Grain - Our Valuable Raw Material

Essentials on Safe Grain Storage

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Innovations for a **better world**.

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Essentials on Safe Grain Storage

Challenges in grain storage

- Heat generation
- Condensation
- Pest development

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Grain is a living organism!

$$C_6H_{12}O_6 + 6\,O_2 \rightarrow 12\,H_2O + 6\,CO_2 + 2872\ kJ/Mol$$

Carbohydrates + Oxygen → Water + Carbon dioxide + Heat

1,000 g + 1,123 g → 579 g + 1,544 g + 16.48 MJ

Respiration → Releasing water, producing carbon dioxide and generating heat.

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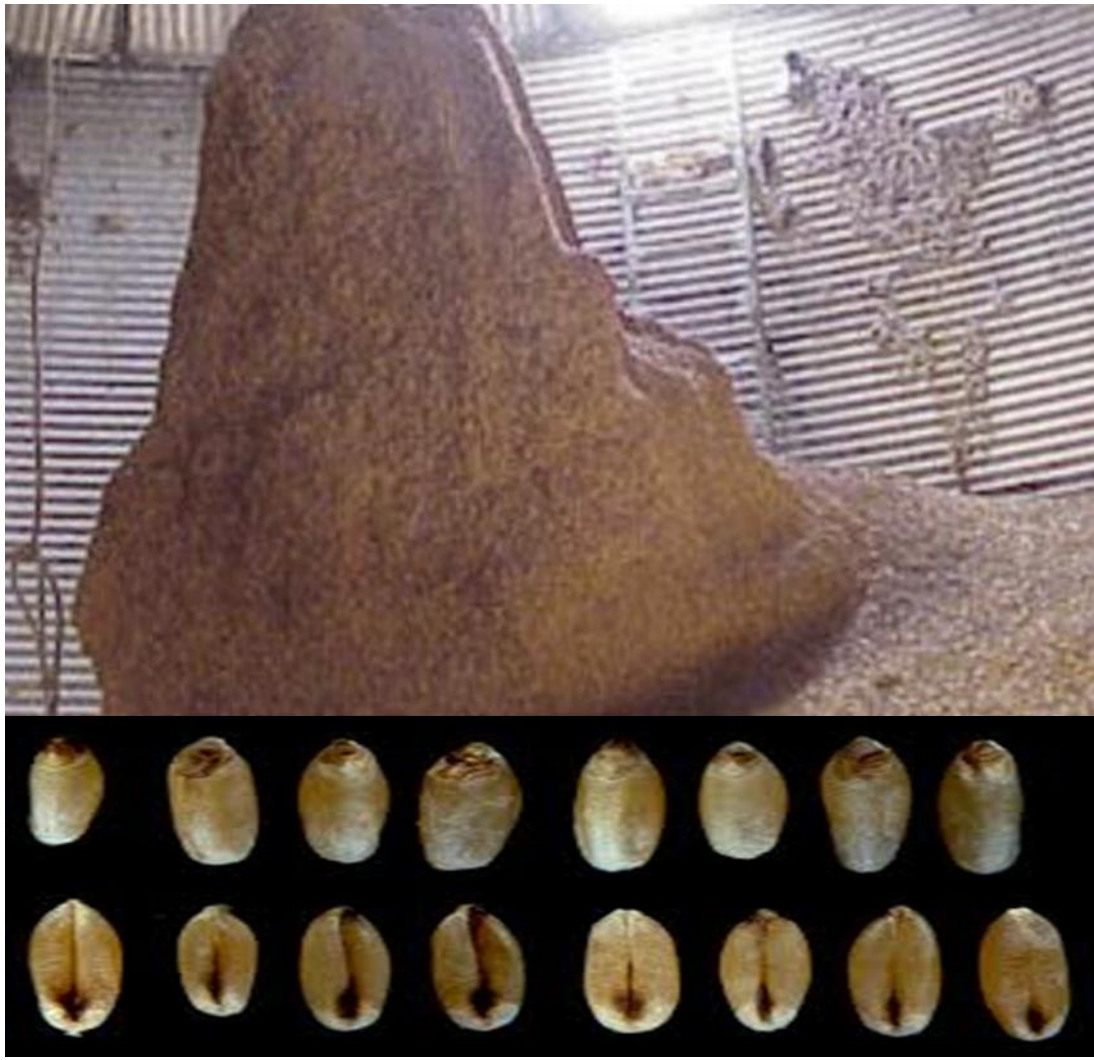
Consequences of respiration

- Wet spots and caking of grain in silos
- Discoloration of kernels by excessive respiration
- Mold on grain due to condensation



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Measures to keep respiration low and avoid damages and loss of grain!

