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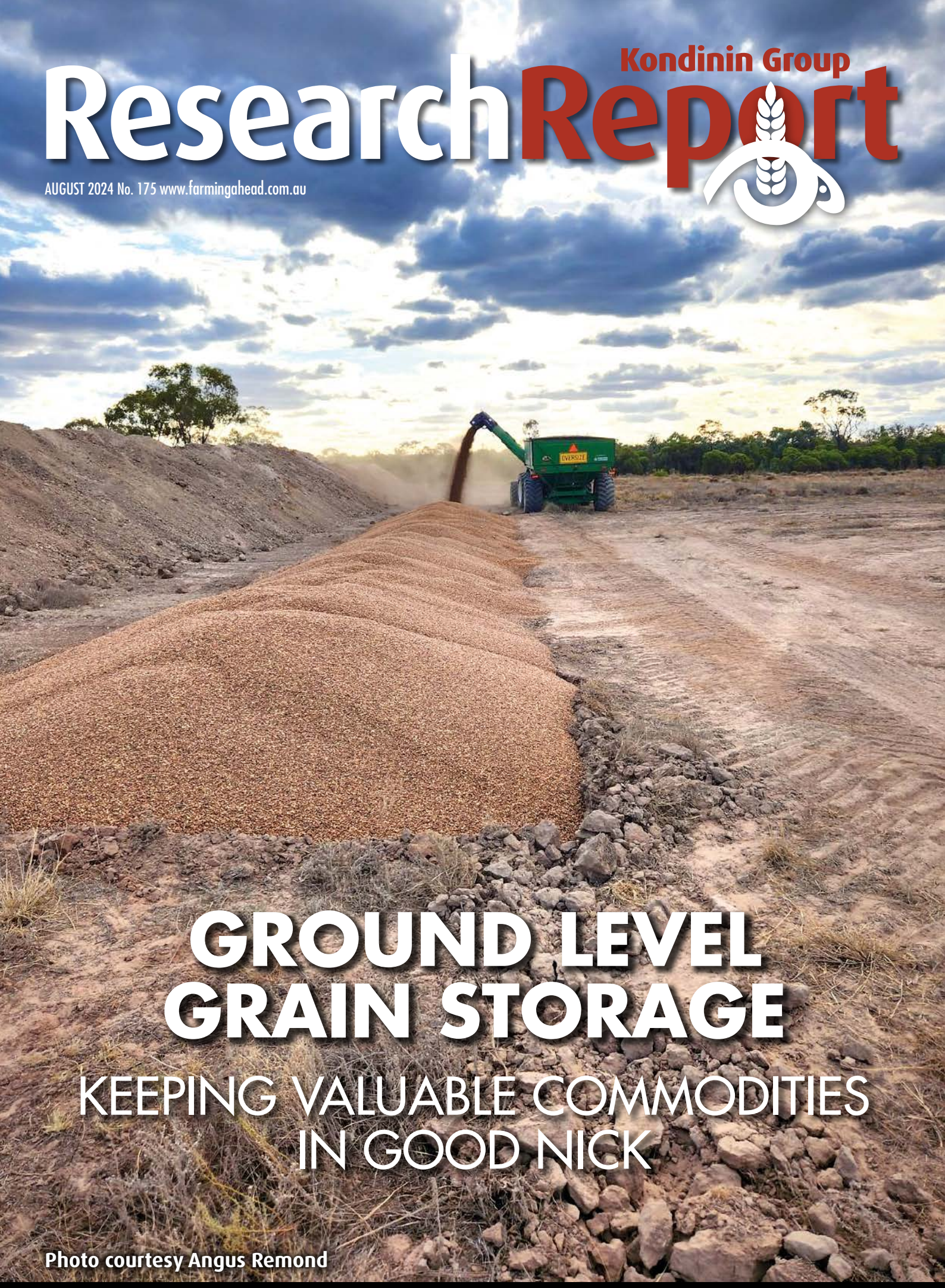

GROUND LEVEL GRAIN STORAGE

KEEPING VALUABLE COMMODITIES IN GOOD NICK

Photo courtesy Angus Remond

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Grounded: Ground level grain storage options can provide short and long- term storage solutions at a variety of price points but like all grain storage, they require best practice to preserve the quality of grain in storage.

Well-grounded: storage options

Ground level grain storage can provide flexibility, rapid deployment and low-cost storage options. As a grain storage option, ground level storage is relatively simple and provided fundamental preparations are made, grain has been successfully stored for a decade or more in some styles of ground level storages. Teaming up with the Grains Research and Development Corporation (GRDC) stored grain extension team, this Research Report looks at the benefits and challenges associated with ground level storage with a focus on growers who have done it successfully.

Words and images: **Ben White, Mark Saunders and Chris Warrick**.

Alternative and complementary grain storage options to silos include bunkers, grain rings, underground pits and sheds.

Each option has benefits and disadvantages and while upright, gas-tight sealable grain storages provide the ultimate in service life, outloading, hygiene, aeration options and insect control, silo initial capital outlay costs range from $200/t to $400/t of wheat storage capacity. Anecdotally, the cost of ground level storage options starts at a nominal $20/t for underground pit storage and goes up from there depending on the permanency and flexibility the option provides.

Ground level storage options also include grain bags which are used extensively for short-term storage but are not specifically covered in this report. A dedicated future report is planned with case study examples of grain bag use.

Ground level storages rely on preparation with ground works the primary requirement to maintain good drainage and the redirection of any overland flow away from the grain stack. ▶

SITE SELECTION

Key to the success of any ground level grain storage facility is the selection of the site. In most cases site selection aids the flow of water, runoff and drainage away from the grain stack.

Water runoff can be significant on larger bunkers with all of the water shed during a rain event to be handled by the drainage system surrounding the storage.

Ground works requirements can also vary with consideration given to the soil type and ability for water to infiltrate.

FREQUENCY OF USE

Ground level storages incorporating tarpaulins can be set up as a temporary solution for short-term or single season storage or can be a permanent option with tarpaulin replacement every few years.

Tarps may also be required in a shed if the grain is to be fumigated. To date, only one shed has been tested and found to meet a three-minute half-life pressure test a requirement for fumigation made by WRL sheds based in Warren, New South Wales. FA

On the doorstep: Large-scale sheds can provide a multi-purpose storage option.

Ground work preparation and drainage are vital for grain bunker storages.

Bunkering down

Bunkers are the heavy lifters when it comes to ground level grain storage. Favoured by bulk handlers and larger producers for bulk farm storage, bunkers have a low nominal cost to install but like silos, require specific equipment for safe and easy inloading and outloading.

Bunkers are used to store significant volumes of grain across Australia with bulk handlers hosting open bulkheads up to 50,000t or more in capacity. On-farm bunkers range in size from a few hundred tonnes to more than 25,000t with the cost per tonne stored reducing as the stack volume increases.

