



## STORED GRAIN MANAGEMENT

# Grain storage: Maintaining grain quality

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Grain stored on farms for seed or livestock feed is an important investment.

Protecting the grain from insect attack can be regarded as an exercise in income protection.

Even light infestations of weevils can drastically reduce the germination of grain.

Weevils contaminate and eat food intended for your livestock. Grain can lose a lot of weight through a heavy infestation.

Weevils which survive over-winter in stored grain are ready to re-infest your harvesting machinery and next year's crop, leading to the risk of your new season's grain being rejected by the buyer.

Protecting the grain from moisture preserves the value of the grain.

Cereals in store are a community of living organisms made up of the grain itself, insects, mites, bacteria and fungi. While the grain stays dry and cool, most of these living organisms remain in a suspended state or at a low level of activity.

If the grain reaches moisture levels higher than the recommended 12 per cent these organisms become active. Bacteria invade the grain, fungal growth proliferates, insects and mites breed more rapidly and produce even more water, all of which ruin your investment.

Moisture levels can be controlled by:

- ensuring the grain is loaded at below 12 per cent moisture content;
- insects are controlled at loading to prevent them creating moisture; and
- an aeration system is fitted to manipulate the internal temperature.

### How to protect farm stored grain

The first essential is to practice good farm hygiene to reduce the overall numbers of insects on your property. This lowers the risk of infested grain being delivered for

export. It also gives any applied treatments a better chance to work.

### **Before harvest - clean up**

Grain handling equipment such as trucks, harvesters, augers and seeders must be cleaned after use. Remove all residues and then apply an insecticide to the clean surfaces as insects can survive even if insecticides are applied on top of the residue they are living in. Treat the cleaned surfaces with insecticide 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. 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, however **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).

Clean all silos before harvest and burn or bury any residues. Treat the inside of the silo with a suitable insecticide, such as Dryacide® dust, malathion dust or spray, fenitrothion spray, to provide residual control until the grain is loaded into the store.

Do not load the new crop on to old grain in the silo.

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 components of the grain mass. This may cause moulding and sprouting. Mouldy grains are unacceptable for feed or milling purposes.

### Important Disclaimer

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## **Silo storage**

### **Sealed silos**

When buying a new grain silo, 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; they also keep the insects out.

#### **But:**

- Sealed silos do not control insects without the help of a fumigant.
- It is 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 as gas will be lost, insects will survive and they may produce future populations with a degree of phosphine resistance.

### **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 but the cost varies depending on the design.

### **Emergency fumigation**

Fumigation is most convenient and effective in a solid sealed structure. However, in the absence of such a grain store, a good fumigation can be carried out under a gasproof tarpaulin. The aim of the procedure is to create a leak-proof envelope of plastic sheeting. Standard black 'builders' plastic sheeting is not gas-proof, is difficult to make leak-proof and is easily damaged. Heavy duty gasproof tarpaulins are recommended for the task.

Lay a tarpaulin on the ground and heap the grain on top, cover with a gas-proof sheet and roll the edges together. Lock them together with soil or weights to prevent gas loss. Calculate the size of the heap and apply 5 grams of phosphine per cubic metre.

Unroll a small section to allow the introduction of phosphine in a bag chain or sachet formulation. If tablets are used on a tray, you must create 30 cm of airspace above the tray of tablets to avoid the development of

explosive concentrations of gas. Allow 10 days for the gas to release and full circulation to occur. Open the rolled edges and let the remaining gas escape. Remove the tarpaulin and allow three days of ventilation before delivery.

If the tarpaulin is large enough it may be possible to dump the grain in the middle and roll the edges together on top of the pile.

### **White silos**

Painting the silo white after installation on the pad is a useful management tool. A white painted silo can be 4°C cooler than a weathered galvanised unit.

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.

### **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.

Fans are run for extended periods during the first few days of storage. An average of 12 hours using the coolest and driest air of the day is common. This removes harvest heat and evens out temperature and moisture, avoiding hot spots and moisture damage.

For longer term storage, aeration fans are run for a few hours when needed.

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 Department of Agriculture.

### **Aeration advantages**

- Lower temperatures allow moist grain to be stored safely for longer periods
- Even temperature of the grain mass in the silo prevents moisture migration
- 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 see Farmnote 24/02 'Aeration for preserving grain quality').

### *Western Australian trials*

Western Australian trials have shown that correctly controlled aeration can reduce grain temperature to 20°C or lower through summer. Use dry, cold air so that moisture levels are not increased and fit a 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 Department of Agriculture for advice on the use of aeration for many different grain storage strategies.