- Aeration
- Recycling
- Cooling
- Drying

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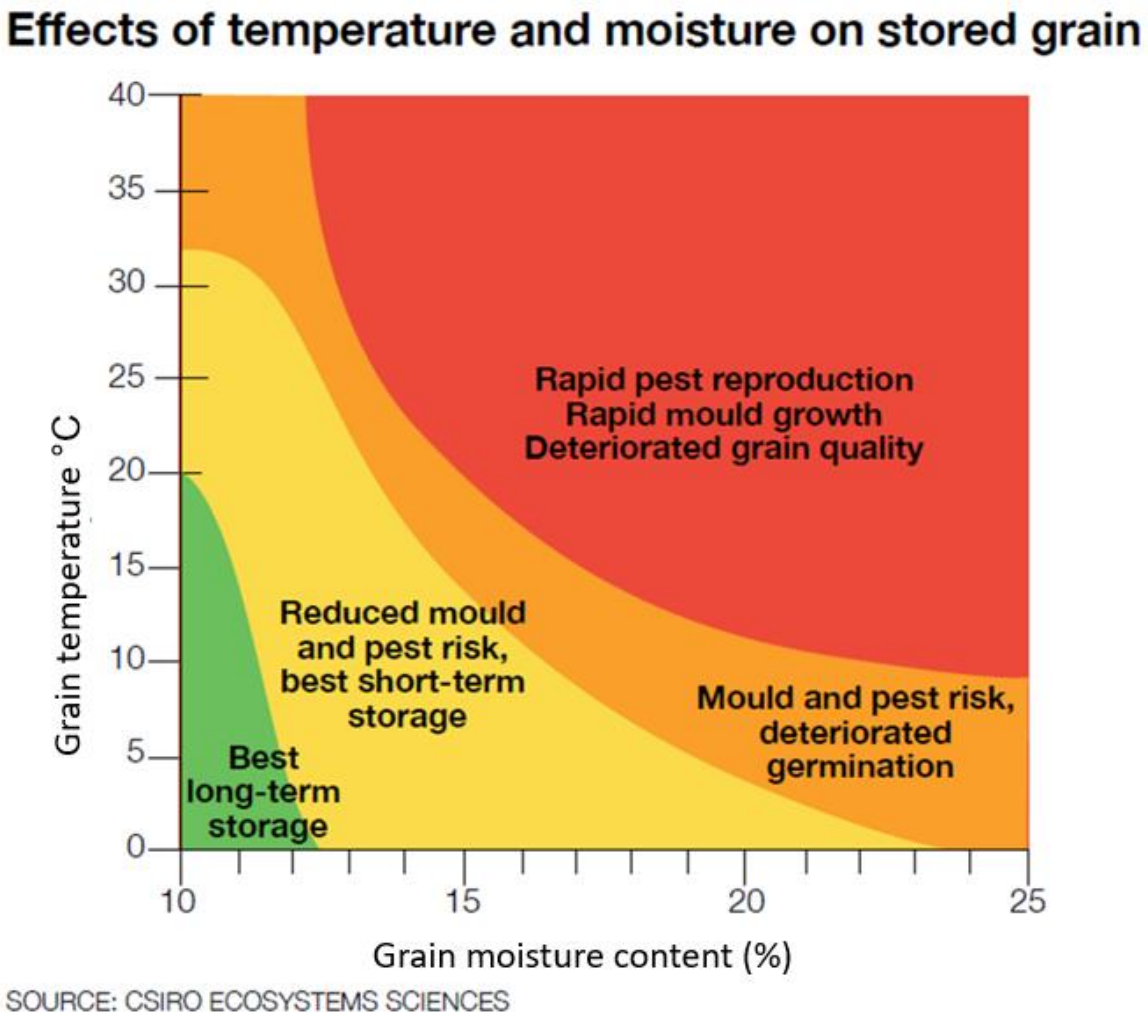
Six major factors are affecting the grain storage;

- Moisture of the grain
- Temperature of the grain
- Moisture of the air (relative humidity)
- Temperature of the air
- Storage period
- Infestation



