Harvest and Storage

Avoid harvesting lightweight maize and extraneous material

Harvest as soon as the grain is mature and sufficiently dry, and when rainfall is not expected. Delaying harvest can increase aflatoxin (and possibly fumonisins) in previously stressed and infected crops.

Mould growth in maize tends to first consume the starch and oil fractions, leaving a less dense fibrous kernel. Studies have shown that a major proportion of mycotoxins can be present in the lightweight fraction of grain. Minimise harvest of lightweight grain by increasing air flows during shelling.

Avoid trash and weed seeds in grain. These greatly impair storage, since such material is often moister than the maize, and they block aeration channels in the grain.

Avoid harvesting stressed patches of plants when these are apparent. Such maize could be harvested separately for less-demanding markets, or ploughed in.

Check moisture at intake, using appropriate sampling protocols

Ensure that the samples for moisture determination are taken in a representative manner. Take as many samples as is feasible and in any batch of maize which you suspect of varying from the norm. It will be better to take several moisture determinations as a check on variability.

Use any of the standard devices for moisture determination, but ensure that they are properly calibrated, operated correctly and well maintained. Keep records of the calibrations.

Dry the grain if necessary

The maximum moisture content for maize in the Australian climate is 14%, but it might be necessary to aim at 12-13% to reduce the risk that some grain pockets could exceed 14%.

If any significant portions exceed 14%, drying is required. Do not rely on mixing during harvesting and augering into silos to ‘blend’ wet and dry grain to meet target levels of <14%: most often little such blending actually occurs and moist grain will remain segregated.

Drying procedures, air temperatures and flow rates, will depend on the type of storage involved and ambient temperature and humidity. Too high a heat will affect grain quality. Advice should be sought from producers of drying and storage equipment, and from grain storage experts.

Select the appropriate type of storage and manage it well

General hygiene

The general hygiene of storage facilities cannot be emphasized enough. Accumulated grain dusts and caked residues can contain extremely high concentrations of fungal spores and mycotoxins, and also harbour storage insects. Only 1 kg of such material could raise the aflatoxin content of 20 tonnes of clean grain to >0.005 mg/kg when it dislodges and falls into clean grain, and it can also form a nucleus of new fungal growth. Thoroughly clean all storage containers and equipment, like augers and belts on which grain residues accumulate, after each use. Completely empty silos on a rotational basis for this purpose, so that walls and struts can be effectively cleaned.

Do not use sealed storage vessels for maize – even maize at <14% moisture will release some moisture as a result of heating and cooling, and this will accumulate and start mould growth in sealed silos.

The ability to seal silos is important for fumigation, and sealed silos can often be used for wheat at 11-12% moisture, but long experience suggests that it carries too high a risk for maize. Regular aeration is essential.

Do not confuse this process with sealed high-moisture maize storage (>20%), which relies on rapid fermentation to control moulds – such grain is only suitable for stockfeed.

Vertical silos used to store maize have had problems from ‘racheting’, in which expansion of the metal silo wall in high temperatures allows the grain to settle, followed by contraction that compresses the grain. This expansion and contraction under pressure fatigues the metal over time and can lead to buckling and collapse. This can be avoided by regularly drawing grain from the bottom of the silo and replacing it in the top to relieve the pressure. Some experienced organisations now store maize in sheds, with tunnel aeration to bypass the problem.

Manage night-day air flows to avoid moisture condensation

Even maize stored at <14% moisture will release some humidity into the air under the influence of temperature changes. Cooling of the metal silo wall and roof at night promotes condensation of this moisture, which will then begin to accumulate in pockets and support mould growth. Maintaining a steady air flow through the grain at certain times is the only way to prevent this. Consult grain storage experts for correct flows for your storage facilities.

Aeration will not work if ambient air is hot and humid. Only aerate grain when relative humidity is < 80% and temperature is < 20oC (usually at night). This can be set automatically.

Control storage insects, using appropriate chemicals

Apart from general effects on grain quality, storage insects promote mould growth by transporting spores into the kernels they damage, and by releasing additional moisture from the grain as they consume the starch. Keeping grain cool with proper aeration is an important control on insect activity.

Use pictorial guides and expert opinion to correctly identify the insects present. Fumigation and chemical treatments should be carefully targeted against these pests, using chemicals approved for the purpose.

Ensure that the chemicals are used appropriately and that the grain will comply with Maximum Residue Limits (MRLs) of an importing country.

Gravity-grade grain to remove light and damaged kernels

Tests have shown that a high proportion of mycotoxins present in some batches of maize can be in the broken and lightweight grain fractions. This particularly applies to heavily contaminated loads. For example, grading of several batches of maize from the MIA and central NSW that were heavily contaminated with fumonisin and aflatoxin, reduced concentrations by over 70%, and allowed its use as stockfood.

It is less clear as to how effective grading is on maize containing lower aflatoxin concentrations (0.005 – 0.010 mg/kg) for the purpose of meeting a milling standard. However, grading is still recommended for milling and export maize since any broken grain is much more vulnerable to infection and mould growth during storage.

Assay to ensure mycotoxin concentration is well below target level

Conduct mycotoxin assay of cleaned grain just prior to shipping. Carefully document all sampling procedures and the results obtained in case of dispute.

From the detailed explanation of variations in sampling and assay of maize for mycotoxins, it can be seen that there will always remain some risk that a laboratory in another country will obtain a higher result than the assay performed before shipping. We must add to this the risk of some increase during transport.

In regard to the sampling and analytical risks, it should be clear that these will be much higher in a shipment of maize assayed at 0.004 mg aflatoxins/kg in Australia, than one assayed at <0.001 mg/kg.

In regard to the risks of mould growth during shipping, a sample assayed at 0.004 mg aflatoxin/kg definitely contains kernels infected with the Aspergillus fungus, and one assayed at <0.001 might not. Once again, the risks are much greater with the former shipment.

The costs of shipping and consequences if a shipment is rejected dictate the precaution of only shipping maize which has no detectable level of aflatoxin.

For fumonisin and other Fusarium mycotoxins, there is less variability as a result of sampling and assay than with aflatoxin (provided these are performed correctly), and these Fusarium fungi will not grow in maize stored in these conditions. Consequently, a result of <50% of the target level prior to shipping should cover the risk.