Bunkers typically utilise a heavy quality top tarpaulin and may or may not employ a bottom sheet. Bottom sheets may not be needed if the soil type is favourable for roller packing and a smooth and sturdy surface can be achieved. In most cases, once the top tarp is ready for replacement due to the nicks, cuts and tears that can happen during use, it can be repurposed to have a second life as a bottom sheet.

Tarps should be sourced from a reputable supplier and can be made using a range of plastics (see Table 1).

It is worth noting that while Polyethylene (PE) and Polypropylene (PP) tarps can potentially be recycled, the chlorine content and chemical additives mean recycling PVC cannot be done easily.

Table 1: Example grain bunker tarp materials

Material	Example manufacturer	Weight (Grams per square metre)	Typical warranty
Polyethylene (PE)	Canvacon or Tarpee	250-320	3 years (UV)
Polypropylene (PP)	Landmark	340-370	3 years (UV)
Poly Vinyl Chloride (PVC)	Various suppliers	325-610	3 years (UV)

Source: Polytex

Bunker capacities are infinite but managing the tarps can be difficult without a team as the bunkers get larger.

Bunkers are arguably the lowest financial outlay short-term storage with a nominal cost of around $6-10/tonne for the tarps for a 500-1000t bunker. But the life of the tarps could be three years or more if well managed so this figure may be significantly less on an annual cost basis.

WALLS

Walls can be used to increase the capacity of the bunker without increasing the tarp size requirement. On-farm these are usually earthen side walls to a height of around 500mm and can be constructed on three sides of the bunker when the drainage earthworks are being done.

But larger farming operations may elect to use concrete or steel fabricated side walls, similar to those used by bulk handlers.

These shiftable wall sections can accommodate shifting lugs as well as ▶

Bunker walls can increase capacity without increasing bunker footprints but require management when unloading.

clamps or tarp tie-down points which are very convenient but will add to the cost. As an example, 3m long, 1m high precast concrete wall sections with rounded tops and clamping ferrules are priced at around $825 each at the time of writing.

WEIGHTS

Most on-farm bunkers use weights to keep the tarpaulins held down. Used tractor or truck tyres are usually available and can be filled with concrete with a reinforcing bar loop or eye bolt cast in for ease of lifting and shifting. Not only does the concrete increase the weight, it prevents the tyres filling with water and can make use of any left-over concrete from a larger pour.

INLOAD AND OUTLOAD

Inloading a bunker requires a stacking elevator or auger that can shift along the grain stack as it is built and the bunker is filled. Larger bunkers may require specialist stack loaders while for outloading, an outload (sweep-style) auger or loader-mounted grain bucket is often used. It isn't unusual for grain to be outloaded directly to the truck and transfer rates are comparable to high output grain conveyors.

INSECT MANAGEMENT

One of the drawbacks with bunkers is that they are not easily disinfested should an insect population break out. The need for gas-tight sealing makes meeting the requirements for fumigation more difficult although it can be achieved with

Table 2: Bunker dimensions and capacity

Bunker dimensions and capacity		Bunker capacity				
Grain Height (H)m	Storage Width (W)m	200t	300t	400t	500t	1000t
		Storage length (L)m				
2	7	34	50	66	82	n/a
2.5	9	24	34	44	54	n/a
3	11.5	18	25	32	39	74
3.5	14	15	20	25	30	55
4	16	n/a	18	22	26	46

*Assumes 500mm wall, wheat bulk density is 750kg/m3. For larger bunker dimensions see www.tinyurl.com/bigbunk
Adapted from Storing, handling and drying grain by Alan Andrews

Figure 1: Bunker cross-section (not to scale)

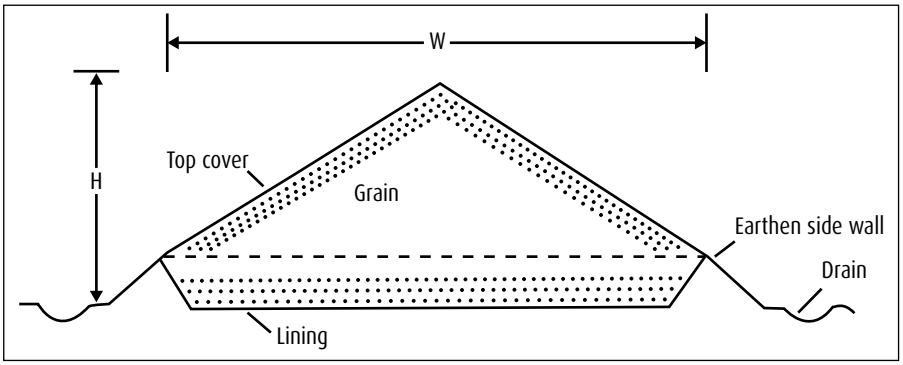
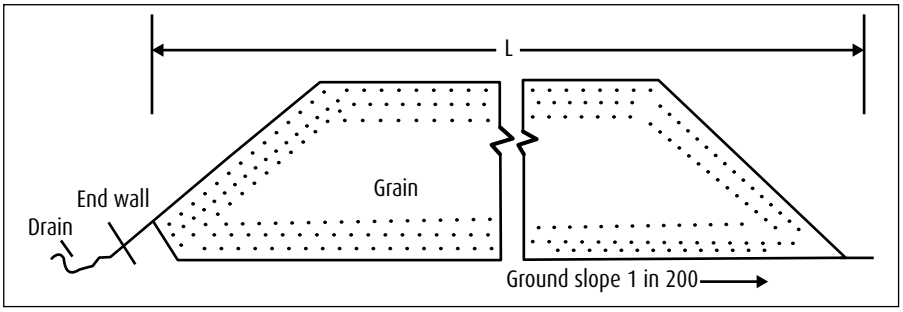


Figure 2: Longitudinal section of bunker (not to scale)



Source: Adapted from *Storing, handling and drying grain* by Alan Andrews.

a top and bottom tarp in place. Options include getting a licensed fumigator in to apply and monitor the fumigation or for medium-term storage requirements, an application of a protectant on inloading could be considered.

CONSIDERATIONS AND TIPS

- Site selection and earthworks must keep water away from the stack and allow access when needed.
- Bottom sheets are optional depending on soil type but will arguably reduce spoilage and shrinkage.
- Top tarps should last around three years or more if well fastened and regularly maintained with small holes and tears patched promptly.
- Walls add capacity without additional space requirements but removable wall sections assist with drainage as they can be removed as the bunker is emptied.
- Fork-mounted brooms may be expensive (circa $6000 for a 2m broom), but growers who have made the investment recommend them for outloading. FA

Clean sweep: Fork-mounted brooms can make cleaning out easier and more thorough.

