Proactive preparation prevents problems

Chris Warrick
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Photos: Chris Warrick

Clean sweep: *Removing grain discourages pests from harbouring in storages between seasons.*

Successful grain storage — controlling grain pests and maintaining grain quality — requires more than a 'set-and-forget' approach. Understanding the required practices for optimal pest and grain quality management will help determine the most appropriate on-farm storage option.

Prevention is better than cure when it comes to controlling pests in stored grain.

Discouraging pests from entering grain storages is often easier than treating an infestation, especially where sealable storage is unavailable.

Meticulous grain hygiene and aeration play a key role in preventing stored grain pests.

Keeping it clean

A bag of infested grain can produce more than one million insects during a year, which can walk and fly to other grain storages where they can start new infestations.

Meticulous grain hygiene involves removing any grain residues that can harbour pests and allow them to breed.

It also includes regular inspection of seed and stock feed grain so any pest infestations can be controlled before pests spread.

A recent Kondinin Group, Grains Research and Development (GRDC)-funded survey of growers across Australia showed that while most growers are carrying out some form of grain hygiene, there is still room for improvement (see Figure 1).

Where to clean

Removing an environment in which pests can live and breed is the basis of sound grain hygiene, which includes removing residues from all grain handling equipment and storages.

Grain pests live in dark, dry areas and breed best in warm conditions.

Common places where pests are found include:

- Empty silos and grain storages
- Aeration ducts
- Augers and conveyers
- Harvesters
- Field bins and chaser bins
- Left-over bags of grain
- Trucks
- Spilt grain around grain storages
- In grass, under leaves and rubbish around storages
- Seed grain
- Stock feed grain

Effective grain hygiene involves carrying out the cleaning of all areas where grain gets trapped in storages and equipment.

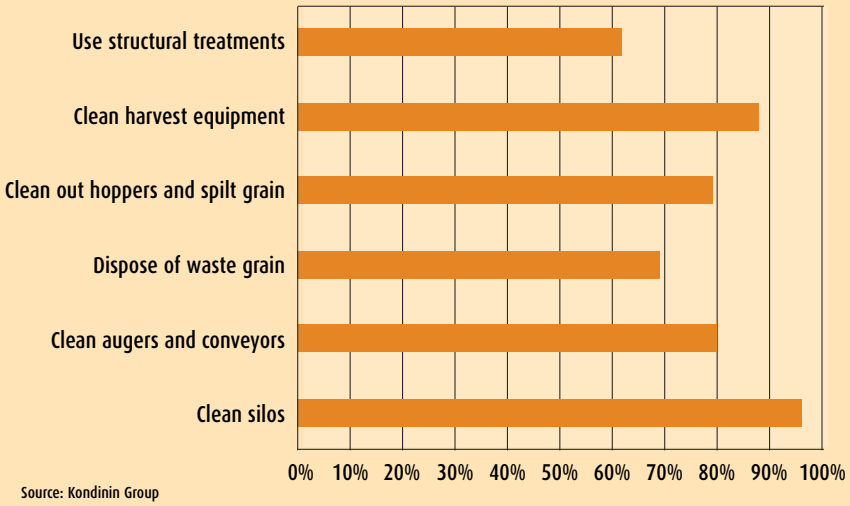
Grain pests can survive in a tiny amount of grain, so any parcel of fresh grain passing through the machine or storage can become infested.

At a glance

- **Successful pest control in grain storage starts with meticulous grain hygiene.**
- **Aeration cooling in storage structures plays a vital role in preventing grain pests.**
- **According to a national grain storage survey, only 47 per cent of respondents understand what constitutes a sealable silo.**
- **A new Australian Standard sets the benchmark for sealable silos.**
- **Fumigating unsealed storages is an off-label approach and ineffective across all life stages of grain pests.**
- **Grain pest and grain quality management requires regular monitoring, correct pest identification and early action.**
- **When choosing a grain storage option, consider more than the initial set-up costs.**

FIGURE 1 Grain hygiene practices across Australia

Which of the following do you carry out regularly?



Source: Kondinin Group

Post-harvest checklist

- Sweep or blow out all empty grain storages and equipment.
- Wash down with water on a warm, dry day.
- Apply a structural treatment, unless storing oil seeds or pulses.
- During summer monitor stored grain on a fortnightly basis and monthly during winter.

