12. On-Farm Stored Grain Management

Maintaining stored grain in good condition requires careful, routine inspection and good storage practices. Good storage practices consist of more than simply putting good-quality grain into a weatherproof container.

Storing Grain in Bins

When grain is loaded into storage it should be at its peak quality. Over time, the quality of the grain will only decrease; it seldom, if ever, improves. The following strategies will help maintain the quality of grain at the same level as when it went into the bin.

Good Bin Management Suggestions

- Treat empty bins to control any stored grain pests that may be living in cracks, crevices and below the aeration floor.
- Clean any grain before the bin is filled.
- Remove fines and other foreign material from the grain, during or immediately after filling the bin, to reduce air flow restrictions and possibly reduce the risk of spoilage.
  - Fines collect in the centre of the grain mass as the bin is filled.
  - Core storage bins (auger out some grain) as they are filled, or within 2–3 days of filling. Coring removes the highest concentration of fines and establishes the flow funnel.
  - Clean the removed grain and put it back in the same bin. Any remaining fines will be redistributed and cause less air flow restriction.
- Install a manometer in the air plenum below the aeration floor to monitor the static pressure of the air moved by the fan. For information on how to build a manometer, see Figure 12–1, *Home-built manometer*.
- Use the measured static pressure and the fan performance curve (available from the fan manufacturer) to determine the air flow delivered by the fan.
- Tightly cover unused aeration fan inlets to prevent unintentional air movement through the grain. Place a reminder on the fan control to remove the cover before starting aeration.

Why Aerate Grain Bins

Grain bin aeration:

- removes field heat at the time of harvest or cools grain from a dryer
- equalizes the moisture content of the grain throughout the bin
- maintains the whole grain mass at proper long-term storage temperature
- prevents convective air movement in the grain mass

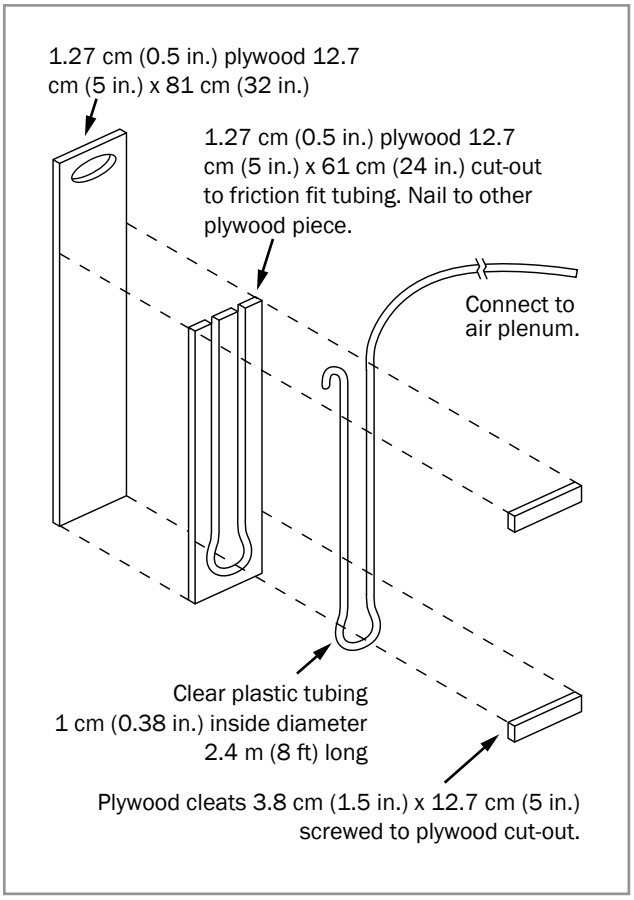

Figure 12–1. Home-built manometer.

A manometer is a simple device that uses a fluid column to measure static pressure. It can be used to measure the static pressure in the air plenum between the perforated floor and the concrete pad under a grain bin.

