

# Breathing fresh air into on-farm grain storage

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A fifth-generation Mid North farming family is developing a chemical-free approach to protect their on-farm grain storage facility against insects.

Evidence of insect resistance to phosphine gas was the main driver behind the Maitland family's adoption of an aeration system and best hygiene practices to prevent pests invading their on-farm silos.

They have five flat-bottom silos with a total capacity of 4,500 tonnes on their property at Hart, 20 kilometres north of Clare. Since 2005 when the first three silos were built, the family has stored grain on-farm to improve harvest logistics.

Like most Australian bulk grain handlers, the Maitlands used phosphine gas to eradicate insects from their stored grain, but decided to explore alternatives to this chemical approach when they observed signs of insect resistance.

"We noticed that the gas hadn't been 100% effective," said Jim Maitland. "We thought if insects are becoming resistant to phosphine, we need to look to another approach, so we're trying methods such as aeration and really good hygiene."

## Aeration system

Jim's father David began the installation of an aeration system on three flat-bottom, elevated steel silos in 2005, while Jim was studying in WA. The system was also fitted to two new silos in 2009.

Aeration is the process of blowing air into the silo to cool the grain. Temperatures of 16°C or less prevent insects from breeding



FANS LIKE THIS (ABOVE) ARE KEY TO THE AERATION SYSTEM THAT CONTROLS TEMPERATURE AND MOISTURE LEVELS IN GRAIN STORED ON FARM. THE FANS ARE ELECTRONICALLY LINKED WITH ACTUATORS THAT OPEN AND CLOSE THE LIDS OF THE SILOS (RIGHT).



THE END AND THE BEGINNING. A VIEW ACROSS THE TOP OF THE ON-FARM STORAGE FACILITY TO PADDOCKS WHERE GRAIN STORED IN THE SILOS IS GROWN.

and are also good for grain that will be used as seed.

"During harvest there will be a number of insects that come in with the grain, that's just a fact of life," said Jim. "Cooling the grain to 16°C won't kill the insects but you stop the breeding process. If you manage to reduce the grain temperature to 6°C you kill anything that's alive and you're really home and hosed.

"We have managed that with small parcels of grain – 100 tonnes in the bottom of a bin. The challenge will be to achieve it with 850 to 1,300 tonnes of grain, but we hope this is where the technology and automation will play a role."



The recommended airflow for aeration cooling of stored grain is two to three litres of air per second for each tonne of grain in the storage. The fans in the Maitlands' storages are rated to supply 1.7 litres a second per tonne when the silos are full.

A fan at the base of the silo pushes air through a ventilation duct and up through the body of grain. Releasing the air is critical, as a build-up of air pressure can cause the silo to explode.

In conventional aeration systems the air is released through several manually operated vents at the top of the silo but the Maitlands chose to permanently close the vents and release the air through the silo's lid, to ensure that the storage remains sealed. "It's important for the silos to be air tight in order to keep the insects out," said Jim. "To me, the normal process of opening the vents defeats the purpose of keeping the silo air tight, so we went down the track of installing electric actuators on the centre lids. The only time the lid is open is when the fan is running, and because there's positive pressure there is air flow out of the silo



DAVID, MARGOT, JIM AND KATHERINE MAITLAND IN A DURUM WHEAT CROP WITH PRODUCTS FROM THEIR PANGKARRA FOODS RANGE.

and insects can't fly in. It's one of the things I really like about this concept."

The fan and electric actuator are automatically controlled using software designed by CSIRO and commercialised by Perth-based Industrial Automation. The software uses predictive technology based on temperature and moisture levels outside and inside the storage to determine when to activate the system, which starts with the actuator opening the lid.

For safety reasons the system is set up so the fan can operate only once the arm that opens the lid reaches the end of its stroke.

"The fan won't start until the lid is completely open and the actuator has hit the external limit to say 'yes, the lid is physically open'," said Jim. "It's a built-in safety mechanism that prevents the fan from operating if the actuator fails to open the lid."

### Problems

While Industrial Automation is responsible for the software, the Maitlands installed the actuators and engineered the lid-opening mechanisms.

Jim is the first to admit that the system is yet to work perfectly. "It's been a long process and it's still not quite right, although we're getting close.