When to clean

Immediately after harvest is the ideal time to clean grain handling equipment and storages, to prevent them from becoming pest-infested.

A trial carried out in Queensland found more than 1000 lesser grain borers in the first 40 litres of grain in a harvester, that was considered reasonably clean at the end of the previous season.

It is well worth the effort to thoroughly clean harvesters at the end of each season and discard the first few bags of grain at the start of the next harvest.

Discarding a small amount of the first batch of grain, stops surviving pests from infesting grain storages — a common occurrence. However, this is no substitute for thorough cleaning.

How to clean

The better the cleaning job, the less chance of harbouring pests. The best way to alleviate grain residues is to use a combination of:

- Sweeping
- Vacuuming
- Compressed air application
- Blow/vacuum pneumatic cleaning guns
- Pressure washers
- Fire-fighting hoses

Using a broom or compressed air removes most grain residues. A follow-up wash-down eliminates any grain left in crevices and hard-to-reach spots.

Choose a warm, dry day to wash storages and equipment so they dry out quickly to prevent rusting.

When inspecting empty storages, look for ways to make the structures easier to keep clean.

Seal or fill any cracks and crevices to prevent grain lodging and insects harbouring.

Bags of left-over grain lying around storages and in sheds create a perfect harbour and breeding ground for storage pests.

After collecting spilt grain and residues, dispose of it by burning or burying, at a site well away from grain storages.

Treating storage structures

After cleaning grain storages and handling equipment, apply a structural treatment, such as diatomaceous earth or amorphous silica, to prevent insect infestations.

While most grain buyers accept small amounts of residue on cereal grains from structural treatments, avoid using them if handling and storing oil seeds and pulses.

It is always safer to check with a grain buyer's delivery standards for maximum residue limit (MRL) allowances before using structural treatments or grain protectants.

An inert dust, such as diatomaceous earth, or amorphous silica, commonly known as Dryacide®, can be applied either as a dust or a slurry to storages and handling equipment for residual control (see Table 1).

Dryacide acts by adsorbing the insect's cuticle (protective exterior), causing death by desiccation (drying out).

If applied correctly, with complete coverage in a dry environment, inert dusts such as Dryacide can provide up to 12 months protection — killing most species of grain insects and with no risk of developing resistance.

Applying inert dust

Inert dust requires a moving air-stream to direct it onto the surface intended to be treated.

Throwing it into silos by hand will not achieve an even cover and therefore will be ineffective.

For small grain silos and bins a hand-operated duster, such as a bellows buster, is suitable.

Larger silos and storages require a powered duster operated by compressed air or a fan.

If compressed air is available it is the most economical and suitable option for on-farm use. Connect to a venturi duster, such as the Blovac BV22.

The application rate is calculated at two grams per square metre of surface area treated.

Avoid breathing in excessive amounts of dust — use a disposable dust mask and goggles during application.

Photo: Chris Warrick

Harvesting equipment: *Thoroughly clean harvesters and grain handling equipment with compressed air and water.*

TABLE 1 Inert dust application rates

Storage capacity (t)	Application rate (kg dust)
20	0.12
56	0.25
112	0.42
224	0.60
450	1.00
900	1.70
1800	2.60

Source: DPI Victoria

Silo treatment

Apply inert dust in silos starting at the top, by coating the inside of the roof, then working down the silo walls, finishing by pointing the stream at the bottom of the silo.

Again, the application rate is calculated at 2g/m² of surface area treated.

If silos are fitted with aeration systems, distribute the inert dust into the ducting without allowing it into the motor, which will potentially cause mechanical damage.

Treating machinery

The calculation of machinery surface area is almost impossible.

For augers, conveyors and grain handling equipment, apply a steady dust stream into accessible openings, coating all the internal surfaces as much as possible.

Continue until a dust stream emerges from the exit or discharge points of the equipment.

For an average harvester the recommended quantity of inert dust is about 2.5 kilograms.

Applying an inert slurry

With the right equipment, diatomaceous earth or amorphous silica can also be applied in a slurry form.

Available as Dryacide the slurry requires mixing with water at a rate of 10–20 per cent and applied at 6g/m² (dry basis).

The aim is to apply the slurry at a consistency thick enough so it does not run off the walls of storages and the surface area of equipment.

A little more involved than applying dust, the slurry needs to be mixed in a mixing tank then applied through a flat fan nozzle capable of at least five litres per minute.