As bin surfaces are warmed or cooled by the sun or outside air, the grain at the bin surfaces change temperatures. Air currents start to move by convection in the grain mass. Moisture from the grain is carried

by these convective air cells and condenses on colder surfaces that are at dew point temperature. These colder areas may be inner bin surfaces (in cold weather) or the grain itself (in warm weather). Spoilage can occur if this convective air movement is not stopped. Routine aeration of the bin contents will maintain uniform grain temperature and prevent convective air movement.

Maintain a temperature differential of no more than 5°C between the grain mass and the average outside air temperature to prevent convective air movement from occurring.

Basics of Aeration

- Bring the whole grain mass to the same temperature.
- Operate the fan only when ambient air relative humidity levels will not add moisture to the grain.
  - Typically, relative humidity levels lower than 70% are suitable for aeration.
  - Relative humidity levels of night-time air are often higher, and can add moisture to small grains, beans and natural air dried corn.
- Become familiar with equilibrium moisture content charts for the grain or beans you are storing.
  - Equilibrium moisture content predicts the final moisture of grain when exposed to air at certain temperatures and relative humidity levels.
  - See the section *Harvest and Storage* in each commodity chapter for the relevant equilibrium moisture content charts.
- Operate the fan long enough to completely change the entire grain mass temperature — this may require a number of days. The time required depends on the airflow rate per bushel.
  - See Table 12–1, *Time required for aeration front to move through grain,* for the aeration time required to completely change the bin content temperature.

Grain Storage Monitoring

> Monitor all bins of grain stored on the farm on a routine schedule.

Monitor stored grain regularly to evaluate its condition and to identify any problems that are developing. Stored grain that is prepared regularly for feed can be monitored as it is being used. Set up a routine for checking the bins of grains that are not being used regularly. In warm weather, grain can go out of condition quickly. Monitor bins at least monthly, or preferably every 2 weeks. By carefully and diligently monitoring storage bins, producers will be able to detect the warning signs of possible spoilage problems and take appropriate action to prevent further reductions in quality.

Table 12–1. Time required for aeration front to move through grain

LEGEND: CFM = cubic feet/minute; 1 CFM/bu = 13 L/sec/m³

	Grain Cooling		
Airflow Rate	**Fall**	**Winter**	**Spring**
0.65 L/s/m³ (1/20 CFM/bu)	300 hours	400 hours	240 hours
1.3 L/s/m³ (1/10 CFM/bu)	150 hours	200 hours	120 hours
2.6 L/s/m³ (1/5 CFM/bu)	75 hours	100 hours	60 hours
3.2 L/s/m³ (1/4 CFM/bu)	60 hours	80 hours	48 hours
4.3 L/s/m³ (1/3 CFM/bu)	45 hours	61 hours	36 hours
6.5 L/s/m³ (1/2 CFM/bu)	30 hours	40 hours	24 hours
9.7 L/s/m³ (3/4 CFM/bu)	20 hours	27 hours	16 hours
13.0 L/s/m³ (1 CFM/bu)	15 hours	20 hours	12 hours

Monthly Bin Monitoring Checklist:

- Turn on the aeration fan.
- Climb up and look inside the bin. Look for signs of moisture on the underside of the roof. If water droplets or ice are present, aerate the bin immediately — moisture from the grain has been carried into the attic space and condensed on the roof metal.
- Check for any off-odours. The air should smell like clean grain.
- Run the aeration fan if a light dusting of snow has been driven into the top of a storage bin. The snow will sublimate and be discharged as harmless water vapour. If much greater amounts of snow are found, shovel it out.
- Check the grain surface to see if it looks different from the last time. If it looks dull or off-colour, investigate further.
- Check for changes in the static pressure or the working pressure of the fan in the plenum under the aeration floor.
  - A decrease is no cause for concern.
  - An increase indicates something has increased

the resistance of the air as it moves through the grain mass. Investigate deeper into the grain mass.
- Watch for any signs of insect activity.
- Record your notes in a monitoring logbook for comparison with the next month's readings.

