



Grain storage: Maintaining grain quality

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Grain stored on farms for seed or livestock feed is an important part of the farm income and protecting the grain from insect attack is an exercise in income protection. The risk to the investment occurs when there is an inability to manage the physical conditions within the grain store. The most important features to observe when storing grain are:

- **Keep it dry**
- **Keep it cool**
- **Keep it insect free**

Be sure the grain is loaded below 12 per cent moisture content. Weevils (stored grain insects) create moisture by consuming grain so eliminating them will prevent unwanted internal moisture. Completely eliminate insects in a fully sealed silo.

Cooler grain temperatures have several advantages: seed germination percentage is maintained longer; moisture migration is reduced; insect breeding is reduced; and less gas is lost through the pressure relief valve of sealed silos. An aeration system will cool and stabilise the internal temperature and reduce internal air currents but can also be sealed for a fumigation procedure.

Risk to investment

Stored grain insects contaminate and eat food intended for seed or feed. A heavy infestation will remove a large amount of dry matter; even light infestations of weevils can drastically reduce the germination of grain. Cereals in store are part of a community of living organisms, along with insects, mites, bacteria and fungi. While the grain stays dry, most of these living organisms remain in a suspended state or at a low level of activity. If the silo has no leaks in the structure, the most likely source of any water is the activity of weevils consuming the grain. Grain will contain up to 12 per cent water in a dry, warm silo (6000 litres in 50 tonnes of grain) and this can be liberated by insects consuming the product. The moisture that has been liberated into the air between the grains is then carried to—and concentrated in—other parts of the silo. In WA this is most likely to be the

upper layers or the north side wall. If the grain reaches moisture levels higher than the recommended 12 per cent the organisms that entered the silo from the field on each kernel of grain become active. Bacteria invade the grain, fungal growth proliferates and begins to warm the grain, insects and mites breed more rapidly in the warm, moist conditions and produce even more water, all of which combine to ruin your investment.

Managing the risk

Practice good farm hygiene

Stored grain insects which survive over winter in stored grain are ready to re-infest your harvesting machinery and next year's crop, with a risk of detection when delivered to the buyer. The most important defence of your stored grain is to reduce the overall numbers of insects on your property which in turn reduces the risk of invasion of the new grain and of infested grain subsequently being delivered to central storage.

After harvest – clean up

Grain-handling equipment such as trucks, harvesters, augers and seeders must be cleaned after use. Removing all residues removes food and shelter for grain insects and applying an insecticide to the clean surfaces will control insects as they fly into the equipment. Treat the cleaned surfaces with protectants such as Dryacide®. This product will give at least 12 months insect control provided it is applied properly. To protect your header measure out 2–2.5 kg of Dryacide® and apply half to all the openings and inspection holes on the header. Probably the most effective application device for powders of this nature is a venturi-type airgun that will suck up dust from a bag and blow it into the header (one commercial brand is BloVac). Alternatively a horticultural hand dust bellows is very effective. Run the machine to disperse this material and then apply the rest of the dust to the same apertures. Fenitrothion may also be used on empty grain-handling equipment, but it is illegal to use it on grain. Clean down the equipment as before and apply Fenitrothion liquid as a 1 per cent solution until it runs off. Alternatively, apply 2 kg of Fenitrothion dust in the same way as Dryacide® (see above).

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Before harvest – clean up

Clean all silos before harvest and burn or bury any residues.

Safety warning: wear dust mask and overalls when shovelling grain from flat floor silos, especially if they have previously been fumigated with phosphine generating products. The fine powder residue retains 1 per cent phosphine which will be released by the moisture in your lungs.

Treat the inside of the silo with a suitable insecticide, such as Dryacide® dust (needs at least two weeks to be effective), Malathion dust or liquid or Fenitrothion liquid, to provide residual control until the grain is loaded into the store. Fenitrothion is a contaminant in exported grain. If you are using either liquid or dust in the weeks prior to harvest it is recommended you leave it in place for 2–3 days and then wash it off to prevent contamination of grain that may come into contact with the sprayed surface. It is better to apply Fenitrothion to an empty silo at least two months before harvest to allow it to degrade to harmless substances.

