IAOM 13th Annual Southeast Asia Region

Conference & Expo

Conservation of Stored Grain by Cooling

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Kernels baked to the silo wall

Kernels in the grain mass, baked together

Grain spoiled by heat

Insect infestation

Insect infestation

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

Fungus infestation

Fungus infestation

Respiration of grain

Grain respiration - the totals formula for the chemical process:

$$C_{12}H_{22}O_{11} \quad + \quad 12\ O_2 \quad \rightarrow 12\ CO_2 \quad + 11\ H_2O \quad + 1{,}567 \times 10^{-3}\ \text{kWh}$$

Carbohydrates + Oxygen → Carbon dioxide + Water + Heat

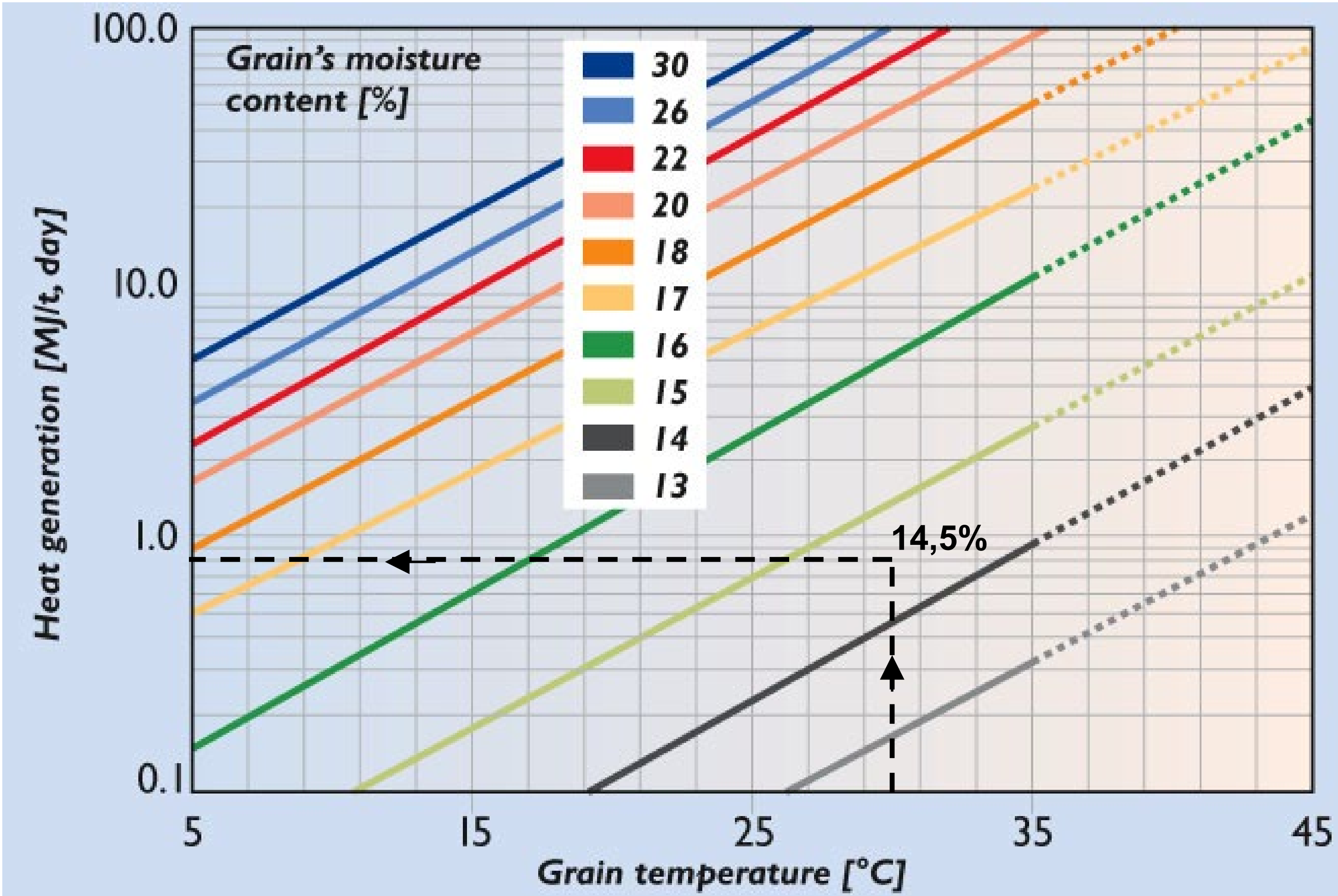
Mass balance for the respiration of 1 kg carbohydrates:

$$1{,}000\text{g} \quad + 1{,}122.81\text{g} \quad \rightarrow 1{,}543.86\text{g} \quad + 578.95\text{g} \quad + 16.48\ \text{MJ}$$

Carbohydrates + Oxygen → Carbon dioxide + Water + Heat

This process depends on the product moisture content and temperature.

Losses of dry-substance (acc. to Jouin)



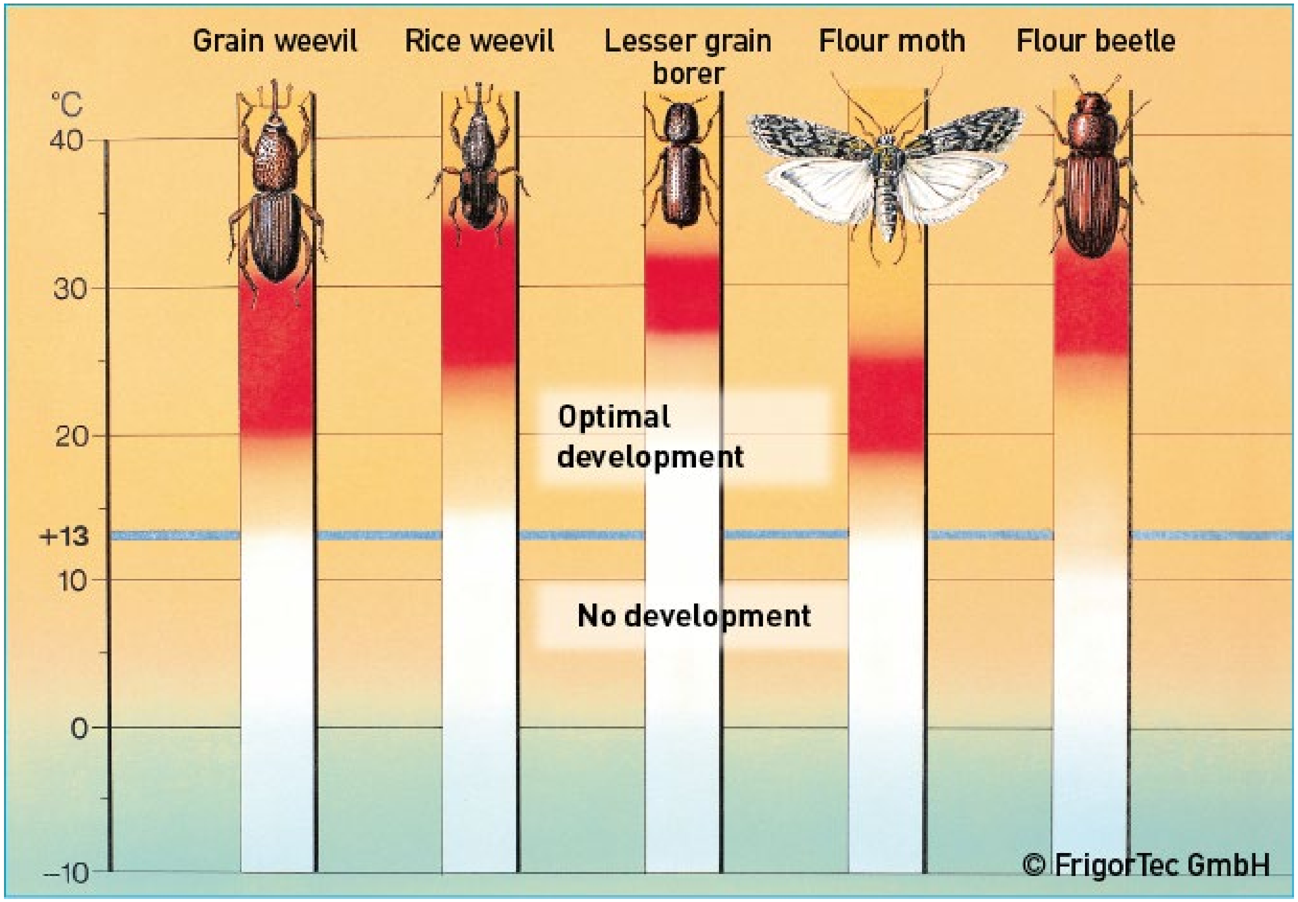
Calculation of wheat losses by respiration