An inline filter with 1000 micron (one millimetre) mesh and a recirculation hose will help prevent nozzle blockages and keep the slurry mixed during application.

Impeller pumps are most suitable — typically a fire-fighting pump with a 3.7 kilowatt (five horsepower) motor.

Do not use positive displacement pumps, such as gear or piston pumps, as they will block easily.

Photo: Chris Warrick

A clean site: *Remove spilt grain and burn or bury it well away from the storage site. A concrete slab under silos makes cleaning easier.*

If applying a lot of slurry regularly, use a designated, older pump as pumping slurry will reduce a pump's working life.

Apply the slurry in the same order as the dust — start at the top of the storage, work down the walls applying an even coat. Avoid runs as a result of spraying too close or using too much slurry.

A solid pipe extension on the application hose will enable a more even coating on hard to reach areas such as silo walls.

Grain protectants

With the exception of Western Australia, where their use is prohibited, grain protectants provide another control option to prevent insect infestations.

The exception to the WA rule is Fenitrothion, which is registered for use in WA as a structural treatment and is effective for two months on most grain pests, except lesser grain borer.

Like structural treatments, grain protectants are only registered for use on cereal grains as grain buyers do not tolerate chemical residues on pulses and oil seeds.

Unlikely to control adult insects in already-infested grain, protectants are designed to be applied to grain as it is put into storage.

However, the lesser grain borer is known to have widespread resistance to all available grain protectants, while the saw-toothed grain beetle and rice weevil are resistant to some protectants.

Table 2 illustrates the effectiveness of available protectants against the main grain storage pests found in Australia.

Keeping it cool

Freshly-harvested grain usually has a temperature of about 30 degrees Celsius, which is an ideal breeding temperature for storage pests (see Table 3).

Research has shown common grain pests multiply by 20–25 times per month at temperatures of 30–35°C and grain moisture levels of 14–16%.

Aeration cooling — keeping grain temperature under control

Grain aeration provides growers with a powerful tool to maintain grain quality during harvest and storage. While it may not eliminate the need for insect control, it will dramatically slow their development.

When placing grain into storage, run aeration fans continuously for the first 2–3 days to push the first cooling front through the grain and to create uniform conditions.

Follow this by running the fans during the coolest 9–12 hours per day for the next 3–5 days.

This aims to push a second cooling front through the grain storage.

Aeration cooling generally only requires air-flow rates of 2–3 litres per second per tonne.

Finally, the grain requires about 50 hours of appropriate quality air each fortnight during storage.

The ideal solution is to use an aeration controller that will perform the cooling process at the right time and continue to aerate the grain selecting the coolest air to run fans.

(For more information on aeration controllers see *Farming Ahead* No. 218, March 2010.)

An effective aeration controller will also ensure fans don't operate when the relative humidity is higher than 85%, which can re-wet and damage grain if operated for extended periods.

Photo: Ben White

Under control: *Aeration controllers make aeration cooling more efficient and take out the guess-work of selecting the most appropriate air.*

TABLE 2 Grain protectant guide — for cereal grains only, not applicable to Western Australian growers*

							
TREATMENTS	**WHP (days)**	**Lesser grain borer (*Rhyzopertha dominica*)**	**Rust-red flour beetle (*Tribolium castaneum*)**	**Rice weevil (*Sitophilus oryzae*)**	**Saw-toothed grain beetle (*Oryzaephilus surinamensis*)**	**Flat grain beetle (*Cryptolestes ferrugineus*)**	**Psocids (booklice) (Order *Psocoptera*)**
Pirimiphos-methyl (eg Actellic 900®)	nil[1]						
Fenitrothion (eg Fenitrothion 1000®)[2]	1–90						
Chlorpyrifos-methy (eg Reldan Grain Protector®)[3]	nil[1]						
Methoprene (Grain Star 50®)	nil[4]		[5]		[5]		
'Combined products' (eg Reldan Plus IGR Grain Protector)	nil[1]						

*Before applying — check with your grain buyer/bulk handlers and read labels carefully.
WHP Withholding Period Not registered for this pest Resistance widespread (unlikely to be effective) Effective control
Notes: [1] When used as directed on label [2] Nufarm label only [3] Stored grains except malting barley and rice/ stored lupins registration for Victoria only/ not on stored maize destined for export [4] When applied as directed, do not move treated grain for 24 hours [5] Periods of 6–9 months storage including mixture in adulticide, for example, Fenitrothion at label rate.