Before harvest – check the silo

Do not load the new crop onto old grain in the silo. Old grain in a poorly sealed silo is most likely to contain grain insects. If the silo is well sealed, fumigate as the top hatch is closed after loading. Grain stores must be maintained in a serviceable and watertight condition. Inspect the walls and hatches and repair any structural damage or faults that could let water penetrate. Water will activate the living organisms of the grain mass which will cause mould and sprouting. Mouldy grains are unacceptable for feed or milling purposes.

Farm grain storage options

When considering investment in on-farm grain storage there are alternatives—small transportable storage, large bolt pack storage constructed on-farm, and shed or bunker storage. All have advantages and disadvantages and the cost of establishment is often the overriding factor in the decision process.

However it is more cost-effective to make the management of the grain the overriding consideration because this investment is long term, marketing and products harvested are likely to change and the system must be flexible.

To produce a successful and profitable outcome from stored grain, management must commence as soon as the grain is loaded and continue at regular intervals until outturn.

Control of stored grain insects is pivotal to retain quality, and the infrastructure built into the grain store will determine success of the program. Sealing and aeration may appear to be an additional charge attached to the capital cost of the silo but in fact are integral to successful management plans and should be regarded as part of the initial investment in large grain silos.

Large silos are attractive because of the lower costs per cubic metre of storage if you intend to store large

tonnage of a specific grade. However it may be worth considering installing smaller storages at a lower capital outlay which can be expanded as profitability permits. Smaller storages have the advantage of greater flexibility to segregate, allowing access to very specific markets, and quality control is more precise. (see http://www.agric.wa.gov.au/content/fcp/cugrain_management08.htm)

Sealed storage

When buying a new grain silo of less than 100 tonnes, a factory-sealed model is a good investment in grain protection. Fumigation with phosphine-generating tablets in sealed silos is one of the best ways to control weevils in farm stored grain. (Refer to Farmnote 67/03 'Sealed silos make \$ense'.)

At least one sealed silo on each farm is essential as it provides a storage within which weevil-infested grain can be fumigated before transporting off the property. Sealed silos not only keep the gas in, but also keep insects out. However, they do not control insects unless a fumigant is used. It is also essential to fumigate the silo every time grain is added.

Once the silo has been purchased, insect control is simple—provided the silo is working correctly. The hatches must be sealed properly and the pressure relief valve filled with oil to the correct level. An annual check is essential. (Refer to Farmnote 68/03 'It makes \$ense to maintain your sealed silo'). Fumigation of a poorly maintained silo does not control insects effectively because gas will be lost, (Figure 1) insects will survive and the next generation may have phosphine resistance. (Refer Farmnote 307 Grain storage: insect control).

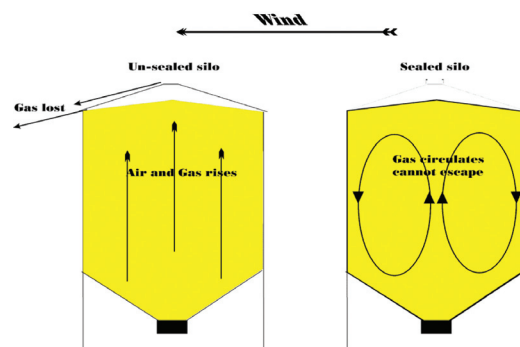


Figure 1 Wind blows against a leaky silo creating a pressure difference that draws out the gas

Bolted steel silos over 100 tonnes can be sealed during construction. This is an essential part of the task unless the silo is to be used short term, for bulk up at harvest or if only aeration is to be used. The contract to construct should contain a clause specifying the demonstration of a pressure test exhibiting at least a 10-minute halving pressure from a 25 mm head of water gauge.

Large silos over 200 tonnes can also be sealed for fumigation but it is recommended that aeration be installed for moisture management and grain insect suppression (see Aeration below). A gas recirculation system should also be installed in sealed silos over 500 tonnes to ensure the effective distribution of phosphine throughout the grain stack.

This avoids low gas concentration zones where insects can survive and confer resistance characteristics to their progeny.

Unsealed silos

Proper fumigation is impossible in unsealed silos. There may be an illusion of success when the adult insects are killed, but once the gas has dissipated the next generation of insects will emerge from eggs or pupae.