Insect Management for Farm-Stored Grain

The key to controlling insects in stored grain is good sanitation and storage practices.

The following strategies are essential for preventing infestations and reducing the need for rescue fumigation treatments.

Keep a Clean Facility

The most important strategy to keeping facilities insect-free is cleaning bins and equipment before storing any new grain. Grain residues from previous crops are the main source of stored pest infestations. At least 2 weeks before filling, clean bins thoroughly, using a good vacuum cleaner, to remove all grain residue or caked material. Ensure old grain has been removed from cracks and crevices, behind partitions, between double walls, outside and under bins, in grain-handling equipment, inside aeration piping and under perforated floors. Harvesting and grain-handling equipment containing old crop residues are another source of new infestations. Fully perforated floors present a problem because they cannot be easily lifted for cleaning, and grain dust will accumulate and may become infested with grain storage pests.

Clean up all spills of grain and feed around handling and storage facilities. Burn all grain that is collected, deposit it in a sanitary landfill or grind it up for feed. Leave space between feed rooms and storage facilities to prevent pest movement from one to the other. Once established, storage pests can quickly spread to nearby storage facilities.

Do not store grain in buildings that shelter animals or hay. Mangers, feed boxes and troughs are often infested with insects. These shelters are also warmer and provide an excellent wintering site for insects.

Maintain Sound Storage Facilities

After clean-up, repair facilities so they are pest-proof. Seal cracks and crevices that may allow insects and other pests to enter.

Store Clean, Dry Grain

Never store new grain with old grain, because insects in the old grain will migrate to the new. Ensure grain being placed in the storage facility is pest-free.

Moulds, as well as insects, are much more troublesome in moist grain. If stored grain is more than 15% moisture content, check it regularly. Dry wheat and other grains down to 12% moisture, if the plan is to store them for longer than a month through the warm summer season. Dry corn to 14% moisture for safe long-term storage.

Monitor Storage Temperature and Sample for Insects

Wheat is the crop most susceptible to infestations, because it is harvested during the summer when the air temperature is warmest, and insects are most active inside and outside the storage facilities. Once in the bin, the grain is still warm and can provide an excellent habitat for stored-grain insects. In Ontario, corn storage usually follows wheat storage, and infestations can easily be carried from the wheat to the corn. Monitor the temperature of the grain using temperature sensors or cables placed throughout the grain pile. Warm areas in the pile often indicate insect and/or spoilage problems.

Use aeration to cool down grain in the fall, to reduce insect infestation and slow reproduction. Insects do not develop in grain when temperatures are below 10°C and can be killed if temperatures are kept below -10°C for extended periods of time (depending on the insect species).

Rusty grain beetle and Indian meal moth can be monitored using plastic probe traps (Photo 12–1). These probe traps are very sensitive and will show an infestation well before it reaches the economic threshold. If rusty grain beetle or Indian meal moths are found, fumigate the grain. Fumigants are restricted-use products that can only treat grain warmer than 5°C.

Photo 12–1. Insect probe for stored grain is inserted into grain to trap Insects.

Treat Empty Bins with Diatomaceous Earth

Diatomaceous earth is a naturally occurring abrasive dust made from a silicone-dioxide mixture of prehistoric, marine diatoms. When in contact with insects, the diatomaceous earth scratches their outer surface and absorbs the protective waxy coating on the insect, causing it to die from dehydration. Apply the product to the empty bin through aeration fans at least 2 weeks prior to grain storage. Diatomaceous earth can also be applied to the grain as it is being transferred into the bin or storage facility. Wear a protective mask when applying diatomaceous earth to avoid inhaling the dust. See OMAFRA Publication 812, *Field Crop Protection Guide,* for detailed application and label information.

Do not exceed application rates when treating grain, as this will result in auger plugging problems.

> Preventative insecticides are not a substitute for good storage sanitation practices.

Ensure bins are clean before applying products. If bin surfaces are dusty or covered with caked material, control products may not penetrate to kill crawling insects.