Top notch: A first-class grain storage facility established by the Greentree family near Mungindi, New South Wales, has over 100,000t of capacity in bunkers alone.

First-class facility incorporates big bunkers

Tom Greentree and his family farm around the Gwydir river in northern New South Wales where topographically the fall over the country is 188mm over every kilometre. While this makes for incredibly productive floodplain farming country, it poses some challenges when establishing a grain storage facility. It's little wonder Tom's number one consideration is drainage.

Tom says farming on the floodplain means early planting and long season wheat varieties to chase moisture down through the very deep soil profile. It also means the different agronomy areas may be cropped according to their drainage profile with faba beans going into country that doesn't drain well while chickpeas, which don't like wet feet, are planted into the better draining areas.

Typical wheat yields are 3t/ha or better topping out at 5t/ha with the bottom end of this range achieved with next to no in-crop rainfall provided a decent flood precedes planting.

Dryland cotton delivers the best gross margin return, eclipsing that from grain production and meaning that Tom typically farms with no residual chemistry to provide flexibility and the option to plant cotton where and when the opportunity is presented. WeedIT sensor-based sprayers are an essential component in the family's battle with weeds, soon to be replaced with SenseSpray-armed CaseIH Patriot 50 series self-propelled sprayers.

Case study

Tom Greentree
"Morialta", Mungindi and Walgett, New South Wales

- 19,000ha of cropping
- Wheat, chickpeas, faba beans, dryland cotton
- 8000t grain shed
- Four 25,000t bunkers

GRAIN STORAGE

The need for on-farm storage at Morialta was initially borne through a need for harvest logistics with increasing harvester capacities and the farm being 100km from the nearest grain receival site.

But with that investment came marketing opportunities and after building a fenced receival yard, installing a weighbridge and an Australian Standard sampling stand to become accredited, Tom has developed

Grain blending from the bunkers comes through these blending hoppers.

a first class storage facility which has in turn attracted five key buyers for the Greentree crop.

Tom says that accreditation has also provided the opportunity to accumulate grain on-farm and go straight to port in Brisbane.

The facility includes a 36m long weighbridge which assists with segregation and helping to understand what grades of grain are on hand.

The fencing was sourced at an auction and dust suppression sprinklers are fitted to the tops of the posts to assist a full time driver with an ex-army water-truck to wet up the roads around the facility during harvest.

Tom says the bunkers have been optimised with shiftable 1.2m high wall sections which have added 33 per cent to the bunker storage capacity without having to expand the site. The wall sections can be shifted out as the bunker is emptied and to improve drainage off the pads which are graded to have a 600mm fall from the centre to the ends. Water then flows off the ends to drainage channels around the bunkers.

Tom says that they always run a ground tarp to keep the outloading process clean and shrinkage below one per cent. Typically, this ground tarp is recycled from the top tarp and a new one sourced from Polytex as required.

For inloading, Grainline drive-over hoppers are used and can each stack the bunkers at a rate of 420t/h. A swivelling spout means they can load about 1000t on the 45m wide bunkers before needing to shift. Tom says that means the trucks are not waiting to unload, rather, they are waiting near the 10-15 harvesters running in the paddock. That level of harvest capacity is essential, according to Tom, who points out they can go from APH to feed quality grain in a single rain event.

A loader with a 5t Kerfab bucket is used to outload the grain straight over the side of the truck trailer or into a blending hopper. ▶

The Kerfab outload loader bucket holds 6m³ heaped.

TARPING

Tarping the bunker is the most difficult aspect of the process with a team of staff, two utes and poles to assist lifting the tarp up to the peak of the stack.

From there, it's straight sailing for two blokes, Tom says.

To keep the tarp held down, tyres filled with concrete are placed as the stack is being built.

Almost all grain sold from Morialta will be blended to meet market specification. With everything having been over the sample stand and weighbridge, Tom says it's like mixing a cake with a defined recipe and the outload hopper used as the mixing bowl to meet the specification. Future plans include half a dozen 1500t elevated cone-base storages which will be used for cleaning up bunkers and allowing outload when it is wet.

For Tom it's all about the efficient use of labour and while he says he has fantastic staff, it's about using their time wisely.

INSECT MANAGEMENT

Once the top and bottom tarps are in place and roll sealed to the wall sections, Tom gets a professional fumigator in to fumigate and remotely monitor the fumigation concentration levels in the bunkers.

Once off the paddock, Tom says that sulfuryl fluoride (Profume) is used for the first fumigation to clean everything up and then this status is maintained with phosphine as required. No protectants are used.

OTHER STORAGE

The 8000t capacity shed measuring 22m wide and 85m long can also be fumigated although it is a more labour intensive task to pull a tarp over the grain and pinch seal to the 2m high angled corrugated wall with bars and threaded rod.

The shed has roof-mounted hatches and a walkway and is filled using the same driveover stackers as the bunkers with 500t of filling between shifts.

Tom uses the shed mainly for chickpeas with caution taken not to grind up the chickpeas when outloading, a disadvantage of the concrete floor, according to Tom. To avoid this, the bucket is kept elevated off the floor and then grain left on the floor is swept back into the pile as they go to avoid driving on it.

When not filled with grain, the shed is used for machinery storage.

A line of large elevated cone-base Kotzur silos are used for seed and fertiliser and are fitted with 45-degree cone bases for ease of outload. Tom says these silos can help make the most of low urea pricing. FA

Chickpea splits in storage are minimised by avoiding driving over the grain and sweeping as the pile is outloaded.

Dust suppression is taken seriously at Morialta.

Fencing was a part of the accreditation requirement.

Bunkers have their place at South Bunarba

Case study

Sam and Annette Heagney
"South Bunarba", Mungindi, New South Wales

- 11,000ha dryland wheat, sorghum, chickpeas, dryland cotton
- 18,000t upright gas-tight sealable silos
- 5500t WRL gas-tight sealable shed
- 30,000t of bunker storage

Grain storage is done well by Sam and Annette Heagney at South Burnaba, Mungindi, New South Wales, with bunkers supplementing significant gas-tight sealable storage facilities as well as a sealable shed. The shed, which has doors at either end allowing segregation, was being used for cotton seed and urea storage at the time of writing. Originally, it was built for chick peas to preserve quality with minimal handling.

The bunkers utilise a ground sheet but Sam doesn't use walls anymore after finding that the effort and time required to pinch clamp the top and bottom tarps together against the wall sections was significant. The semi-permanent wall sections also tended to create a dam because they couldn't be easily removed as the bunker was outloaded.

Sam says that the option to remove the wall sections and instead use tarps with concrete-filled tyres to quickly cover and secure the grain stack during harvest was significantly quicker and less labour intensive.

The trade off is the loss of some capacity, but Sam says it has been worth the change.

