Conservation of Stored Grain by Cooling

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Kernels baked to the silo wall

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Insect infestation

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Insect infestation

Trial on damage of lesser grain borer by infestation of grain with 100 adults which are taken out after 7 days and stored at 30°C

Start | 28 days | 56 days | 76 days | 106 days | 128 days

Source: Edmond L. Bonjour, Oklahoma State University, Stillwater

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Fungus infestation

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Respiration of grain

Grain respiration - the totals formula for the chemical process:

$C_{12}H_{22}O_{11}$ + 12 O_2 → 12 CO_2 + 11 H_2O + 1,567 x 10^{-3} kWh

Carbohydrates + Oxygen → Carbon dioxide + Water + Heat

Mass balance for the respiration of 1 kg carbohydrates:

1,000g + 1,122.81g → 1,543.86g + 578.95g + 16.48 MJ

Carbohydrates + Oxygen → Carbon dioxide + Water + Heat

This process depends on the product moisture content and temperature.

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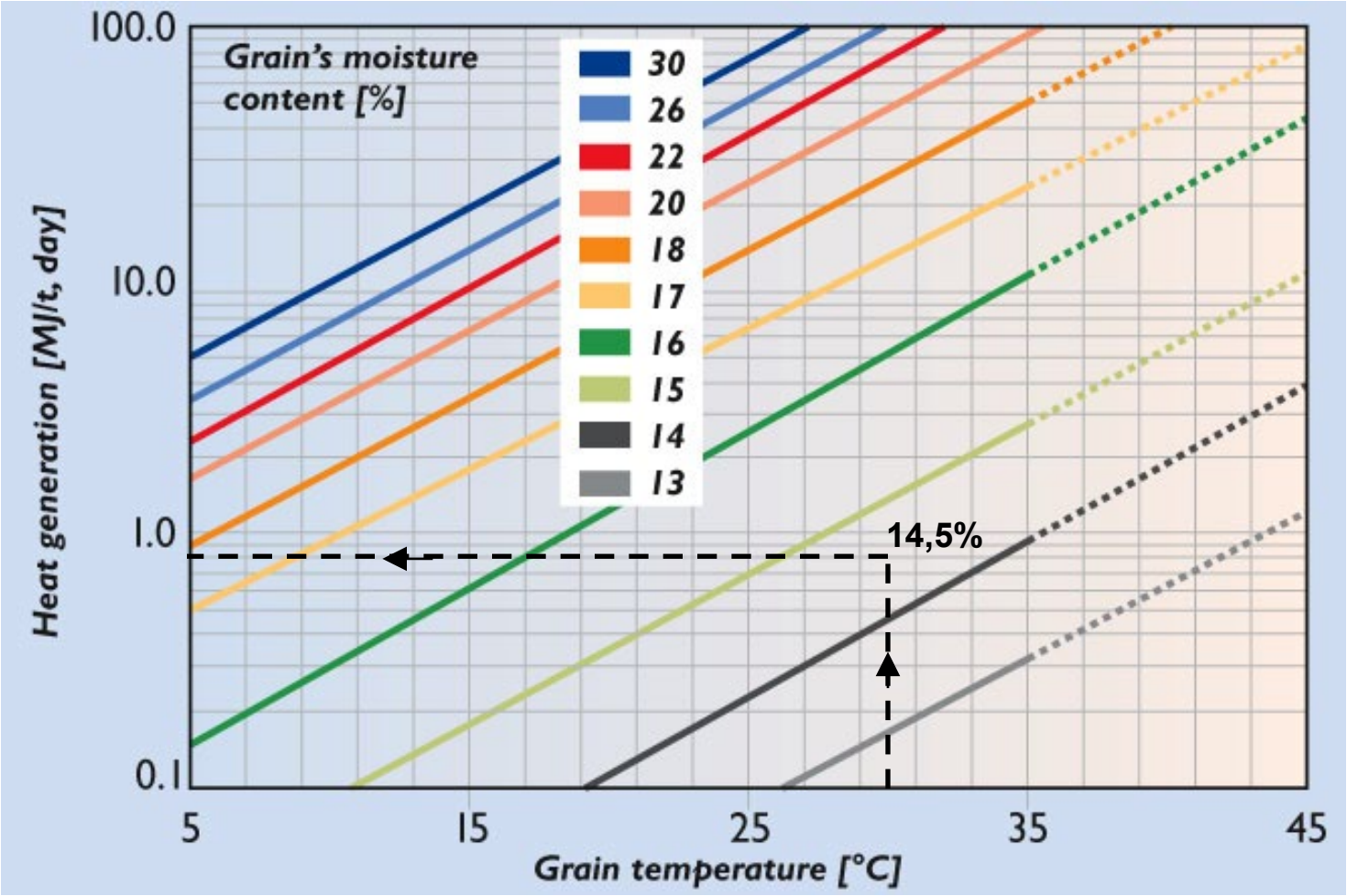
Losses of dry-substance (acc. to Jouin)



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Calculation of wheat losses by respiration

