Careful drying and storage avoids penalties

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High quality maize grain for grit production can attract price premiums in domestic and export markets. But processors seek chemical residue-free, undamaged whole kernels for reliable production of flakes, flours and pearled grits. The major processors and their agents measure grain moisture content and test weight during receival. They also inspect for adult insects, kernel damage, odours, sweating, discolouration and moulding which is often linked to inappropriate drying or storage. Grain can be rejected at receival or premiums can be lost.

Artificial drying

Most growers use artificial drying to ensure reliable production of good quality maize. Drying gives growers more control over their harvest and reduces the risk of weather-related field losses.

at a GLANCE

- **Drying maize gives producers more control over their harvest and reduces weather damage but care must be taken to avoid stress cracks during this process.**
- **Well-managed storage systems can increase maize marketing options.**
- **Effective management, moisture, temperature and aeration are important to avoid stored grain spoilage.**
- **Correct phosphine fumigation of stored grain provides effective insect control.**

But grain quality will be lost when excessive drying rates or temperatures are used. Maize is highly susceptible to hairline fractures (known as stress cracks), which occur when grain is dried or cooled too quickly. Poor grit size and shape result when cracks are present. Excessive grain temperatures can also cause discolouration and affect the milling results.

During drying moisture evaporates from the maize endosperm surface. As the grain endosperm dries, it also shrinks. Drying too quickly causes uneven shrinkage within the grain endosperm, creating stress. These stresses are released by the formation of stress cracks in the grain. A similar cracking process occurs if warm and dry maize kernels are re-wetted.

Stress cracks are difficult to detect, as they form in the starchy endosperm under the seed coat and often develop after the drying process has finished. Samples which appear sound after drying may have high cracking levels on delivery.

Stress cracking in the grain is avoided by slow steady drying. Single pass continuous-flow drying to 14 per cent moisture at high temperatures causes stress cracks. Typical maximum grain temperatures recommended for drying maize are 38-43°Celsius. Note this is grain temperature, not drying air temperature. Some dryer designs allow higher air temperatures without exceeding safe grain temperatures.

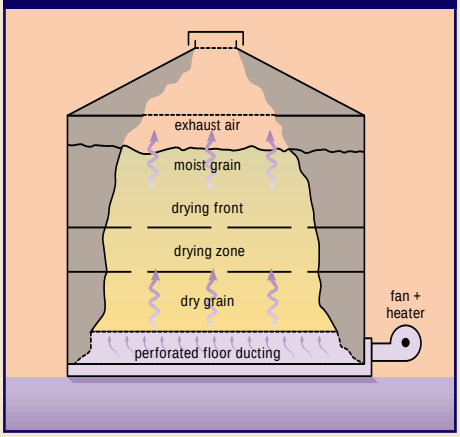
Ideally grain should be dried early in the day to enable slow cooling as the day temperatures slowly decrease in the evening. Maize should not be rapidly cooled over night after drying late in the day. Overdried maize is fragile and will break during handling. It is best to cover dried grain overnight to avoid stress cracking from dew, condensation or rain on the top layers.

Dryers

Most growers use high temperature batch, or continuous flow dryers to dry maize. Batch dryers reduce the average moisture content in single loads or batches of grain. Non-recirculating or static batch dryers do not dry grain as evenly as continuous flow dryers where grain moves in a constant stream, giving better control of drying conditions.

