Monitoring stored grain on farm
Biosecurity is the protection of livelihoods from the threats posed by pests. Comprehensive biosecurity systems help ensure Australia’s food security and food safety, while good biosecurity practices protect productivity and make good business sense.

In a deregulated grain market, on-farm storage is more important than ever before. If stored grain is not properly managed it can become infested with stored grain pests, which can be difficult and costly to control.

The presence of live insects can close grain markets and reduce grain value. It is everyone’s responsibility to keep pests out of stored grain.

Management practices applied early in the value chain have an impact on grain quality and pest numbers in the months ahead as grain moves towards its end use.

This booklet is designed to assist you in protecting your stored grain from new and invasive pests. Further information on grain storage is also available from www.storedgrain.com.au.

Grain markets demand that delivered grain is free of live insects. If insects are detected as grain is out-loaded for sale, treatment is likely to delay the delivery by 2–4 weeks.

To maintain pest-free stored grain of good quality and value, growers need to:

- Make full use of good hygiene and aeration cooling – this can overcome 70% of pest problems.
- Identify pest incursions early through monthly monitoring.
- Select the right storage treatments and apply them correctly.
**Pest prevention is better than cure**

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

Finding grain pests early allows them to be identified and treated appropriately before they spread and become a much larger problem.

With growers increasing the amount of grain stored on farm, an integrated approach to pest control is crucial.

There are four key factors in stored grain protection:

- hygiene
- aeration cooling
- regular pest monitoring
- use of correct fumigation practices.

**Hygiene**

Grain residues left to provide shelter and food for pests allow large numbers of storage pests to fly and infest other grain storage sites, once conditions warm at the start of spring.

Remove all grain residues to limit the areas where insects can survive and breed.

The first grain harvested is often at the greatest risk of pest infestation due to contamination with grain left over from the previous season. It is good practice to separate the first few tonnes of grain that pass through headers and grain handling equipment at the start of harvest. Use it quickly for stock feed, or plan to aeration cool, then fumigate this grain within 4 weeks.

Maintain good hygiene around your storage areas, including thorough cleaning of grain handling equipment like headers, augers, field bins, silos and bulk storages, well before harvest.
Storage choices

A good quality storage environment not only inhibits insect activity, but also maintains grain quality. A storage facility should have at least two sealable, aerated silos on-farm to provide the option for an effective fumigation and delivery program.

When buying a new silo, purchase a quality, sealable (gas tight) silo preferably fitted with an aeration fan.

Check with the manufacturer that it meets the Australian Standard for sealable silos (AS2628) and pressure test at least once a year.

Many older silos were not designed to be sealed and cannot be used for fumigation, however fitting aeration cooling fans and maintaining good hygiene standards will reduce insect numbers.
Aeration cooling
Freshly harvested grain usually has a temperature around 30°C, which is an ideal breeding temperature for grain storage pests. Aeration fans fitted to stores can rapidly cool grain temperature, reducing pest breeding and development. Aim to keep grain at less than 23°C in summer and less than 15°C in winter. Aeration is also useful in helping to manage grain moisture content. Creating uniform low moisture in bulk grain storages will also limit pest development and maintain seed viability. Prompt blending or drying is a common way to reduce the average moisture content of stored grain.

Aerate grain as soon as it is placed into storage. For reliable results use an automatic controller that will maintain optimal temperature and humidity.

Monitoring
Regular monitoring of stored grain is essential. Grain should be checked for insect pests, temperature, moisture content, quality and germination. Early detection of pests gives the best chance of effectively treating the grain, preventing loss of grain quality and market access. See page 10 for details on monitoring stored grain.
Effective fumigation

When fumigating stored grain always read the chemical label and follow all directions.

Fumigants such as phosphine are only effective when used in gas-tight, sealable grain storage facilities.

Only fumigate grain in a gas-tight silo.

Grain storage is well sealed when it is able to pass at least a 3 minute half-life pressure test (i.e. once pressurised the pressure drops by no more than 50% in 3 minutes). For more, see www.storedgrain.com.au.

If the silo isn’t well sealed the gases leak out rapidly and the fumigation will not kill all stages of the pest’s lifecycle. In addition to being ineffective this practice results in the proliferation of insecticide-resistant pests.

Check that grain buyers or potential markets will accept any insecticides you intend to use.

Ensure that phosphine tablets do not come into direct contact with grain, as grain must be free of insecticide residues.