Data			
	Grain Type	Wheat	
	Moisture Content of Grain	14.5	[%]
	Grain temperature	30	[°C]
	Grain price	400	[EUR/t]
	Storage period	4	[months]
	Storage quantity	10,000	[t]

Formula

$$\text{Grain loss [t]} = \frac{\text{heat generation [MJ/t, day]} \times \text{storage period [day]} \times \text{storage quantity [t]}}{15{,}000\ \text{[MJ/t]} \times (1 - \text{moisture content of grain})}$$

Result

	Grain loss [t]	Monetary loss [EUR]
grain stored at 30°C	74,8	29,920
grain stored at 25°C	37,4	14,960
grain cooled to 10°C	minimal (< 1)	---------

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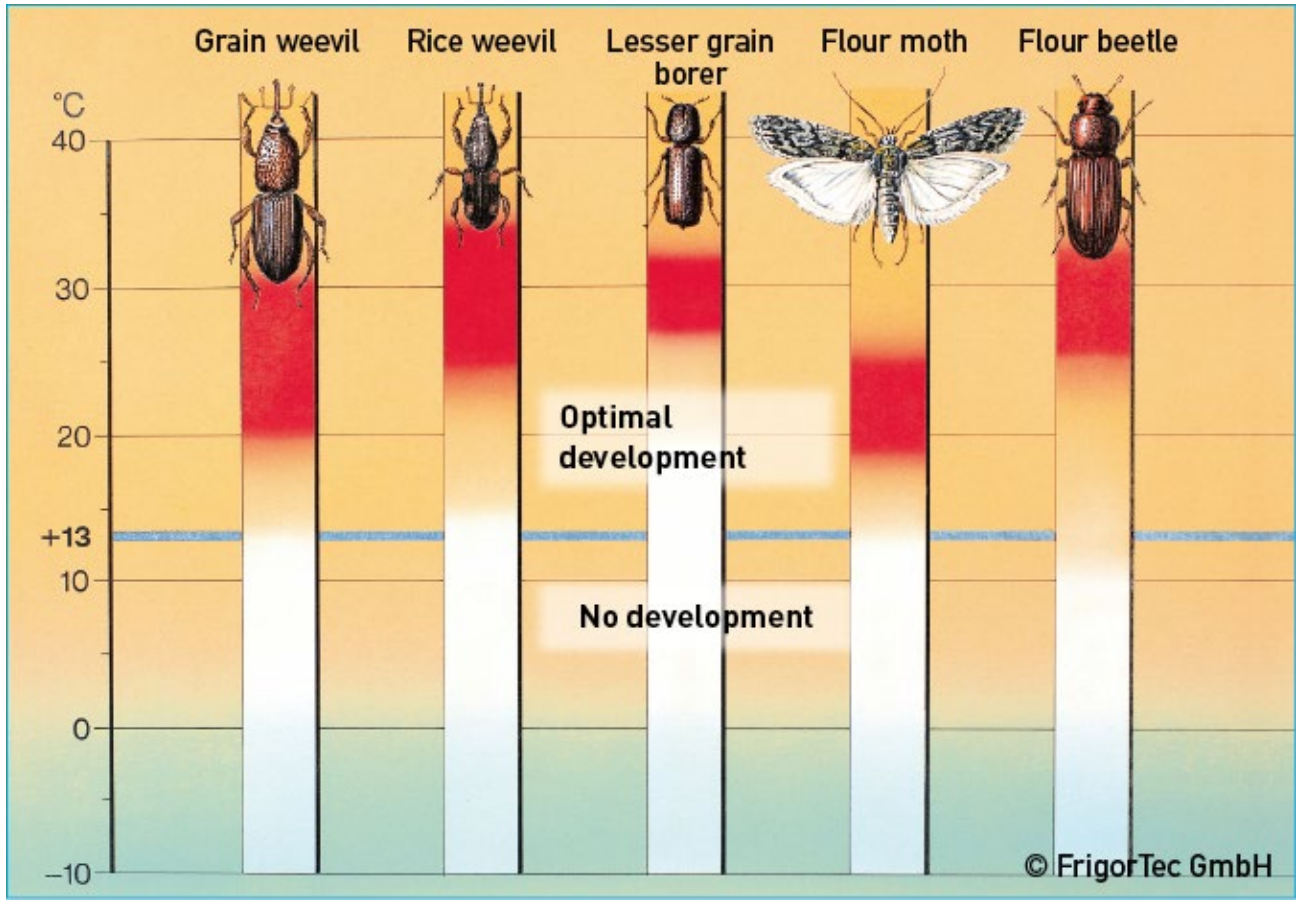
Development of pests



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Profit loss by damage of weevil

Data			
	Grain type	Wheat	
	Moisture content	14	[%]
	Grain price	400	[EUR/t]
	Storage quantity	10,000	[t]

Formula

$$\text{Damaged grain [\%]} = \frac{\text{Number of damaged kernels [n]} \times 100}{1{,}000}$$

Dry mass loss [t] = 0,5 x damaged grain [%] x storage quantity [t]

