Aeration system options – what can they achieve and what do they cost?

JOHN CAMERON AND PETER HUGHES EXPLAIN THE DIFFERENT APPROACHES TO AERATION AND THE DIFFERENCE BETWEEN COOLING AND DRYING

GRAIN IN STORAGE is a valuable commodity – the quality of which must be maintained. What are the quality impacts on grain in storage and how can aeration systems be used to maintain quality and improve farming system profit?

Essentially there are two main types of aeration system:

- low flow-rate systems for maintenance and cooling (often separated into two systems); and
- high flow-rate systems purpose-built for drying grain.

COOLING SYSTEMS

Low flow-rate aeration fans either fitted or retro-fitted to a new or existing storage are a relatively low-cost way to maintain grain quality in storage for longer. Low flow-rates of one to two litres per second per tonne (L/s/t) will cool grain and suppress moulds and insects.

Used correctly, flow-rates of two to 6L/s/t can, in addition to cooling grain, enable the safe storage of grain for weeks to months at moisture levels at two per cent above normal receival standards.

Low flow-rate aeration cools grain and slows most quality deterioration processes affecting:

- barley malting grade;
- germination and seed vigour;
- insect and mould development;
- wheat bread-making quality; and
- oil quality of oilseeds – free fatty acid, rancidity, colour and odour.

HIGH FLOW-RATE DRYING SYSTEMS

High flow-rate aeration drying with flow rates greater than 10L/s/t in a purpose-designed drying silo, provides the capability to dry grain from quite high moisture contents using ambient air, provided that:

- air of appropriate quality is available;
- a properly designed aeration-drying silo is used; and
- the drying process is well managed.

There is a risk when storing over-moist grain in a system not designed for that purpose, or where the system is not properly managed. Aeration can be a highly profitable addition to on-farm storage, but requires good management and a supply of approriate air and storages designed for this purpose.

HARVEST MANAGEMENT

With proper management and correct flow-rates, aeration cooling can be used to cool and store grain at moisture levels a little above receival standards. This could allow time to dry the grain in a dedicated drier, back-blend with drier grain or sell into a market that accepts higher-moisture grain. Aeration cooling will not reliably dry grain and if used for this purpose, places the grain at significant risk.

The ability to store or dry over-moisture grain enables the option of an earlier harvest, with potential benefits in yield and quality and reduced risk of weather damage. Benefits can include:

- more harvest hours as the harvest can start earlier and finish later each day, and resume earlier after rain;
- if a grain dryer is available, harvest can potentially start at even higher grain moisture content; and
- harvesting high-moisture grain closer to physiological maturity lowers the risk of downgrading or quality losses due to rain. Also, as moist grain is less prone to pre- and post-harvest shatter losses and splitting, yield and sample quality are usually better than if left to dry in the field. However, moist grain must be managed correctly.

HOW SIGNIFICANT ARE IN-FIELD AND HARVEST LOSSES?

Trials have shown large yield losses due to shattering from the head or pod prior to and at harvest, deterioration in seed size, weight and colour, and increases in splitting.

While each crop and year are different, trials from Esperance in WA showed yield losses of typically 0.25 to 0.75 per cent averaging about 0.5 per cent per day for barley and 0.18 to 0.53 per cent per day for wheat.

In Queensland, losses of 0.3 to 2.5 per cent per day for wheat were reported (average of about one per cent per day). Significant rain at harvest can greatly increase these losses. Trials in pulse crops show even higher losses than for cereals, but with the added issue of increased splitting when crops are harvested dry.

INSECTS

In the Australian climate, insects are a major threat to grain quality. Chemical control options for grain protection on most farms are limited to phosphine and a decreasing number of protectants. Insect resistance to low doses of phosphine is becoming widespread. To control resistant populations, phosphine must be used in a sealed silo.

Cooling grain with aeration may not eliminate the need for insect control, but will slow insect development. At below 15°C most insect reproduction stops.

However, phosphine works better when the temperature is higher, about 25°C. This is at odds with the objective of cooling grain to preserve grain quality (see page 18).

APPROXIMATE SYSTEM COSTS

In a 70 to 100-tonne silo, it typically costs about $750 (DIY plus GST) to install ducting and a fan to deliver 2L/s/t for aeration cooling. Two to three fans and ducts may be needed for reliable storage of higher-moisture grain.

Retro-fitting aeration to older leaky storages that are not suited to using phosphine is an ideal option. It is low-cost and reduces insect management problems in older storages. While it is possible to retro-fit high flow-rate aeration-drying fans and ducts to existing silos, considerable design issues are involved and should only be undertaken with the input of an aeration-storage designer.

The cost for new purpose-built high flow-rate aeration-drying silos varies. One NSW-based manufacturer indicated that sealable drying silos up to 200-tonne capacity fitted with high flow-rate fans cost 25 per cent to 35 per cent more than standard, sealed, upright storage.