INLOADING AND OUTLOADING

For inloading bunkers, an AGI swing-away auger with a sliding hopper to reach in between trailers was initially selected. Sam originally thought ▶

Efficient: South Bunarba has bunkers, a shed and significant upright storage facilities. Sam Heagney says ease of use, efficiency and flexibility are key themes employed in the development of the site.

Bunkers are used without side walls to minimise the time requirement for covering and securing bunker tarps at harvest.

this selection should save a lot of time at harvest because it negates the need to split trailers and can be used on other storages, but he says a Grainline drive-over stacker makes filling the bunkers simpler and is easier to move.

The shed at South Burnaba is also filled using the drive-over stacker and is fixed in one position, relying on a chain drag on the top of the shed roof to deposit the grain through a series of roof hatches in 500t drops. Sam says the drag was an expensive addition to the shed but negates the need to shift the stacker which is important for a targeted 24-hour non-stop harvest operation.

For outloading the bunkers and sheds, a 14t wheel loader with a 4t grain bucket is used to load directly into truck trailers.

TARPS

To save the ground tarp on the bunkers from damage when outloading, Sam put four wheels on the bucket to keep it off the deck. A forklift-mounted broom is then used "every few trucks" to sweep the bottom layer of grain back into the stack.

Most of the bunker ground tarps are in two sections, sewn together which will be unstitched when the bunker is sufficiently outloaded to go back to a single tarp. Bunkers are sourced through AgriStorage in Moree, New South Wales.

Two of the bunkers have a sandy base while another couple are on a softer soil which Sam says will benefit from an application of gravel this year. Keeping the water away is the number one priority of storing grain in bunkers, according to Sam.

The combination of bunkers with other storage types is an important aspect to the South Burnaba facility, allowing segregation and blending as needed to assist marketing.

INSECT PEST MANAGEMENT

Fumigation with phosphine is conducted by a licensed fumigator and the stack fumigant levels are monitored throughout the fumigation. Tarp sealing for fumigation is done with sand over the top tarp pressing it down to form a seal onto the bottom tarp.

INVENTORY AND LOGISTICS

Flows of grain in and out of the facility are recorded using Agrichain, a software platform that helps to manage grain stocks, scheduling and logistics. FA

Keeping ground tarps in one piece is made easier with the addition of wheels on the bucket and a fork-mounted broom. Photo: Sam Heagney

South Bunarba incorporates a range of storage options including sheds, bunkers and upright storage.

Low cost option: Grain rings can be a low-cost method of storing grain with cost per tonne decreasing as capacity increases.

Ringing it in

Grain storage rings come in capacities from 60t to 2500t and can be purchased with a heavy-duty tarp. As with most ground level storage options, initial capital outlay on a cost per tonne basis reduces significantly with increasing scale down to around $10/t at the bottom end, making rings a cost competitive option up front. But outloading is a one-shot job.

A grain ring is a short to medium-term storage option with relatively low capital outlay. Grain rings are often constructed with galvanised steel walls profiled with strengthening ribs and bolted together in sections.

The sections are typically 600mm to 1200mm high and are assembled (usually using more than a dozen bolts joining wall sections) on the ground on a well-prepared, elevated pad.

Depending on the quality of the pad, grain rings may be prepared for filling with or without a ground sheet. Some growers opt to use a ground tarp while others have achieved a satisfactory result with a base of asphalt or compacted gravel.

Example ring diameters range from 8.8m to 32m resulting in stored grain capacities of 60t to 2500t. Indicatively, the initial capital outlay costs per tonne of stored grain decrease as the storage diameter increases but start at around $70/t reducing to under $10/t.

INLOADING AND OUTLOADING

Filling grain rings is as simple as positioning a sufficiently long inload auger outlet over the centre of the grain ring and topping the ring up until it has reached capacity. Full capacity is when grain has reached the top lip of the ring at the angle of repose to the peak.

It is essential that grain rings are filled to capacity at the height of the wall to prevent water pooling around the edge of the wall.

Positioning tarps can be tricky although operators have successfully extended telehandler booms to place the tarp at the peak of the stack and used gravity to assist with the rollout down the grain stack. Other options include using larger augers to position the tarp at the peak, although if contemplating using an auger to position the tarp, consider the weight of the tarp and the potential for the auger to tip forward.

Getting grain out of rings is different to a bunker because sufficient grain has to be removed with an extended telehandler bucket or auger over the wall into the grain stack. Once sufficient grain has been removed, a wall section can be taken out.

Once the ring wall section is removed, access can be gained to sweep grain into an auger or outloaded with a grain bucket on a loader. In some cases, growers have found it easier to vacuum the grain out once the initial top section of the stack has been removed.

Grain vacuums are typically PTO driven and have capacity up to 100t/h. Many growers will opt to hire a vacuum given the high initial outlay and low frequency of use.

The major drawback with grain ring storage is that small parcels of grain cannot be withdrawn from the stack over a period of days or weeks because the tarp relies on the grain stack to keep it supported. Without this support, water will simply pool in the tarp. Instead, all grain must be removed at once and sold or stored elsewhere out of the weather.

CONSIDERATIONS AND TIPS

- Rings must be filled to capacity to prevent water pooling.
- Rings must be emptied completely in one operation to prevent tarp damage and water pooling.
- Inload is simple, outload is more complex.
- Initial capital outlay cost varies significantly but can be as low as $10/t.
- Rings and tarps can be re-used but use plenty of tyres to prevent tarp billowing.
- Fumigation in grain rings is usually not possible as a gas tight seal cannot be guaranteed. FA

Stockpiled grain provides feed insurance

Case study

Paul Sinderberry
Condobolin,
New South Wales

- 4000ha wheat, canola, barley, biserrula
- Around 600t gas-tight sealable Kotzur silos
- 400-1200t grain rings
- 250t underground pits

Cyclical production years including being short on feed grain in 2018-19 has seen Paul Sinderberry utilise grain rings and pits as a form of seasonal livestock feed insurance on the farm at Condobolin in central New South Wales.

With a stud bull and commercial cattle enterprise supported by grain produced on-farm, the grain in the rings is typically stored for eight to nine months.