Result

	Dry mass loss [t]	Grain loss [%]	Monetary loss [EUR]
10% damaged grain	500	5,8	232,000
5% damaged grain	250	2.9	116,000
1% damaged grain	50	0.58	23,200
cooled grain	-	-	-

Source: Quitco, R.T. and Quiodoza N.M., 1986

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Development of Flour Mill beetle (Cryptolestes Trucicus)

Population index	Temperature [°C]	Generation period [d]
0	18	-
1	18.7	85
2	19,5	80
3	20.4	74
4	21.4	68
5	22.6	62
6	24.0	54
7.17	28.2	38
6	32.3	27
5	33.7	24
4	34.9	22
3	35.9	20
2	36.8	18
1	37.6	17
0	38.3	-

Source: CAF 2016

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Preventing weight and quality losses through insects

- Storage temperatures over 21°C offer most of the insects ideal conditions for living and reproduction.
- Below 18 to 13°C insects go into a hybernation and can not harm the crop.
  - ➢ No chemical treatment is necessary !

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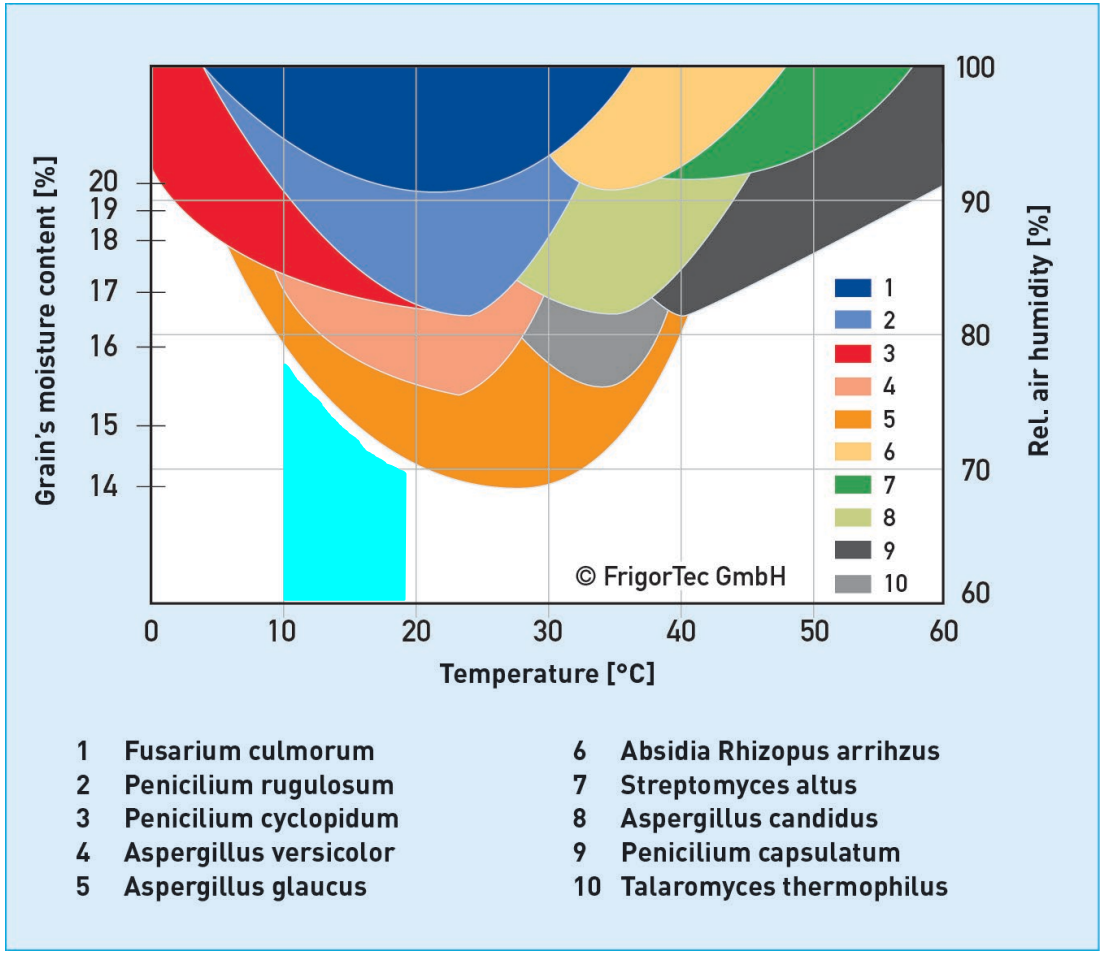
Development of various mould fungi