Source: Registration information courtesy of Pestgenie, APVMA and InfoPest (QPI&F) websites and GRDC

Photo: Chris Warrick

Temperature: *Checking grain temperature is a simple and effective monitoring tool. A commercial temperature probe can take temperatures from well beneath the surface, or a home-made probe can be made by taping a thermometer to a piece of rod.*

Fans: *Aeration cooling can be achieved with air-flow rates of 2–3 litres per second per tonne delivered from fans driven by an 0.37 kilowatt (0.5 horse power) electric motor.*

TABLE 3 The effect of grain temperature and moisture on stored grain insect development

Grain temperature (°C)	Insect and mould development	Grain moisture content (%)
40–55	Seed damage occurs, reducing viability	–
30–40	Mould and insects are prolific	>18
25–30	Mould and insects active	13–18
20–25	Mould development is limited	10–13
18–20	Young insects stop developing	9
<15	Most insects stop reproducing, mould stops developing	<8

Source: Kondinin Group

Insect pest activity is reduced at low temperatures and reproduction can even stop if temperatures are reduced far enough.

Photo: Chris Warrick

While adult insects can still survive at low temperatures, young insects stop developing at temperatures below 18–20°C.

Studies have shown that rust-red flour beetles stop breeding at 20°C; the lesser grain borer at 18°C and below 15°C all storage pests stop breeding.

Grain temperature also impacts on seed germination. Storing wheat at 12% moisture content at 30–35°C (un-aerated grain temperature) will reduce the germination percentage and seedling vigour.

Aim for grain temperatures of less than 23°C during summer and less than 15°C during winter.

Position small seed silos in the shade or paint them reflective white to help keep grain cool. Grain aeration is an effective way to ensure stable grain temperatures during storage.

When storing oilseeds and pulses, meticulous grain hygiene and aeration cooling are the main control methods for grain pests as chemical treatments are not accepted by many grain buyers.

Identify intruders before planning attack

Photo: Chris Warrick

Avoid devastating surprises when out-loading grain by monitoring for pests regularly. Early detection and correct identification of grain pests allows a better chance of control before they spread.

Sampling: *Taking a representative grain sample requires a grain probe. Some pest species avoid exposure so will only be easily detected by using a probe and sieve.*

Poor monitoring leads to incorrect and ineffective control attempts, which is the leading cause of the increasing resistance problems across Australia.

Regular monitoring and correct identification are the keys to controlling grain storage pests before they do damage.

A recent Grains Research and Development Corporation (GRDC)-funded survey carried out by Kondinin Group found only 37 per cent of growers monitor their stored grain as often as they should — monthly or more frequently.

More alarmingly, 15% of growers only check for pests when out-loading their grain.

Things to monitor include:

- Insect pests
- Grain temperature
- Grain moisture content
- Grain quality and germination

Where to look

Grain kept for seed or stock feed is a common breeding ground for pests so monitor these places every two weeks during warmer months and at least monthly during cooler periods.

Other places to keep an eye on are empty storages and grain harvesting and handling equipment.

Pest traps and sieving are the most effective methods of collecting grain pests.

Take samples from the top (if safe) and bottom of storages to detect low levels of insects early.

Sieving samples onto a white tray will make it easier to see small insects.

Holding the tray in the sunlight warms the insects and encourages movement making it easier to identify pests and estimate population numbers.

When pests are found, correct identification will help determine which control method will be most effective.

Identifying pests for ultimate control

Being able to identify the six most common insect pests of stored grain enables a more informed decision for appropriate control.

For example, the lesser grain borer is a serious pest in most areas of Australia, but can now only be reliably controlled with one or two products due to resistance.

Identification of the particular pest present can also highlight a future preventative measure.

With an increasing number of grain markets requesting reduced chemical residues, it is increasingly important to identify pests and learn more about them.

In doing so growers can exploit the best use of both chemical and non-chemical control measures for a successful integrated pest management (IPM) solution.

The most common insect pests of stored cereal grains in Australia are:

- Weevils (*Sitophilus* spp.). Rice weevil is the most common weevil in wheat in Australia
- Lesser grain borer (*Rhyzopertha dominica*)
- Rust-red flour beetle (*Tribolium* spp.)
- Saw-toothed grain beetle (*Oryzaephilus* spp.)
- Flat grain beetle (*Cryptolestes* spp.)
- Indian meal moth (*Plodia interpunctella*)
- Angoumois grain moth (*Sitotroga cerealella*)

Another dozen or so beetles, psocids (booklice) and mites can also be found as pests in stored cereal grain.

