Preserving the grain
Dare aerate the grain if the weather is damp!

With a few precautions, aerating cereals when the weather is damp is not a problem. If ambient air is colder than the grain, the moisture content of the batch will decrease. Here are some details.

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When it comes to aerating cereals, farmers and grain stores are sometimes reluctant to use their facilities if it is raining or foggy. They feel that the batch might get damp again. However, if the air blown is colder than the grain, this practice does not compromise the quality of the batch.
This is how: When the fans are on, the blown air first cools the grain down, then the moisture content of the grain decreases proportionally depending on how high the initial level was. Any cooling down process is accompanied by a slight reduction in moisture.

The moisture transfer (in the form of evaporating water) between the grain and the air varies depending on air humidity and grain moisture content, as well as on their respective temperatures. If the air is cooler than the grain, the grain will lightly dry. On the contrary, if the batch is aerated with air which is warmer than the grain, the latter may gain in moisture again through localized condensation around the ducts.

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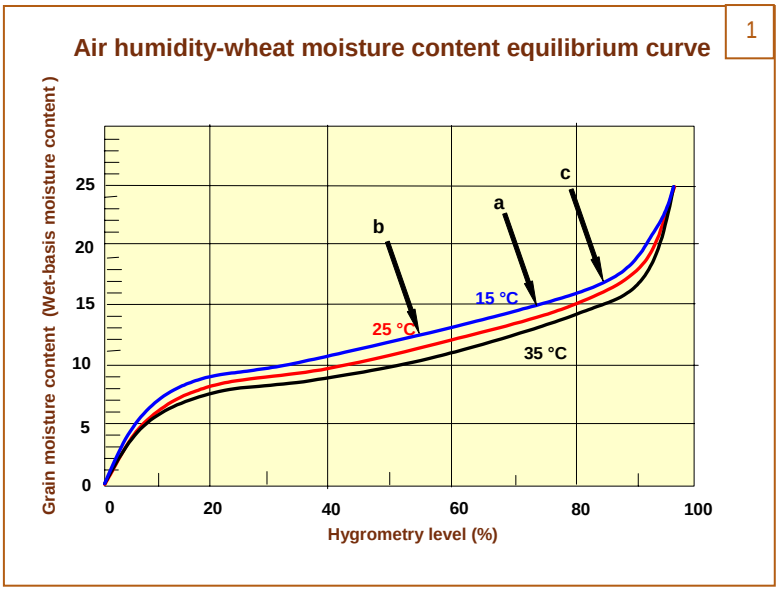

During storage without aeration, the relative humidity of the interstitial air reaches equilibrium with the moisture content of the grain (a). During the aeration process, grain moisture content tends to reach equilibrium locally with the air passing through it, without ever exceeding 16% around the ducts (c).

Cooling down to dry the grain

If soft wheat is put in a bin without being aerated, the relative humidity of the interstitial air will reach equilibrium with the moisture content of the grain *(figure 1)*. Wheat with 15% moisture content and a temperature of 15°C automatically means that the hygrometry level of the interstitial air has to be 75% (a). The moisture level is therefore stabilized, even if, without aeration, the grain temperature only changes where it is close to the walls and very slowly. On the contrary, if that grain is aerated with air registering a level of hygrometry of 55%, the whole batch tends to stabilize slowly around 12% moisture where it is in contact with air (b) while its temperature levels out.

Conversely, if the batch is aerated with air registering a level of hygrometry of 85% (c),
only the first few tens of centimetres of grain situated around the aeration ducts will gain about 15% moisture again at around 16-17% whilst the moisture content of the total volume of grain actually drops a few points as it cools down.
The temperature equilibrium is reached around 30 times faster than that of moisture and humidity. Therefore, the grain cannot get damp again if aeration is stopped as soon as temperatures have evened out.
This is why temperature is the only factor to be taken into consideration.

Cooling down in stages

The significant cooling down of the grain, from its initial temperature (often between 25 and 35°C) to a proper storage temperature (around 10°C or less), cannot be achieved all at once; it must be reached through a succession of stages.

The first one is achieved in summer using night air as soon as the grain is put into the bin, which brings it down to around 20 to 22°C. At that temperature, the colder feel stops insects that might be present in the store from colonizing the heaps.
The second stage is triggered at the end of the summer or beginning of autumn and usually helps lower the temperature towards 12°C. No grain pest is able to reproduce at that temperature and grain can then be properly stored over a long period of time. Batches needing to be stored beyond the following summer should go through a third cooling stage during the winter, to reach 5°C (or less), which in the space of three months works as a totally effective insecticide.
If, during the aeration process, moisture content is allowed to reach up to 16% locally (around the ducts), experience has shown that this level is an absolute upper limit, even if aerating the whole time in damp conditions.
Indeed, all the trials conducted by ARVALIS-Institut du végétal show that relative humidity of the blown air, i.e. the air arriving in the middle of the grain, is never 100%. Its slight compression by the fan means it loses at least 10 hygrometry points, often more. This phenomenon gets more pronounced the deeper the heap is. Moreover, the relative humidity of the air used to aerate the grain, gradually decreases further as it warms up, passing through the layers of grain which it is cooling down.