Source: Lacey, J., Hill, S.T., Edwards, M.A., 1988

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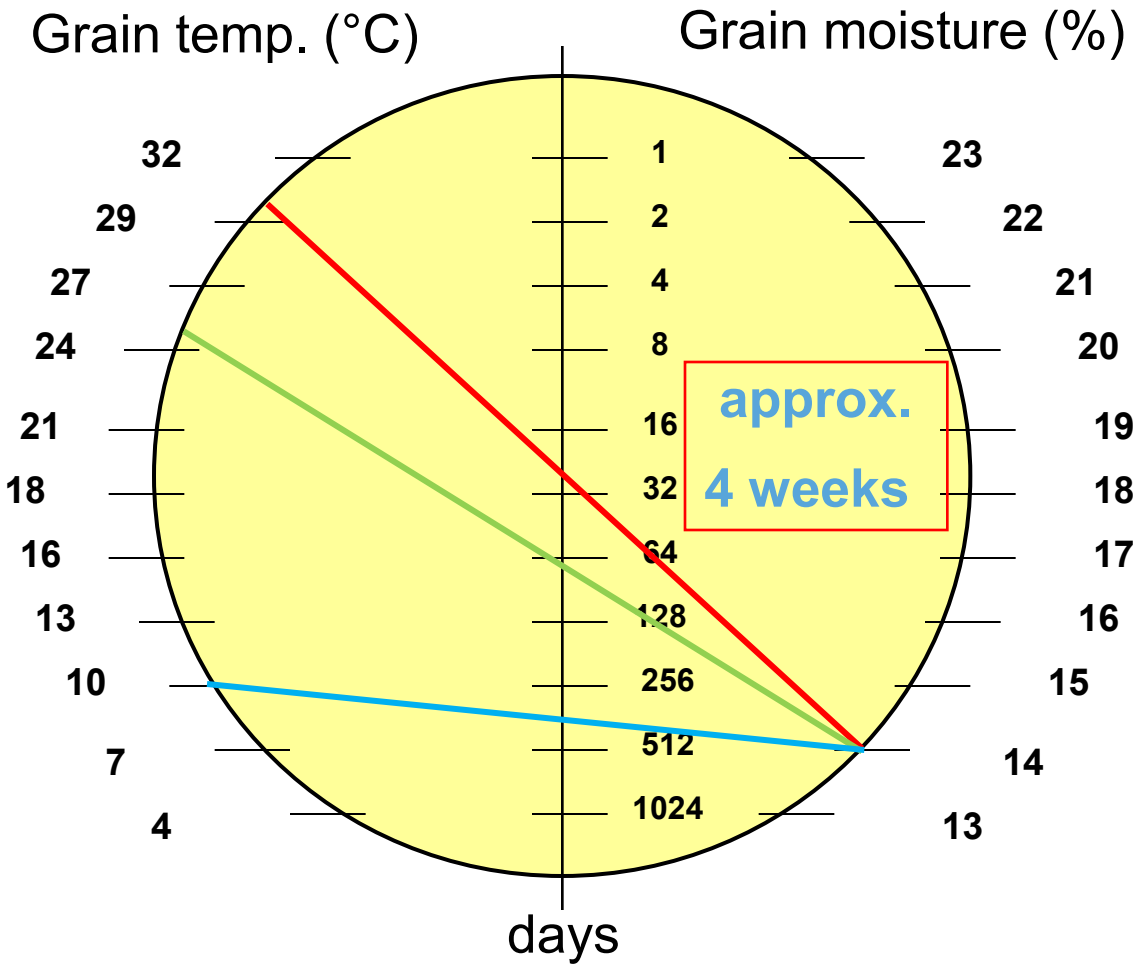
Storage time for grain (days)



Guidelines for grain cooling!

The storage time and treatment measures depend on the results of continuous controls.

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Quality Parameter of Wheat

- Amylases
  - crucial role in baking by breaking down starches in flour into simpler sugars
- Water soluble Amyloses
  - plays role in the baking process, especially when it comes to the texture, structure, and moisture retention of baked goods
- Lysine
  - an essential amino acid that plays a crucial role in the nutritional quality and functionality of baked goods