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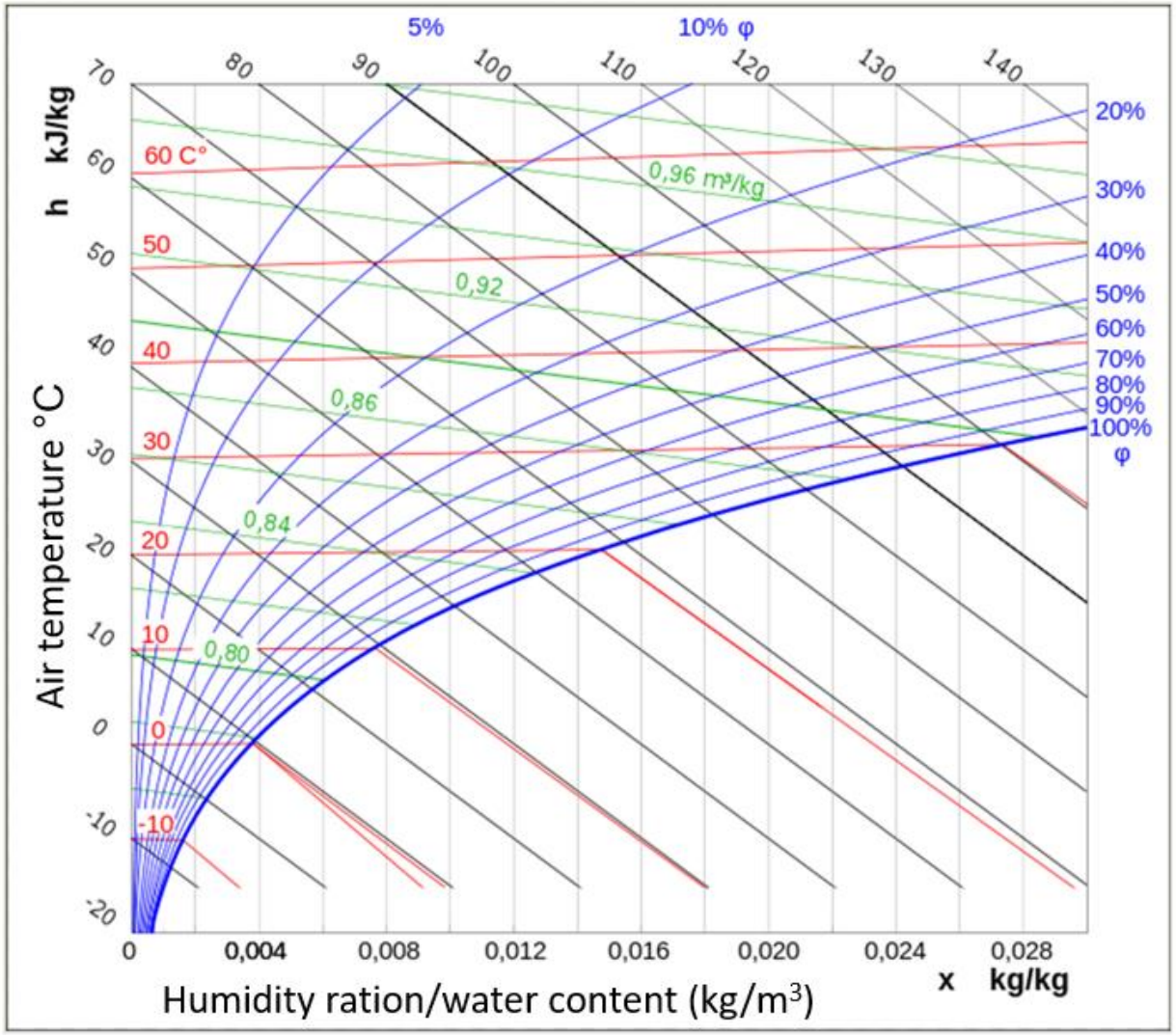
Hygrometric chart HX – Diagram
Interaction of;

- Air temperature
  →Red lines
- Air relative humidity (RH)
  →Blue lines
- Saturation/dew point temperature
  →**Blue bold lines**
- Humidity ratio, water content, air absolute humidity (AH)
  →Vertical grey lines



