CROPPING

Grain storage

Aeration minimises moisture problems

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Properly maintained silos offer the greatest chance of protecting the thousands of dollars Australian growers have invested in stored grain.

Surveys indicate growers store an average of 200 tonnes of grains per farm and based on \$175/t, this means an average investment of \$35,000 each. Whether grain is stored to be fed to livestock or for later sale, the investment must be protected.

Problems with stored grain have been reported from all agricultural areas and include caking on silo walls, damp mouldy grain and sprouting grain. These problems are caused by poor grain management or inadequate maintenance of the storage vessels and they can result in losing all or part of the investment. Almost all problems can be eliminated by correctly maintaining silos.

Moisture is one of the greatest threats to stored grain and comes from three sources:

- 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 living and it releases moisture as it respires. This moisture is carried upwards in a silo by thermal currents of air.

These air currents are created by the temperature difference between the warm grain in the centre of the silo and the cool walls or vice versa. When grain is stored at less than 12 per cent moisture content, the increase in the upper layers of the grain will not be significant.

If it is stored at more than 12% 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



- Stored grain represents a substantial investment on each Australian farm.
- Many problems which devalue stored grain are caused by insect activity and moisture.
- Aeration can alter and maintain the moisture levels and temperature of stored grain.
- The combination of aeration and a sealed silo offers superior moisture and insect control.



Almost all problems associated with grain stored in silos including caking on silo walls, damp mouldy grain and sprouting grain can be eliminated by following correct maintenance procedures. Aeration is used widely throughout the world to preserve the quality of stored grain. Inset: Fans powered by small engines on the base of the silos regulate the amount of air that passes through the grain.

grains. Moisture builds up faster and to higher levels from the insect activity 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, increased moisture will promote a damp mouldy layer across the top of the grain. Water entering through structural damage will increase grain moisture to the point where mould growth occurs.

Aeration

Aerated silos are fitted with fans which pass controlled amounts of air through the grain. When aerated correctly this cools the grain, equalising its temperature and moisture throughout the silo. Aeration is used widely throughout the world to preserve the quality of stored grain and it is particularly useful to at least permit the temporary storage of higher moisture grains.

The Smart Aeration trial investigated the timing and control of aeration procedures and the integration of the process into pest management programmes.

The trial, run by the CSIRO on properties in Western Australia and Queensland, aimed to develop low cost, effective ways to aerate small and large grain stores to achieve pest and residue free grain.

During long-term grain storage, aeration equalises and lowers the temperature throughout the silo, keeping grain at a temperature which is safe for its moisture content. The heat in stored grain may be due to respiration or because the grain was harvested under hot conditions. This heat can be removed by passing cooler ambient air through the grain. Equalising temperatures throughout the stored grain prevents the development of thermal air currents found in a non-aerated grain bulk. Preventing thermal cycling reduces the risk of moisture migration and there will be less chance of crusting on the surface, reducing the risk of moulding and sprouting of grain.

Grain cooling

Grain cools under aeration because the relative humidity of the incoming air is lower than the equilibrium moisture content of the grain. This is called evaporative cooling .

Direct cooling occurs when the incoming air is colder than the grain mass. This will not happen in many parts of Australia until some months after harvesting.

The benefits of cool grain include maintaining seed viability and reducing insect population growth. In eastern Australia added benefits are reduced dependence on chemical protectants and an extension of the active life of any chemical applied.

Sealed aerated silos

Aeration alone slows or stops the growth of insect populations but does not usually kill them. It is necessary to have an effective insect control technique in addition to aeration if insect-free grain is needed at outloading. Fumigation in a sealable silo is the best option for most grain-growing areas.

Hybrid silos which can be sealed and have aeration equipment fitted are now available in the eastern states of Australia. While grain is being aerated, a venting device on the roof allows air to escape from the silo. When fumigation is underway the vent is sealed and an airtight plate secured across the inlet of the

Grain storage...

aeration fan. The aeration trial, which started in 1993, undertook a number of full scale trials in various regions in large and small stores. It demonstrated that well controlled aeration, sometimes combined with a surface treatment of Dryacide of pesticide could effectively control pest infestations. Significant grain

drying was also achieved in aerated farm silos. An earlier trial at Wickepin, Western Australia, in 1992 involved oats being loaded into a silo at about 14% moisture content between 21 degrees Celsius and 34°C. The silo was fitted with a fan and ducting and a venting lid replaced the top loading hatch cover. Aeration started as soon as the grain was placed in the silo and the temperature was reduced to 20°C by evaporative cooling.

Ambient temperatures during this period ranged from 22°C to 37°C. During the winter months the temperature was reduced to between 10°C and 15°C. This proved to be too low and some moisture was drawn into the silo with the cold air.

Condensation caused moulding and caking around the ducting. Despite this minor problem, the quality of the oats when out loaded in October 1993, was excellent and had a 'fresh' odour.

Insect activity was monitored using traps in the aerated silo and a control silo. While some insects were found in the aerated silo, they did not increase to the extent found in an unaerated silo.

During subsequent trials at Wickepin and Jondaryan, Queensland, higher moisture oats and sorghum were safely stored under aeration with minimal insect infestation and no significant quality losses.

In both instances the growers chose to harvest at higher than normal receival



Fan operation can be controlled by a switch but the operator must take regular weather checks to ensure the right quality of air is being taken in. A more reliable method is to use a fan controller which selects the best operating hours during the day. Inset: A vented lid fitted to the roof of the silo allows air to escape. The vent is sealed with an airtight plate when fumigation is underway.

moisture contents to take advantage of the better yields from high moisture harvesting.

Remote sensing

The ability to control aeration by remote sensing was critical to the success of the storage strategy, eliminating the earlier problem of moisture addition and caking around the duct.

Each site had a computer linked by land line to CSIRO Stored Grain Research Laboratory in Canberra.

Where grain can be dried on the stalk to a safe level and stored in a sealed silo, it is questionable whether aeration is of any benefit. Under these conditions grain can be stored safely in a sealed silo or treated with a suitable insecticide if it is to be kept for feed on the property. Aeration is particularly useful where chemical protectants cannot be used on grain to be fed to animals. In the wetter or more humid grain growing areas, aeration has more important benefits.

Harvesters can work later in the day or earlier in the season to reduce the risk of weather damage. Harvested grain can then be stored safely for a short period under aeration pending delivery to a drier. Grain can be stored under aeration for later feeding to livestock or retained as seed.

Costs

Equipment costs vary with the size and number of storages to be aerated. As an example, equipping a 50-60 tonne elevated steel silo with a single fan and ducting could cost about \$500. Installation and power to the site are extra costs.

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These cost about \$700. CSIRO is developing a refined version of this controller which will take into account the relative humidity of the air throughout the day. Further details on aeration equipment is available by contacting FarmLine on 1800 677 761.

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