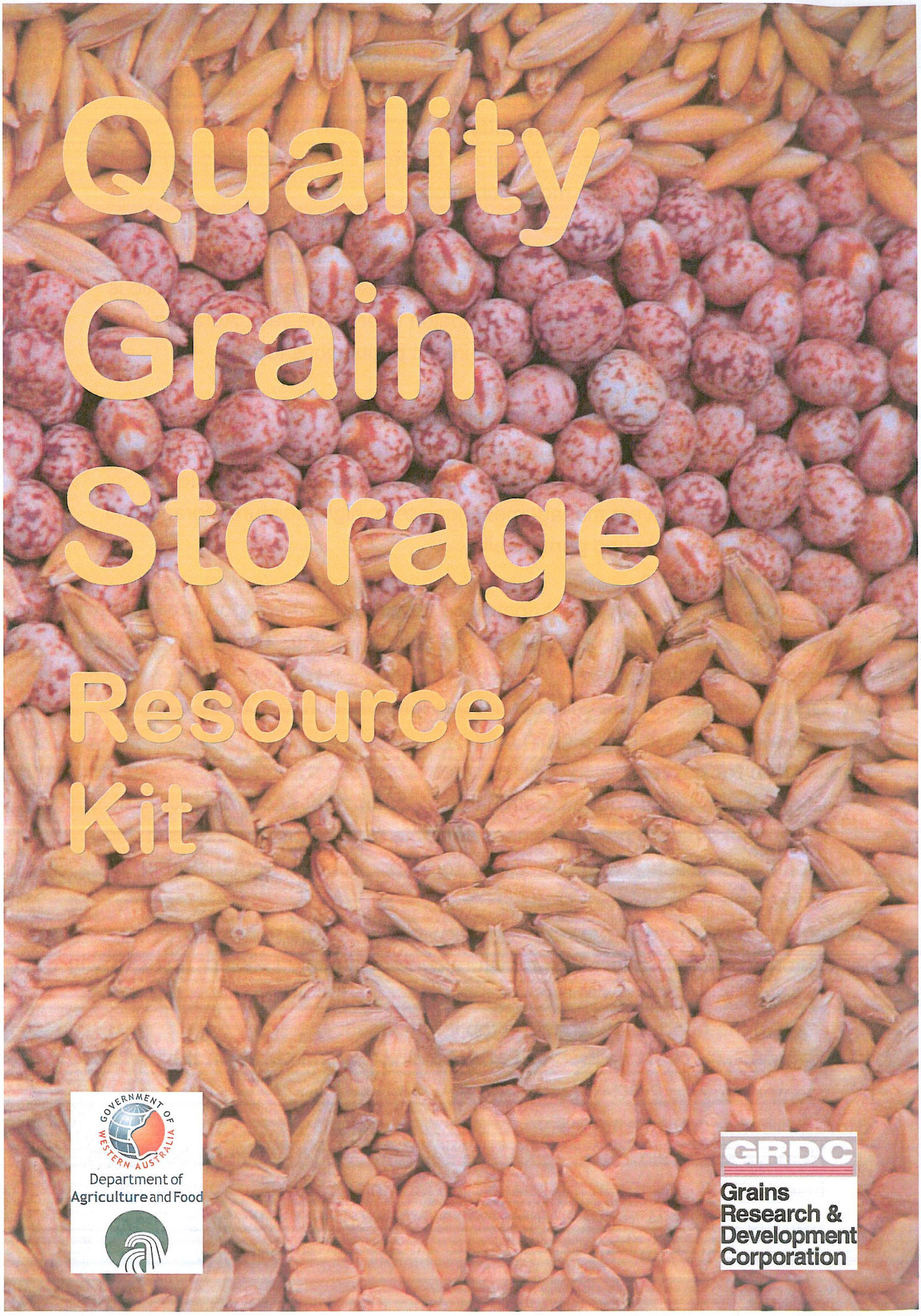
Quality
Grain
Storage
Resource
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GOVERNMENT OF WESTERN AUSTRALIA
Department of
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Checklist for Quality Grain Storage

Physical factors affecting grain quality

Organisms such as insects, fungi and bacteria exist in stored grain and be come active under warm moist conditions.

Insects in grain

Insects are present in the environment and will enter the new grain as it is being loaded into the silo. Fumigation at harvest in a tested sealed silo is essential to prevent a population explosion later in the year. Aeration in un sealed silos will keep grain cool and insect populations low.

Options to protect grain

Options to control stored grain insects are limited in WA, chemicals other than malathion are banned. Fumigation is the main alternative and Dryacide® for un sealed storage and organic storage. ***Aeration*** cools grain providing advantages in harvest management, long term high moisture storage and retains grain quality and germinability.