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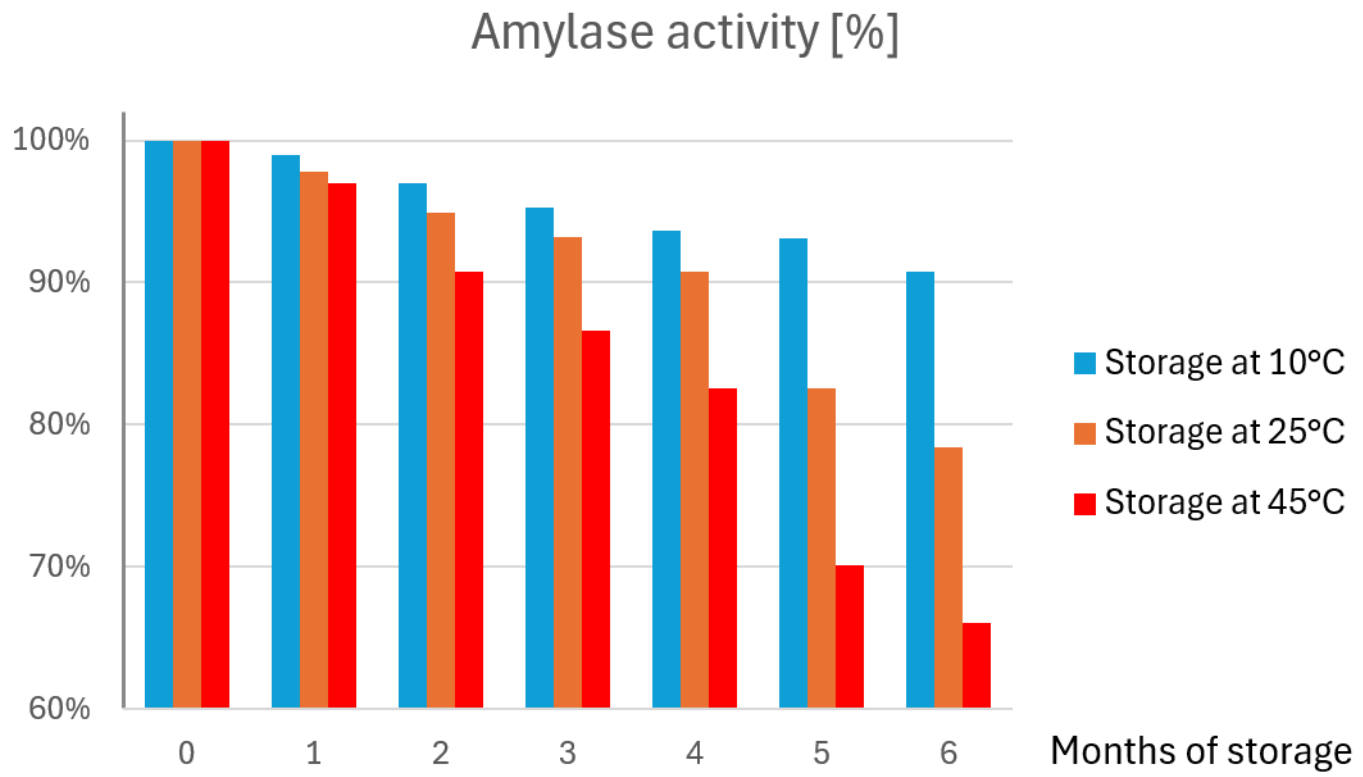
Influence of storage temperature and time on amylase activity of wheat



Source: Rehman 2001

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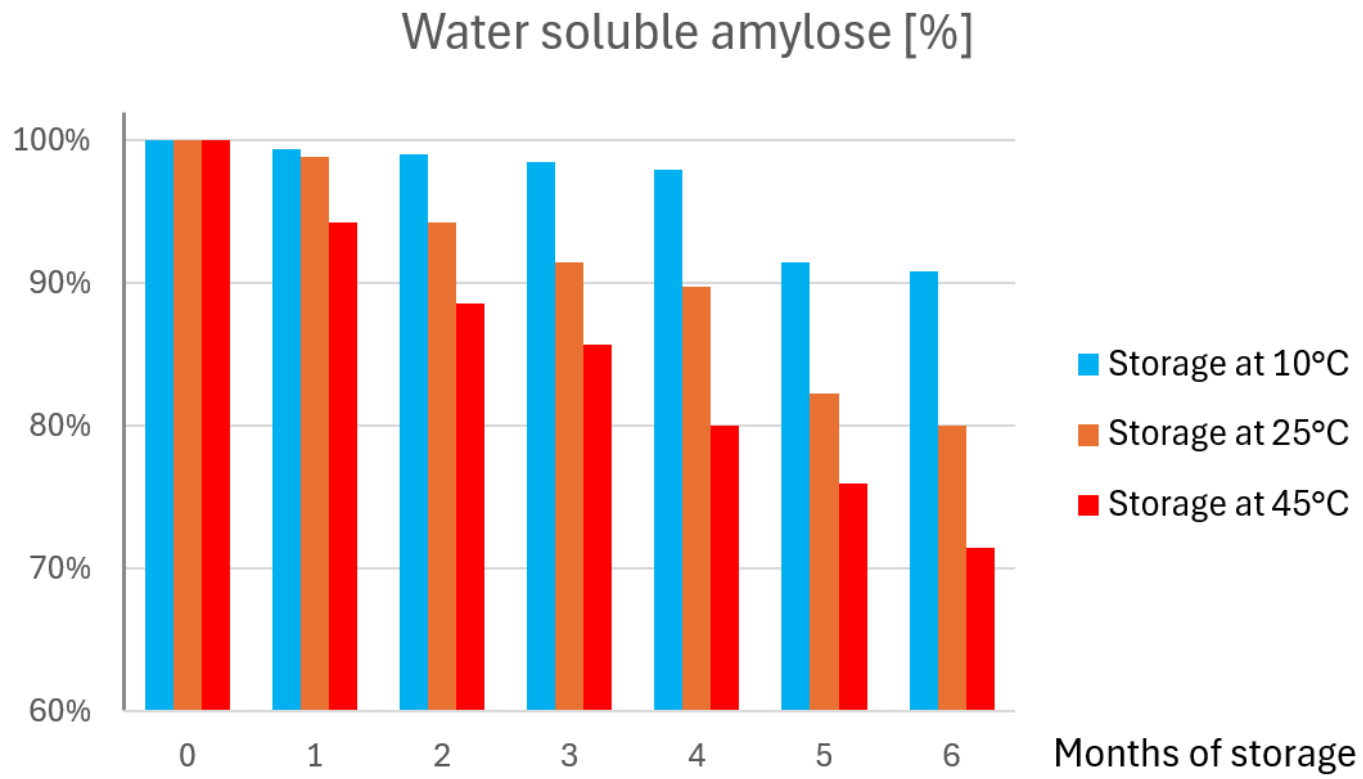
Influence of storage temperature and time on content water soluble amylose of wheat



