage areas where usually only one or two buildings are involved. Grain storage buildings should have concrete foundations and floors whenever possible. Doors and windows should fit tightly. All windows should be properly screened.

To exclude mice and rats, all openings larger than $\frac{3}{8}$ inch must be closed or screened. Materials most useful for rat and mouse proofing include concrete made with a quick-setting cement, $\frac{1}{4}$ -inch mesh hardware cloth of 20-gauge wire or heavier, and sheet metal of 26-gauge or heavier. Concrete is used to fill openings or cracks in foundations or to patch holes made for pipes or electrical cables and wiring. Steel wool or hardware cloth can be used to reinforce such patches. Hardware cloth is useful in screening windows and ventilators. Sheet metal is used to sheath sills and doors to prevent rodents from gaining entrance by gnawing holes.

After completion, rodent proofing should be inspected regularly. The success of control methods may be judged by rechecking for the presence or absence of fresh sign. Fresh rodent droppings are dark, soft, and shiny, while old droppings are hard, grayish in color, and dull in appearance. Areas formerly covered with tracks or tail marks soon become covered with dirt when no longer used. Sack cutting stops and signs of feeding are no longer present when rodents have been eliminated. For a constant check, patches of flour or whitening may be dusted along walls and runways formerly in use and examined daily for sign of rodent presence.

Community Control Programs

Ordinarily, institution of a community-wide or area-wide control program is the most effective way to combat rats and mice. This is particularly true of commercial storage areas. Since these are almost always located in or near towns or cities, it is almost impossible to eliminate rodents from one without considering the other. Grain storage operators should encourage and assist such community campaigns in every way possible.



Figure 7. Using structures not intended for grain storage results in making exclusion of rodents and birds both difficult and expensive.

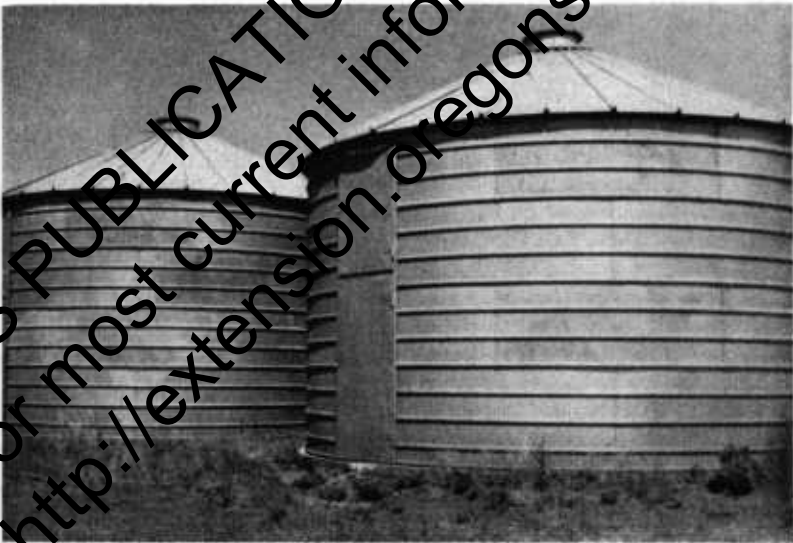


Figure 8. Although storage buildings may be rodent proof when built, regular inspections of doors, windows, and foundations are essential.

Bird Control Methods

1. Exclude birds by screening or blocking all possible points of entry.
2. Institute and maintain "good housekeeping" practices to reduce food and shelter available to the birds.
3. Where other means fail to eradicate bird pests completely, control by poisoning, trapping, or shooting may be necessary. Prior to using these methods, *always* consult local, state, and federal authorities to determine whether such practices are permitted by law.

Contamination of stored grain by birds is especially important in the case of on-the-farm stored grain. Farmers sometimes use temporary storage facilities that were never intended to hold grain and are not properly constructed. (Figure 7) Farmers often permit broken or unscreened windows to go without attention, thus allowing free access to birds for roosting within the storage building (Figure 9). Farmers often leave storage buildings open when no grain is being held, thus permitting bird droppings, nests and feathers to accumulate. Unless these materials are removed prior to filling with clean grain, such grain becomes contaminated.

Elimination of contamination caused by birds is mainly a matter of exclusion by screening windows and blocking all other points of entry. Good housekeeping is also effective in controlling bird infestations by eliminating food and roosting and nesting cover.



Figure 9. Closing doors and screening windows and other openings in grain-storage buildings will eliminate most contamination by birds.



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*A Control Program
for Rodents and Birds
in Stored Grain*

1. Destroy rodent populations by poisoning, trapping, and fumigating.
2. Reduce food and shelter available to rodents and birds by continuous good housekeeping.
3. Exclude rodents by building them out.
4. Exclude birds by screening windows and other points of entry.
5. Examine stored grain regularly for signs of rodent and bird infestation and contamination.
6. Give full assistance and cooperation to community or area-wide control programs.