Fumigation procedure

Phosphine is the main insect control on farms and in the export grain pathway. Resistance to phosphine is widespread and increasing. Correct fumigation means no survivors.

Only a sealed structure will hold the gas long enough to achieve complete elimination of insects in a grain bulk.

Preparation for harvest

Clean out and spray out all grain handling equipment and grain stores at least three weeks before harvest. Check sealable silos by pressure testing and repair as necessary. Remove weeds rocks and rubbish from the grain storage area.

Storage management at harvest

Store only grain below 12% moisture content in sealed silos or up to 15% in aerated silos. Do not put phosphine tablets up the auger, place them on a tray in the headspace when the top lid is closed.

Run aeration fans for 48 hours after loading the grain to lower the temperature to 20°C or below

Storage management after harvest

Remove spilt grain and keep the site free of rubbish that can harbour grain insects. Check grain in the headspace monthly. Pitfall traps give an early warning of insects in the grain. Leave silo sealed until outloading. Run aeration fans manually for a few hours a week to maintain a low temperature.

Quality Grain Storage

Factors Affecting Grain Quality

Physical factors in a bulk of grain

- A bulk of grain is not static. Grain respires and many organisms exist that, given the right conditions become active, with the potential to lower the value of the grain. Grain insects exist in the farm environment and you must always assume that some have entered the silo while loading.
- Respiration of the grain at 12% moisture is effectively zero but when moisture migrates to one part of the stack, it can stimulate the grain to a higher respiration rate and activate moulds.
- The most notable creators of moisture are insects. The accumulation of moisture stimulates moulds which not only downgrade the quality but release more heat which in turn stimulate more rapid insect development. A vicious cycle!

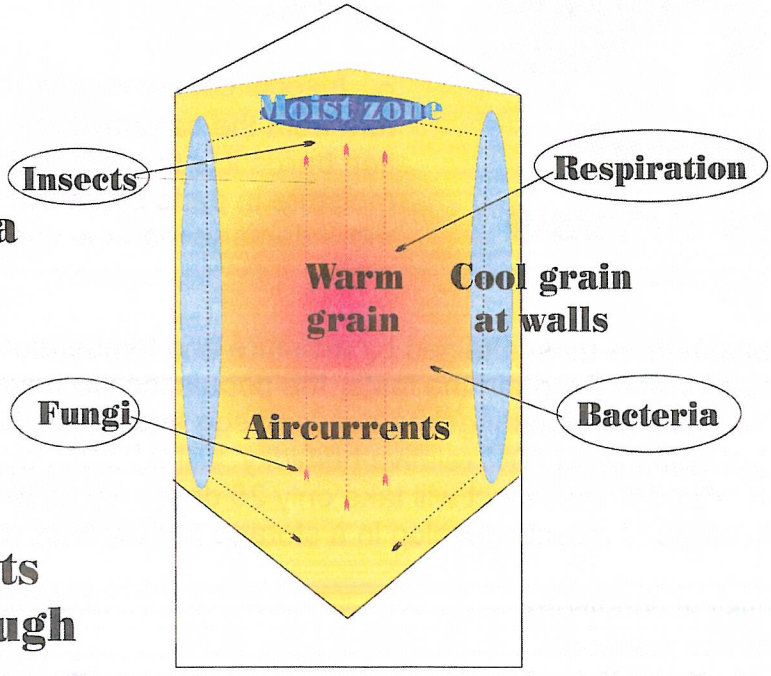
A bulk of grain is not static

grain respires

micro flora exist

insects exist

air currents move through



When insects or moulds are active lower in the grain stack the moisture they create is carried to the upper layers where it condenses. This moisture is moved by the air currents, caused by cool walls and a warm core, circulating within the grain stack. This condensation be comes evident inside the top of the silo in the cooler months. In a very bad situation, moulds and bacteria severely damage the grain in the upper layers. When the bottom hatch is opened this mouldy grain will flow down as the central column moves, drawing the upper layers first, and contaminate the better grain. In severe situations it can also block the lower outlet.

