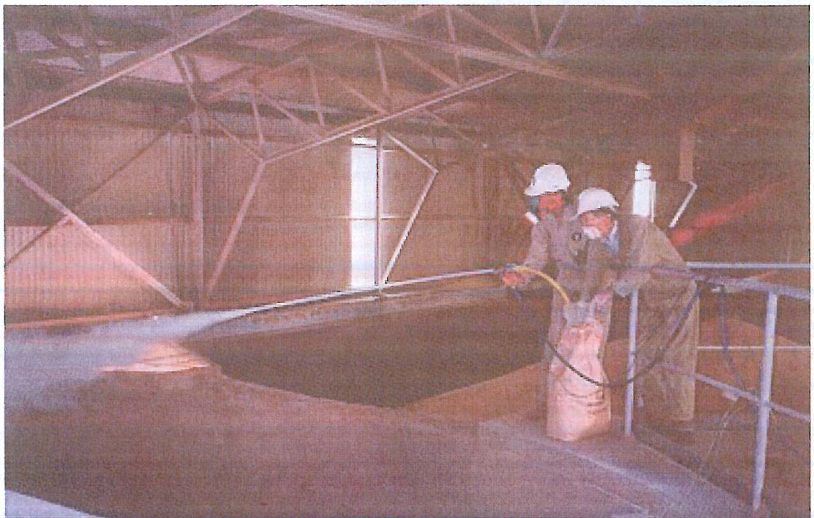
# The many uses of inert dusts in grain storage

Inert dusts are mineral earths that are used to protect stored grain from insect attack. Diatomite, magnesite, and silica are some of the mineral earths tested for insecticidal activity in recent years. The use of physical insecticides in this way is not new: the ancient Egyptians used a type of inert dust. Diatomaceous earths are the most common inert dusts registered for protection of grain in storage. These products kill insects by abrading and adsorbing their waxy cuticle layer. The insects then dehydrate and die.

Storers of seed and feed grain, in particular, can benefit from the use of inert dusts to protect grain. The advantages include:

- long-term protection (months to years);
- no chemical residues;
- maintenance of grain quality;
- safe for animal consumption;
- acceptance of some products by the NASAA Organic Standards and Certification Scheme; and
- ease of application.

Inert dusts can be used for a variety of storage situations. The end-use of your products, however, should be considered, since there are some disadvantages and restrictions to their use. Admixture of diatomaceous earth products with grain alters some grain properties. For example, it slows down the speed that grain will flow onto conveyor belts. This is one of the reasons that grain admixed with inert dusts cannot be delivered to bulk-handling facilities. The effectiveness of inert dusts at killing insects also decreases as grain moisture content increases. Above 13% grain moisture content, the effectiveness of a dust is reduced because the insects can absorb moisture from the surrounding air.



Dust application using blower and extension wand

Photo: Sylvia Allen

Inert dusts are added to the grain stream by auger, generally at a rate of 1 kg dust per tonne or 1.5–2 kg per tonne for heavily infested grain. To avoid blockages during application, care should be taken to ensure dust is admixed at an even rate into the grain stream.

Apart from admixture to grain, inert dusts are used for structural and spot treatments, such as application to the walls of empty storages, to farm equipment (e.g. headers and augers), and around grain stores. Inert dusts can be applied to walls and floors, either as a dry dust or water-based slurry. The dry dust can be applied with an air gun powered by a compressor. Dryacide® (a registered dust formulation) applied at the rate of 1 g dust per $m^2$ will produce a very light coating on the structure treated, similar to the dust that will settle on household furniture over time. Care should be taken to avoid excessive application since a thick dust coating may flake off. A hand bellows pump and extension pipe (to provide distance from the dust) can also be used to apply the dust as a dry powder.

Some dusts can also be applied as a water-based slurry, reducing the problem of dust during application. Dryacide® is often applied as a slurry. In commercial use, the slurry is made up of Dryacide® in water at 11% weight to volume and is applied to structures at 6 g dust per $m^2$. The slurry application

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requires more dust per square metre because insects don't pick the dust up on their bodies as easily in this form. The slurry can also be applied with a broom or paintbrush if necessary.

