On-floor drying to minimise grain spoilage

Action

Determine a safe drying regime using the 'safe storage calculator' (CD free from HGCA).

Research to date suggests that it is advisable to follow a regime for maximum drying speed. In particular:

1. Whatever the bed depth, ensure adequate airflow (0.05m^3/second/tonne is recommended).
2. Reduce bed depth (by about 1m) for grain with moisture contents above 20%, especially in cold or moist weather.
3. Above 18% mc, run fans continuously.
4. Below 20% mc, use heaters (switched on at over 80% rh by humidistat) to give a maximum 5°C temperature rise.
5. Consider installing grain stirrers to increase drying rate of wettest grain.

Always consider your local conditions and consult a professional agronomist if necessary.

Mycotoxins - in growing crops and in store

Mycotoxins are toxic compounds produced by certain fungi under specific conditions. Grain is susceptible to mycotoxins produced either whilst the crop is growing by *Fusarium* species or during storage by *Penicillium* species.

This Project Progress concerns storage mycotoxins – see Topic Sheet 91 for information on mycotoxins that may be produced whilst the crop is growing. Ochratoxin A (OTA) is produced in grain above 18% moisture content (mc). The greatest risk occurs during harvest backlogs and during ambient air drying when grain may take weeks to dry.

OTA incidence can be unpredictable. In the UK only some strains of the fungus *Penicillium verrucosum* produce OTA. Even when present, those strains do not always produce toxins. Toxin formation is not easily assessed, so it is difficult to predict safe storage or drying times before regulatory thresholds are exceeded.

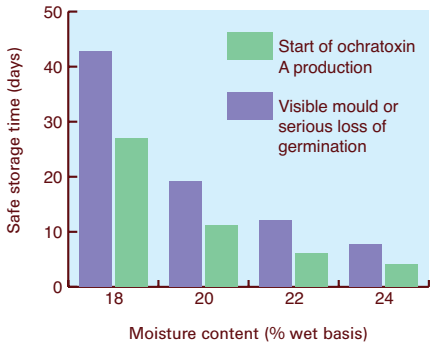
Project Progress 12 gives some data on incidence in UK crops over recent years. A small proportion of UK crops exceed the EU regulatory limit (5ppb) which applies only to grain intended for human consumption. Feed limits are likely to be 20 times higher than those for food.

Modelling toxin formation

Due to new information about the speed at which OTA can form, the old recommendation – to dry to 14.5% within ten days – needs to be reviewed.

Toxin formation coincides with rapid (logarithmic) fungal growth. Using carbon dioxide production as a measure, a model of safe storage times to avoid OTA was produced for the UK (Figure 1). The model, based on data from an EU project, was used to replace the old criteria used as the best predictor of likely spoilage.

Figure 1. Safe storage time at 15°C



Incorporated in a simulation of ambient air drying developed by Silsoe Research Institute, the model predicts how long grain will be safe from OTA during ambient drying. Costs of different drying regimes can also be compared.

'Safe' drying scenarios

1. New spoilage criteria more accurately predict OTA risk

A total of 1,600 simulations of drying with a 3m bed depth were run for four moisture contents, five locations, two drying dates, three widely-adopted drying strategies and using 20 years of weather data. 53% of the simulations succeeded as judged by the old criteria but 36% of these (19% of the total) FAILED when spoilage was judged by the criterion of the new model based on OTA production. So, in about a third of drying conditions, faster drying is needed to avoid risk of OTA.

2. Increasing drying success by reducing bed depth

Simulations showed that reducing bed depth allowed the top layers to start drying sooner, and increased airflow. This increased drying speed of the wettest layers, so drying was more likely to finish before grain deteriorated.

Simulation of a drier with wheat at 20% mc, using 20 years of weather data, showed the bed depth had to be reduced from 3m, the design depth, to 2m to keep the risk of OTA below 5%, ie successful in all 20 years. These results support reducing depth by a metre, perhaps more in cold and/or damp climatic areas, to control risk of OTA.