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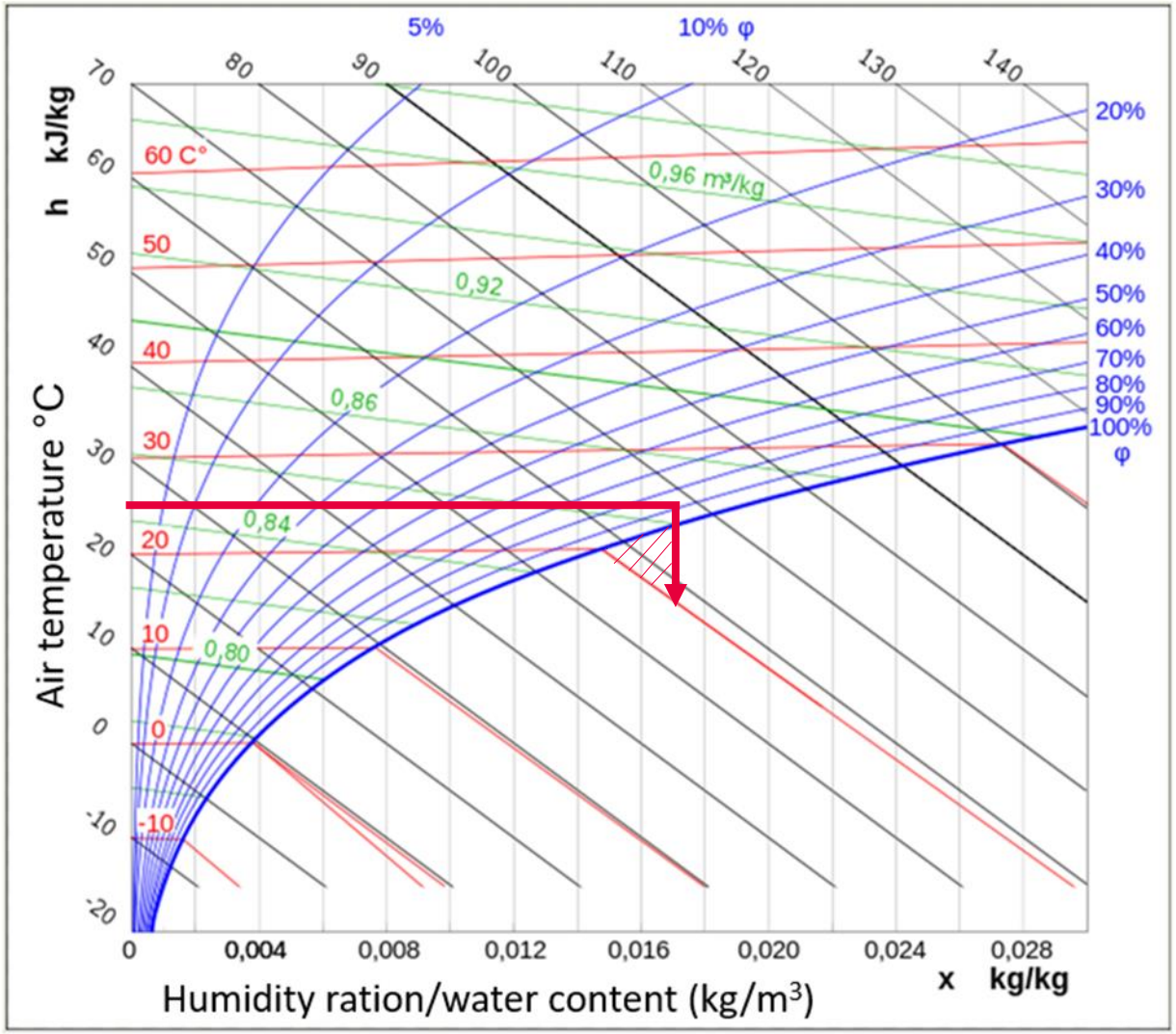
Hygrometric chart HX – Diagram