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			

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

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)	---------

Development of pests



Profit loss by damage of weevil

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

Formula

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

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

Development of Flour Mill beetle (Cryptolestes Trucicus)

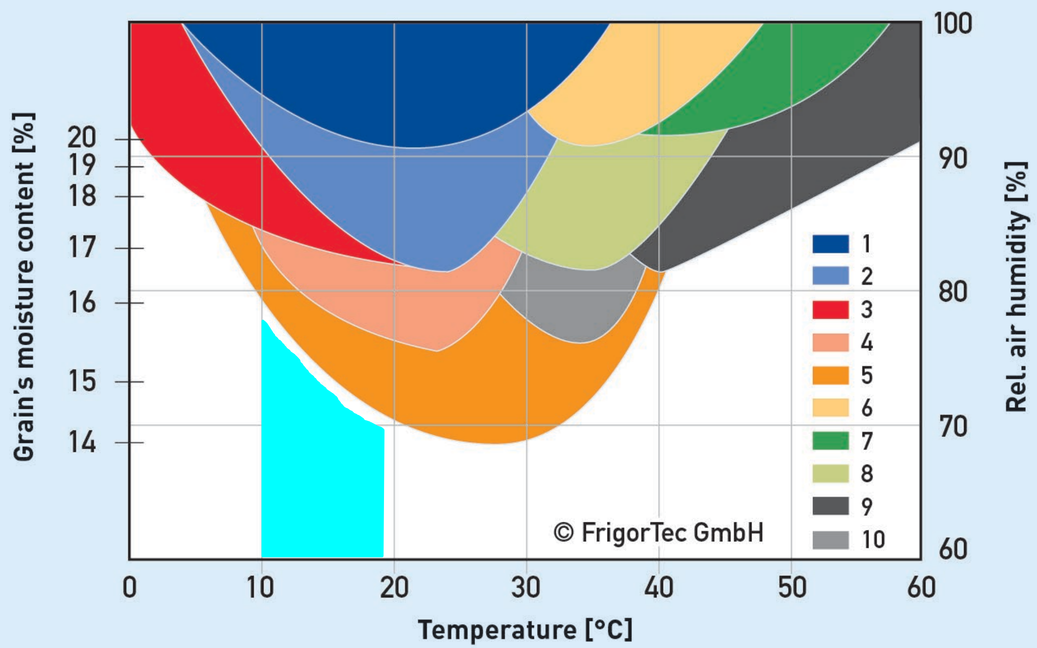
Population index	Temperature [°C]	Generation period [d]
0	18	-
1	18.7	85
2	19,5	80
3	20.4	74
4	21.4	68
5	22.6	62
6	24.0	54
7.17	28.2	38
6	32.3	27
5	33.7	24
4	34.9	22
3	35.9	20
2	36.8	18
1	37.6	17
0	38.3	-