Resistant insects, transported in machinery or flying between stores, threaten grain exports and the industry.

Only treat grain when insects are found.

Grain markets have limitations on levels of chemical residues that must be adhered to. The demand for freedom from insecticide residues is increasing.
Aluminium phosphide record keeping sheet – for silo fumigation

**Supervisor’s details (if applicable):**

**Applicator’s details:**

**Name and location of fumigated silo:**

**Contents and approximate tonnage:**

<table>
<thead>
<tr>
<th>Pest ID/date found</th>
<th>Half-life press test</th>
<th>Silo capacity (m³ or tonnes of wheat when full)</th>
<th>Treatment product information</th>
<th>Fumigation</th>
<th>Ventilation</th>
<th>Monitoring of fumigation levels (date/time/result (ppm))</th>
<th>Date(s) of follow up inspection for insects</th>
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<td>Treatment product/type (tablets, bag chains, etc.)</td>
<td>Application method/location</td>
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How to monitor stored grain

**SAMPLING GRAIN FOR PESTS**

Damage by grain insect pests often goes unnoticed until the grain is removed from the storage.

Regular monitoring will help to ensure that grain quality is maintained.

- Sample each grain storage at least monthly. During warmer periods of the year fortnightly sampling is recommended.
- Take samples from the top and bottom of grain stores and sieve (using 2 mm mesh) onto a white tray to separate any insects.
- Hold tray in the sunlight for 10–20 seconds to trigger movement of any insects, making them easier to see. Use a magnifying glass to identify pests. Refer to grain pest identification chart on page 13.

- Grain probes or pitfall traps should also be used to check for insects. These traps are left in the grain during storage and are often able to detect the start of an infestation.
- Push probe/trap into the grain surface and pull up for inspection fortnightly/monthly. Place 1–2 traps in the top of a silo or several traps in a grain shed.

- Be sure to check grain 3 weeks prior to sale to allow time for treatment if required.
- Further information on sampling grain is available from www.storedgrain.com.au.
MONITORING GRAIN TEMPERATURE AND MOISTURE CONTENT

- Pests and grain moulds thrive in warm, moist conditions. Monitor grain moisture content and temperature to prevent storage problems.
- Use a grain temperature probe to check storage conditions and aeration performance.
- When checking grain, smell air at the top of storages for signs of high grain moisture or mould problems.
- Check germination and vigour of planting seed in storage.
- Aeration fans can be used to cool and dry grain to reduce storage environment problems.

It is vital to monitor grain moisture content and temperature to prevent pests and grain moulds from thriving.
Stored grain pest identification

The tolerance for live storage pests in grain either for domestic animal feed, human consumption or export markets is nil. Furthermore, an increasing number of grain markets are requesting low chemical residues on grain.

It is important to accurately identify any pests to ensure use of the most appropriate control options.

Correct identification and treatment choice helps prevent pest treatment failures due to chemical resistance. Follow the pest identification chart to work out which pest you have.

HOW TO IDENTIFY COMMON GRAIN PESTS

Keep a good magnifying glass handy to see the key features of these small insects. A piece of sticky tape may be helpful to hold insects still.

To assist identification, place live insects into a glass container and check if they can climb up the glass. If it is cold, warm the jar in the sun briefly to encourage the insects to move. Use the identification chart on the following page.

WHAT TO DO IF LIVE INSECTS ARE FOUND

Identify pests and select the appropriate treatment for the grain type and insect. See www.storedgrain.com.au for insect control in the western, northern and southern regions. Always use correct fumigation techniques in pressure tested, sealed silos. Ensure potential grain buyers and end users will accept the treatments you select.

Regular monitoring of grain avoids surprises when out-loading

Chris Warrick, ProAdvice

Philip Burrill, DAFF Qld

Bruchids on mungbeans
STORcED GRAIN PEST IDENTIFICATION CHART

Do the insects have a snout?

- YES: Weevil
- NO: Saw-toothed grain beetle

Can the insects walk up the side of a glass jar?

- YES: Cylindrical, dark brown
- NO: Are the insects ... Flattish, red-brown and ...

Are the insects ... Ant-like, less than 3 mm, long antennae

- YES: Lesser grain borer
- NO: Flattish, red-brown and ...