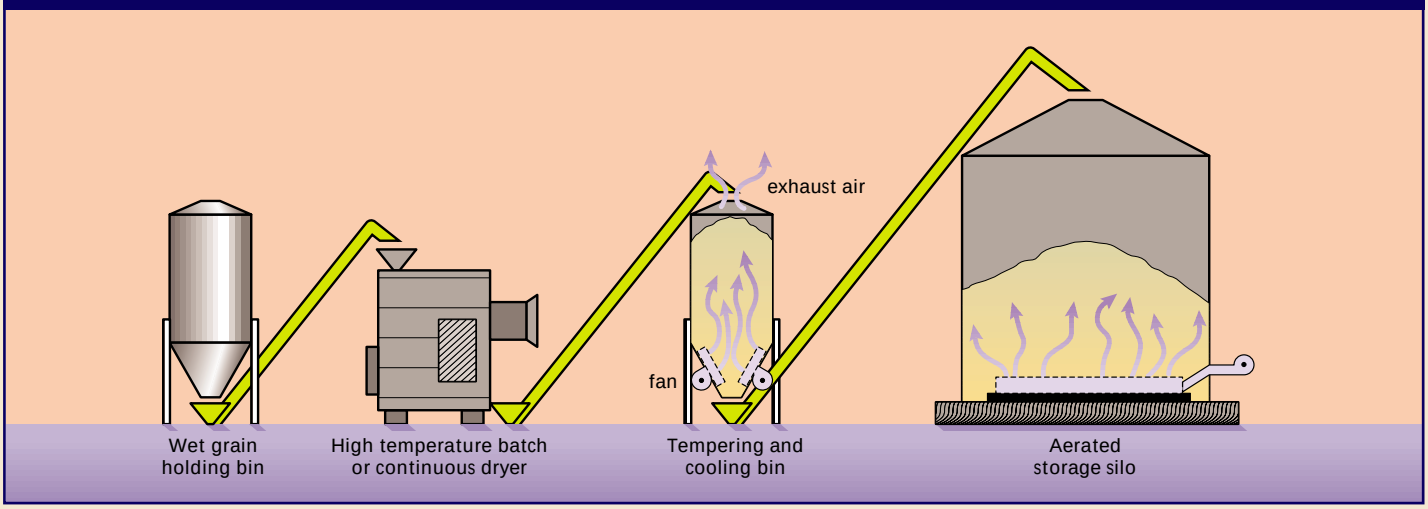
Some batch dryers use recirculating augers to mix the grain during drying, giving more uniform moisture removal. But the extra mechanical handling in these dryers increases the risk of grain damage so correct operation

FIGURE 1 In-store drying



In-store drying removes the final one or two per cent of moisture left after rapid drying.

FIGURE 2 Dryeration tempers hot or moist grain before final cooling and storage



and regular maintenance is essential.

Rapid grain dryers need good handling equipment, wet-grain holding silos, cooling silos and storage silos to operate efficiently.

In-store drying

In-store drying is sometimes used to remove the final one or two percentage points of moisture left after a rapid drying process (see Figure 1). Several drying equipment suppliers are exploring options to accommodate all moisture loads. The equipment used is similar to aeration but with higher air flows.

In-store drying using natural air is slow and does not suit operations which aim for rapid delivery to processors. Correct equipment design and control is needed to dry evenly throughout the silo and to avoid overdrying. The system is energy-efficient. The low air temperatures used do not cause stress cracking or discolouration. This system must be set up correctly to ensure the drying zone reaches the top of the grain bulk fast enough to prevent spoilage of the top layers by mould or sprouting.

Dryeration process

'Dryeration' is a three-stage drying process which includes features of both continuous flow and in-store drying (see Figure 2). Initially, the maize is rapidly dried to about 2% above the target moisture content but is not cooled.

This hot, over-moist maize then tempers in a dryeration silo for up to 10 hours.

Tempering allows the moisture and temperature levels in the rapidly dried grain to even out, minimising shrinkage stresses within each maize kernel. After tempering, small fans push air through the grain, cooling it and removing the final moisture.

Dryeration reduces stress-cracking by decreasing the overall drying rate and not re-wetting the hot, dry maize. The amount of moisture removed during dryeration cooling is more than that achieved using conventional rapid dryer cooling. Moisture reductions of up to 2% are typical with dryeration cooling, compared with less than 1% with rapid dryer cooling.

This system increases the throughput and fuel efficiency of the rapid dryer. Time normally used for cooling in the rapid dryer is freed up by using small, inexpensive aeration fans to complete the final stage of drying.

To minimise stress cracking

- Dry slowly
- Do not overdry
- Use dryeration or in-store drying
- Cool hot maize slowly
- Prevent re-wetting

To reduce handling damage

- Minimise the number of grain transfer operations.
- Use belts wherever possible for gritting maize.
- Avoid high drop heights from conveyors.
- Operate auger as full as possible.

Storage

Effective storage ensures a reliable supply of raw material for maize processing throughout the year. Most of Australia's maize is stored by major processors, some by grain traders and occasional tonnages are contracted with state-based bulk handling authorities.

Little processing grain is stored on farm by growers. Yet growers could make use of a well managed storage system to increase their harvesting options and explore alternative marketing arrangements.