The most common pests in stored oilseeds are:

- Flour beetles
- Saw-toothed grain beetles
- Moths

Photo: Ben White

Moisture monitor: *Grain moisture meters are available in various forms and should be used to monitor grain monthly.*

Quality control: *Regular monitoring and correctly identifying pests ensures grain comes out of storage at the same quality as it went in.*

Beetle identification tips

A clean glass container helps identify grain beetles.

Place the live insects into a warm glass container (above 20°C so they are active, but not hotter than 40°C or they will die).

Weevils and saw-toothed grain beetles can walk up the walls of the glass easily, but flour beetles and the lesser grain borer cannot.

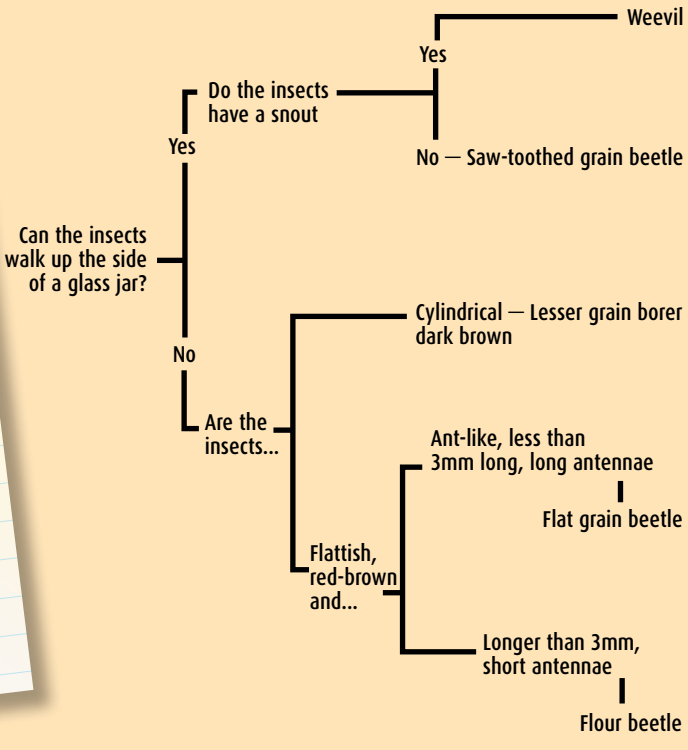
Look closely at the insects — weevils have a curved snout at the front but saw-toothed grain beetles do not.

If a pest cannot be identified, local agricultural department offices should be able to help if provided with a sample.

If a pest is unable to be identified and is suspected to be an exotic species report it to the Exotic Plant and Pest Hotline 1800 084 881.

FIGURE 2 Identification of common beetle pests of stored grain

The following flow chart provides a useful guide to accurate grain pest identification.



Source: DPI&F Queensland

Rice weevil (*Sitophilus oryzae*)
- 3–4mm long
- Dark brown-black
- Long snout and four light spots on back

Saw-toothed grain beetle (*Oryzaephilus surinamensis*)
- 3mm long
- Dark brown-black
- Fast moving with characteristic saw-toothed pattern on each side of thorax (middle section)

Lesser grain borer (*Rhyzopertha dominica*)
- 3mm long
- Dark brown
- Cylindrical beetle preferring to remain hidden in grain

Flat grain beetle (*Cryptolestes* spp.)
- 2mm long
- Reddish-brown
- Flat, fast moving (often flying) with long antennae

Rust-red flour beetle (*Tribolium castaneum*)
- 3–4.5mm long
- Reddish-brown
- Club-shaped segments on antennae ends

Traps: *Insect traps are an efficient monitoring tool. Push whole probe or pitfall cone trap just below the surface of the grain to capture insects moving through grain and inspect traps at least monthly.*

Psocids (*Liposcelis* spp.), booklice

Another common pest found in stored grain, Psocids are difficult to see without a magnifying glass.