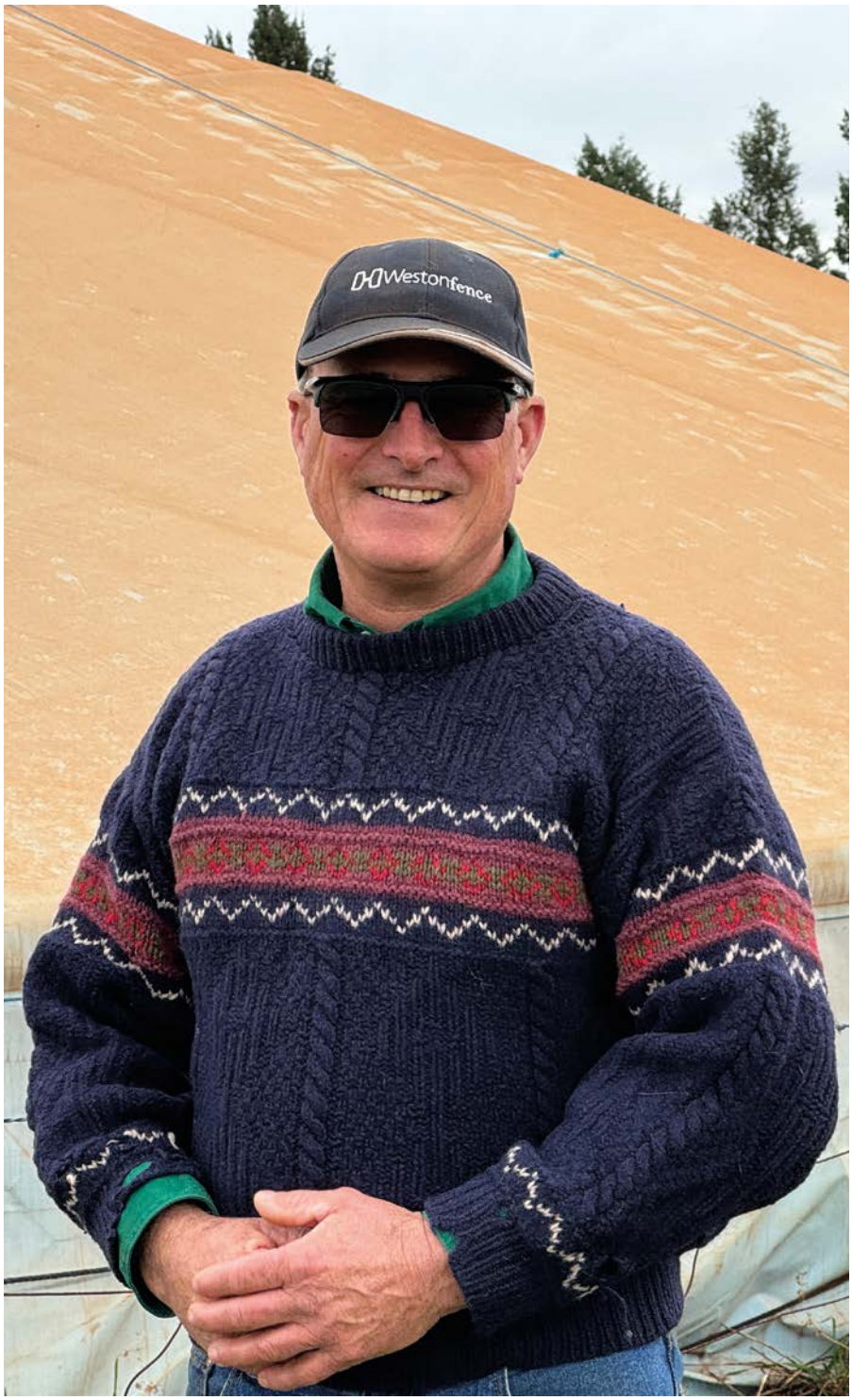
It is only sold off once the production risk of the following year's crop diminishes. If the season is looking like it might be tight, grain in the rings is held and can be drawn on if needed to maintain the stud and herd cattle.

Paul says that like two others used for 2022 crop storage, a grain ring was positioned in the corner of a paddock close to the road to assist with access for outloading. But given the difficulty of paddock access with the current wet season, Paul suggests he will shift all three grain rings to a more elevated position near the sheds. This will provide better outload access and improve monitoring frequency.

The grain rings are 18m in diameter and should be good for 400t of barley storage. Paul says he opted not to use a ground tarp because he wanted to be sure that if water was to infiltrate the tarp into the grain, it could then also drain out.

The top tarp requires three or four people to install but is done with a 21.3m swing-away auger to raise the tarp to the top of the stack where it then unrolled. Four old truck tyres are then used to stop the tarp from billowing.

Paul says the rings are labour intensive to put together with a "lot of bolts"



Paul Sinderberry is self-insuring against grain shortages when the next drought comes, with a rotating stockpile of feed grain in rings and underground in pits which can be drawn on to sustain his stud cattle as needed.

but to shift, only every second sheet is disassembled, halving the workload and making the sections larger but not overly cumbersome.

Feral pigs have done a lot of damage to grain bags on neighbouring farms and Paul says they have also been walking around the grain rings, but haven't been able to get to the grain.

With the insurance approach to barley storage, Paul will continue to turn grain over through the rings, but on outload, buyers will typically want the grain fumigated.

Without the option for fumigation in the grain rings, Paul removes the grain and loads it into a series of Kotzur elevated cone-base silos which meet AS2628-2010 and are suitable for fumigation.

INLOADING AND OUTLOADING

Inloading is straight from the harvester or chaser bin into the centre of the ring with a top-up via an auger.

Paul will use a combination of augers and telehandlers to initially remove grain from the rings and get it into trucks to take to the silo storage facility for fumigation. Once able, he will then use a grain vacuum to remove the balance of the grain.

He has also heard of strainer posts being installed at the edge of a couple of wall sheets allowing the wall section to be more easily removed for access with a telehandler without compromising the strength of the ring.

OTHER STORAGE

Prior to storing grain in rings in 2022, Paul says that they also had a large production year in 2020 so some of that grain went into pits for long-term drought storage. The pit storage for 250t of oats comprises an excavator-dug 30m long, 4m wide pit, around 4m deep. The grain is filled to the top of the pit walls with a peak formed in the middle of the pit section down to the edge of the pit at the angle of repose. A 6m wide sheet of plastic covers the grain with 300-500mm of soil covering the plastic over the pit. Paul says that when the grain comes out, they will bring in a local excavator driver for the job. FA

Paul has had some challenges stopping the ring tarp billowing but has it weighed down with tyres which was proving effective.

Placement of the ring close to the road for ease of outload.

Buffer ring: Despite having a Vitera site closeby, Matt and Sharon Starick utilise a grain ring as a feed storage buffer. Drawing on their on-farm grain production, grain is used to supply their piggery operation on farm. Photo: Matt Starick

Rings provide flexibility but with ground rules

Case study

Matt and Sharon Starick,
Punthari, South Australia

- Wheat, barley, canola, lentils, piggery
- 250-300t grain rings for feed grain storage
- Aerated Jacksons silos

While Vitera sites aren't too far from Matt and Sharon Starick's Punthari, South Australia operation, the use of on-farm grain storage in rings is predominantly to provide a 250-300t feed buffer for their piggery operation.

