Australian Grain Industry – Code of Practice Technical Guideline Document

No. 12
MANAGING SEVERELY DAMAGED GRAIN

Compiled on behalf of the Australian Grain Industry by:
Grain Trade Australia

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For more information contact Grain Trade Australia

www.graintrade.org.au
Phone: 02 9235 2155
Email: admin@graintrade.org.au

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1. Application

Refers to activities that may be undertaken to minimise the risk of occurrence and reduce the impact on grain quality of Severely Damaged grain that may arise through various causes such as Heat Damage, Bin Burn and Storage Mould.

2. Discussion on Severely Damaged

2.1 What is Severely Damaged

In most commodity standards, Severely Damaged relates to any major defect of the grain that may or may not be stipulated or otherwise defined. This may include the following quality parameters or others not listed. Frequently these quality parameters are placed together in the one category as they are often difficult to distinguish. In general the following definitions apply:

Heat Damaged or Bin Burnt

Heat Damaged or Bin Burnt refers to those kernels that have become discoloured. Affected grains appear reddish brown, or in severe cases, blackened.

Mould

Affected grains appear discoloured and visibly affected by mould. Mould may arise through various means, mainly as a result of the development of fungi or bacteria due to an increase in grain moisture levels during storage.

Other Serious Visual Defects

Other Serious Defects refers to those kernels that have become discoloured and / or have a serious visual defect that is not otherwise listed in the Standards. Affected grain may have a range of visual appearances. Such grains may also have a detectable odour (in which case a nil tolerance applies).

The definitions for each defect by commodity are to be read in conjunction with the photographs in the Visual Recognition Standards Guide (VRSG) which depicts the minimum affected standard for a grain to be classified as Severely Damaged.

Refer to:

- GTA Trading Standards http://www.graintrade.org.au/commodity_standards
- GTA VRSG http://www.graintrade.org.au/fact-sheets-publications

2.2 What is the Cause of Severely Damaged

There are many causes of grains being categorised as Severely Damaged. These may include:

- Damage to grain during ripening in the field;
- Damage during storage due to storage of high moisture grain, leading to moisture migration and an increase in temperature;
- Damage during storage due to moisture ingress;
- Damage to grain quality during storage due to inadequate storage procedures; and
- Localised damage to grain in storage due to high temperature, such as
    - Insect infestation;
    - Bacteria and /or fungi/mould;

- A high moisture area; and
- Large temperature variances.

Storage type and design, initial grain quality, grain temperature, grain moisture, storage period and storage hygiene have a major impact on the development of any such grain damage.

Refer to:

- GRDC website www.grdc.com.au
- Stored grain information hub www.storedgrain.com.au

2.3 Standards that apply

Standards for this parameter may be set by a number of parties:

Industry:

- Industry standards vary by commodity.

Customers:

- Customers may apply industry standards or implement their own standard, as outlined in contracts;
- For example, in Pulse Export Standards a 1% tolerance by weight for mould applies "when not in conflict with Storage and Handling Agreement or Marketing Contract limits".

Regulators:

- An importing country government may stipulate a limit to apply.
- In Australia, regulations may apply:
  - By State on commodities sold for the stockfeed market;
  - To prescribed grain commodities exported whereby grain on export is inspected and must be "considered to be fit for human and animal consumption".

When referencing these quality parameters, the Standards applied by industry, customers or regulators may refer to:

- Visual indicators of the end result on the grain of Severely Damaged, such as Heat Damage, Bin Burn or Mould;
- The specific parameters of Heat Damage, Bin Burn or Mould or a variation; and
- Other indicators of some of these parameters such as:
  - Nil odour; or
  - Limits on the presence of specific mycotoxins.

2.4 Impacts of Severely Damaged

Severely Damaged grains may impact on grain quality in a number of ways:

2.4.1 Visually

These parameters are visually defined in industry standards such as the Visual Recognition Standards Guide (VRSG). Depending on the commodity, when present in a sample, they may be identified by a number of means such as:

- Grain materially discoloured e.g., Heat Damaged barley; and
- A brown powdery appearance when crushed e.g., Heat Damaged canola.

