Department of Agriculture
Farmnote
No. 70/2003
Replaces 11/99

Stored grain management : Underground storage of grain

By Chris Newman, Technical Officer, Department of Agriculture, Forrestfield

Several Western Australian farmers have stored grain underground with minimal deterioration for up to 11 years. They found it a cheap and reliable way to preserve surplus or unsaleable grain for times of feed shortage.

The Department of Agriculture has supervised trials involving up to 120 tonnes of grain underground. After three and a half years storage, the pit was opened during the 1977 drought, with virtually all the coarse grain in good condition.

Reports of underground storage have also come from grain and stock farms in eastern Australia. All sources indicate that pit storage is cheap and simple and provides perfect insect control by excluding air. The method could have value for long term storage provided that a few guidelines are followed.

Choosing a site

The main consideration in pit construction is to exclude water from the grain. Choosing a high site in suitable soil is the first step to achieve dry grain. Ideally, the site should be at the highest point in the local landscape so there is no movement of surface or underground water to the pit. Rainfall also must be encouraged to flow away rather than soak in.

Clay or conglomerate is the most suitable soil. This will allow the pit sides to be nearly vertical without collapsing and the formation of a water-shedding mound over the pit. Vehicle access must be easy at any time of the year, emphasising the need for a clear, well-drained site.

Locating the pit near grain production or feeding out areas is also desirable but must not be allowed to override the selection of a site that is ‘high and dry’.

Pits should not be placed close together because water seepage from an empty pit may spoil the grain in a nearby pit.

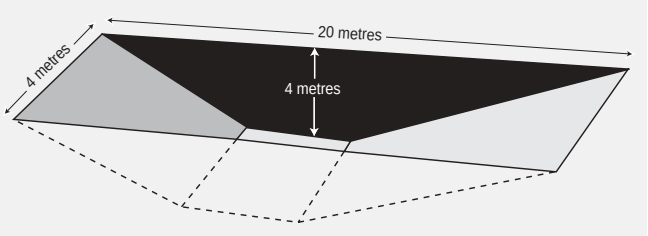

Figure 1. Approximate dimensions of a pit for 100 tonnes of oats

Pit shapes

A number of shapes are equally suitable. The design chosen will largely depend on the grain handling equipment available. If an auger is operated from the ground surface to remove grain, the pit ends should be as steep as possible, limited only by the need to allow a bulldozer to push soil out. The dimensions of a typical pit with steep ends for about 100 tonnes of oats is shown in Figure 1. Most of this pit could be filled by tipping the grain at the ends, with the final topping-up by auger.

If a truck, front-end loader or other equipment is to work in the pit during filling or removal of grain, one end must slope no steeper than 1 in 3. A typical pit of this type is shown in Figure 2). As with the previous pit design, topping up is best done by auger. Tipping over the vertical sides is generally unsafe because of the risk of a cave-in. The pit volume is tailored to the amount of grain available so that the final grain level is slightly above the ground surface. Approximate volumes per tonne of grain are, wheat 1.3 cubic metres, barley 1.6 and oats 1.9.

Pits should be as deep as the site and excavator allow. Generally the pit is about one and a half times the width of a bulldozer blade, with the required volume achieved by the length of the pit. The soil is pushed out each end and moved clear to allow access during filling. When grain is to be removed by front-end loader, pipe or steel skid rails can be placed along the floor as a base for the bucket. Timber may not be suitable for this purpose because of termite attack.

Lining the pit

One Western Australian farmer in a 325 mm rainfall area achieves good results without any form of lining in the pit. Only a few centimetres of grain at the sides deteriorates and this does not warrant the time and small expense of lining the walls. He also advises against lining the floor of the pit, believing that any water that enters the grain should be allowed to drain away.

The trial pits dug by Department of Agriculture were fully lined with 0.1 mm black polythene. If the pit is lined, all horizontal joints must overlap with the higher sheets outside the lower ones. Water will then flow down the outside of the sheets without entering the grain.

On suitable heavy soils there should be little contamination of grain by soil from the pit sides during emptying.