While most of the grain required for the piggery is safely stored in aerated 70 and 90t Jacksons silos and fed into an automated mill system, the grain ring provides a top-up as required but comes with a few cautions, says Matt.

Firstly, over moisture or even questionably uneven moisture grain is at high risk in a non-aerated grain ring, Matt points out.

Secondly, site selection is critical to provide drainage and access for outloading.

A lighter plastic ground tarp is used by the Staricks, albeit with a few holes patched up. The 15.2m ring is then filled with grain via a 22.9m auger which Matt says is only just long enough. Once the ring is filled to the top of the walls, a Jaylon-sourced top tarpaulin is installed at the peak of the stack using a 3m spreader bar and a couple of slings on a telehandler mounted jib.

When it comes to outloading, a telehandler is used with a materials bucket to extract around 150t of grain before the remaining 100-150t is vacuumed out with a hired unit. The extraction process in total takes around 12 hours over two days.

Matt says that while they provide great flexibility, one of the downsides is that the grain in the rings needs to be emptied in one go and that the grain then must also have a storage destination or delivery point to go to. FA

STORAGE SNAPSHOT: BRAD AND KATE JONES

Location: Tammin, Western Australia

Farming at Tammin, Western Australia, Brad Jones utilises bunkers and grain rings as part of an extensive on-farm grain storage facility with a mix of aerated and gas-tight sealable large flat-bottom and elevated cone base silos.

Brad uses the rings on a seasonal basis for harvest logistics and blending. While initially using compacted soil (as pictured), Brad has since laid asphalt in the base to assist with cleanout and reports that it works well.

Shedding light on storage options

As an option for short to medium-term grain storage, sheds are becoming increasingly popular as they offer a dual-purpose functionality for machinery, hay or fertiliser. The latter providing producers with the option of securing product as the price cycle ebbs. Until recently, fumigation in a shed required the installation of a tarp over the stack but a gas-tight sealable option is now available. Sheds can also be a valuable method of rain water catchment.

To minimise the side wall loading from grain, sheds designed for grain storage will typically have significant structural steel support or concrete walls installed to a designated height to match the shed capacity.

COSTS AND OPPORTUNITIES

The cost of storage in sheds varies significantly depending on the size, proportions and overall capacity. But by comparison with bunkers, pits and rings, they are relatively expensive if only comparing them on a per-tonne of stored grain basis. It should be remembered however that the shed service life will be significantly longer and multiple use flexibility applies.

As a pricing example, at the time of writing, the initial capital outlay a large (3200t) 24x42m dual-purpose shed with walls suited to grain storage costs around $160/tonne of stored grain (assuming it is filled).

But with volatile fertiliser pricing, the cost of a shed could be quickly recouped with fertiliser requirements purchased when fertiliser prices are relatively low.

SEALING STATUS

Like bunkers, most conventional sheds are difficult to seal to a gas-tight standard so effective fumigation to disinfest grain for insect pests can be difficult. But recent Kondinin Group and Grains Research and Development Corporation (GRDC) testing indicates one make of shed will pass a three-minute half-life pressure test for gas-tight sealing. See the Maxwell case study snapshot on page 20.

FEATURES AND OPTIONS

Sheds may also include design features to make inloading and outloading easier. Examples include sub-floor-level hoppers integrated near one of the walls allowing grain to be pushed toward the hopper and outloaded by an external auger.

As with bunkers, protectants could be a useful tool in sheds that are not gas-tight sealable or in facilities where there are no gas-tight sealable options for fumigation disinfestation. Protectants can be used for some grain types (limited options in Western Australia) for medium term (3-9 months) storage. Withholding periods (WHP) vary with product choice and application rate.

CONSIDERATIONS AND TIPS

- Always opt for a shed as large as the budget can afford. The nominal cost per unit of area and volume decreases as sheds get larger.
- Consider a gas-tight sealable option if they are within the budget.
- In-shed segregation can provide additional flexibility.
- Don't forget the cost of inloading and outloading equipment.
- For crack-prone pulses consider a fork-mounted broom. FA

Under cover: Sheds are becoming popular for grain storage and multiple uses.

STORAGE SNAPSHOT: BIGG FAMILY

Location:
Balaklava South Australia

The Bigg family from Balaklava, South Australia utilise a series of large sheds to store bulk grain.

Kotzur gas-tight, sealable, flat-bottom silos nearby are used to batch fumigate grain as it comes out of the sheds as required to meet market requirements or to control infestations.

Photo: Chris Warrick

STORAGE SNAPSHOT: MARK AND STEVE DAY

Location:
Lockhart, New South Wales

Mark and Steve Day have utilised a series of Intermediate Bulk Containers (IBCs) and hay bales to form a wall to protect grain stored in his open-sided shed.

An integrated elevator facility with eight large MFS Allied gas-tight sealable and Cyclone silos are also located on-farm.

Photo: Chris Warrick

Shed helps grain handling in south-western Victoria

Case study

Luke Fay
"Riponhurst", Carranballac, south-western Victoria

- 2800ha wheat, canola, barley and beans
- 10,000t grain shed
- 7000t of silo storage

Flexibility: This shed provides the Fay family in south-western Victoria with plenty of flexibility when it comes to storing and handling up to 10,000t of red wheat every year. Photos: Mark Saunders

Luke Fay and his family decided to build a large capacity grain shed on the family farm, 'Riponhurst', at Carranballac in south-west Victoria, about 10 years ago.

The shed, which measures 30m in width by 120m in length can hold about 10,000 tonnes of wheat.

Luke said the shed was built on the site of a 6000t capacity grain bunker after some struggles with handling the large tarps required for the bunker.

"We soon learnt the tarps could be very difficult to handle without the right equipment, so we decided on a shed," Luke said.

A contractor poured the concrete floor of the shed while Luke and his family fabricated the concrete inner walls on the property.

The inner concrete walls were 2m tall but the Fays soon added steel hungry boards to ensure spills were kept to minimum. The steel (zincalume) sheets added another metre of height to the internal walls allowing plenty of room for the natural repose of the grain stack when getting close to the peak of the gable roof height of about 12m.

One end of the shed is enclosed but Luke added ventilation to that end after it became clear dust was an issue with little air flow.

The concrete slopes downward, heading outward from the shed's front third in length to help keep things dry but Luke said the site is well elevated and moisture ingress has never been an issue, however there is some occasional condensation from the underside of the roof.

"All in all, it's been a good asset as we use it mostly for the red wheat we produce here for stock feed requirements," Luke said.

"We occasionally buy grain in so there is always grain coming and going."

Trucks are able to back into the shed, with a generous hard stand of gravel at the shed entrance. Luke said grain is emptied from the trucks into a swing-away auger (30m in length) which allows the shed to be filled pretty much to the roof peak.

Outloading is done via a CLAAS Scorpion telehandler.