Eliminating any chance of the grain warming up

It is also worth noting that when the air is very dry, the evaporation process, which accompanies the cooling down, uses calories from the grain, which generates an additional drop in temperature ("overcooling") of the latter of around 1°C. This rarely happens however, as during the day the air tends to be warmer than the grain and at night it is colder but damper.
Conversely, cooling down grain with very humid ambient air tends to limit water evaporation from the grain and reduce cooling potential by 1 to 2°C. It is then a case of "undercooling".
If the air is warmer than the grain, air humidity might condense on the grain. This may, in turn, alter the quality. But this cannot occur if the temperature of the grain is properly monitored throughout the storage period, as well as ambient air temperature during the aeration process.
To cool batches down completely and rapidly, without any chance of localized rise in temperature in the grain heap, a thermostat based automatic triggering of aeration has proven very useful and inexpensive for many years. It means that the aeration system switches on automatically once a trigger point, set by the silo manager, has been reached and external conditions warrant it, and switches off once they no longer do.
This simple and cheap technique is an efficient way of preventing mould and insect proliferation.

Controlling humidity during storage Safe from mycotoxins

**To proliferate, mycotoxins like very damp conditions.
Apart from exceptional circumstances, French conditions at harvest time and expertise protect stored batches of grain from such contamination.**

Cooling down grain by aeration using ambient air is a technique readily used by farmers and grain stores, which reduces even further the risk of any mycotoxins appearing.

Moulds are made up of microorganisms present everywhere. They constitute the best part of the natural microflora in grain. In certain conditions, which are not fully understood yet, they can produce toxins called mycotoxins, potentially harmful when ingested by humans or animals.

The most important factor in the development of moulds is water activity in the medium, scientifically known as Activity water (Aw).

Aw is the pressure of evaporating water from a product over the pressure of pure evaporating water at the same temperature. Aw reflects the availability of water in a medium for chemical reactions and/or the development of microflora (including moulds).

Aw levels are expressed on a scale of 0 to 1, zero being characteristic of dry matter and 1 of pure water. In simple terms, Aw corresponds to the hygrometry level of interstitial air around the product. Therefore, air with a level of hygrometry of 80% corresponds to a medium with 0.8 Aw, 60% hygrometry corresponds to 0.6 Aw and so on.

Limited physiological processes

In our part of the world and in a batch harvested in proper conditions, the microflora seems unable to develop.
Indeed, field flora (*Fusarium)* requires a minimum Aw of 0.87 in the grain heap, which corresponds to cereal with 18 to 20% moisture content and oilseeds at around 15-16%. In France, the majority of stored cereal grain shows Aw levels in the grain heap between 0.70 and 0.75 and between 0.6 and 0.7 in oilseeds

As for "storage flora" (*Aspergillus* amd *Penicillium*) which can produce ochratoxin A type mycotoxins, it needs Aw levels in excess of 0.83, i.e. a moisture content approaching 17-19% for cereals and 14-15% for oilseeds. Again, grain is rarely harvested with such moisture contents! In the very rare cases where this happens, the batch is quickly identified, dried and aerated. The chance of any ochratoxin A developing is therefore very slim.

Cooling down grain by aeration using ambient air is a technique readily used by farmers and grain stores, which reduces even further the risk of any mycotoxins appearing. It means that the grain is dormant, which reduces to a minimum any risk of physiological processes such as breathing, oxidation and fermentation, likely to lead to localized rehumidification, mould development and shrinkage.
Aeration also helps limit insect population and maintain the overall technical and commercial quality of the grain.

Insufficient humidity of the medium/environement

It is also worth noting that blown air extremely rarely registers above 75-80% relative humidity, or 0.75-0.80 Aw. Even if blown ambient air displays an Aw value exceeding 0.90, it warms up through the fan, resulting in an Aw drop of 0.1 to 0.2 points. So, once again, *Aspergillus* and *Penicillium*, potential sources of ochratoxin A, are unable to develop.
When grain is stored in bins with 15-15.5% moisture content, and then aerated, it loses around 0.8 to 1% moisture. When grain is at 14%, the loss goes down to 0.5% and at 12.5-13%, the loss is negligible. If good storage practices are implemented, the humidity of the medium is insufficient for any moulds to develop.

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