Precautions must be taken to protect the eyes and respiratory passages when applying inert dusts. Also, hand cream and gloves can be used to protect the skin from drying out. Additional information is given on the product labels of commercially available dusts.

The Stored Grain Research Laboratory has developed other application techniques to enable inert dusts to be used in combination with other grain protection strategies. The effectiveness of the SIROFLO® fumigation technique can be improved by applying to the grain surface, a thin, dry-blown layer of dust that acts as a cap to retard phosphine gas loss. In addition, a capping treatment can be combined with aeration where the top 30 cm of the grain is admixed with 1–2 kg dust per tonne of grain. This layer acts as a barrier to re-invasion by most stored grain pests. In the presence of the saw-toothed grain beetle (*Oryzaephilus surinamensis*) and flat grain beetle (*Cryptolestes* species), the depth of treatment should be increased to 1 m.

Inert dusts are a versatile and effective treatment for long-term protection of grain from insect attack and for disinfestation of structures. With funding from the GRDC, the Stored Grain Research Laboratory is continuing to research new application techniques to broaden the range of uses of inert dusts and to assess the attributes of effective dusts.

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CSIRO

# Heat — an alternative metho grain insects

Heat provides a rapid, non-chemical alternative to fumigation for control of stored-grain insects. The concept of heating grain to control insect pests is not new. During the First World War, stored wheat was heated to 58–60°C for at least 3 minutes as an insect control strategy. A continuous-flow machine was used and wheat was circulated over steam-filled pipes. The mean residence time within the machine was 15 minutes at an average throughput of 28 t/h. In the early 1900s, several food-processing companies in the United States used heat to control pests.

The Australian grain industry needs to develop alternatives to chemical methods of grain preservation and pest control. Fumigation and grain protectant applications are the most common and immediately available methods for insect control. More than 80% of the Australian cereal, oilseeds and pulse crop is treated with the fumigant phosphine to control infestations. A declining proportion is treated with residual chemical protectants. Increasing market preference for residue-free grain, development of high-level insect resistance to phosphine, and the current phase-out of methyl bromide (MeBr), currently used for rapid disinfestation of grain, are all reasons supporting the need for research and development in heating technology.

It is worth asking: "What technology will be available for rapid grain disinfestation when MeBr is phased out

Using a steam generator to add water vapour into hot air steam during thermal disinfestation.

Photo: Julie Cassells

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Using a steam generator to add water vapour into hot air steam during thermal disinfestation.

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## ethod to control

in 2005?" Heat disinfestation, in one or more forms, is likely to be widely used in the grain industry within the next 10 years, particularly in an integrated approach to grain protection. Three different approaches to insect disinfestation using heating technology are described in this article.

### Fluid-bed heat disinfestation

Hot-air convection heating in a fluidised bed was first studied in Australia in 1978. The disinfestation process involved rapid heating followed by rapid cooling to safe handling and storage temperatures. In a fluidised bed, the grain passes at a predetermined flow rate across a sloping metal plate perforated with holes of specified diameter and orientation. During flow of grain across the fluidised bed, the grain is heated to a predetermined temperature that kills all developmental insect stages, including the larval and pupal stages of those species that develop inside grain kernels.

The effectiveness of different heat treatment regimes is influenced by the target temperature, exposure time, insect species and their age-structure, and initial grain temperature and moisture content. The lesser grain borer and grain weevils are the most heat-tolerant species of stored-grain pests. Studies show that grain flowing at 360–500 kg/h at a depth of 100–250 mm across a fluidised bed, with an inlet air temperature of 80–90°C, is completely disinfested within 3 minutes.

Susceptibility of grain to heat damage varies considerably, and is influenced by grain type and by moisture content at the time of heat treatment. Both physical and biochemical damage of the grain can result from rapid heating. It is important to choose a disinfestation strategy that will achieve control of the insect pests without reducing grain quality. Dry grain is more tolerant of the effects of rapid heating. The majority of grain harvested and delivered into central storage in Australia is received at moisture contents below 12.5%. The dryness of grain at the time of harvest makes an in-line rapid disinfestation technique, such as fluidised-bed technology, a feasible option for the Australian grain industry.