- 1mm long
- White or pale, slightly transparent appearance
- Appears as a 'moving carpet of dust' on grain or storage structures

Evicting unwanted guests

Photo: Chris Warrick

Gas-tight silos: *Testing a gas-tight silo requires pressurising it and timing how long the oil takes to drop from 12.5 millimetres apart to 6mm apart. The Australian Standard for new silos is a five-minute half-life pressure test.*

For many years Australian growers have relied on phosphine to control pests in stored grain. But unfortunately, misuse of phosphine has seen resistance problems develop in some insect species.

The 2009 Kondinin Group National Agricultural Survey (NAS) revealed that 83 per cent of respondents who store grain have used phosphine during the past five years to control pests.

This confirms the high reliance on phosphine in Australia.

More alarmingly another recent Kondinin Group survey found that only 36% of growers were using it correctly.

If phosphine is to remain a reliable pest control option it must be used correctly to stop resistance increasing.

Gas-tight silos only

The first thing to understand is that phosphine is a gas fumigant — meaning it requires a gas-tight chamber to be effective.

In order to kill grain pests at all life stages, phosphine must be held at a concentration level of 300 parts per million for seven days or 200ppm for 10 days. Anything less than this will select for resistance making them even more difficult to control next time

These gas concentration levels are only achievable in gas-tight silos — sealable silos that have met the five minute, half-life pressure test.

Hanging around: *Phosphine must only be used in gas-tight sealable silos.*

There is now an Australian Standard (AS2628) that sets the five-minute, half-life pressure test as the benchmark for sealable silos.

For instructions on how to perform the five-minute, half-life pressure test refer to *Farming Ahead* No, 211, August 2009.

Phosphine application

Achieve effective fumigation by placing the correct dosage of phosphine (as directed on the label) onto a tray and hanging it in the top of a gas-tight silo.

Some newer silos are fitted with ground-level application systems for phosphine but remember the silo still needs to be gas tight and the phosphine needs plenty of air space to disperse.

If phosphine is released in a confined space with restricted air movement there is a risk it could reach explosive concentration levels.

Thermo siphons or closed loop recirculation systems are thought to distribute the phosphine gas faster for a more even distribution.

However, thermo siphons have not yet been independently tested and research is planned to determine their effectiveness.

Ventilate after application

After fumigation, ventilate grain for a minimum of five days or if aeration fans are fitted, the minimum run time required for ventilation is one day.

A minimum withholding period of two days is required after ventilation before grain can be used for human consumption or stock feed.

The total time needed for fumigating is 10–17 days, depending on whether aeration fans are used for ventilation.

As a general rule, only keep a silo sealed while carrying out the fumigation (for example, 1-2 weeks). Leaving silos sealed increases the risk of grain sweating and moisture from condensation on the top of the silo damaging grain.

After fumigation has been completed, return to aeration cooling to hold the stored grain at a suitable temperature level.

In Western Australia where grain is harvested and stored at lower moisture content levels, (below 10%) storages can remain sealed to prevent a reinfestation but regular monitoring is still required.

Regularly (fortnightly during summer, monthly during winter) check grain temperature, moisture content and quality as well as checking for insects.

Other options

Although phosphine is still the most commonly-used gas fumigant for controlling pests in stored grain, there are other options.

The main ones are carbon dioxide (CO_2), nitrogen and ProFume.

Each of these alternatives still requires a gas-tight, sealable storage and is currently more expensive than using phosphine but they offer an alternative for resistant species.

Nitrogen and CO_2 also carry the advantage of being non-chemical control alternatives.

Both nitrogen and CO_2 methods of control are sometimes referred to as controlled atmosphere (CA) because they are essentially starving the insects of oxygen by replacing it with nitrogen or CO_2.

Carbon dioxide

Treatment with CO_2 involves displacing the air inside a gas-tight silo with a concentration level high enough to be toxic to grain pests.

To achieve a complete kill on all the main grain pests at all life stages CO_2 must be retained at a minimum concentration of 35% for 15 days.

The amount of CO_2 required to reach 35% concentration for 15 days is one 30 kilogram (size G) cylinder per 15 tonnes of storage capacity plus one extra cylinder.

Even in a silo that meets the five-minute half-life pressure test, an initial CO_2 concentration of 80% or more is required to retain an atmosphere of 35% for the full 15 days.

Nitrogen

Research is being carried out to enable the use of nitrogen for grain storage pest control on farm but it is currently not recommended and only a few bulk handlers are equipped to use it.

The process involves using pressure swinging adsorption (PSA) technology, modifying the atmosphere within the grain storage to remove everything except nitrogen, effectively fumigating the grain load.