Existing unsealed silos may be modified and sealed successfully but the cost varies depending on the design. The age and strength of the silo should be considered before investing in retro-sealing. It may be an option to install aeration in unsealed silos and store only grain that does not require fumigation. Options for grain use could be feedlot, seed or short-term storage of high moisture grain for blending and delivery. Aeration keeps grain cool and insect numbers low, removing the need to use phosphine.

Shed or bunker storage

It may be possible to use an existing shed for very short-term storage such as harvest management. If the shed was not constructed to hold grain there may be problems with wall strength or hygiene. A purpose-built shed should have concrete thrust walls and a good concrete or bitumen floor for efficient grain extraction and good follow-up hygiene procedures. Sheds can be fitted with aeration systems, either permanent or temporary. Contact the aeration equipment providers to assess the design and power needed. Lateral portable ducts are a good option where it is uncertain if the entire shed will be filled.

Bunkers are a bitumen or concrete pad surrounded by removable thrust walls and covered with tarpaulins. These too have been proved capable of aerating with lateral or sucking system fans that draw the air through the grain stack instead of blowing.

White silos

Painting the silo white after installation on the pad will increase the reflection of solar radiation. The silo can be 4° C cooler than a weathered galvanised unit. A new Zinalume® silo also has good reflectant properties, almost as good as a white silo but on its own a reflective wall structure will not affect the core temperature in the short term. Forced ventilation (aeration) is needed to create an even temperature through the grain profile.

Aeration

Aerated silos are fitted with fans that pass controlled amounts of air through the grain. When aerated correctly, the grain is cooled and the grain temperature and moisture are equalised throughout the silo (Figure 3).

Aeration advantages

- Lower temperatures allow moist grain to be stored safely for longer periods.
- Moisture variations between loads is equalised.
- Equalised temperature of the grain mass in the silo prevents moisture migration (see moisture migration below).
- Hot spots are prevented from developing.

- Mould growth is slowed and insect development is reduced dramatically.
- Cool stored seed retains its viability and vigour for a longer period (for more information refer to Farmnote 24/ 02 'Aeration for preserving grain quality').

The recommended strategy is to run the fan for extended periods during the first few days of storage. Run the fans continuously for 24–48 hours to remove harvest heat and create even temperatures and moisture through the grain bulk. Even on the hottest days the grain temperature will be reduced by evaporative cooling. After the initial period the aeration fans are run when needed for a few hours to maintain the temperature or lower it still further.

The amount of cooling achieved during storage depends on the moisture content of the grain and the humidity and temperature of the incoming air. Seek advice on fan operation times from the equipment manufacturer or DAFWA.

The target grain temperature is 20 °C or lower, which is achievable under Western Australian climatic conditions with correctly controlled aeration. Selecting the coolest air can present a challenge if doing it manually. A power timing device will switch on at selected times and it is possible this will be sufficient if you reset it according to the season. Much improved control will be achieved by fitting an automatic controller that responds to temperature changes. A time-proportioning controller automatically resets its thermostat to draw in only the coldest air.

Should you use aeration?

Before deciding to fit an aeration unit, it is important to consider the final destination of the grain. If the grain is to be fed out or used for seed on the property, aeration will keep insect damage at a low level by slowing reproduction. If the product is to be transported off the property for sale, it must not contain any live grain insects. Aeration alone does not guarantee insect-free grain, so fumigation may also have to be carried out. Contact DAFWA for advice on the use of aeration for many different grain storage strategies.

Aeratable sealable silos

A silo can be constructed as a sealed unit with an aeration system fitted to its base. A vent is installed on the top of the silo to allow the air that is forced in at the base to escape. This can be a waterproof perforated lid in place of the sealed lid or a venting tube that can be capped for fumigation. Your silo or aeration equipment supplier should provide detailed operating instructions to help you store the grain safely in your silo.

Underground storage

Low-cost but makeshift underground storage has a place in some farming systems but a good natural site is essential and grain recovery will present some challenges. This system is appropriate mainly for long-term storage as a drought reserve. Grain left in properly designed underground stores will last for several years without any deterioration. It has even been delivered to bulk store after four years underground. (Refer to Farmnote 70/03 'Underground storage of grain').