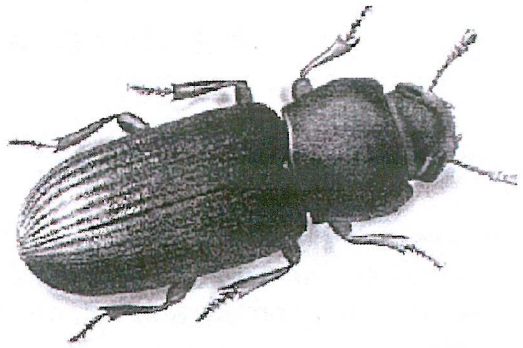
Warm air moves moisture in the silo

moist zone can develop at the top of the stack
grain funnel flows at outloading
quality of all grain in silo downgraded

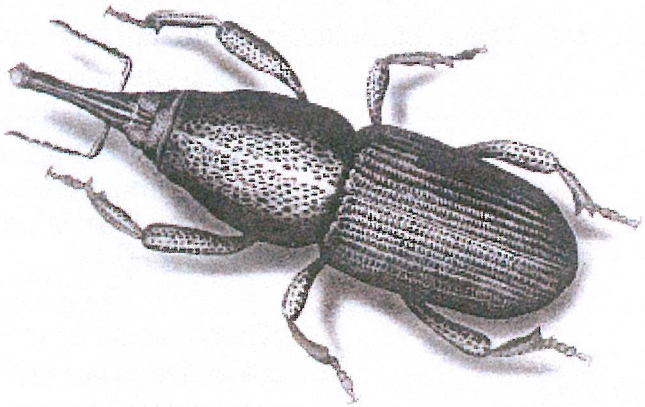
Insects in Grain

how insects damage grain

- Grain insects are divided into two groups, internal feeders (Primary insects) and external feeders (secondary insects). So called because of their feeding habits, the internal feeders produce larvae that burrow into the grain. Inside the kernel they complete their larval and pupation stage before boring out as an adult. The damaged grain and flour they have created are consumed by the external feeders.



Rust red flour beetle
Tribolium castaneum



Rice weevil
Sitophilus oryzae

- Early detection of insects is very important. If you leave it until you see insects before fumigating, numbers are quite high and much damage has already been done. Detection is best done by screening grain from the lower outlets, or pitfall traps set in the top of the silo.

- Insects consume grain and create moisture from the carbohydrate. As the population builds it is the accumulation of this moisture in parts of the silo that causes more damage than the consumption of grain alone.

- Insect population development is most affected by moisture and temperature. As a rule of thumb the more moist and warm the grain the faster the population will develop. The key to the speed of development is the shortening time between egg and adult. As an example the Lesser grain borer at the optimum of 70% relative humidity will take 84 days at 22°C to
- cycle from egg to adult. At 34°C the insect will take only 25 days. So at 30 plus degrees, there will be greater numbers of insects develop in a storage period, than at 22°C.

- Manipulation of the physical conditions in the grain bulk will reduce insect development considerably. **Keep it cool and dry.**

Lesser grain borer
Rhyzopertha dominica

Defend Your Grain

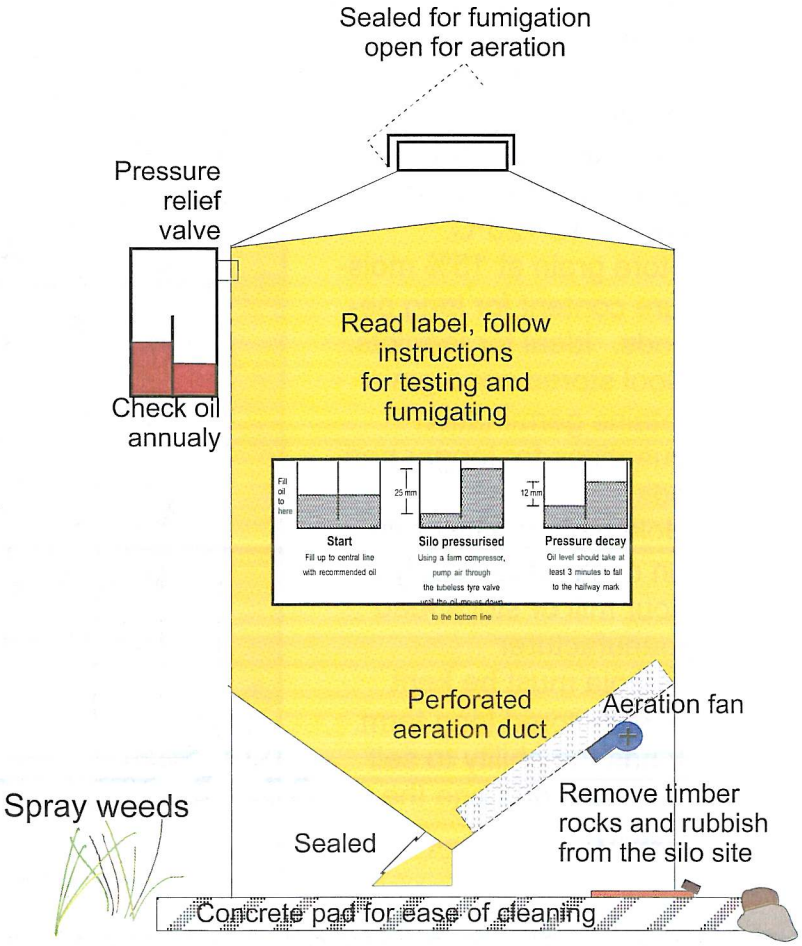
50 tonne silo = $6000 or more of farm income. Feed grain is potential income.