ProFume

Only licensed fumigators trained under Dow AgroSciences' Precision Fumigation program can use ProFume (sulfuryl fluoride).

For this reason there is little information available to the public, so contacting the local Dow AgroScience retailer is the best way to find a licensed operator for more information.

According to the product label, ProFume is only suitable for cereal grains and it is always safer to check with a grain buyer before using any chemical treatments.

Vapormate

Vapormate Fumigant® (166.7g/kg ethyl formate) is approved for use in stored cereal and oil seed grains but has three considerable limitations — it only controls insects in the adult life stage, is only registered for control of rice weevil, lesser grain borer, rust-red flour beetle and psocids (booklice) and must only be used by a licensed fumigator.

Controlling adult insects only means the eggs and larvae will continue in their cycle, hatching into adult insects and reinfesting the grain.

Photo: Chris Warrick

Phosphine: *Before fumigating, tubes can be inserted into various positions within a sealable silo. A phosphine meter can then be connected to the tubes to monitor the concentration levels of phosphine during the fumigation period.*


Photo: Ben White

Safety: *A personal safety monitor like the one pictured will sound an alarm when it senses phosphine levels that are potentially dangerous to humans.*

Select suitable storage for ultimate control

Photo: Ben White

Signed, sealable and delivered: *Sealable silos provide the best pest control options.*

Choosing the appropriate storage option will enable correct and effective storage pest and grain quality management practices. Controlling insects is becoming more difficult and reliance on sealable storage is increasing.

Photo: Contributed

Maintenance: *Temporary grain storage requires additional monitoring and maintenance.*

According to Kondinin Group's National Agricultural Survey (NAS) during 2009, 93 per cent of respondents used silos, 10% used grain bags and 13% used pits or bunkers to store grain on farm.

There are many aspects to consider when choosing suitable grain storage options, but the key is to focus on market requirements for now and the future.

Planning a storage system to meet the end-user requirements for grain will enable safe storage and control over grain quality.

Photo: Chris Warrick

Grain storage facilities: *Best constructed in a way that allows easy and thoroughly cleaning and prevents the build-up of moisture (see above), grain residues and foreign substances.*

Ideally, grain would only be stored in sealable silos with aeration, but that is not always possible or practical — so what's the next best option?

Hygiene

In terms of hygiene in permanent storage, cone bottom silos are the best option being the easiest to clean out, leaving little grain inside providing the silo is well designed with no ledges for grain to get stuck on.

Flat-bottom silos are fitted with various emptying and aeration systems, some easier to clean than others.

Silos with a perforated false floor offer superior aeration, but are difficult to clean thoroughly.

While grain doesn't fall through the perforated floor, dust and small particles build up over the years creating a perfect harbour for pests to breed under the floor.

Take extra care to clean as much of this dust out as possible in such storages. This can require removing a few floor panels.

For temporary storage, grain bags are, in theory, the perfect answer to grain hygiene essentially starting with no existing storage and leaving no storage on-site in which insects can harbour.

However, grain insects will harbour in spilt grain and in grain handling equipment, such as the loading and unloading machines.

Grain sheds, bunkers and pits are not ideal in terms of grain hygiene.

Sheds require extra time to clean out, often with ledges and cracked floors where pests can survive.

Any spilt grain around a bunker or pit is best removed from the site and burned or buried well away from the storage area.

Aeration

The ultimate storage option for aeration is silos. Aeration cooling only requires two to three litres per second per tonne but air distribution is the key.

Take greater, more affordable control of your grain storage

SilverTube™ is an innovative storage system for the management of dry coarse grains, such as wheat, barley, oats, triticale, sorghum and maize.

The tubes have been developed to fit 2.75m (9ft) diameter grain loaders and fit neatly on most popular bagging machines.

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Tapex®


Photo: Chris Warrick


Photo: Chris Warrick

A weak seal: *Replace broken seals to ensure sealable silos remain gas tight.*

Photo: Chris Warrick

Relief: *Oil relief valves allow for air expansion and contraction in a sealable silo and double as a pressure-test gauge.*

Flat-bottomed silos with a perforated floor are ideal, but a silo with aeration ducting to disperse the air will also do the job.

Aeration cooling in grain bags, sheds and bunkers is not as efficient or as simple to set up.

Fumigation

Fumigation, whether it be with phosphine or one of the alternatives, must only be carried out in a gas-tight, sealable silo.