"Industrial Automation has done a terrific job customising the software but we've had a few hiccups along the way with the hardware. We've burnt out a few actuators, either due to incorrect wiring or because we didn't tune the mechanism correctly.

"This project has taken up a lot of time and the final stages are proving slightly testing. Now it's a matter of getting

the technology to line up with all of the hardware."

Jim returned to the farm in 2007 and took over management of the aeration system from his father; continuing to work on the original set up until 2011. "I don't blame Dad for not having worked it all out by the time I got here, because I've had a few years working on it now," he said.

## FARM SNAPSHOT

<b>Farmers:</b>	Jim and Katherine Maitland, with Jim's parents David and Margot
<b>Land:</b>	2,095 ha in the Mid North; 1,487 ha owned, 608 ha leased or share farmed
<b>Soil type:</b>	Red brown earth over areas of limestone
<b>Rainfall:</b>	357 mm
<b>Crop rotation:</b>	Wheat, canola, beans and hay
<b>No-till:</b>	Ausplow DBS precision seeder with knife points on 260 mm spacings. The Maitlands inter-row sow and plan to upgrade from John Deere iGuide to John Deere iSteer, an active implement guidance system, to improve sowing accuracy. They have been using no-till methods for almost three decades.
<b>Stubble:</b>	Cut at 250 mm from the soil surface and left standing
<b>Fertiliser:</b>	Chicken litter: 4 t/ha in first application, with targeted applications planned in March 2014 for limestone and redder soils. They also use 40 to 50 kg/ha of DAP.



HYGIENE AND AERATION ARE VITAL TO MAINTAINING GRAIN QUALITY IN THE ON-FARM STORAGE.

## Remote access

For eight years the Maitlands used an on-site programmable logic controller (computer) to control the system; entering information about the grain conditions via a touch screen in an enclosed cabinet and making daily visits to check the system.

“You’d punch in all the information and then drive down there the next day to see whether the fan had run when it should have and inevitably it hadn’t, so you’d have to get on the phone to Perth,” Jim said.

“At the beginning of last year I decided we needed extra help from Industrial Automation, so we went down the path of remote access and installed a modem at the site.”

Remote access allows the software engineers to perform diagnostic work and software modifications from Perth. It also means Jim can monitor the system via the Internet, through his smart phone or computer, regardless of his location. SMS functionality was also added, allowing him to receive text message notifications.

Weather data is real-time, with climate conditions fed into the system via a weather station and conditions of the grain – such as moisture, humidity and temperature – measured and entered

manually with every truckload, with all the data automatically submitted to ‘cloud’ storage via the Internet.

The Maitlands use Dropbox, an online storage and sharing system, to store all of their farm data and computer files. “Dropbox is one of the best tools we use in our business,” said Jim. “We know that our information is going somewhere safe, rather than to an on-site hard drive.” They also back up all of the data stored on Dropbox to a computer drive in their farm office, as an extra measure of data security.

Inadequate power to the site was another limiting factor in the system’s first phase of development. The farm has access to only enough single-phase electricity to operate two of the five fans at one time, so the team at Industrial Automation has engineered the program to switch to the farm’s three-phase generator when more than two fans are required. The generator was installed previously to operate the grain outloaders.

## Silo hygiene

Hygiene is a critical element of successful grain storage, according to Jim. “Hygiene is the first line of defence. We pick up any spilt grain in the area around the silos and

commit the time and effort needed to clean the silos annually.”

The first step in the cleaning process, in July or August, is to vacuum each silo, using an industrial vacuum cleaner. “We vacuum the silos out by hand. You could eat dinner off the floor afterwards,” Jim said.

The next step is to apply diatomaceous earth (DE), a naturally-occurring, talc-like powder made from the fossilised remains of marine phytoplankton. DE kills insects by damaging their waxy outer cuticle layer. Without this waterproof layer, the insect loses moisture and dies. An industrial blower is used to blow the powder into the fan and ventilation duct and onto the internal walls, floor and ceiling of each silo and a slurry of DE is applied to the silo footings to minimise the risk of grain insects surviving in the area around the silos. When a silo is full of grain they dust DE over the top of the grain.