2.4.2 Inherent Grain Quality

Various changes to the quality of the grain may occur including:

Odour

- The presence of an odour not normally associated with that commodity e.g., mouldy wheat. This mouldy/musky odour will often remain in the processed product e.g., bread baked with mouldy grain.
- Bin Burnt grain may produce a burnt smell.

Physical Properties

- Analytical testing for the presence of various mycotoxins may be required. The presence of specific mycotoxins or fungal organisms may indicate the grain has become affected by mould. As mycotoxins are stable compounds, they may end up in downstream products such as bread and pasta.
- A reduced germination may indicate the presence of various fungal species.
- Fungal species may also cause a change in the fatty acid profile and other constituents of grain.
- A reduced starch and protein content may also arise as a consequence of the presence of various fungal species that cause mould.

2.4.3 Other Impacts

- The presence of mould may lead to the development of mites and stored grain insects.
- The presence of these quality parameters may cause off-flavours, leading to a loss in palatability of the grain for livestock.
- End-products made from mouldy grain may have a reduced shelf-life.

2.5 Minimising the Development and Impact of Severely Damaged

As outlined in the Australia Grain Industry Code of Practice under Section 2.3 to 2.5, there are many actions that may minimise the potential for the development of Severely Damaged grains such as Heat Damage, Bin Burn and Storage Mould grains to arise. Particular examples of such actions are included in Section 2.3.1 referring to Grain Storage Facilities:

“Grain storage facilities are to be:

- Soundly constructed;
- Must be maintained in order to prevent the entry of pests, vermin and moisture;
- Are to be located in an area and the surrounds are to be of suitable construction material to minimise contamination of grain and to prevent damage to stored grain through water ingress;
- Suitable for the commodity to be stored; and
- The structural integrity of storages is monitored regularly during the storage period to maintain the integrity of the stored grain and to assist in maintaining its quality. Any storage condition that may impact on the quality of grain to be stored should be addressed as soon as possible following detection”.

2.5.1 Grain Quality

Grain moisture content has an important influence on grain quality changes which occur during storage as the hotter and wetter the grain, the higher the risk of negatively affecting the quality of the grain whilst in storage. High moisture grain will not only be prone to stored grain insect attack, but also prone to fungal damage and the development of storage mould. Assessors of grain and storage operators must:

- Apply industry Standards to all grain received. Even when harvest conditions are hot (and all prior loads were low in moisture) assess each load received; as grain harvested prior to those hot conditions may be tendered for delivery containing high moisture content.
- Ensure all moisture testing equipment is calibrated, monitored, suited to the purpose and used by trained operators.
- Monitor the moisture content of received grain and if necessary outturn stored grain as soon as possible where levels are potentially high.
    - Storage of higher moisture grain should be accompanied by a clear storage risk management plan. This may outline a number of remedial actions to mitigate the risk of grain quality deterioration.

As localised high moisture grain may lead to rapid quality deterioration it is important the storage operator implements a management plan:

- Aeration coupled with drying, or maintenance aeration, will assist in reducing the moisture content and preventing mould development.
- Where possible and economically feasible, turning of the grain may assist reducing the risk of hot spots developing.

Heat Damaged or Bin Burnt grains generally refer to those that arise through poor drying techniques to lower the moisture content of early harvested grain, or arise in storage. Storage of high moisture grain or moisture ingress can cause a hot spot to develop through microbial or fungal activity, leading to localised heat generation and damage of the grain.

In these situations mouldy grains arise through storage and are sometimes referred to as storage mould or caked grains. *Storage mould should not be confused with field fungi*. Mould should be seen to be visible on the surface of the grain, although this definition may vary by commodity. Refer to the VRSG on the GTA website for the definition and relevant photographs of this quality parameter.

Refer to:

- GTA website - VRSG

Mouldy grains may also be referred to as Rotted grains. In some commodities, Field Mould may also be included within this category.

These mouldy grains may become a food safety issue and render the grain unsuitable for human and/or animal consumption. Hence there are very strict tolerances for these defective grains in a sample, with many standards specifying a nil tolerance. They may also produce an odour, either musty or mouldy.

Storage Facilities

Mouldy grains arise through moisture ingress into a storage and spoilage of the grain due to the presence of fungi. All storages should be soundly constructed to prevent the ingress of moisture.