Aeration of wheat
Example A

- Air temperature 25°C
- Air relative humidity (RH) 90%
- Wheat temperature 20°C

Result

→ Condensation on wheat
→ Risk of mold, heating up and caking



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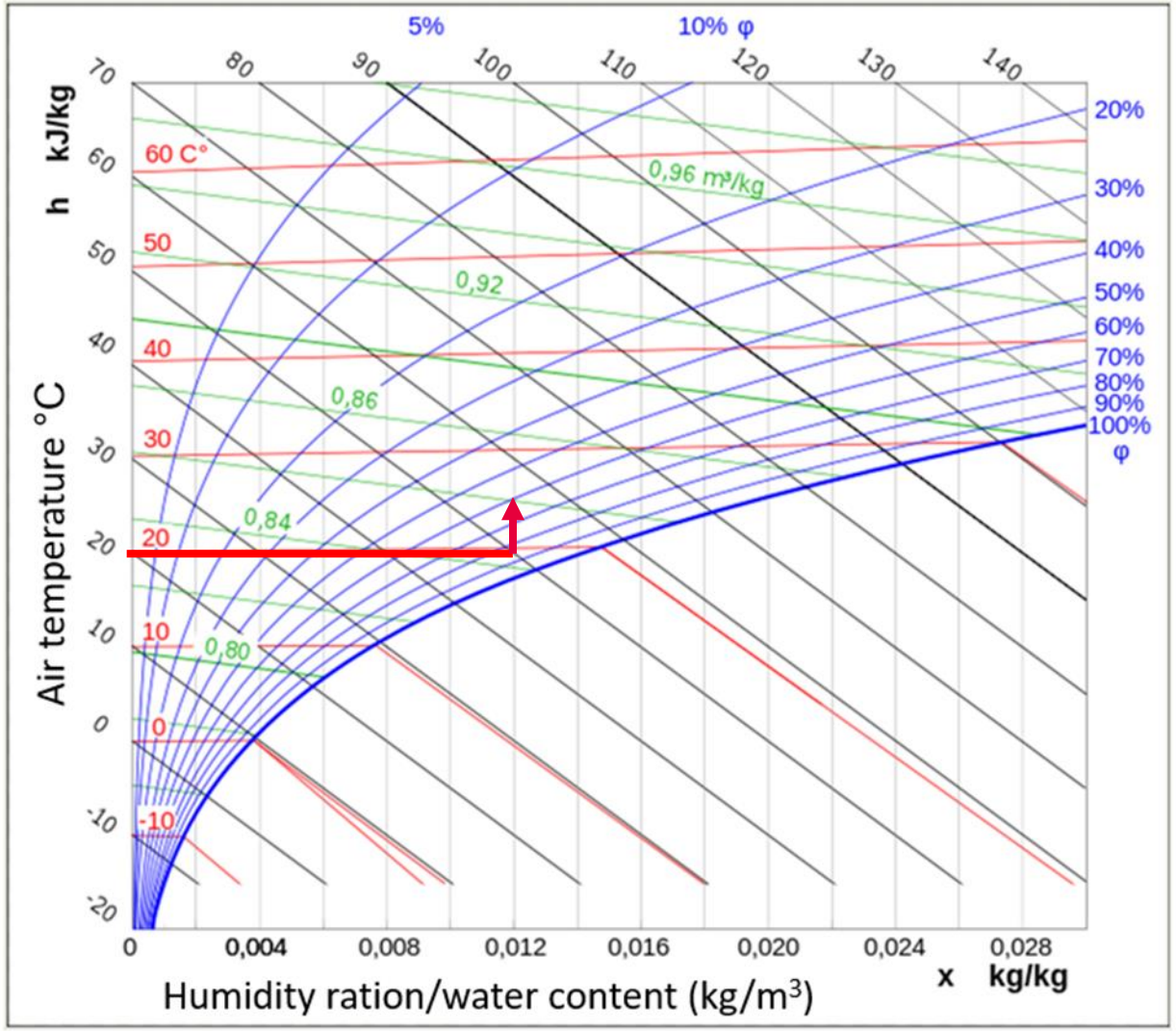
Hygrometric chart HX – Diagram

Aeration of wheat
Example B

- Air temperature 20°C
- Air relative humidity (RH) 80%
- Wheat temperature 25°C

Result

→ Air touching wheat at RH 60%
No problem on wheat
→ Safe storage



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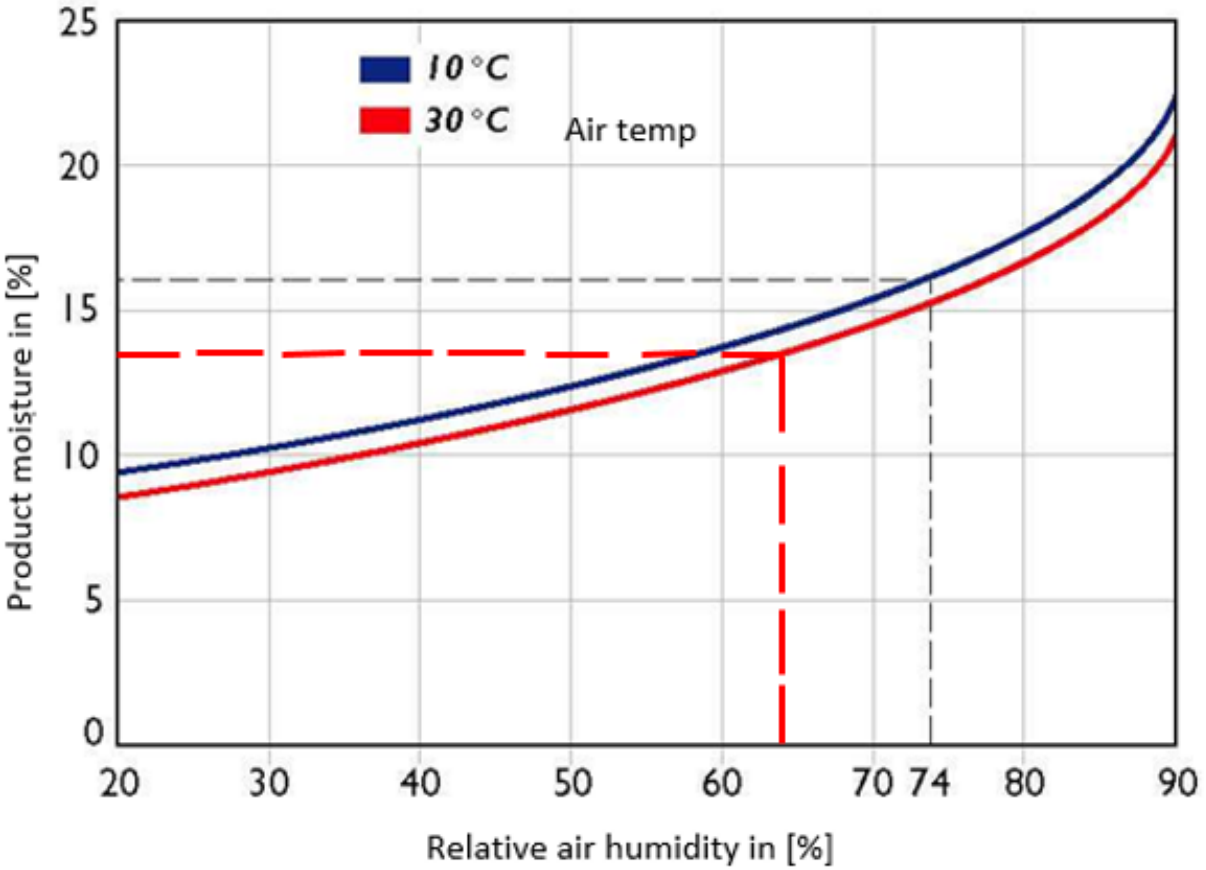
Hygroscopic equilibrium