- Longer than 3 mm, short antennae: Flat grain beetles

- Ant-like, less than 3 mm, long antennae: Flour beetles

Source: DAFF, QLD
Common grain storage pests in Australia

Lesser grain borer (*Rhyzopertha dominica*)

Serious pest of stored grain that is widespread across Australian grain producing regions.

**KEY FEATURES**

- Adult beetles (3 mm long) reddish-brown to very dark brown in colour.
- Head tucked under body with eyes and mouth only visible from side.
- Adult beetles are strong fliers and live for 2–3 months.
- Life cycle completed in 4 weeks at 35°C; 7 weeks at 22°C; breeding stops below 18°C.
- Young larvae (white with brown heads) initially feed externally, then bore into grain.
- Usually remains hidden in grain so sieving required to detect.
- Resistant to a number of grain insecticides.
Rust-red flour beetle (*Tribolium castaneum*)

Common in stored cereal grain, processed grain products, oilseeds, nuts and dried fruit.

**KEY FEATURES**

- Adult beetles (3–4.5 mm long) bright reddish-brown in colour when young and a darker brown when older.
- Club-shaped segments on antennae ends.
- Similar in appearance to the Confused flour beetle (*Tribolium confusum*) which is more common in cool, temperate regions.
- Adults live from 200 days to 2 years and fly in warm conditions.
- Life cycle completed in 4 weeks at 30°C; 11 weeks at 22°C; breeding stops below 20°C.
- Cream-coloured larvae feed externally on damaged grain and cereal dust.
- Will infest whole grain, but breeds more successfully on processed products.
- Use sieving and probe traps to detect.
Flat grain beetle (*Cryptolestes* spp.)

Small, fast moving pest of stored grain. *Cryptolestes* species feed on damaged grain.

**KEY FEATURES**

- Small, flat and fast moving reddish-brown beetles (2 mm long) with long thin antennae.
- Adults live for several months and can fly readily.
- Life cycle completed in 4 weeks at 30–35°C with moist conditions; 13 weeks at 20°C; breeding stops below 17°C.
- Larvae with characteristic tail and horns feed and develop externally on damaged grain.
- Sieving and probe traps usually required to detect as they avoid the grain surface.
- Some populations have developed high levels of phosphine resistance.
- There are now a number of flat grain beetle species with a similar appearance. *Cryptolestes ferrugineus* is also called the ‘Rusty flat grain beetle’.
Saw-toothed grain beetle (*Oryzaephilus surinamensis*)

Found throughout Australia and infests cereal grains, oilseeds, processed products, peanuts and dried fruits.

**KEY FEATURES**

- Fast moving, dark brown-black beetle up to 3 mm long.
- Characteristic saw-toothed pattern on each side of thorax and 3 distinct ridge lines on top.
- Adults climb vertical surfaces (eg glass jar) and fly in warm conditions.
- Prefers damaged or processed grain.
- Life cycle completed in 3 weeks at 30–33°C; 17 weeks at 20°C; breeding stops below 17°C.
- White, flattened larvae feed and develop externally but are hard to see.
- Sieving and probe traps are recommended to detect.
- Resistant to a number of insecticides.
**Rice weevil (Sitophilus oryzae)**

Major pest of whole cereal grains commonly found throughout Australia.

**KEY FEATURES**

- Adults are small (2–4 mm long), dark brownish black with a long weevil ‘snout’ and four light spots on back.
- Adults live 2–3 months, do not readily fly but climb vertical surfaces (eg glass jar).
- Life cycle completed in 4 weeks at 30°C; 15 weeks at 18°C; breeding stops below 15°C.
- White larvae generally not seen as they feed and develop inside grains.
- Often observed climbing up vertical surfaces under warm conditions or when grain is moved.
- Use sieves and probe traps to detect low numbers of insects.
- The Maize weevil, *Sitophilus zeamais* is a strong flier and very similar in appearance to the Rice weevil.
Pea weevil (*Bruchus pisorum*)

Field and storage pest of field pea. Currently found in Australia’s field pea-growing states (excluding Tasmania).

**KEY FEATURES**

- Adults have globular shaped body (4–5 mm long) with long legs and antennae.
- Does not have a long snout like true weevils.
- Wings are patterned with white/cream spots.
- 1 generation per year and only breed in standing pea crops before harvest. Eggs laid and glued onto pods.
- Adult is long-lived and overwinters, but does not feed on field peas.
- Cream coloured and C-shaped larvae bore into the seed.
- Adults are strong fliers and reappear in spring to visit flowers to feed on the nectar, then seek out new field pea crops to lay eggs.
- Field peas should be regularly checked when first pods are forming using a sweep net when temperatures are above 18°C.
- Sieve and check pea seed for neat round holes (evidence adults have emerged).
Cowpea weevils or Bruchids (*Callosobruchus* spp.)