Quality control at harvest

Store only dry and clean grain that contains no seconds, foreign seeds or other material that would be disallowed by the bulk storage operators such as Co-operative Bulk Handling, stock feed manufacturers and maltsters. Do not guess the moisture content of grain from the paddock, check it with a moisture meter. The moisture content of standing grain can increase dramatically in the late afternoon, particularly near the coast or under cloudy conditions. Fumigate as soon as the silo is filled to stop any insects that are present from creating moisture.

After harvest – preventing moisture migration

Grain loaded into sealed silos must be of sufficiently low moisture content to prevent moisture migration problems. Grain must be stored below 12 per cent moisture content. If the central store operator rejects a load because of excess moisture, do not load this grain into a sealed store where there is no escape for the moisture. In a sealed silo, there is no free venting and therefore no escape for moisture in the headspace.

If there is any chance high moisture grain may be loaded into the silo or it is a very large store, install aeration to cool the grain uniformly and prevent air currents moving moisture.

Grain loaded into an unsealed store should also have less than 12 per cent moisture content because moisture can still migrate and condense in the upper layers even though there will be some venting of moisture to the atmosphere. This upper area of the grain is at high risk from insect colonisation.

Moisture in a silo may come from:

- the stored grain itself and any weed seeds or impurities
- respiration of insects or mites in the grain
- water entering through a leak.

Grain is a living organism and releases moisture as it respire; the higher the moisture content the faster the respiration. This is carried upwards in a silo by convection currents of air (Figure 2). These air currents are created by the temperature difference between the warm grain in the centre of the silo and cool silo walls, or vice versa. When grain is stored at less than 12 per cent moisture and is free of insects, the moisture increase in the upper layers of the grain will not be significant. If it is stored at above 12 per cent moisture content, however enough moisture may be carried into the upper layers to place the grain at risk of activating moulds and bacteria.

Installation of aeration will equalise the temperature throughout the silo and reduce the circulating air currents that may carry moisture into the headspace (Figure 3).

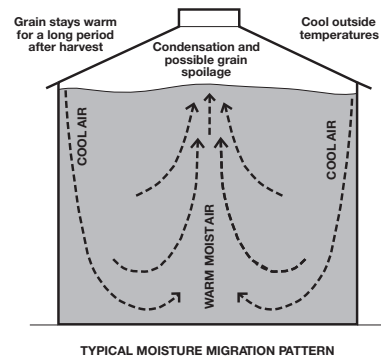


Figure 2

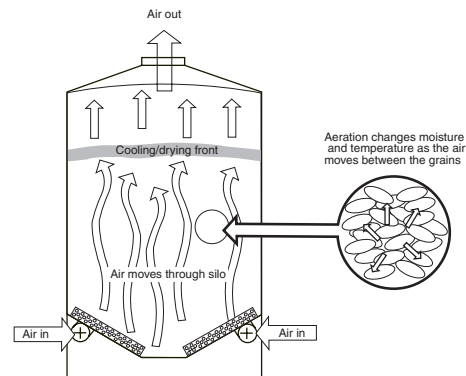


Figure 3

Insect activity releases moisture and heat into the spaces between the grains. Moisture builds up faster and to higher levels from insects than from grain respiration alone. Moisture carried into the silo headspace may condense on a cold roof and fall back as free water. This will sometimes cause a ring of grain to germinate against the silo wall. When the grain contains insects in large numbers, increased moisture can cause a damp mouldy layer across the top of the grain which can be difficult to outload.

Water entering through structural damage will increase grain moisture content to the point where mould growth occurs. This moisture may also migrate to other areas. Insects will develop more rapidly in these high moisture zones.

Further reading

- Farmnote 24/02 Aeration: for preserving grain quality
- Farmnote 64/03 Grain storage: Design and installation
- Farmnote 66/03 Grain storage: Handling and maintenance
- Farmnote 307 Grain storage: Insect control
- Farmnote 67/03 Sealed silos make \$ense
- Farmnote 68/03 It makes \$ense to maintain your sealed silo
- Farmnote 69/03 Effective fumigation needs a properly sealed silo
- Farmnote 70/03 Stored grain management: underground storage of grain