Source: Rehman 2001

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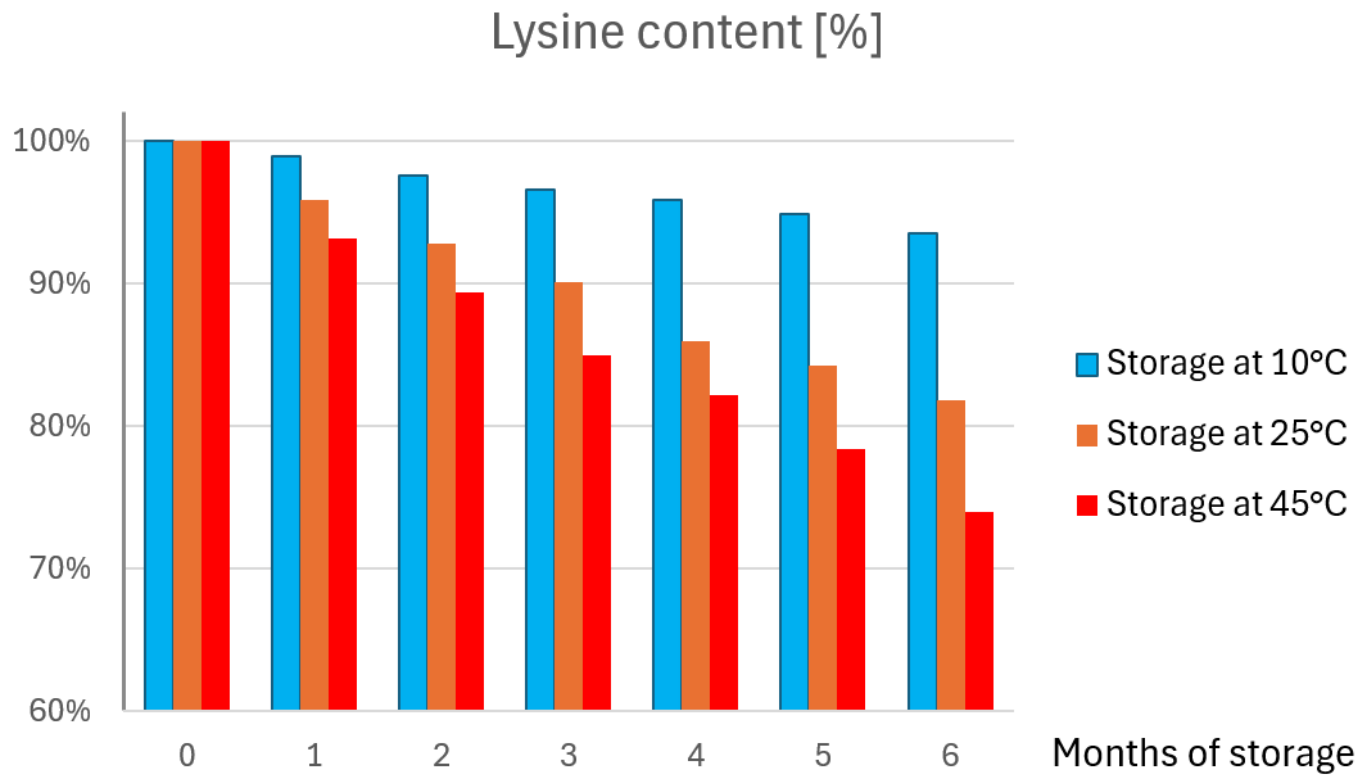
Influence of storage temperature and time on Lysine content of wheat