Bruchids are pests of most pulse crops including mungbeans, cowpeas, field peas, chickpeas, soybeans and lentils.

**KEY FEATURES**

- Adults (up to 4 mm long) have long antennae, climb vertical surfaces (eg glass jar) and are strong flyers.
- Globular, tear-shaped body is reddish brown with black and grey markings.
- Does not have a long snout like true weevils.
- Adults have a short lifespan (10–12 days).
- Adults do not feed, but lay about 100 white eggs on the outside of seed.
- Larvae feed and develop within individual seeds and emerge as adults leaving a neat round hole.
- Common problem in warmer months for mungbeans especially.
- Fortnightly sampling and sieving is important to prevent serious losses.
Angoumois grain moth (*Sitotroga cerealella*)

Infests surface layers of whole cereal stored grains. Can infest standing maize crops prior to harvest and occasionally other cereal crops.

**KEY FEATURES**

- Adults (5–7 mm long) have brownish-grey body and silvery grey to grey-brown wings.
- Wings have a long fringe of fine hairs along the bottom edge and taper to a point.
- Adults cannot penetrate grain, therefore only infest surface layers of bulk grain.
- Life cycle around 5–7 weeks in warm conditions.
- Adult moths do not feed but lay 150–300 eggs on or near the grain surface, with no webbing.
- Larvae burrow into a single grain. The adult moth emerges in 10–14 days through a visible hole.
- Pupal cases are often found protruding from grain.
- Sample monthly for moths near grain surface.
Indian meal moth (*Plodia interpunctella*)

An established pest common in flour mills, processing plants, dried fruit and on the surface of stored grains.

**KEY FEATURES**

- Adults (5–7 mm long) have distinctive coloured wings that are dark reddish brown on rear and grey at front.
- Adults fly readily and in summer life cycle takes about 4 weeks.
- Larvae are pinkish with brown head and create webbing that accumulates faecal pellets, cast skins and egg shells, resulting in grain contamination.
- Larvae pupate in grains webbed together in a clump.
- Sample monthly and look for webbing and moths near grain surface.
- Check for leftover grain in harvesting and handling equipment before use to avoid contamination of next season’s grain.
Warehouse moth (*Cadra cautella*)

A widespread pest, commonly infesting flour mills, food processing plants, cereal grains and oilseeds.

**KEY FEATURES**

- Adults fly readily and are 8–10 mm long.
- Moth wings brownish to blackish-grey with many fine, dark wavy markings, including lighter stripes extending horizontally across each forewing.
- Wings rounded at tip with a fringe of hairs.
- Adult moths do not feed and are short-lived.
- Life cycle takes 30 days under ideal conditions (30°C and 75% relative humidity).
- Larvae coloured cream to light pink with moths typically active at dusk and dawn.
- Sample monthly. Look for webbing and moths near grain surface.
Booklice or Psocids (*Liposcelis* spp.)

Psocids are widely established. They infest a wide range of grains, commodities and storage facilities. More commonly seen during warm, humid conditions.

**KEY FEATURES**

- Considered a secondary pest, feeding on damaged grain and moulds.
- Very small (less than 1 mm long), soft-bodied and opaque.
- Thrives in warm, moist conditions (optimum 25°C and 75% relative humidity).
- Life cycle 21 days with eggs laid on grain surface.
- There are 3 main species of psocids in Australia, often in mixed populations. Some can fly.
- Heavily infested grain becomes tainted and may trigger allergic reactions.
- Large infestations appear as a ‘moving carpet of dust’ on grain storage structures.
- Sample and sieve to detect when in low numbers.
Lemon-scented mite (*Tyrophagus putrescentiae*)

Common pest of high protein, moist foods such as stock feeds, processed grains and stored grain. Infestations reduce grain or product quality.