- In warm climates approximately at 65 – 75% relative air humidity (RH)
- No migration of humidity



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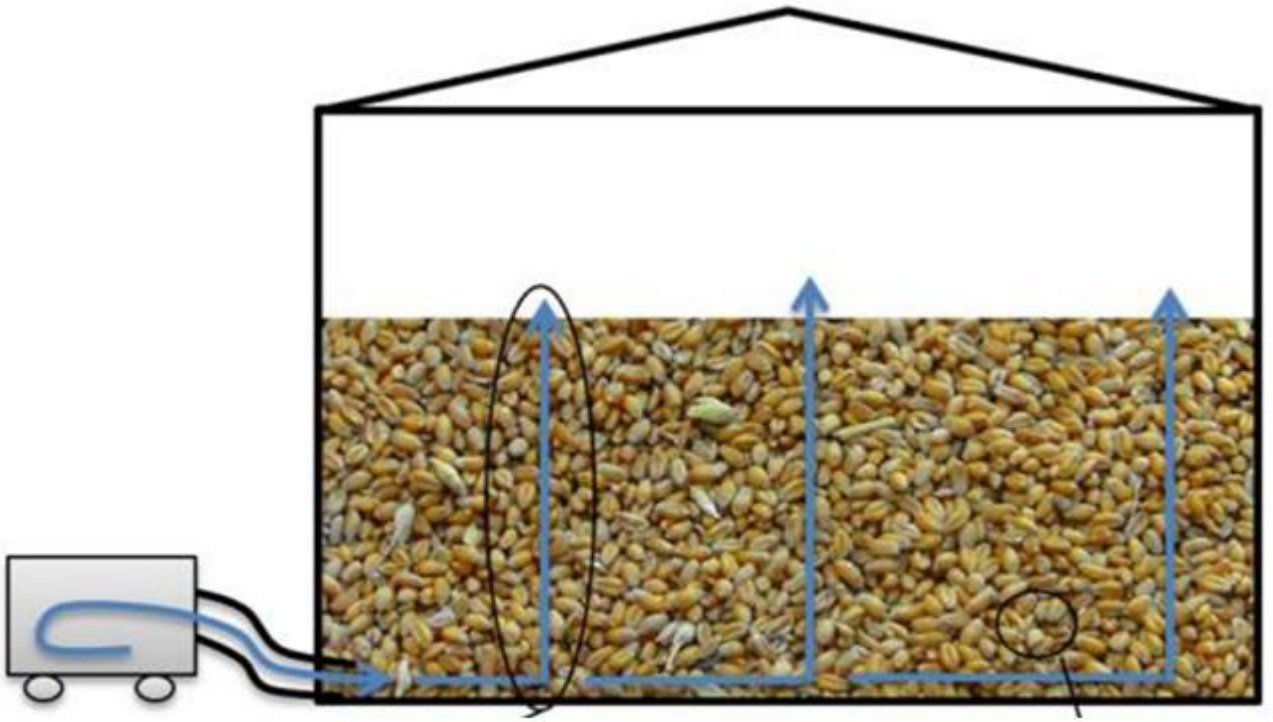
Rules of aeration of grain:

- Never let warm air touch cold grain
  →Target air temperature at least 5°C below wheat temperature