Source: Rehman 2001

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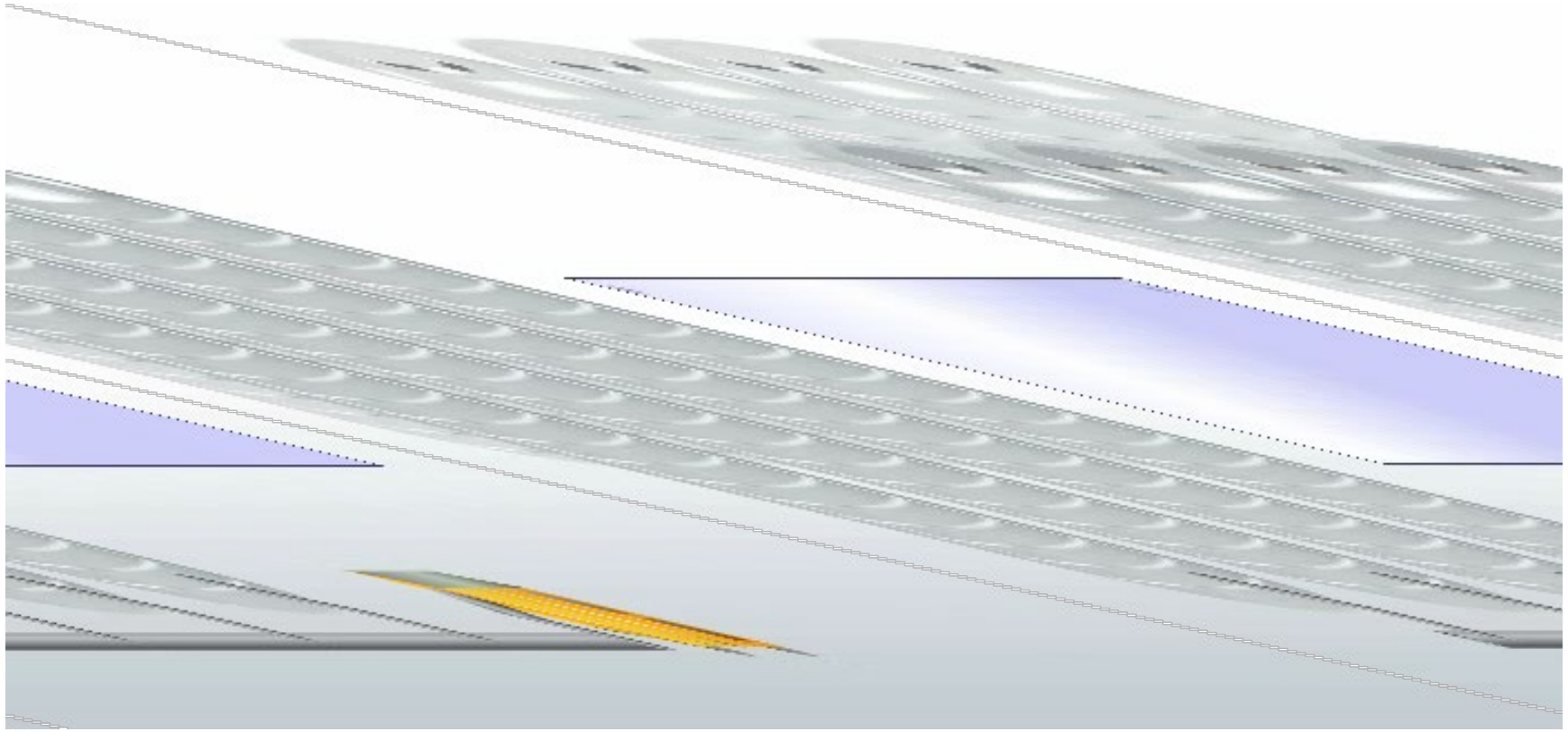

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GRANIFRIGOR™

Conservation of Stored Grain by Cooling

Basics for efficient operation of the GRANIFRIGOR™

- Grain type (wheat, corn barley, paddy, rice,…)
- Grain condition (temperature, moisture content)
- Grain property (sorption of water, bulk density)
- Storage site (geographic location, climate condition)
- Storage type (capacity, dimension)
- Specification of grain cooler (size, model type)
- Operation of the grain cooler