All grain delivered into the shed is treated with ConservePlus protectant as a preventative measure against common grain insects.

"We have never really had any insect issues however with 7000 tonnes of silo storage also on the property, grain can be moved into (gas-tight sealable) silos pretty easily if needed," Luke said.

An added bonus is the rainwater catchment the shed provides – feeding a dozen 22,500 litre capacity poly tanks. The water is predominantly used for spraying.

"Water is expensive and the rainwater collected from the shed ensures we have a good supply of quality water for spraying," Luke said. FA

Rainwater is captured in a series of 22,500L poly tanks.

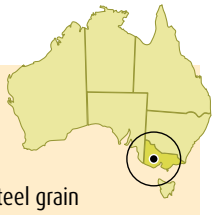
The shed can hold up to 10,000t of wheat.

A swing-way auger helps with unloading duties in the shed as well as loading silos.

Future-proofing: This shed is part of future-proofing plans for more efficient grain handling and farming. Photos: Mark Saunders

Big shed part of big plans for better grain handling

Case study



Blythvale Pastoral

Skipton, Victoria

- Purpose-built Action Steel grain shed measuring 90m x 30m
- Extensive hard stand
- Plans for future expansion

A large-scale shed in south-western Victoria is part of ongoing plans to improve grain handling facilities on a multi-property holding.

The 90m long x 30m wide shed, manufactured and installed by Action Steel, is only a couple of years old and is used as the primary storage for faba beans (about 4000 tonnes in an average year) and red wheat.

The shed's owner, Ed Weatherly, Blythvale Pastoral, Skipton, Victoria, was happy to pass on some experiences when it came to having a large shed installed on the property.

"We have previously used grain bags for quite a bit of storage but are phasing them out, so the shed seemed a good alternative," Ed said.

"It's built on a separate title, so at some point in the future we have the option of selling it off."

Internally the shed has a concrete floor and structural concrete wall panels to a height of 3m. Peak shed roof height is about 12m, allowing plenty of room for truck trailers to tip grain out.

Two large sliding doors are fitted at each end, making the shed a "drive through" affair at harvest.

Ed said at harvest, trucks drive in and simply dump grain on the floor. From there, grain is loaded into the hopper of a shifter via a telehandler and loaded into position in the shed.

The concrete joins along the length of the floor and in between and vertical wall panel joints have been filled with an industrial sealant and clean out is with a commercial broom attachment which fits on the JCB telehandler forks.

Ed said to date, there have been few insect issues and in the future, wheat will be treated with a protectant when it is loaded into the shed.

"We find the beans don't sweat as much in the shed either, with both ends' double doors open."

Hundreds of tonnes of gravel have been used to create an extensive hard stand at both ends of the shed and along one side, providing plenty of room for truck movement.

Two 175,000 litre capacity water tanks (one at each end of the shed) were a ▶

Extensive hard stand at either end of the shed.

The shed feeds two 175,000L water tanks with rainwater.

Structural walls to a height of 3m.

requirement from local council building regulations as were personnel access doors.

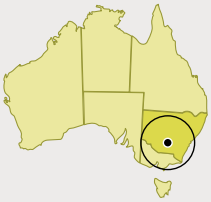
Ed said the water storage was actually a bonus as it would save carting water to the site, which is part of a 1000ha block located away from the home farm.

Future plans include a wash bay, weigh bridge and internal divisions to aid for storing multiple products, including urea as needed.

Ed said for anyone planning to build a similar-sized shed on a greenfield site, attention needs to be paid to initial earthworks.

"I would do the earthworks well ahead of time and give the ground plenty of time to settle, even after compaction, before building. We underestimated the earthmoving required which was obviously a significant cost." FA

STORAGE SNAPSHOT: MAXWELL FAMILY



Location: Ariah Park, New South Wales

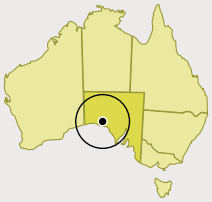
Ariah Park, New South Wales-based Graeme Maxwell has been using two gas-tight sealable sheds for three years in tandem with a pair of 3000t and two 500t flat bottom silos.

The 24m wide x 76m long WRL sheds are used for grain storage and logistics during and post-harvest as well as fertiliser and machinery storage. Grain has also been successfully fumigated in the sheds, according to market requirements.

Graeme has installed enormous graded hardstand areas around the sheds and silos accounting for equipment and transport scale and expansion of the facility in the future.

Kondinin Group researchers together with the Grains Research and Development Corporation stored grain extension team tested Graeme's shed sealability to the Australian Standard AS2628-2010 and found it to meet a three-minute half-life with a little additional force applied on a door seal that had been damaged in three years of operation.

STORAGE SNAPSHOT: SETH COOPER



Location: Coorabie, South Australia

Farming about as far west as one can farm in South Australia at Coorabie, Dr David (Seth) Cooper has to make the most of favourable seasons when they come along in the Great Australian Bight.

With a significant 2022 season, Seth invested in a series of 7000t capacity sheds to aid harvest logistics and temporarily hold grain so it could be sold early in 2023 via T-Ports.

The circa 22x80m sheds were completed just prior to harvest and despite the significant investment, they gave Seth the opportunity to minimise harvest risk and get the crop off the paddock. When Kondinin Group researchers visited in early 2023, the team were busy with the grain cleaner.

STORAGE SNAPSHOT: GRASS SEED DRYING SHED

Location: Cressy, Tasmania

Designed to pull moisture out of harvested grass seed in Tasmania, this high flow grain shed incorporates a vented floor, a 75kW heater and a pair of 30kW "Typhoon" fans.

Seed quality and the floor is also protected by a nylon strip fixed to the bucket edge.

Photos: Ben White and Chris Warrick

STORAGE SNAPSHOT: EVANDALE, TASMANIA

Location: Evandale, Tasmania

Also in Tasmania, there is a grain shed with a series of aeration ducts, each powered individually by a fan. Unfortunately, this shed is filled via a roof-mounted auger conveyor which has seen some overloading, resulting damage to the shed structure, a cautionary tale for roof mounted filling.

Photo: Chris Warrick

Pit stops preserve buried treasure

For long-term storage, underground pits can be an effective low-cost storage option and have been successfully used as feed reserves for drought conditions. Grain must be less than 12 per cent moisture to minimise spoilage risk. Underground pits have been used to store grain successfully for 10 years or more, but careful site preparation is essential.

Provided it is constructed to be airtight, a well-made underground grain storage pit should theoretically see oxygen levels gradually reduce over time.

A low or zero-oxygen environment is the aim, to prevent the development of grain insect pests.

Underground storage pits should be situated in well-drained soil above the water table with the area around the pit graded to direct water away from the pit area.

Where pit walls and floor are firm and clean, the pit can be unlined although if in doubt, a liner can be used.