- Never let humid air touch dry grain
  →Target air RH below 70%



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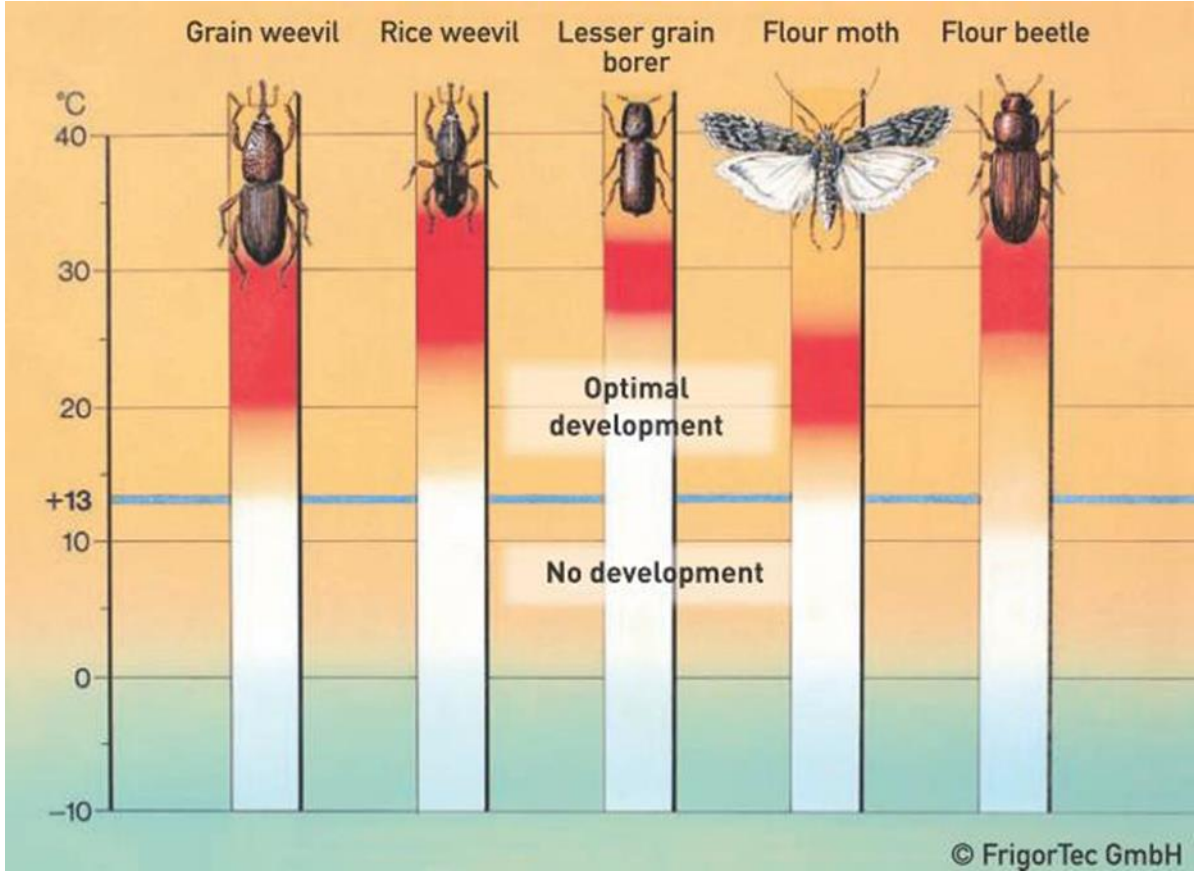