According to a recent GRDC-funded survey carried out by Kondinin Group, only 47% of respondents understand what constitutes a sealable silo.

Only silos that meet a five-minute, half-life pressure test can be classed as sealable and there is now an Australian Standard (AS2628) for growers to use as a benchmark when purchasing new silos.

For older sealable silos, a three-minute, half-life pressure test is acceptable but anything less will not allow for an effective fumigation with any fumigant.

Maintenance

Grain storage is not unlike other equipment on the farm in that it also requires maintenance.

Sealable silos will not remain gas tight forever — seals around lids and hatches need replacing, oil in pressure relief valves needs topping up occasionally and structural joins may need resealing over time.

If done regularly, maintenance need not be a big job but a small amount of attention will prolong the life of sealable silos and ensure they meet the Australian Standard.

Grain bags typically require the highest amount of maintenance to patch up holes caused by vermin and storms.

Careful site preparation, fencing and correct loading can reduce maintenance on grain bags but they still need to be checked more regularly than permanent storages.


Photo: Chris Warrick

Cool choice of storage: *Flat-bottom silos allow for effective aeration cooling through vents in the floor.*

Ease of use

In most cases, ease of use in terms of loading and out-loading grain is a direct trade-off for cost of setting up the storage.

After they are set up, silos are clearly the quickest and easiest to use option, limited only by the capacity of the auger or conveyor.

Sheds and bunkers are easy enough to load but out-loading requires a considerable amount of time and effort with the right equipment.

Grain bags are tricky to use at first and require practice and know-how before loading and out-loading can be done efficiently.

Like bunkers, grain bags require site preparation and more regular maintenance but are often used for the same purpose — cheaper, short-term storage to manage large quantities of grain in high-yielding years.

If used correctly with the right equipment, grain bags are easier to out-load than bunkers and sheds.

That is providing the grain bags are set up on a site that is accessible in all weather conditions, such as a bunker or shed would be.

Cost

There are many variables to consider when comparing the cost of each storage option, the main two being the quantity of grain and for how long it's being stored.

As a general rule, silos are the most expensive form of grain storage in terms of initial set-up costs, followed by sheds, followed by grain bags.

But if storing grain for any length of time, (more than a few months) the cheaper storage option may not work out to be the least expensive in the long run if it doesn't allow for effective insect and quality control.

Damage from insects, high moisture content or high temperature, which cannot be managed as well in some storages, can reduce the value of grain significantly.

Consider the time and therefore the cost of loading and out-loading along with the time and cost involved in site preparation and storage maintenance.

For example, grain bags may have a lower initial set-up cost than silos, (providing the loading and out-loading machines are hired or the cost is spread across a large portion of grain) but grain bags require a lot more time in terms of site preparation and during-storage maintenance .

Considerations contributing to the cost of grain storage options:

- Initial set-up cost
- Ongoing storage maintenance cost
- Time taken to prepare the storage facility each year

- Time taken to clean the storage for meticulous hygiene
- Loading and out-loading time
- Cost of spoilt grain if insects or quality are unable to be controlled
- Period of time grain is in storage
- How often the storage is required
- Cost of occupational health and safety (OH&S) compliance
- Value of the grain being stored
- Quantity of grain to be stored
- Segregation requirements for different varieties and grades of grain
- Multiple purpose use for grain sheds

Unfortunately there is no one formula to take all of these considerations into account but they must be considered when evaluating the cost of different storage options.


Photo: Chris Warrick

Summary

When choosing grain storage options think about more than the initial cost.

Grain storage pest and quality control involves meticulous grain hygiene, storage preparation, aeration, regular monitoring, pest identification and pest control options (i.e. sealable storage). GT

FURTHER READING ▶ Next month, *Farming Ahead* will feature two case studies on growers' experiences with on-farm grain storage.

www.storedgrain.com.au

www.farmingahead.com.au

Research Report: Keeping aeration under control *Farming Ahead*, March 2010, No. 218.

Research Report: Unearthing savvy storage secrets *Farming Ahead*, August 2009, No. 211.

***Stalk to Store* published by Kondinin Group is available to members for $35 and non-members for $40 (plus postage) by phoning 1800 677 761 or ordering online at www.kondinin.com.au.**

Stored grain monitoring and testing equipment pictured in this article can be purchased from Graintec Toowoomba www.graintec.com.au.

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