➢ Requirement for an experienced grain manager to achieve best results

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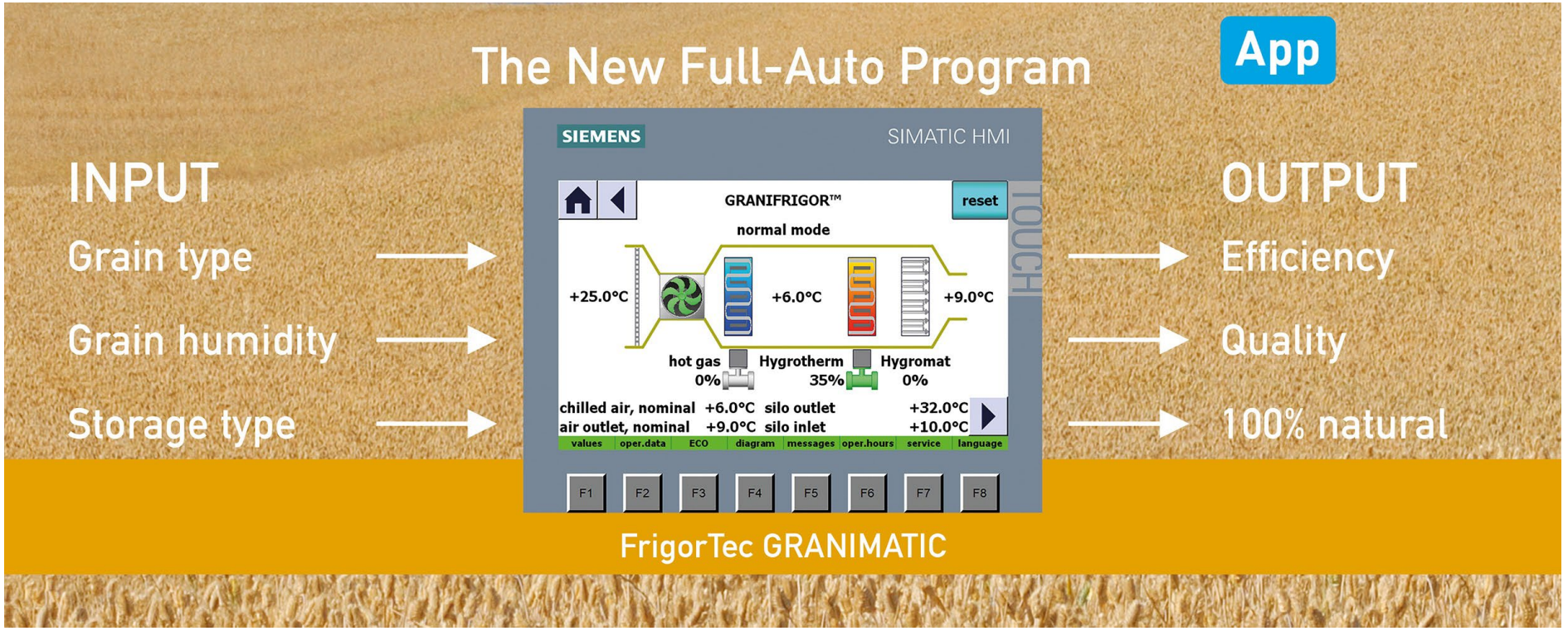

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GRANIFRIGOR™ Online Control

- Online connection by smartphone, tablet, laptop or PC via VPN tunnel
- Data analysis of the recorded operation (protocol)
- Remote control for full access to the GRANIFIRGOR™
- Remote maintenance and online analysis of operation condition by service specialist of FrigorTec

Conservation of Stored Grain by Cooling

Advantages of grain conservation by cooling

- Risk-free long-term storage without quality loss
- Minimizing respiration losses
- Protection from insects and their damage
- Avoiding expensive and risky chemical treatment like fumigation
- Protection of organic grain
- Protection from fungi and their mycotoxins
- Simplification of storage management
- Independent operation of weather conditions
- Increase of revenue and improving of market position

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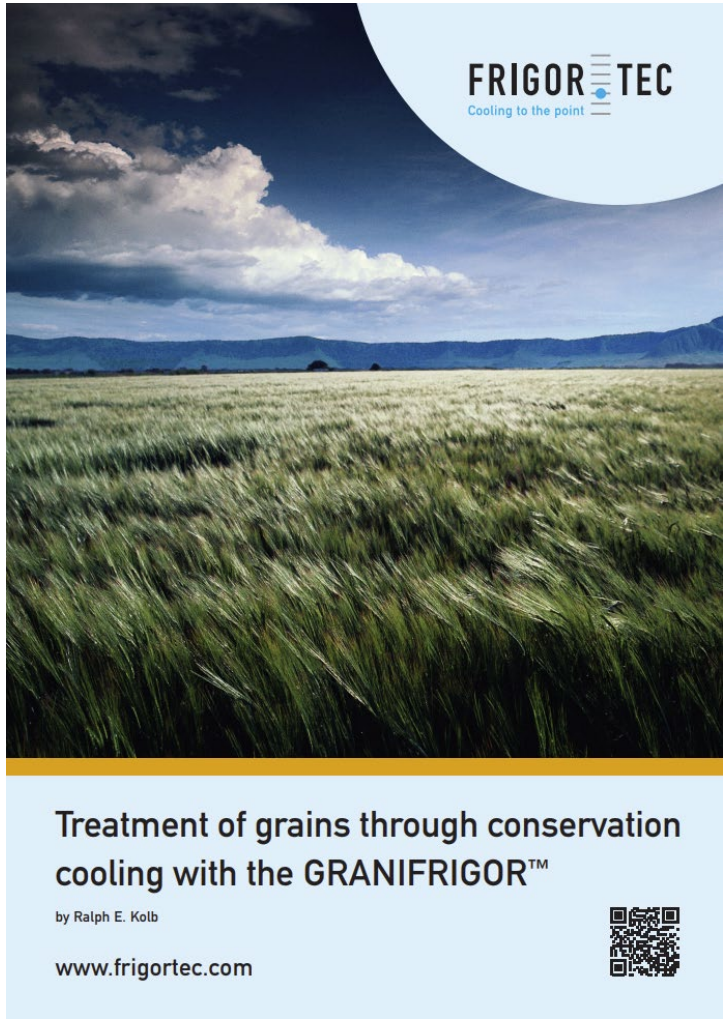

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Stay cool!

Thank you for your attention!

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GRAIN CHAT