### In-situ heat disinfestation

In-situ heating of grain is a technology that shows promise for use in small capacity (up to 50 t) farm silos. It is currently being investigated at SGRL with funding from GRDC. This process involves slowly heating the infested bulk by moving a heating front through the grain. Ambient air is heated to the required temperature and fan forced into the grain. The concept is similar to that used for rapid cooling of grain using aeration. There is a workable window between heat dosages that kill insect pests and those that cause significant damage to product quality. SGRL is evaluating suitable heat-disinfestation systems and heating/cooling regimes. Grain temperatures in the range 48–50°C are being evaluated. The system currently being evaluated at SGRL comprises a high-capacity fan, a heating unit with variable output, and four perforated ducts inside the silo. The addition of a steam generator improves the performance of the system. Typically,

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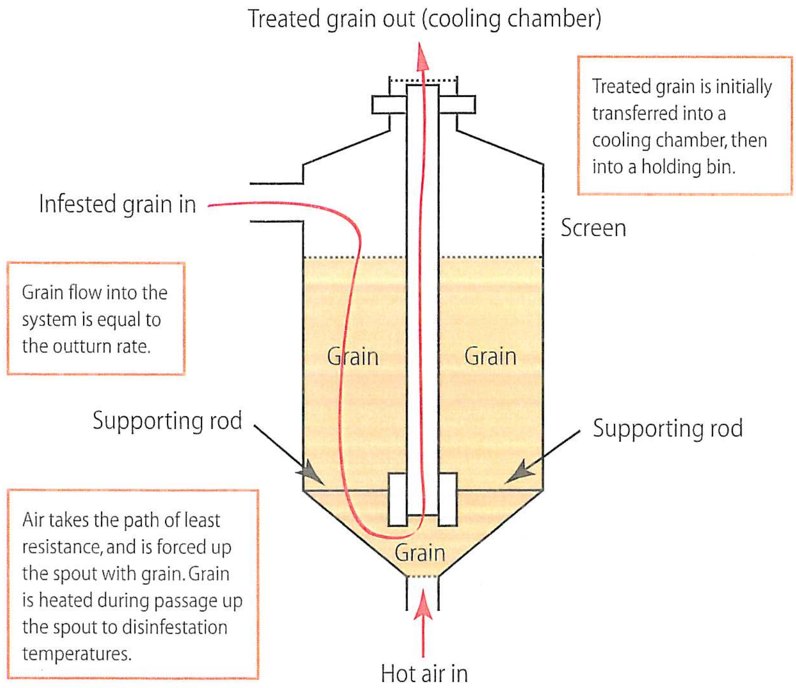


Spouted-bed heat disinfestation

# The Egyptian beetle - *Blaps polychresta* Forskäl

Native to northern Africa, the Egyptian beetle was first found in South Australia in 1930. The beetle is now relatively common in South Australia around human habitations. Adults and larvae of the Egyptian beetle feed on faeces of rats, mice and rabbits. The beetle is an incidental pest in premises associated with storage of grain and grain products, where its presence is a likely result of heavy rodent numbers. In Europe, the beetles are known to carry helminth parasites and nematodes, which they pick up from rodent faeces. The beetle also produces a defensive substance that consists of a mixture of hydrocarbons and quinones. The liquid is released from a gland at the abdominal tip and is very toxic. Care should therefore be taken when handling these unusual looking beetles.

The Egyptian beetle - *Blaps polychresta* Forskäl

Photo: Noel Starick

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hot air with higher relative humidity raises grain temperature without excessive drying, and improves performance by reducing loss of energy through evaporative cooling. The system also includes a complementary cooling unit that prevents prolonged heating of treated grain.

## Spouted-bed heat disinfestation

Spouted beds are a modified form of the fluidised-bed heat disinfestation system. In a spouted bed, heated air enters at high velocity through a nozzle located at the conical bottom of the bed (see accompanying diagram). A high velocity air stream causes grain to spout above the air inlet, fall into the surrounding annulus, and slowly flow downwards until re-entering the air stream.

A spouted-bed heat disinfestation system capable of heat treating grain at 10 t/h is currently under investigation at SGRL, again with funding from GRDC. This system has potential use on-farm, being more rapid than an in-store heat disinfestation unit. The spouted-bed system could also be used as a grain dryer if required. Preliminary results showed that the cost of disinfesting grain by a spouted-bed is less than that using an in-situ heat disinfestation unit.

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