**KEY FEATURES**
- Very tiny, about 0.5 mm long with 8 legs.
- Body translucent to pearly white with sparse, long hairs.
- Life cycle of 8–12 days.
- Usually seen in late spring to early summer in damp or moist grain.
- Mites appear as moving carpet of brown dust on grains or storage bags.
- Feeding damages grain, increases mould growth and creates an ‘off’ odour.
- Mites can cause allergies to humans.
Exotic grain storage pests – not present in Australia

A number of pests present in other countries have been identified as potential threats to the grains industry. Any of these exotic pests would have serious consequences should they enter and become established in Australia.

Grain storage pests damage grain and can also have significant market access impacts which can potentially affect the ability to export grain.

Early reporting enhances the chance of effective control and eradication.

The two exotic stored grain pests of greatest concern to the Australian grains industry are Karnal bunt (*Tilletia indica*) and Khapra beetle (*Trogoderma granarium*). Either pest would have a serious impact on grain export markets and the value of grain should they be detected in Australia.

If you see anything unusual, call the Exotic Plant Pest Hotline 1800 084 881
Khapra beetle (*Trogoderma granarium*)

A serious pest of all stored grain that can cause losses of up to 75% from direct feeding, as well as reduced grain value and impact on market access.

**KEY FEATURES**

- Adults reddish brown in colour, 1.5–3 mm long and covered in dense yellowish-brown hairs.
- Looks identical to the warehouse beetle to the naked eye.
- Larvae covered in hairs and are yellowish-brown when young, becoming reddish-brown as they mature.
- Damage mostly caused by larval feeding and up to 30% of grain can be damaged before it is noticed.
- Larvae can survive without food for over 12 months.
- Cast skins and hair of larvae contaminate grain.
- Phosphine fumigation not reliably effective.
- When examining grain samples, look for characteristic hairy larvae and cast skins.
Karnal bunt (*Tilletia indica*)

Most serious exotic pest of grain (infecting wheat, durum and triticale) and greatly reduces grain quality. If established in Australia, grain price and market access would be seriously impacted.

**KEY FEATURES**

- Difficult to detect in the field since only a few grains in an ear become infected and are hidden within the glumes.
- Usually only part of each grain is affected.
- Harvesting breaks infected grains, releasing spores that can survive in soil or stored grain for at least 5 years.
- Infected stored grain has a sooty appearance and crushes easily, leaving a greasy black powder.
- Infected grain often has a rotten fish smell and flour quality is seriously reduced.
- Symptoms are similar to common bunt.
- Import restrictions exist in over 15 countries.
Report suspect pests

Early detection and reporting may prevent or minimise the long-term impact of an exotic pest on your farm and the grains industry as a whole.

Report any unusual or suspect plant pest immediately via the Exotic Plant Pest Hotline on 1800 084 881.

Calls to the Exotic Plant Pest Hotline will be forwarded to an experienced person in your state or territory government, who will ask some questions about what you have seen and will either arrange to collect a sample or give information on how and where samples should be sent.

Do not send samples without first speaking to someone from the state department.

If you have found a suspect exotic plant pest, the following precautions should be taken immediately to contain the pest and protect other parts of your farm:

- Do not touch, move or transport affected grain or plant material.
- Wash hands, clothes and footwear that have been in contact with affected plant material or soil.
- Mark the location of the pest detection and limit access to the area.
- Restrict the movement of people and operations in the area.

If you see anything unusual, call the Exotic Plant Pest Hotline 1800 084 881.
## Resources

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<td><strong>Queensland and northern NSW</strong></td>
<td><strong>South Australia</strong></td>
<td><strong>Plant Health Australia</strong></td>
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<tr>
<td>Philip Burrill 0427 696 500</td>
<td>Judy Bellati 08 8207 7843</td>
<td>02 6215 7700</td>
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<td><strong>Southern NSW, Vic, SA and Tas</strong></td>
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<td><strong>Plant Biosecurity CRC</strong></td>
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<tr>
<td>Peter Botta 0417 501 890</td>
<td>Jim Moran 03 5430 4479</td>
<td>02 6201 2882</td>
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<td><strong>Western Australia</strong></td>
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<tr>
<td>Rob Emery 08 9368 3247</td>
<td>Jeff Russell 08 9690 2000</td>
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<td><strong>Graintec Scientific</strong></td>
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<td>1800 084 881</td>
<td>Kym McIntyre 07 4639 8864</td>
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**Plant Health Australia**
02 6215 7700
www.planthealthaustralia.com.au

**Plant Biosecurity CRC**
02 6201 2882
www.crcplantbiosecurity.com.au

**Grain Producers Australia**
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