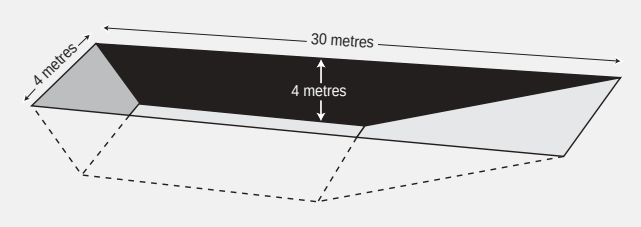

Figure 2. This pit allows vehicle access and would hold about 250 tonnes of oats.

Filling the pit

It is important to ensure the pit and its contents are as dry as possible at this stage. The grain must be under 13 per cent moisture content. If the pit is dug just before harvest, there is usually little chance of the soil being damp in a high site. If rain wets the soil, or if an old pit contains water from the previous winter, the soil must be allowed to dry out. In the Eastern States, pits have been pumped out and the soil dried by burning wood in them. An alternative is to refill unused pits with soil, opening them again when the need arises.

The pit is filled to ground level at the sides, sloping up to a ridge of grain along the centre line to aid formation of a water-shedding surface.

Covering the pit

Before covering with soil, polythene sheeting is laid across the ridged grain and for about 2 m either side of the pit, as shown in Figure 3. Sheets should overlap at least 20 cm at the edges and full sections should be used without cross joins. Medium grade 0.1 mm polythene will resist breakage by lumpy overburden better than 0.05 mm grade sheeting. Sheeting is generally not reused as the cost is small and damage during uncovering is inevitable.

The polythene cover provides a barrier to any water penetrating through the soil overlay, but the aim should be to shed most of the rain on impact with the soil. Care over forming a water-shedding cover is the most important aspect of underground storage after the selection of a dry site. Quick run-off from a smooth covering mound is the main aim together with sufficient depth of soil to exclude air and protect the grain from large temperature changes. The soil cover needs to be 30 - 100 cm deep, sloping to ground level well clear of the pit.

Peg the pit corners to allow easy location when emptying. It could be 10 years or more after filling before the grain is needed.

A modified cover which will speed up the opening of a pit is achieved by attaching the polythene to sections of welded steel mesh. These are long enough to span the pit in one section and are placed overlapping in the reverse order of removal. Once the overburden has been reduced to about 20 cm deep by blade or loader the mesh sections and remaining soil can be towed off with little soil contamination to grain.

Maintenance and safety

During the first winter the soil cover may need to be reformed and smoothed after settling to eliminate cavities and promote run-off. There will be virtually no settling of the grain. Little else is needed except to see that no depressions which hold water remain near the pit. Periodic checking for rats and mice may be necessary but they are generally deterred by a well-compacted soil cover.

Once open, the pit should be emptied out quickly to avoid the risk of rain damage and infestation by insects.

If the grain is to be held for more than a month or so, transfer it to sealed silos where insects can be readily controlled by fumigation. In the shorter term, sufficient unsealed or temporary storage must be on hand when the pit is opened.

When emptying the pit with an auger operated from the ground surface there is a risk of injury to anyone falling into the cone of grain. This risk is increased by irregular edges to pits, deep grain and slippery polythene. Great care should be taken when moving near the pit.

Pits left open for any period are a hazard to people and stock. They should be fenced or refilled with soil.

Costs

The cost of underground storage consists of the earthmoving involved in excavation, covering with soil and later removing the cover: the soil is handled three times. The cost will depend on the farm equipment available and the contract price for the work, which cannot be done by the farmer.

Uses of grain

Provided care is taken over the siting and covering of the pit to prevent water entry, there will be no deterioration in grain quality for stock feed.

One seeding sample buried for six years had 100 per cent germination, but grain of this age should not be sown as seedling vigour may be reduced.

Delivery of aged, pit-stored grain to CBH may be subject to various conditions. Before delivery is considered, check with CBH.

Acknowledgement

David McDonald of Lake Biddy provided much of the practical information for this Farmnote.

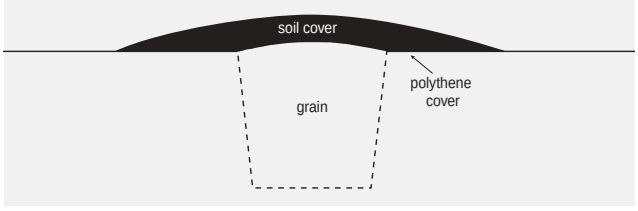

Figure 3. Cross section of pit showing polythene and soil cover in place

01100/01/04-1300-inhouse

ISSN 0726-934X