## Insects

The insects at the root of grain storage problems are the lesser grain borer (*Rhyzopertha dominica*) and the rust-red flour beetle (*Tribolium castaneum*). The lesser grain borer is a primary pest that bores through the grain, leaving behind

dust which the rust-red flour beetle, a secondary pest, feeds on. Left unchecked, these and other grain storage insects will multiply rapidly in a silo, damaging the grain and increasing temperature and moisture in the storage as a result of their presence and activity.

### On-farm storage

Improving harvest logistics was one of the key reasons the Maitlands invested in on-farm storage. Being able to hold grain on the property has enabled them to use one header instead of two, reducing the amount of capital tied up in harvest machinery, and regain control of the quality of grain they deliver to the bulk handler.

“Prior to 2005 we ran two headers for extended day shifts then used carriers or our own trucks to get the grain away while the silo system was open. Now we use one machine that operates around the clock in two 12-hour shifts. Having our own storage has really helped us get better utilisation of our harvest equipment and means we can run our own agenda because we can deliver to our silos at any hour of the day,” said Jim.

It also means they are able to blend grain for increased profitability and can avoid delivering their grain after a rain event, when the subjective nature of grain classification can have a negative impact on pricing.

“Every farmer will know that over the past few years there have been some issues with classification around grain quality. I don’t blame some of these companies, because it would be a stressful job after a rain event, with the grain coming in at a lower quality. The classifiers have to make a subjective decision about whether the grain goes into a grade that is worth \$10 or \$20 less.

“We’ve found that it’s worthwhile to keep the grain back and let that stress blow over.”

The Maitlands also blend their grain to meet specifications. “Two years ago half our grain was a little low on protein but high on test weight and the other half was low on test weight and high on protein. Blending the grain meant half our crop was upgraded by one grade and the other by two grades. It meant a significant economic benefit,” said Jim. “We’re only doing what the grain merchants would have done and were up front about it at the time.”

## PANGKARRA PUTTING MAITLAND GRAIN ON THE PLATE

After almost 150 years and five generations, the launch of Pangkarra Foods has put the Anama Park enterprise at Hart, in SA’s Mid North, on the map.

The Pangkarra Foods paddock-to-plate food production business was founded in 2011. It produces whole-grain pasta from 100% durum wheat grown on the farm, Wholegrain Durum Flour and Wholegrain Lavosh.



All the grain used in their products is stone ground, so the flour contains all the endosperm, bran layers and vitamin-rich germ of the original grain.

The family is proud of their products’ wholegrain status, which is achieved through the use of traditional stone milling methods used by Laucke Flour Mills in Strathalbyn.

“We’re excited about the prospects for wholegrain foods in the future,” said Jim. “As a nation, we need these slow foods rather than highly processed foods to survive.

“The way we look at it, the world’s diabetes and obesity issues stem from processed foods. There are colonies in Africa who, like the caveman, still make their flour by crushing grain between two rocks and they don’t suffer from diabetes, colon cancer or other chronic illnesses.

“Our challenge is that the benefits of wholegrain can’t be explained in two words. We hope more influential people will help share the good word about wholegrain foods, because without a really significant marketing budget, it’s not going to happen in a hurry.”

In the meantime, the Maitlands post-gate, value-adding venture is gaining momentum, with Pangkarra products now available nationally and recently named as finalists in the 2013 Delicious Magazine Produce Awards. They have also achieved a 24% growth in sales during the second year of trading.

Jim believes that if the business is developed and managed well, it will be an asset for the next generation of Maitlands.



They are also providing contract storage for Flinders Ranges Premium Grain (FRPG), which produces GM-free wheat to make premium flour for the hospitality industry.

Setting up the silos and aeration system has cost \$150/tonne of capacity, with \$50/tonne spent on earthworks, electricity, augers and technology and the silos, weigh bridge, office, overhead walkway, grain sampling equipment and a protein machine costing \$100/tonne.

### The future

Jim believes aeration will continue to play a role in on-farm grain storage, but sees

other emerging technologies such as nitrogen generators as the future.

“Flooding a silo with nitrogen will eradicate any insect present. There are nitrogen generators available now that produce nitrogen gas from the atmosphere but they’re about \$70,000 each, so their cost is a deterrent.

“I think aeration will always play a part in grain storage because there are other issues like germination. Getting the grain down to a reasonable temperature helps it from a germination perspective, if the grain is being used for seed purposes.”