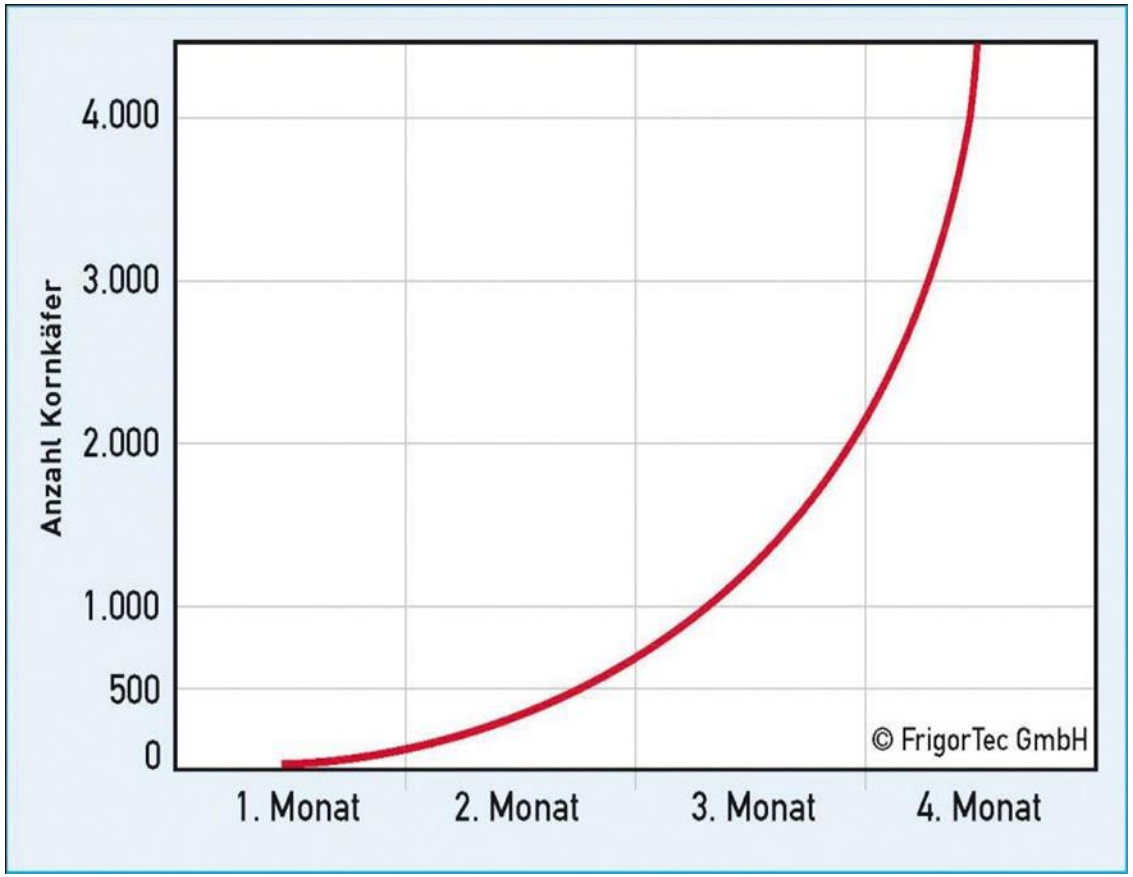

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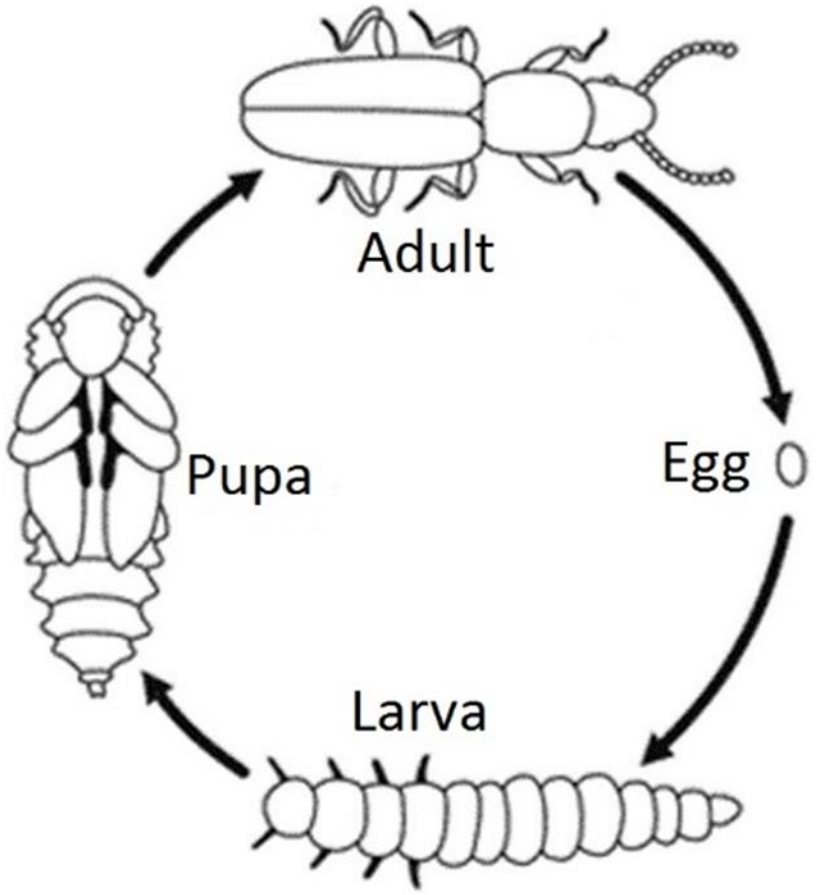
Life cycle of an insect (grain weevil)

- Egg stage 4 – 6 days
- Larva stage 25 – 30 days
- Pupa stage 4 – 5 days
- Insect

Development cycle approximately 36 days



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Primary and secondary pests
Two groups of insect pests in grain

Primary pests

Wheat moth

Grain weevil

Wheat weevil

Rice weevil

Maize weevil

Grain moth

Khapra weevil
(trogoderma granarium)

Secondary pests

Flat grain weevil

Flour mite

Saw-tooth grain weevil

Flour weevil

Cadelle beetle

Thank you for your attention!