When storages are damaged, repair the storage as soon as possible to prevent the risk of moisture ingress. For example:

- Tarpaulins covering the surface of a bunker or floor/walls of a bunker may allow seepage of water following damage due to birds, rodents or wind
- Silo bags (sausage bags) may become damaged due to birds, foxes, kangaroos or pigs, allowing moisture ingress.

Greater care should also be taken with grain in silo bags as this grain should ideally be stored at moisture content at or below the current receival limit for the grain type. This is because condensation and water aggregation under the polythene film can cause localised mould and spoilage of grain in storage.

Refer to:

- Grain Bags for Pulse Storage – Use Care

http://www.pulseaus.com.au/storage/app/media/crops/2010_APB-Pulse-grain-bag-storage.pdf

Aeration

Depending on the storage type, grain may be further protected from potential deterioration by the use of aeration. For most grain producing areas across Australia, an appropriate aeration system will enable storage operators to condition grain to a desired moisture and temperature state and assist to maintain grain quality.

However, in order to achieve the desired grain conditioning performance, the aeration system requires the appropriate design, operation and control. This needs to be based on an understanding of aeration principles, equipment options and associated performance.

There are many commercial suppliers of this technology that produce brochures and technical pamphlets to assist industry to design and select the most appropriate system.

Similarly, there are purpose-built driers used to reduce the initial moisture content of the grain. These must be used correctly otherwise there is a risk of grain quality damage due to excessive grain temperature. Manufacturer instructions must be followed to ensure the grain is not excessively heated.

On outturn from storages where visual grain deterioration has been observed, ensure any damaged grain is kept separate from good quality grain. For example:

- Consider leaving several centimetres of good quality grain in the bottom of the storage where water damaged grain is present on the base floor of the grain storage.
- Work around any pillars of damaged grain where formed in a storage as a result of damage from water ingress.

Refer to

- TGD 9, Grain Drying and other various documents related to storage selection, design, location, maintenance and aeration systems www.storedgrain.com.au

2.5.2 Other

Quality checks on grain should be carried out from the time grain is received into storage, up to the time it is outturned. These quality checks are carried out during storage:

- To confirm the integrity of segregations; and
- To ensure that there is no deterioration of quality as a result of insect infestation, unsound storage practices, or admixture between grain types or grades.

3. Further Information

- Various documents, including cooling or drying for quality control "A Grains Industry Guide" www.storedgrain.com.au

- December 2011 No. 23 Research Report Kondinin Group Slick grain storage systems https://subscriptions.farmingahead.com.au/subscribe?sourcecode=slick-grain-storage-systems-august-2017

- RPD No. 119 - Rots and Germ Damage of Small Grains in Storage January 2002 http://ipm.illinois.edu/diseases/series100/rpd119/

- Artificial Grain Drying Fact Sheet http://www.awb.com.au/nr/rdonlyres/01bbc660-8bba-4f37-9c51-a222b2f2f955/0/art_grain_drying_factsheet.pdf

- Grain storage techniques - Evolution and trends in developing countries - Food and Agriculture Organization of the United Nations (FAO) http://www.fao.org/docrep/t1838e/T1838E00.htm#Contents

- GRDC Fact Sheet Aerating Stored Grain http://storedgrain.com.au/wp-content/uploads/2016/10/GRDC-Aeration-Book-2016_R2.pdf

- Pulse Australia - Grain Bags for Pulse Storage – Use Care http://www.pulseaus.com.au/storage/app/media/crops/2010_APB-Pulse-grain-bag-storage.pdf

- The WA Guide to High Moisture Harvest Management, Grain Storage and Handling – CBH/SEPWA CBH SEPWA High Moisture Harvesting and Storage

- Code of Practice for the Prevention and Reduction of Mycotoxin Contamination in Cereals, including Annexes on Ochratoxin A, Zearalenone, Fumonisins and Tricothecenes (currently being updated and re-drafted http://www.codexalimentarius.org/committees-and-task-forces/en/?provide=committeeDetail&idList=39 – refer Codex Australia http://www.agriculture.gov.au/agriculture-food/codex/committees/contaminants for the latest copy)