- The control options in WA are limited to phosphine gas, Dryacide® in unsealed structures and occasionally the insecticide malathion where the insects remain susceptible. However malathion resistance is widespread and few farmers are using it. All other grain insecticides are illegal to be applied to whole grain. The chemical Fenitrothion is limited to hygiene treatments on empty storages and grain handling equipment. Applying the chemical to an empty cleaned silo and allowing it to dry does not present a contamination hazard. If there is concern of chemical residue at destination, use Dryacide® dust as the hygiene treatment.

- The most important message for good protection from insect attack is to ensure the silo is sealed to the recommended standard. Phosphine can only give total control in a sealed and tested structure. **Refer section on the principles of fumigation.**

- Pressure test the silo annually, referring to the yellow label stuck on all sealed silos. The silo is not hermetically sealed and so there will be a gradual decay of pressure. The silo should be able to hold at least half the initial level of 25 mm for three minutes or longer.

- The pressure required is very low, 250 Pascal (one quarter of one kilopascal) and demonstrated by a change in oil levels in the pressure relief valve. (See Farmnote 68/03 for Moylan silos) The test can be easily carried out with a standard farm compressor, pumping the air into the silo via a tubeless tyre valve mounted in the wall or boot of the silo. Better still use a venturi type blower / vacuum device, with a PVC fitting in the wall or seal plate of the silo. The ambient condition at the time of the test should be stable i.e. full sun or full cloud and light winds. Part cloud cover causes variations in the wall temperature of the silo and results in expansion and contraction of the internal air, which causes the oil levels in the manometer to rise and fall making a pressure test very difficult.



- Most of the problems with failure to achieve pressure are to be found in the inlet and outlet rubber seals and the oil level in the pressure relief valve / manometer. The rubber seals are readily available from any industrial rubber supplier and the recommended oil in the valve is light hydraulic. All other oils with the exception of paraffin may react with phosphine and solidify.

- Maintain a level of hygiene around the silos, particularly clean up grain spills. Remove the grass around the silo and remove general rubbish which provides a harbourage for insects.

Aeration

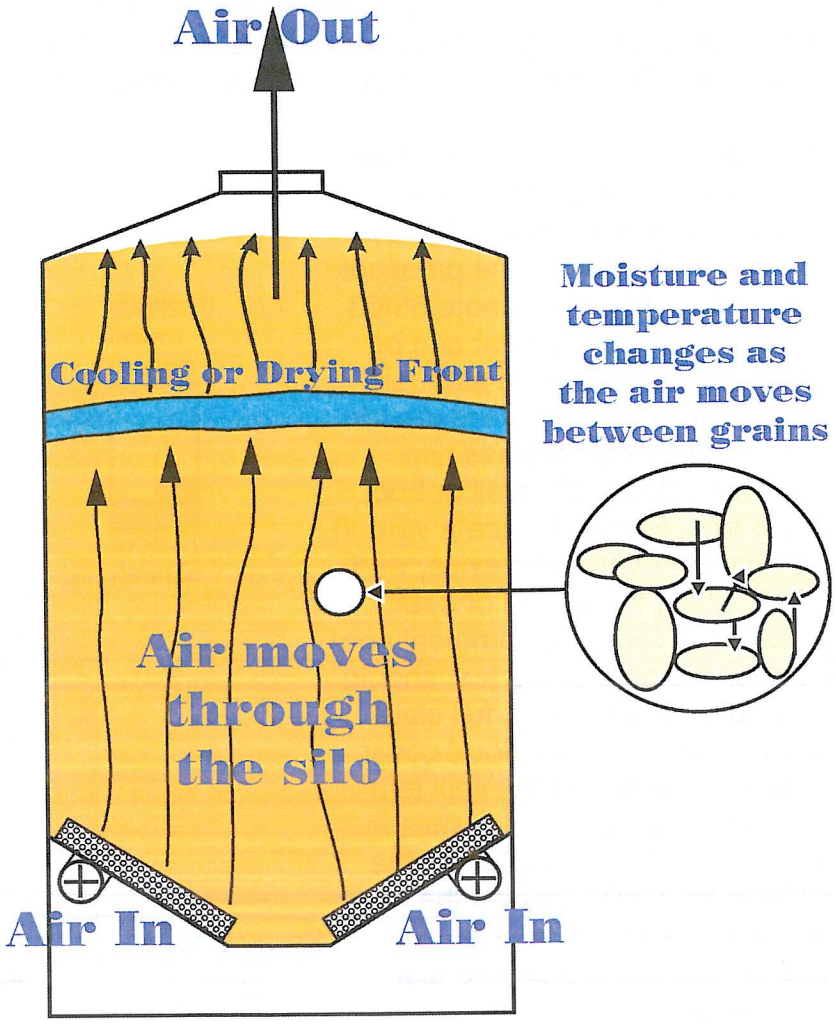
Aeration is a versatile system, when installed in a silo will defend the value of your grain