Use Rescue Treatments When Necessary

Should an insect problem occur, fumigation might be necessary. Turning the grain or moving it from one bin to another bin may reduce a secondary pest problem to below economic damage levels. However, if rusty grain beetles or Indian meal moths are evident, the problem is serious. If webbing is found on the surface of the pile, rake and remove this layer before fumigating. For information on fumigants, see OMAFRA Publication 812, *Field Crop Protection Guide*.

Grain must be above freezing temperatures for all fumigants to work properly. As a result, fumigation may not always be possible when desired. Fumigants may only be applied by a licensed exterminator. Before fumigating, remove livestock and poultry that are in the same building, especially if they are under the grain bin.

Malathion is no longer recommended for Indian meal moth control as this insect has acquired resistance and is frequently not affected by this product.

Identify Pests Properly

Stored-grain insects are not specific to one crop but can move and feed across commodities. It is important to know which insect pest is causing problems in the facility. Proper identification and pest density assessment is important because management strategies may differ, depending on the pest. Proper identification will also help determine the source of infestation. Some insects are only incidental pests and may not cause economic loss.

Stored-Grain Insects

Scouting Technique for Stored-Grain Insects

In the grain pile, place four plastic probe traps halfway between the centre and edge of the bin, in an X-pattern, with the centre of the bin as the centre point of the X (Photo 12–1). Place the traps vertically into the grain so the top of the probe traps are about 25 cm (10 in.) below the grain surface. Retrieve and examine the traps at least once a week. Under high infestation levels, insects may be trapped in a day or two. These probe traps are very sensitive and will show an infestation well before it is economically threatening. If insects are present in probes, follow the management strategies listed in Table 12–2, *Insect management strategies for farm-stored grain*. Insecticide and fumigant guidelines can be found in OMAFRA Publication 812, *Field Crop Protection Guide.*

Table 12–2. Insect management strategies for farm-stored grain

Description	Life History	Damage	Management Strategies
Rusty Grain Beetle (Photo 12–2)			
· flat, reddish-brown beetle · approx. 2 mm long · antennae as long or longer than its head and thorax combined · flies when temperatures are above 25°C · larvae are white, approx. 3 mm long, have two brown projections at the rear · moves easily through the whole grain pile because of its small size	· cold-tolerant · overwinters as an adult · lays up to 500 eggs on surface of kernels · larvae hatch in 35 days · larvae penetrate seed and pupate inside · adults emerge, leaving distinctive exit hole	· adult and larvae feed on germ and bran · feeds on cracked or sound grain · feeds throughout pile of grain · high infestations generate heat, causing grain to mould and spoil	· proper sanitation and monitoring practices · treatment with diatomaceous earth to protect from re-infestation · see OMAFRA Publication 812, *Field Crop Protection Guide,* for insecticide and fumigant information
Indian Meal Moth (Photo 12–3)			
· adult approx. 12 mm (0.5 in) long and A-shaped when wings are at rest · wings are grey, bottom half are bronzy · active in the evening · larvae grow to approx. 8 mm long · larvae range from pinkish-cream to pale yellow to pale green/yellow with black heads · larvae have three pairs of legs on thorax, five pairs of abdominal prolegs · mature larvae wander, looking for places to pupate	· can go through its entire life cycle in approximately 21–30 days under warm conditions · not cold-tolerant · temperature limits number of generations per year · females lay eggs on kernels of grain on pile surface · young larvae found in grain clumps (3–10 kernels) held together by silk	· adults do not feed or cause damage · larvae feed on germ and bran, leaving kernels with these missing · all stages of larvae spin webbing (increases as preparing to pupate) · typically stays on top of pile, no more than 50 cm (20 in.) deep · high populations result in a mat of grain with silks up to 50 cm (20 in.) deep	· moth is resistant to malathion · remove webbed layer of grain before fumigation · see OMAFRA Publication 812, *Field Crop Protection Guide,* for insecticide and fumigant information.
Granary Weevil (Photo 12–4)			
· adult is a dark-brown snout beetle · approx. 4 mm long · larvae are white, wrinkled and wingless, approx. 4 mm long · larvae always found inside grain, only leave kernel as adults · only attacks cereal grains, not legumes · cannot fly · can be confused with rice weevil; on surface of thorax, the small pits are round rather than oval · cannot survive cold	· female lays eggs into holes in the grain created with her snout · cements holes shut · larvae develop inside grain · adults live up to 8 months	· adult and larvae feed on sound grain · larvae spend entire life in one kernel, feeding on endosperm · several larvae can be inside one kernel · leaves round exit holes when exits kernel as adult	· see OMAFRA Publication 812, *Field Crop Protection Guide,* for insecticide and fumigant information
Pea/Bean Weevils			
· two species that attack peas or beans · larvae and damage to crop resemble that of granary weevil · adults are short and squat approx. 3–4 mm long · heads are tapered at front · usually tan coloured with faint longitudinal striping · larvae are creamy, yellow, legless and have a brass-coloured head capsule	· life cycle can be very short	· pea weevils attack peas, bean weevils attack beans · adults lay eggs in maturing beans in field with no apparent visible damage · damage noticed when new adults emerge from seeds, leaving round holes	· monitor beans for damage in storage · react with a fumigation · sort beans visually to remove “picks” · heavily infested peas or beans can be fed to livestock · see OMAFRA Publication 812, *Field Crop Protection Guide,* for insecticide and fumigant information

