Grain silo considerations and aeration performance

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Take home messages

- Once installed the decision to modify or upgrade silos is problematic. Consequently, the initial selection of silos in particularly important as they may provide significant advantages or headaches for the next 30+ years.
- Aeration cooling provides many benefits including maintaining high germinations rates, seedling vigour and grain colour, as well as reducing the impact of invasive grain insect pests and shortening fumigation venting time.
- Testing aeration in stored grain has highlighted the need for system designs that ensure ducting doesn't increase backpressure on fans, and that systems can provide adequate airflow for the types and depths of grain being stored.
- The fan performance provided by the manufacture, should were possible be cross referenced with industry data to ensure system airflows are verified with field testing (silo) results for the grain volume and types likely to be stored.

New silo considerations

Because silos cannot be traded in for a better model the decisions made at the time of purchase can determine if they are easy to use or a headache for the next 30+ years of their life. While transportable, cone-bottom silos may be sold and replaced, larger built-on-site silos are there for good, and some aspects are difficult or even impossible to improve later. Below is a list of considerations that growers often regret not giving more attention at the time of purchase.

Gas-tight sealable

Ignore any vague references to sealed or fumigatable and insist the silo is gas-tight sealable to the Australian Standard 2628-2010. Ensuring this standard is referenced in the purchase contract or invoice clarifies the manufacturer's obligation to demonstrate the silo performs a five-minute, half-life pressure test. While retro-sealing can be an option, it is a significant cost, with varying success and often a short lifespan. Insect resistance is still increasing in Australia and gas-tight storage is the only knock-down option.

Easy to clean

Insects only require a small amount of grain in a sheltered environment to survive. Silos that are difficult or impossible to remove all grain residue from are likely to harbour insects through the off-season, ready to infest fresh grain as it's in-loaded. Poorly designed wall-to-roof joints, lid or hatch joints, and aeration ducting that can't be removed for cleaning will accumulate grain residue, which harbours insects.

Easy and safe to operate

As already stated, built-on-site silos can't be traded in, so any aspects that make them difficult or dangerous to operate, will be a nuisance and potential hazard for the next 30+ years.

Safe ladder

Too often, ladders are left off new silo purchases to save money or remove the potential risk of falling from heights. Reality is, access to the top of silos is required to check for insects, monitor grain quality, test fumigation clearance and maintain lids and seals. Safe access via a compliant ladder, staircase, elevated walkway or work platform is required.

Aeration cooling

While aeration can be retrofitted to cone bottom silos, adding it to flat bottom silos after constructed is difficult and compromising. See further explanation below.

Roof vents

Manufacturers of large flat bottom silos generally insist on roof vents if aeration is included, but vents are often overlooked on cone bottom silos. The compromise is leaving the lid partly open, which runs the risk of rain or birds entering the silo. Ensure fan performance is not inhibited by inadequate vent space out the top of the silo, and that vents are gas-tight sealable when fumigation is required.

Outload speed

Occasionally I hear of growers surprised that the silo outlet or unloader can't supply their truck-loading auger to its operating capacity. I'm yet to hear a grower say they want to load trucks slower in the future, so to cater for the demands of the next 30+ years, outload speeds should arguably exceed current expectations.

Recirculation for fumigation

If silos are fitted with ground level application for phosphine, a recirculation system is required to facilitate gas liberation and distribution. On silos larger than 300t, powered recirculation achieves more uniform gas concentration throughout the silo and reduces the exposure period from 20 days, down to 7–10 days. Powered recirculation can be in the form of a portable box with an inbuilt fan, phosphine is placed in the box and recirculation is achieved by connecting it to the silo's aeration duct and headspace. An alternative is to plumb a small fan between the silo's aeration duct and headspace and place the phosphine in the silo headspace as directed on the label.

Aeration cooling – why bother

The benefits of aeration cooling are numerous and emerging research and experience has highlighted some helpful uses not previously considered priority.

Grain quality

Recent research by Agriculture Victoria has confirmed that grain quality in terms of germination, vigour and colour deteriorate rapidly when stored warm, but can be maintained at cool storage temperatures. Research currently underway is also investigating the potential for improving grain quality through manipulation of temperature during storage.

Insect prevention

Thanks to research by the Queensland Department of Agriculture and Fisheries, (QDAF) we know that insects of stored grain can't reproduce at temperatures below 15 °C and are not attracted to infest cool grain as it is not conducive to breeding.

Moisture management

Growers are more commonly using aeration cooling to manage high moisture grain during a wet harvest. While aeration cooling can't dry grain, it has been proven successful in blending moisture throughout a silo, preventing green grains and the occasional truckload from going mouldy, and holding slightly over moisture grain until it can be dried or blended with dry grain.

Phosphine venting

Recent research by QDAF has also proven that aeration cooling fans significantly reduce venting periods after fumigation, an issue when delivery sites are spear testing to a clearance level of 0.3 parts per million. Of particular concern, Workplace Health and Safety Ministers have announced this limit will reduce to 0.05ppm as of December 2026.

Airflow system design

Once the purposes of aeration cooling are determined, the system must be designed to handle the backpressure of the quantity and type of grain being stored. For cooling, the target airflow is 2–3 litres of air per second per tonne (L/s/t) and drying requires airflow of at least 15 L/s/t.

The GRDC Grain Storage Extension Team have been testing aeration system performance to provide manufacturers with current design parameters, rather than relying on modelling and calculated performance based on primitive research done in the USA, 70 years ago.

Grain type and settling

The recent aeration testing revealed that the type of grain being stored has a significant impact on fan performance. Canola for example, inflicts 2.4 times the backpressure on fans than wheat, and conversely, chick peas only create one quarter of the backpressure of wheat.

In addition to the type of grain, the size of the grain and how much it settles in the silo can increase the backpressure even further. During test rig experiments, grain settled vs loose filled increased bulk density by around 8% but increased the back pressure by up to 60%.

Field testing

Test rig results were verified against 48 aeration systems operating on silos, which revealed more variables and anomalies. The shape of the grain surface determines the route of most of the airflow as it takes the path of least resistance – the shortest path, or the shallowest depth out of the grain stack.

Duct restriction

The aeration duct style and perforation design has more of an impact on fan backpressure than previously understood. In two instances, inadequate ducting meant that fan performance was inhibited more from the duct, than from the grain in the silo. Evidenced by similar backpressure readings in silos that were full, compared to the same silo and fan that had only a shallow depth of the same grain. To put it into perspective, a silo that was supplied with a fan said to be able to deliver >5 L/s/t and recommended to be fitted with restrictor plates, was in fact only delivering 1.2 L/s/t.

Fan performance

On several occasions during field testing, fans were found to be significantly underperforming, compared to the manufacturer’s calculated, claimed output. This led to performance testing 13 commonly used aeration fans for manufacturers who were willing to participate. Intended to be a learning exercise rather than a policing attempt, those manufacturers have been provided with their results. Where the tested fan performance was less than the claimed output, (in one instance only 65% of the claimed output), manufacturers have been put on notice to correct their claimed performance figures or redesign their fan.

Multiple fans

As a side experiment, where silos were fitted with multiple fans, measurements were taken with one, two, three and four fans operating to quantify the airflow increase with each additional fan. Turning on the second fan increased total airflow by 1.8 times rather than doubling, due to the increased backpressure. Similarly, running all four fans did not quadruple total airflow of the single fan, rather increased it by a factor of 2.5 due to the increased back pressure.

Detailed results of the aeration back pressure and performance testing will be available from storedgrain.com.au once published in the coming few weeks.

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