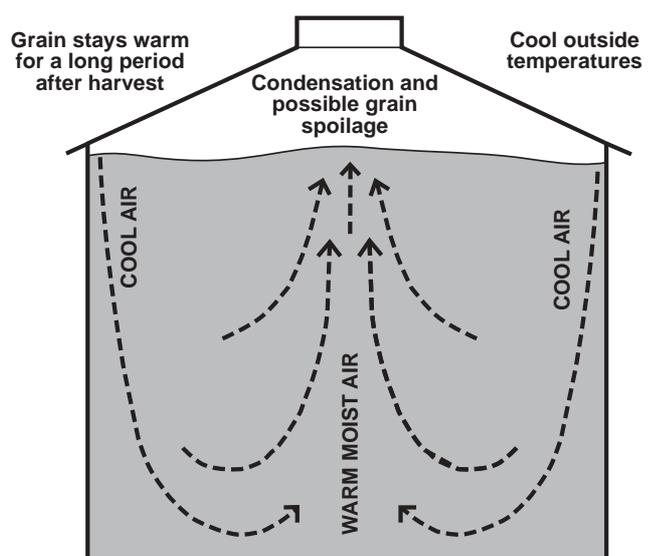
### **Aeratable sealable silos**

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 recovery may be difficult. This system has



**TYPICAL MOISTURE MIGRATION PATTERN**

a place 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 allowed 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, creating moisture.

#### **After harvest - preventing moisture migration**

Grain loaded into sealed silos must be of sufficiently low moisture content to prevent moisture migration problems. 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. Grain must be stored below 12 per cent moisture content.

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

#### **Moisture in a silo comes from three sources:**

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

Grain is a living organism and releases moisture as it respire. This is carried upwards in a silo by convection currents of air. 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, enough moisture may be carried into the upper layers to place the grain at risk of going mouldy.

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.

## **Insect control**

### ***Fumigation***

Grain in a well maintained sealed silo may be protected indefinitely by adding two phosphine generating tablets per tonne of silo capacity. Place them on the surface of the grain in trays and observe the correct fumigation period of at least seven days. (Refer to Farmnote 67/03 'Sealed silos make Sense'.)

Although a well-sealed silo will not allow insects to re-enter, it is still necessary to check the grain at regular intervals for insect infestation after fumigation.

Phosphine leaves no detectable residue when applied correctly and treated grain may be delivered at the bin with no penalty but a declaration must be made. It is **illegal to transport grain under fumigation or deliver grain with partly decomposed phosphine tablets**. Phosphine will not damage germination at this recommended rate.

### ***Insecticide***

Malathion is the only insecticide registered for application to grain by farmers in Western Australia. Malathion resistance among insects is widespread throughout the State and you should consider other control methods whenever possible. Malathion will protect your grain for three to six months where insects are still susceptible.

Spray the label recommended mix onto the grain at the rate of 1 L per tonne as it is augured into the silo. Alternatively, add Malathion dust at 1 kg per tonne. Increasing the dose rate will not significantly increase protection. Malathion will break down in three to six months under ideal (cool, dry) conditions.

The use of other insecticides for protecting grain is illegal in Western Australia.

### ***Dryacide®***

The treatment of grain with Dryacide® dust at 1 kg per tonne will give protection for at least one year, and sometimes more. In all cases the grain must be dry (no more than 12 per cent moisture) and the Dryacide® must

be thoroughly incorporated, preferably using a mechanical applicator. Dryacide® should not be used on dusty grain or if insects are already active in the grain. This is because Dryacide® is a **protectant** and does not kill a large population of insects quickly.

Dryacide® treated grain may be stored in unsealed silos or in any convenient place. It is the best treatment for grain stored in old silos which are difficult or expensive to seal. The cost of treating grain with Dryacide® is much greater than fumigation in sealed silos but enables the use of existing silos without incurring the cost of sealing.

Dryacide® treated grain is safe to feed to both humans and animals but it cannot be delivered to CBH because of dust and because of the changed flow characteristics of treated grain. If sowing Dryacide® treated seed remember to recalibrate the seeder. A machine set for untreated grain can sow 10-15 per cent less grain with Dryacide®.

### ***Dryacide® and moisture migration***

To be effective, Dryacide® must be applied evenly throughout the grain with a mechanical applicator. If it is not mixed thoroughly, isolated pockets of weevils may survive. Moisture and heat liberated by these insects as they feed may migrate to surrounding areas and ultimately into the headspace.

In a poorly maintained silo that has been factory sealed but is no longer airtight, it is difficult for moisture to vent to the atmosphere so the upper levels of grain may rise above 12 per cent moisture content. Above this moisture content, Dryacide® continues to absorb the wax from the cuticle of the insect but the weevils can survive without this covering.

**Note:** Mention of trade names does not imply endorsement or preference of any company's product by Department of Agriculture, and any omission of a trade name is unintentional. Recommendations were current at the time of preparation of this publication.

### ***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 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"