Table 12–2. Insect management strategies for farm-stored grain

Description	Life History	Damage	Management Strategies
Lesser Grain Borer (Photo 12–5)			
· adult is a brown-to-black beetle · approximately 2 mm long · cylindrical in shape · small numerous pits on surface of wings · adult identified by location of head · head is turned downward and covered by large hood (prothorax) · larvae are creamy-white, C-shaped, with a dark head tucked into the thorax · musty odour associated with this pest	· female borer lays eggs in cluster on surface of kernels · larvae hatch and bore into the kernel · completes development inside kernel	· pest may move into Ontario due to climate warming · adult and larvae cause damage to sound grain · bore irregularly shaped holes into the grain · leave only shell and powdery dust · adult and larvae enter and exit several grain kernels · several individuals may attack same kernel · also feed off grain dust	· advise provincial field crop entomologist if found · see OMAFRA Publication 812, *Field Crop Protection Guide,* for insecticide and fumigant information
Grain Lice			
· also known as psocids or book lice · adults are soft-bodied · approximately 1–2 mm long · have large heads with long antennae · range from brown to white and often are opaque · can be winged or wingless · resemble aphids · young are smaller and slightly paler than adults	· incomplete metamorphosis (young nymphs resemble adults) · several generations in one season · can multiply quickly under warm conditions	· not a direct pest of grain · secondary pest that feeds on grain dust and damaged kernels · can be seen running over pile when numerous; visually inspect grain surface for tiny, fast-moving insects · generally restricted to the top of the grain pile	· turning and cleaning the grain reduces populations · lice are found in damp conditions · lowering humidity lowers populations · see OMAFRA Publication 812, *Field Crop Protection Guide,* for insecticide and fumigant information
Mites			
· adults barely visible to the naked eye · approximately 0.5 mm long · rounded, eight-legged, yellowish-brown · larvae look like adults but have six legs · two nymphal stages look similar to adult with four pairs of legs	· influenced by moisture level in bin	· incidental insect on grain going out of condition · prefers damp grain · feeds on grain dusts and moulds	· keep grain dry and in good condition · see OMAFRA Publication 812, *Field Crop Protection Guide,* for insecticide and fumigant information

Photo 12–2. Rusty grain beetle adults have antennae as long as or longer than their head and thorax combined.

Photo 12–3. Indian meal moths leave webbing on top of the grain pile.

Photo 12–4. Granary weevil is a snout beetle that has oval pits on the surface of the thorax.

Photo 12–5. Lesser grain borer's head is turned downward and covered by a large hood (prothorax). A musty odour is often associated with this pest.