Harvest management – Need fans to deliver 2 - 5 litres / sec /tonne to cool it to a safe 20ºC

- Harvest grain at up to 15% moisture.
- Retain quality by removing it from weather damage.
- Earlier harvest removes the grain at optimum performance preserving the germination quality.
- Hold grain for blending or later drying.

Cool grain for long term storage – Need fans to deliver 1 – 2 litres / sec/ tonne for temperature maintenance

- Aeration equalises the temperature in the silo which prevents moisture migration and development of 'wet' zones where insect activity is greater
- Grain quality is retained by keeping the grain cool at 18 - 20ºC.
- Store grain at 15% moisture content for long periods. Ideal for feedlots.
- Cool stored seed grain retains germination quantities for longer periods
- Hold high quality grain on contract to supply a flour mill or stock feed manufacturer
- Canola must be kept cool if stored long term. It has the ability to self heat and damage the oil quality.



Grain drying – Needs large fans delivering about 20 litres / sec/ tonne for frequent air changes around each grain.

- Aeration is often regarded as a cheap form of drying but the principal function is to cool grain.
- To dry grain you need good ducting for maximum air distribution,
- A controller to select only the driest air available during the day.

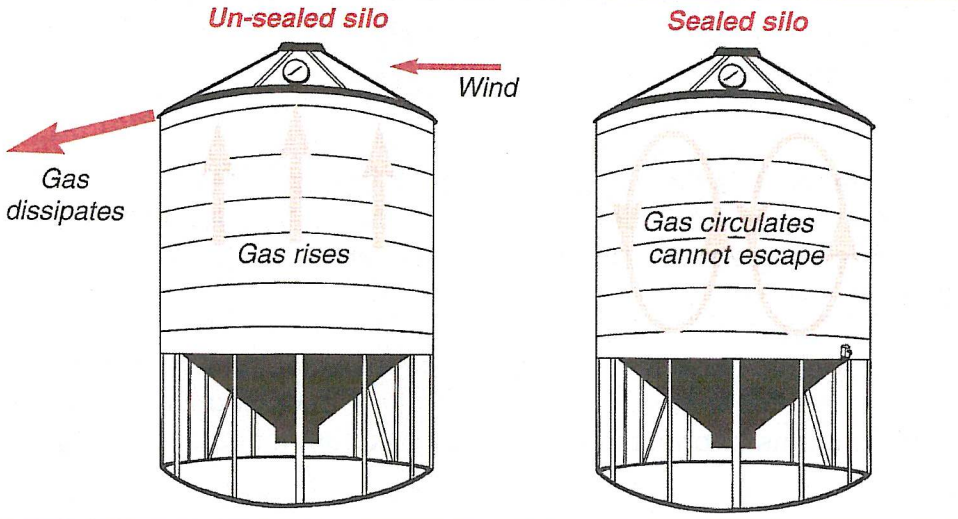
Fumigants and Fumigations

Fumigation is precise - only a well sealed silo will do.

Definition

Fumigation is the use of toxic gas within a confined airspace to kill 100% of the target species. The most common fumigant readily available to farmers without a fumigators licence is phosphine. There will be other fumigants available in the future but it is likely all will have training limitations imposed before they can be purchased and used. It is most important that availability of phosphine is retained. It is vital phosphine is used responsibly to prevent operator accidents and resistance developing in grain insects. ***Repeat fumigations in poorly sealed structures continually select the most phosphine resistant strain of insects in the silo.***

Controlled atmosphere is the use of an inert gas within a confined airspace to kill 100% of the target species. The gas may be Carbon dioxide or Nitrogen.