The major causes of grain quality loss during storage result from self-heating, insects, moulds, grain respiration and moisture migration. All of these storage risks depend on moisture content and temperature and control of these two factors ensures safe storage.

Moisture is most critical as maize stored at moistures above 13.5% for any length of time is at risk.

Mould grows rapidly on warm, moist grain. Incomplete drying, moisture migration, condensation and self-heating all encourage mould growth (see Figure 3).

'Moulding' is faster when kernels are damaged or significant mould is present from the field or previous storage.

Maize is attacked in-field and in-store by mould varieties which produce human and animal toxins. Many stored-product insects infest maize with moisture and temperature again playing a critical part in their control (see Figure 4).

Grain insects are sensitive to temperature, so cooling maize to 15-19°C generally slows insect growth enough for good control.

Large amounts of trash, fines and damaged grains within the grain favour insect infestation and can isolate parts of the bulk from cooling with aeration.

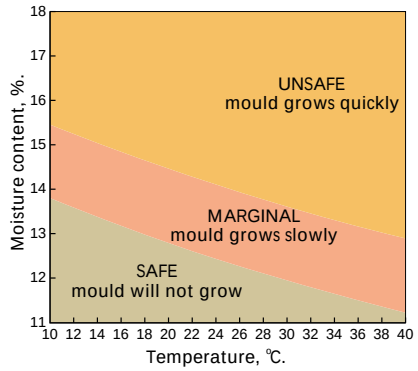
Moisture and temperature

Effective management of moisture and temperature are critical to safe maize storage. If left uncontrolled, self-heating or 'stackburn' causes grain spoilage through discolouration, foul smells, sprouting and higher levels of

Batch dryers (above) can be used to reduce the average moisture content in single loads or batches of grain. Continuous flow dryers are also commonly used.

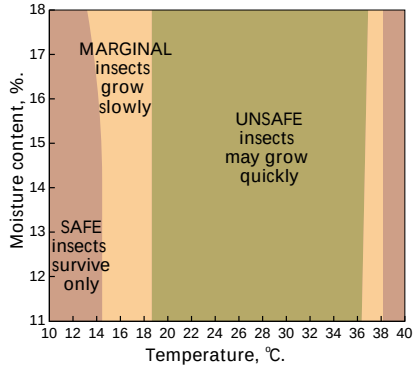
Maize...

FIGURE 3 Avoiding moulds in maize stores



Safe moisture and temperature conditions

FIGURE 4 Avoiding insects in maize stores



Safe moisture and temperature conditions

insects and moulds. Dry cool storage conditions prevent self-heating.

Moisture migration causes localised increases in grain moisture and usually occurs in the peaks and edges of the grain pile causing spoilage similar to self-heating.

The moisture moves as a result of temperature differences throughout the grain bulk and this is common during the winter season.

Spoilage due to moisture migration may take several months to appear but can occur faster with higher moisture grain.

Aeration

Aeration uses fans and distribution ducting to pass controlled amounts of air through the grain. It cools the grain, prevents moisture migration to keep it fresh and free running. As maize is often dried rapidly and non-uniformly, it can exit the drier at temperatures above 40°C in a sweaty condition.

Aerating such hot, moist maize to remove any excess moisture is essential. Reliable aeration systems use electronic controllers to select appropriate air to cool the grain.

Phosphine fumigation

Fumigating with phosphine controls all insect pests which attack maize. Phosphine can be applied using Siroflo or tablet preparations and when used correctly, will provide effective control without protectant residues.

Siroflo is a phosphine application system developed by the CSIRO. It accurately controls the phosphine dose to ensure complete insect kill in a safe manner.

A sealed store or silo is necessary to achieve an effective kill with phosphine powder or tablet formulations although Siroflo can be used with poorly sealed silos. If maize is cooled after fumigation, insect population growth resulting from re-infestation will be slow. This will extend the time period before additional fumigation is needed.

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Australian Maize - a guide to maize production and use in Australia will be released by the Kondinin Group next month. *Australian Maize* contains practical information from leading maize producers, agronomists, industry representatives and consultants. It has information on variety selection, sowing methods, machinery, weed and pest management, crop rotations, harvesting, storage, feeding and marketing. The book retails for $35 or to Kondinin Group members for $25.