To fit a supplemental heater to raise air temperature four to 10°C costs around $1000 for a gas-powered unit that can potentially service two 200-tonne silos. However with supplemental heating fitted, some silo designs may have to be run at half capacity (ie 100 tonnes each) to maximise air-flow rates and minimise the extra condensation that can occur. A diesel unit would cost closer to $1500.

Running costs of a gas-powered supplementary heater (if needed) are estimated at around $2 per tonne. Diesel heaters are likely to be closer to $3/t for fuel.

An automatic aeration-cooling controller with a four-storage control panel costs around $2600 plus GST (not installed). Labour, plus the cost of additional hardware, cabinet, overloads, contractors and time delays, must also be budgeted. Aeration-drying controllers are also available, but vary in their function and cost. A new type of controller capable of controlling both drying and cooling has just been commercialised. It is based on the Adaptive Discount Control (ADC) method developed by CSIRO (see page 17).

Typical electricity costs to run cooling fans of 2L/s/t using a time-proportioning cooling controller set to run one-seventh of the time are around $0.05/tonne/month.

The electricity costs to dry grain vary widely – but commercial feedback shows that many drying jobs use between $2 and $5 per tonne.

It may also be necessary to upgrade the supply transformer and install soft starts or time delays to keeps amps within allowable limits.

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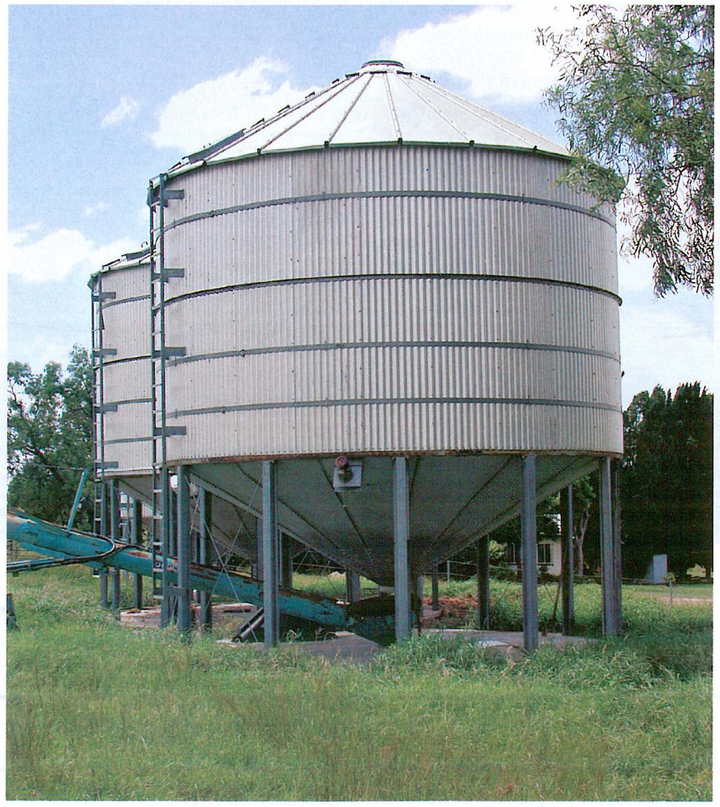
Grain in storage is a valuable commodity.



Tasks and key aeration system features

Task	Type of system	Key system features
Cool dry grain for extended storage	Aeration cooling	Flow-rates of ~1-2L/s/t. Good ventilation. Easy and inexpensive to retro-fit to old elevated upright storage. Low cost to install on new sealable storages.
Store moist grain (ie 13-~15% for cereals) for weeks/several months	Aeration cooling	Flow-rates of ~2-6L/s/t. Flow-rates at the higher end of the range and suitable ducts are needed if grain moistures are near the high end of the moisture range. Good ventilation is needed. Shallow bed depths may be needed if moistures are near the higher end of the range. Easy and inexpensive to retro-fit to old elevated upright storage. Low cost to install on new sealable storages.
Dry wet grain (ie 13-20% for cereals)	Purpose-built high flow-rate aeration drying system	Flow rates of ~10-30+L/s/t. Shallow bed depth with even flow fields of air in the whole grain stack are needed. Air of low relative humidity or supplemental heating is needed to dry grain. Heating raises the temperature of inlet air by 4-10°C and greatly improves the drying potential of air. Good ventilation is needed. More complex to retro-fit than for cooling. Wet grain is always at risk and good management is essential.
Dry wet grain in coastal or humid regions (not tropics)	Purpose-built high flow-rate aeration drying system with a supplemental heater	As above, but flow-rate should not be less than 20L/s/t and system should be fitted with a supplemental heater to raise air temperature. This increases the ability to gently dry grain when the relative humidity of ambient air is too high for natural air-drying. More complex to retro-fit than for cooling. Seek advice to ensure that the system is in balance with the expected air quality in your region.