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

Procedure

Whether it's a fumigation or a controlled atmosphere, the aim is hold a concentration of the gas within the structure for a specified time. This is known as the C x T product (concentration x time) and is specified for each target species. For the purposes of grain insect control in WA we specify 150 ppm for 7 days, which will eliminate all known stored grain insects. But to allow time for the gas to evolve from the tablets and reach lethal levels throughout the grain bulk, add three days.
So fumigation takes about 10 days above 25°C and 13 days below 25°C.
In addition there is a ventilation period of 1 – 5 days. If aeration is installed this can vent the silo correctly within 24 hours. For the majority of farmers the recommendation is to remove the top and bottom seal plates and open the top hatch for 5 days. There is an additional 2 days withholding period,
before the grain can be consumed.

Unsealed silos cannot hold the gas long enough to achieve the recommended C x T product. As the wind blows across a silo, a chimney effect is created and the air (and gas) are drawn upwards and dissipated on the leeward side of the silo. There are usually enough gaps at the top and bottom of the silo to enable the gas to be drawn out.

Few farmers have gas monitoring devices but if the recommended dose rate is used and the structure is properly sealed, the silo will reach the recommended C X T product. To check you have achieved a correct fumigation, put a Phoscard® under a seal plate furthest away from where the tablets were placed. If the copper strip goes green or black the fumigation has been effective.

Timing is important. The correct time to fumigate is at harvest when insect numbers are low, so we recommend taking the tablets to the top of the silo when the lid is to be closed and sealed after filling.
If you leave the fumigation until you see insects, damage has been done and the grain could have lost quality. After fumigation leave the silo in a sealed condition and insects cannot re-invade.

Remember. The dose rate is related to storage capacity not quantity of grain in the silo, you are fumigating the airspace not the grain. 2 tablets / tonne of silo capacity in wheat.

Controlling insects without a sealed silo.
Dryacide® is the main option. Many farmers have returned to Dryacide despite the changes in flow characteristics of the grain. It gives really good protection in the unsealed environment and is the only insecticide that can be used by organic growers. It gives 12 months protection but must be applied with a pickle applicator to ensure an even coverage.

Aeration will slow the insects down but if the market demands insect free grain, then it has to be fumigated in a sealed enclosure to control all stages of the insect. It is recommended to have at least one sealed silo on the property to be used as a hospital silo to fumigate grain before it leaves the property. It remains illegal under the Agriculture and Related Resources Protection Act to move live, stored grain insects off your property.

Unsafe practice
A fumigation practice that must not be used, is the fumigation of grain in trucks. It is illegal under the Health Act to move a load of grain that is still under fumigation. The full fumigation and ventilation period must be observed before the grain can be moved. This can be up to 15 days depending on the grain temperature.

Feed manufacturers in Perth do not like receiving weevily grain and have clamped down on the delivery of live phosphine (hot loads) into their mills. Some of them now have phosphine monitoring probes which can detect small amounts of phosphine in a load that has not had sufficient time to vent.

The practice of adding water to tablets or placing them on a wet bag is also a dangerous practice. Many farmers have set their grain on fire doing this. The water releases the gas very rapidly, reaching the flammability concentration within hours.

Safety at fumigation
When fumigating always do the job from the outside, never climb down to the surface of the grain to probe the tablets. The tablets should be suspended in the headspace of the silo and the air currents will carry the gas around as it liberates from the tablets.

We recommend the use of safety harness, full face respirator and neoprene gloves. This is an S7 product and must be handled with respect. The tablets are best placed in a tray suspended in the headspace or use a bag chain of phosphine.

After sealing the silo, the details of the fumigation should be recorded on a sign attached to the silo which also contains the text **DANGER POISON GAS KEEP AWAY.** This is so that all workers on the farm understand when the silo can be opened and correct ventilation and withholding periods observed.