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3. Fan and heater control strategy has a major effect on safe bed depth and on drying cost (Figure 2)

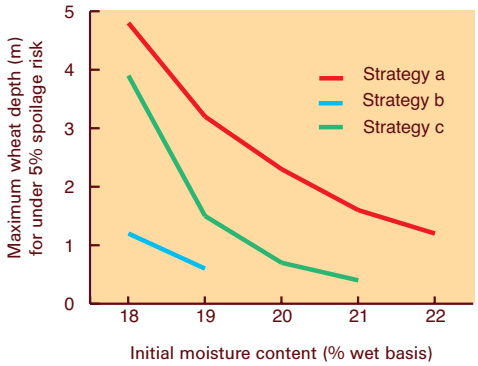
The following commonly-used strategies were compared:

a Running fans continuously and switching heater on with a humidistat set at 80%.

b Fans switched on and off using humidistat with settings reduced as the bed dries.

c Fans switched initially by humidistat and then heaters switched in stages by humidistat.

Figure 2. Lower grain depth must be used at higher moistures



Using these depths or less will keep the risk of OTA below 5%, provided airflow is adequate (0.05m³/second/tonne at 3m bed depth).

Strategy 'a' was most successful but the most expensive. Strategy 'b' was cheapest but was only effective at or below 19% mc. Running costs averaged over the range of 18-22% initial mc and drying to below 16% (drying not complete but risk of OTA eliminated) were £3.75, £1.55 and £3.50/dried tonne for strategies 'a', 'b' and 'c' respectively.

4. Increasing drying success by improved fan control strategies

Improvements in drying speed for strategies 'b' and 'c' were achieved by changing humidistat settings. Costs/tonne were generally higher. The change in strategies 'b' and 'c' to increase depth incurred on average 20% higher costs (data for one site only).

5. Increasing drying success by grain stirring

Grain stirring allowed bed depths to be increased without spoilage but increased running costs at grain moisture contents above 20% (Table 1).

Table 1. Stirring can increase drying rate and reduce bed depth#

	Initial mc % wet basis				
	18	19	20	21	22
No stirring					
Maximum depth (m)*	>4.8	3.2	2.3	1.6	1.2
Running cost (£/dried tonne)	3.37	3.46	3.72	3.93	4.34
Elapsed time (h)	400	270	210	160	130
Stirring every 12 h					
Maximum depth (m)*	>4.8	>4.8	4.4	3	2.1
Running cost (£/dried tonne)	2.33	2.94	3.81	4.58	5.16
Elapsed time (h)	285	355	415	340	270

Grain dried to below 16% mc (drying not complete but risk of OTA eliminated).

* At this depth, the risk of OTA production is less than 5%.

Lessons from modelling project

The simulations have shown that, with existing equipment, the OTA threat can be reduced by using lower bed depths or improved strategies. Drying costs and times have been calculated. Further validation work will be carried out in 2006 and 2007.

Background

It is essential that grain stored on-floor is dried sufficiently quickly to prevent growth of *Penicillium verrucosum* and the possible formation of the mycotoxin OTA.

A model of safe storage times to avoid fungal deterioration (including OTA production) was produced in EU project 'OTA PREV' by Nils Jonsson, JTI, Sweden. An HGCA and Defra-funded project by Silsoe Research Institute then incorporated the model into HGCAs 'safe storage time calculator' and tested its use in various drying scenarios in a project led by Central Science Laboratory.

Use of the HGCA safe storage time calculator can provide guidance on pre-hot-air drying storage times and ambient air drying times.

Further information

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Safe storage calculator CD
available from HGCA on request

The grain storage guide, HGCA (2003)

Project Progress 12

Bulk grain drying and conditioning, FEC Services (1990)

Prevention of ochratoxin A in cereals. Final Report
http://www.slv.se/upload/dokument/fou/MIB/FINAL%20REPORT.pdf

Ongoing project 2982

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