Heat Disinfestation – the potential use of grain dryers on farm

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The use of chemicals is almost a cornerstone of agricultural practices throughout the world. Agrochemicals including fertilisers, herbicides, and pesticides are being used extensively to sustain food production systems. I have no doubt that we shall be using such chemicals and capturing benefits for many years to come. However, I am equally convinced that attitudes to the use of pesticides in Australia and overseas are changing. This is especially true in the Australian grain industry where research is aimed at developing economical non-chemical, residue-free and rapid-process alternative to fumigation and other chemical control methods for the extermination of insect pests in bulk stored grain.

Fumigation and grain protectant applications are currently the most common and immediately available methods for insect control. Over 80% of the Australian cereal, oilseeds and pulse crop is treated with the fumigant phosphine to control infestation. The fumigant, methyl bromide, is used largely at port facilities when rapid treatment is required. A declining proportion is treated with residual chemical protectants.

The planned elimination of methyl bromide by 2005 for general agricultural use, increasing pest resistance to phosphine and increasing consumer intolerance of chemical residues in food, are prime drivers supporting research and development into alternative methods of pest control. .

Heat is a rapid, non-chemical alternative to fumigation for the control stored grain insects. The concept of heating grain to control insect pests is not new. In the early 1900s, several food processing companies in the United States used heat to successfully control pests. Now a number of flour mills and food processing plants in the United States and Canada have incorporated heat disinfestation into their pest control strategy. In Australia during the First World War, stored wheat was disinfested by heated to 58-60°C for at least 3 minutes. A continuous flow machine was used and wheat was circulated over steam-filled pipes. The average residence time within the machine was 15 minutes at an average throughput of 28 tonnes per hour (t/h).

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. Previous research showed that heat treatment of grain rapidly kills insects. The higher capital and operational costs however along with dust handling capacities of continuous flow type systems have limited its use. Modern processes used to heat grain include mixing of grain in hot air in convective heating devices such as pneumatic conveyors, fluidised bed and spouted bed systems. In these systems, the difference between hot air temperature and grain temperature may be higher with a shorter heating period and very little occurrence of drying.

Hot air convection in a fluidised bed was investigated by CSIRO scientists during the 1980's as a rapid means of disinfesting bulk wheat without appreciably changing its moisture content or impairing its baking quality. The process involves rapid heating followed by rapid cooling to safe handling and storage temperatures. Passive cooling is however not suitable for bulk handlers in Australia where grain is handled at high throughput (up to 2000 t/h).

I believe that CSIRO has both the opportunity and capacity to make an important contribution to a wide range of rural industries by helping them with environmentally friendly alternatives. At the moment we are working on a continuous flow, spouted bed heat disinfestation system with a throughput of up to 8 t/h. Air enters this system at high velocity through a nozzle located at the conical bottom of the treatment bin. Grain spouts above the air inlet and falls into the surrounding annulus and flows slowly downwards until it re-enters the air stream. The power requirements of a spouted bed system are likely to be less than those of a fluidised bed dryer/disinfestor. A continuous flow spouted bed heat disinfestation system developed at the CSIRO Stored Grain Research Laboratory is shown in Figure 1. Grain is heated up rapidly to 60°C in a heating chamber followed by a rapid cooling in a cooling chamber to a safe storage and handling temperature. Further cooling may be carried out in the storage bin using aeration if necessary. The time taken at a given temperature to kill all insects infesting grain is shown in Table 1.

Table 1: Temperature-time mortality relationship

Mortality is reached in	at a temperature of
2 seconds	60°C
3 minutes	57°C
About 10 hours	50°C
About 3 days	45°C

Figure 1: A continuous flow spouted bed heat disinfestation system developed at SGRL

Use of grain dryers for heat disinfestation with or without minor modifications or adjustments

The high capital cost and typically low annual use of dryers on-farm in Australia increases their operational costs significantly. Finding another application for grain dryers will be an attractive option for owners. The suitability of the different types, makes and models of commercial grain dryers available and currently in use by contractors and growers throughout Australia for the purpose of heat disinfestation needs to be assessed. The use of existing dryers for heat disinfestation will make the system more flexible and ultimately will reduce the overall cost of drying and disinfestation by increasing its utility.

In order to achieve the target grain temperature and improve the thermal efficiency required for heat disinfestation, minor modifications may need to be made to an existing dryer.

For example, changing the position of the platform separating the heating and cooling zone in a cross-flow grain dryer will improve the performance of the system to achieve a grain temperature that is lethal to all stages of grain pests. Further adjustments could improve the uniformity of heat treatment. This will present many opportunities for on-farm heat disinfestation of grain. Some dryers that can potentially be used for heat disinfestation of grain are show in Figure 2.

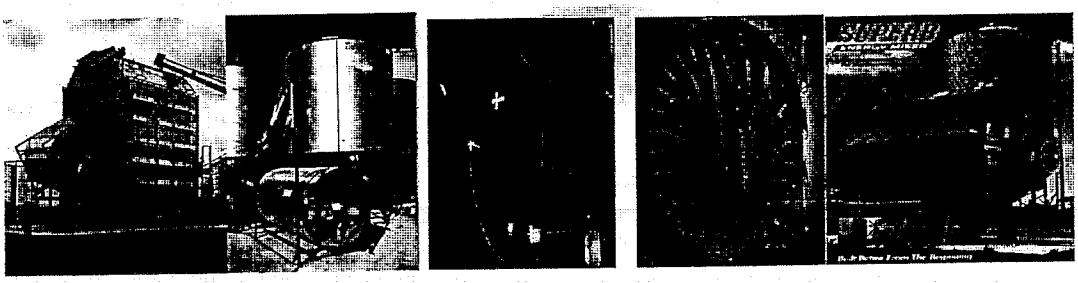

Figure 2: Some of the potential dryers those can be used for heat disinfestation of grain

The Stored Grain Research Laboratory would like to work with owners of dryers to assess the feasibility of their units for heat disinfestation.

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Further information on the use of heat and grain drying can be obtained from the SGRL web site at http://sgrl.csiro.au/storage/default.html