Before Harvest

Check before loading new grain

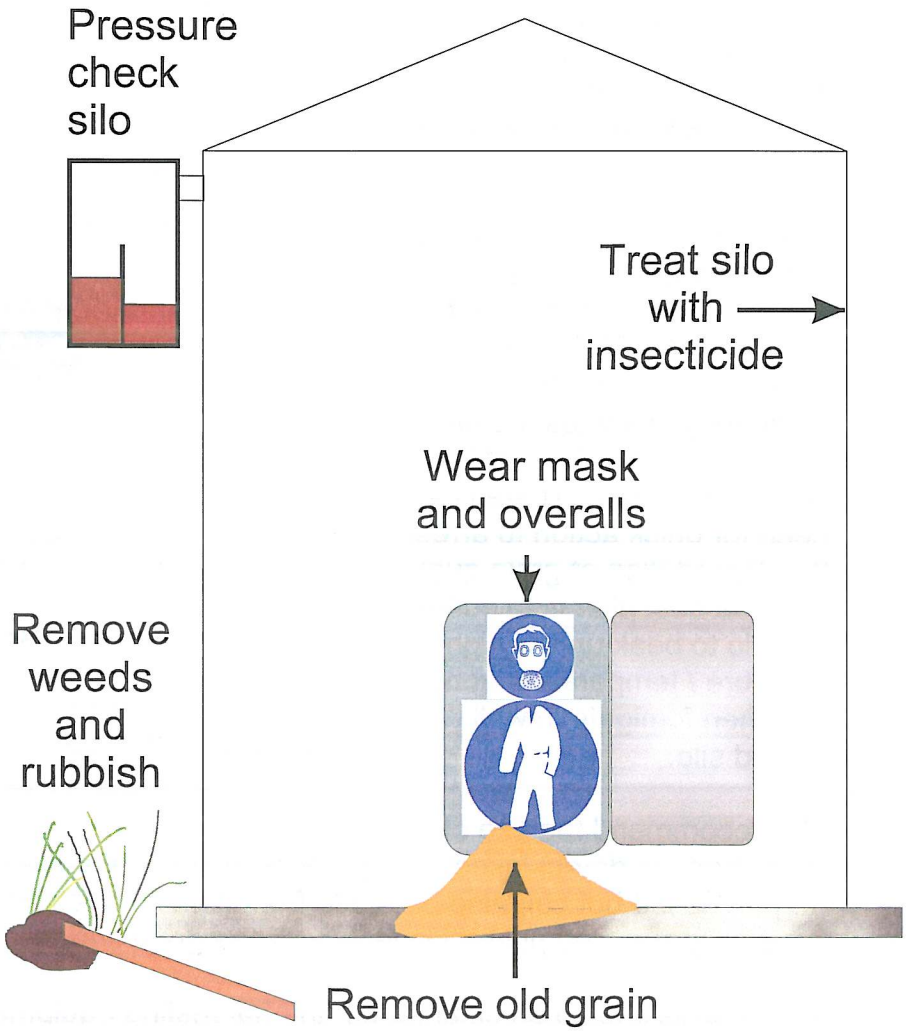
- Silos should be cleaned out and sprayed out when they are first emptied, an unclean silo has sufficient residue on the walls to keep a population of insects alive until harvest. If not cleaned out earlier, then at least three weeks before harvest the residues must be removed and the silo sprayed out with a suitable insecticide. Dryacide is effective at this stage but as the harvest approaches, Fenitrothion should be used for a fast knockdown. Dryacide needs at least two weeks to be effective. There is a risk of contamination of the new grain if Fenitrothion is used very close to harvest so the silos / grain handling equipment should be washed out before grain passes through them.

- Protect yourself when shovelling grain in a flat floor silo. The dust is a safety hazard in itself but when the grain has been previously treated with phosphine is can be extremely dangerous. The powder residue from the phosphine tablets retains a fraction of unreleased phosphine which can only be extracted in water. When breathed into the lungs there is sufficient moisture to activate the remaining phosphine. We have not had a death from this poisoning yet but many farmers across the country have ended up in hospital suffering the effects of phosphine poisoning.

- Weeds and general rubbish harbour insects and must be removed from the site. The old grain should also be removed from the vicinity of the silos and fed out to the sheep or burnt if it is low grade residue. If you don't have stock or a fire is forbidden, spread the residues thinly on a salt scald or along a fire break and turned in.

Pressure test

Ensure there is sufficient light hydraulic oil in the pressure relief valve. Compress the silo to create a difference of 25 mm in the two chambers of the pressure relief valve. Check the time taken for the level to fall to half of the original level - this should be three minutes or longer. Pressurise through a tubeless tyre valve in the silo wall. For a faster result use a vacuum / blow gun on the end of the air hose, pushed onto a PVC fitting in the wall or a seal plate of the silo. The PVC fitting can be drilled into the inspection opening cap of a Moylan pressure relief valve. If the silo valve levels do not respond, replace the rubber seals that are faulty.



At Harvest

load and protect the grain

- Store grain at or below 12% moisture content, or up to 15% if aeration is fitted. It's most important to check the grain with a moisture meter prior to loading. In a sealed silo moisture migrating to the upper layers cannot escape and a wet zone may develop.