A typical pit is around 4m wide and is dug out using a dozer, excavator, telehandler or wheel loader usually to a depth of around 4m.

INLOADING AND OUTLOADING

Pits are usually filled until grain is level with the top shoulders of the pit and a peaked ridge of grain has been formed along the centre. A plastic sheet is then used to cover the grain extending outside the pit walls by 1-2m before soil is spread over the top of the pit.

Pits are usually sized to match a silo, so that once opened, the pit can be completely emptied and put into a safe storage facility.

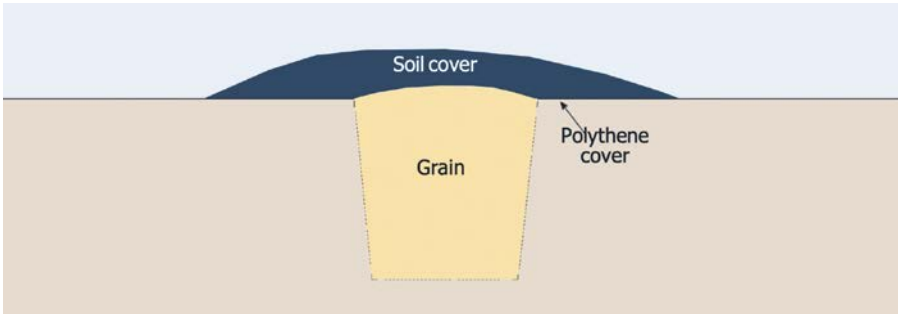
Where there are a number of pits together, separate them by 10m to allow access for filling and emptying and to prevent pits collecting water and seeping into the adjacent full pit.

When filling the pit, avoid driving close to the edge with heavy machinery as this may cause the pit to collapse. Alternatively, an auger in from the side can be used, or, where suitable, grain can be directly tipped having driven into the pit.

Once filled and covered with a plastic sheet, a layer of sand to protect the plastic sheet should be applied before covering with a half metre of soil graded to keep water away from the pit.

When outloading, the half metre of soil must be carefully removed with minimal contamination of grain in the pit. A grain vacuum is ideal for extracting the grain from the pit. Augers or conveyors with cross sweeps or alternatively loader buckets can also be used. FA

Pits can be a good long-term strategy for storage if soil type is suitable. Photo: Richard Quigley



Source: GRDC

Below-ground bounty: Cross section of underground grain storage pit.

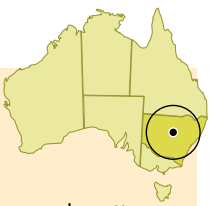
Buried treasure: The Quigley family at Nevertire, New South Wales, have a long-term view of underground pit storage which has proven to work with grain successfully stored for more than a decade.

Pits play an important role for long game

The Quigley family is a dynamic, enthusiastic and professional farming family outfit based just south-east of Nevertire in central New South Wales.

Grain and feed storage is something Tony Quigley has done for more than two decades, including, as his son Richard explains, grain coming out of the ground in the 2018-19 drought that had been underground for more than a decade.

Case study



Quigley family

Nevertire,
New South Wales

- Wheat, chickpeas, beans, canola, cotton
- Underground pits for grain (and silage) storage
- Gas-tight sealable silos to handle pit outload
- Long-term feed storage focus for drought-proofing

STORAGE STRATEGY

Amongst the background of a complex and diverse farming business, the strategy is a simple one; take grain and feed that has a low value during favourable seasons and store it (provided cash flow allows it) until the feed is needed or has a suitably high value.

Tony rightly points out that when supply is good, downgrade quality issues like black-point or screenings come into play and can impact pricing heavily. But when feed is tight, these things quickly cease to be an issue for buyers, who are just happy to be able to access feed grain. Successful long-term storage with minimal shrinkage is key to making this strategy work.

CONSTRUCTION AND INLOADING

Richard explains that the initial excavation for the grain pits was sized to match a couple of silos located closeby to a bull paddock which accommodates numerous linear mounds of soil sitting over hundreds of tonnes of grain and silage buried underground.

The pits are first dug with a standard excavation bucket to a depth of about 4m. With a smooth and clean base and walls, grain is loaded directly into the pit from a chaser bin outload auger and the pit is filled until grain is peaked and the wall level matches the shoulder of the natural ground surface.

Plastic sheet is then laid over the peaked grain as a barrier to the covering soil layer and the Quigleys have found a split grain bag works very well for this purpose.

Soil is then loaded onto the covered pit to a depth of about 500mm. All of the soil dug from the pit goes back on top of it.

Richard says that there has never been an issue with vermin or livestock trying to dig up the bag to get to the grain.

OUTLOADING AND BACKFILLING

When it comes time to take grain out of the pit, Richard explains that the top

layer of soil is carefully scraped back using a silt bucket on the excavator until a small layer of the covering plastic can be seen. From there, the plastic is carefully shovelled and peeled back to reveal the pit boundaries before the excavator goes to work to extract the grain one bucket after another into a waiting truck or chaser bin.

Once completely empty, Richard explains that the hole is once again filled in with soil to prevent it damming water and keep the facility safe.

If the pits are used again, the same silt bucket is used to extract the soft fill from the original pit without damaging it. The Quigley's pits have all been used three or four times each according to Richard.

Tony explains that the breadth of the silt bucket cutting edge means it has a reduced cutting pressure and therefore will not damage the pit. FA

More information: For more information visit the GRDC Stored Grain Extension website: www.storedgrain.com.au or call 1800 WEEVIL (1800 933845).

STORAGE SNAPSHOT: ANGUS AND LYDIA REMOND

Location: Walgett, New South Wales

Walgett, New South Wales farmer Angus Remond has dabbled with underground pits over the past 18 months with some off-specification and rejected faba beans and chickpeas being loaded into a pit. The long-term view is to use the faba beans and chickpeas for feed or to boost cashflow down the track.

Angus practices a long-fallow farming system employed around Walgett that makes the most of the variable seasonal conditions. Wheat and barley are the dominant rotation with chickpeas also in the mix.

Pits are dug into the side of a ridge to aid runoff and drainage.

Grain in the pits came out of grain bags which were used to manage the logistics at harvest in 2022 but the hope is that grain this coming harvest will be able to go directly into the pit.

Angus didn't line the 4m wide, 3m deep and 50m long pits dug by a contractor but extended the top tarp cover sourced from Polytex beyond the outside of the pits by a metre or two.

A series of rinsed white plastic adjuvant drums were placed along the length of the pits prior to soil covering them to assist a future excavator operator to identify the immediate top of the pit when clearing the covering soil for outloading.

Angus estimates the contractor excavator costs were about $6 per tonne to dig the pit and then lay the soil back over the pit after it has been inloaded.

Photo: Angus Remond

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