- If aeration is fitted it should be switched on as soon as the ducts are covered. It is normal to run the fan(s) for at least 24 - 48 hours to equalise the temperature in the grain. The time taken to achieve this depends on the size of the fan

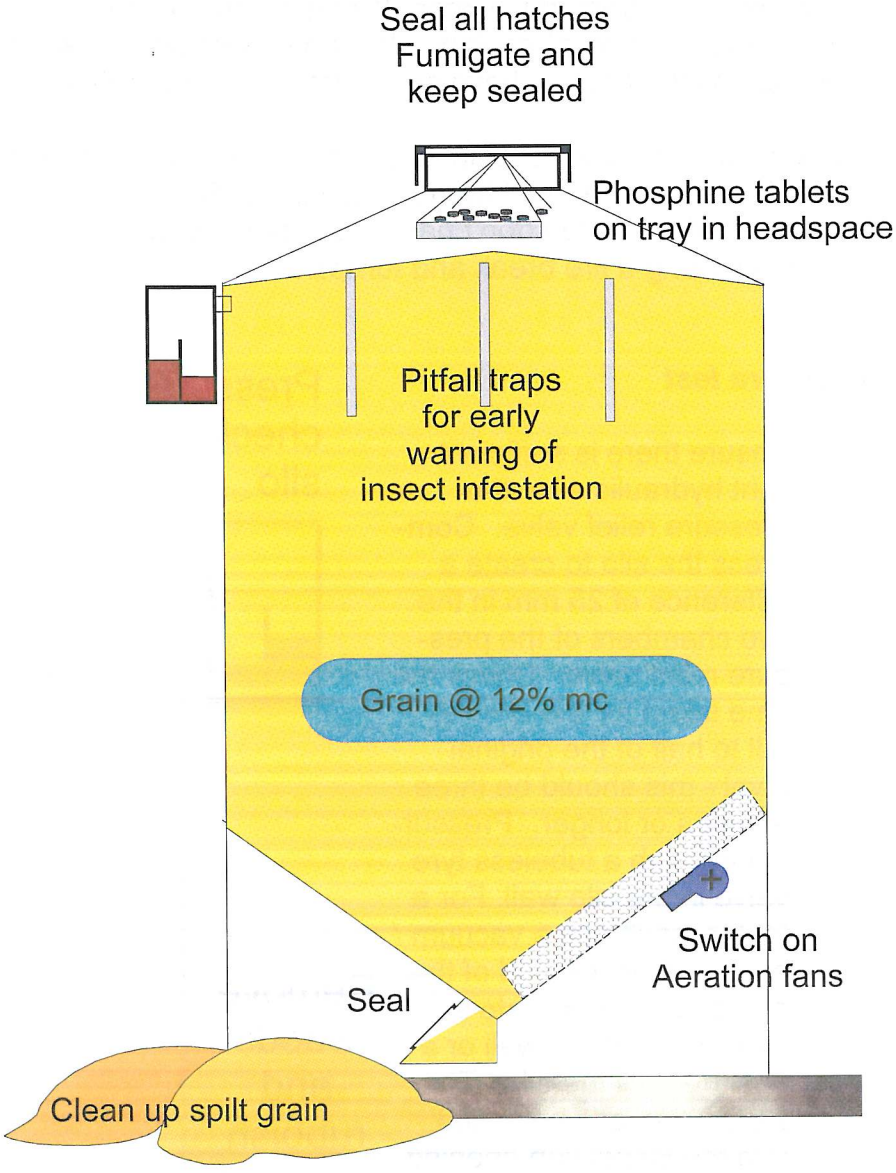
- We strongly recommend that the phosphine tablets are placed on a tray in the headspace and not put up the auger. Phosphine tablets start to liberate their gas on contact with air, so if the silo remains open for a day, a large part of the gas will be lost. If the silo is open for 24 hours - all the gas is lost from the first tablets placed in the auger. When you climb the silo to close and seal the lid take the tablets with you and place them in a tray.

After harvest

monitor the silo regularly

- The tray holding the toxic powder residue must be disposed of properly after fumigation. Burial is probably the best option but it can also be swamped with water to release the last fraction of phosphine locked in the powder.

- The silo should be left sealed until the grain is needed but check the headspace monthly for problems. Moisture increasing in the headspace, most likely indicates the presence of high numbers of insects in the grain. There is a need for quick action to arrest the degradation of grain quality. The best plan is to outload the silo to beak up the high moisture / temperature zones and then fumigate in well sealed silo.



- We recommend the use of pitfall traps to detect insects long before they become visible in the grain. Pitfall traps can be purchased but can also be made from item such as an open beer can or plastic cup covered in fly wire and pushed in level with the grain surface.

- Grain spills should be cleaned up and harvesting equipment cleaned out and treated with Dryacide to reduce insect harbourage.