Source: CAF 2016

Preventing weight and quality losses through insects

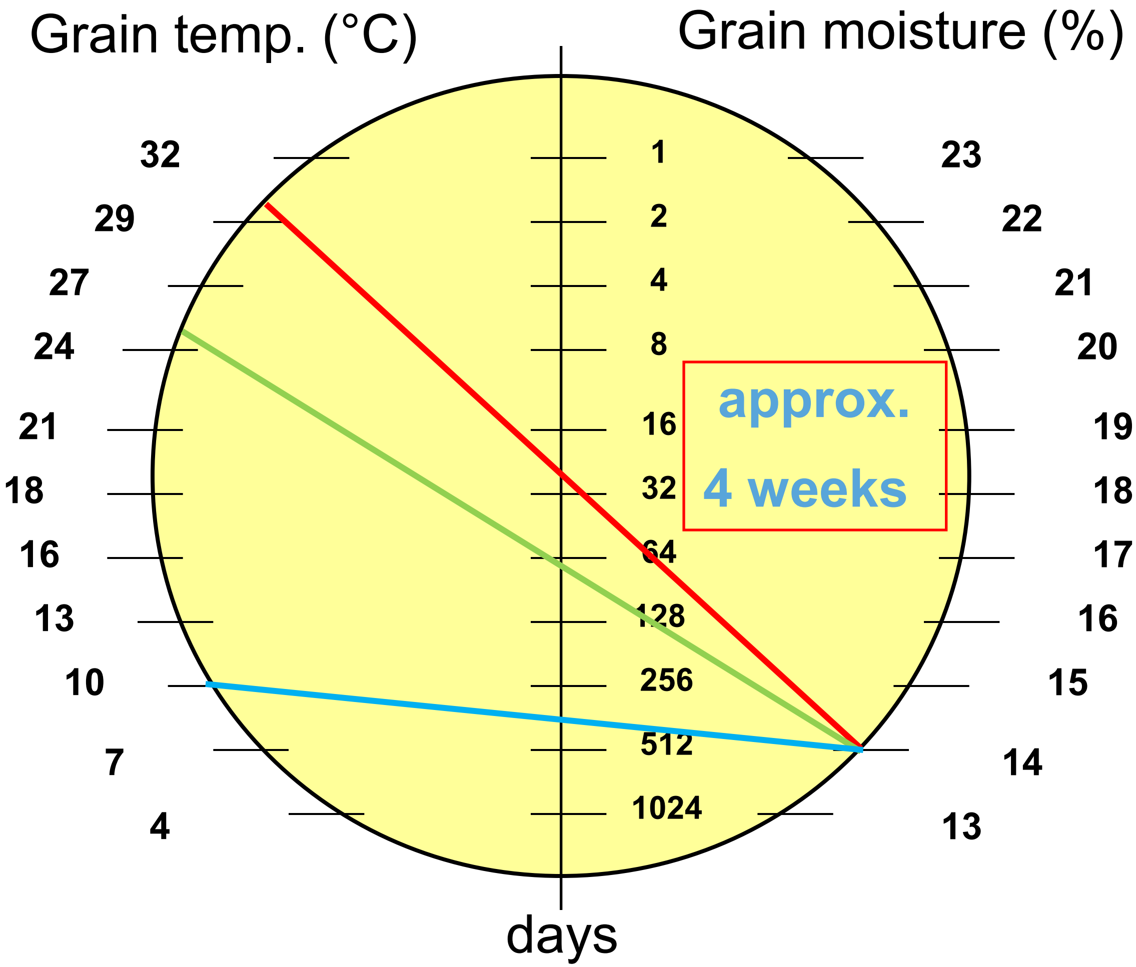
- Storage temperatures over 21°C offer most of the insects ideal conditions for living and reproduction.
- Below 18 to 13°C insects go into a hybernation and can not harm the crop.
  - ➢ No chemical treatment is necessary !

Development of various mould fungi



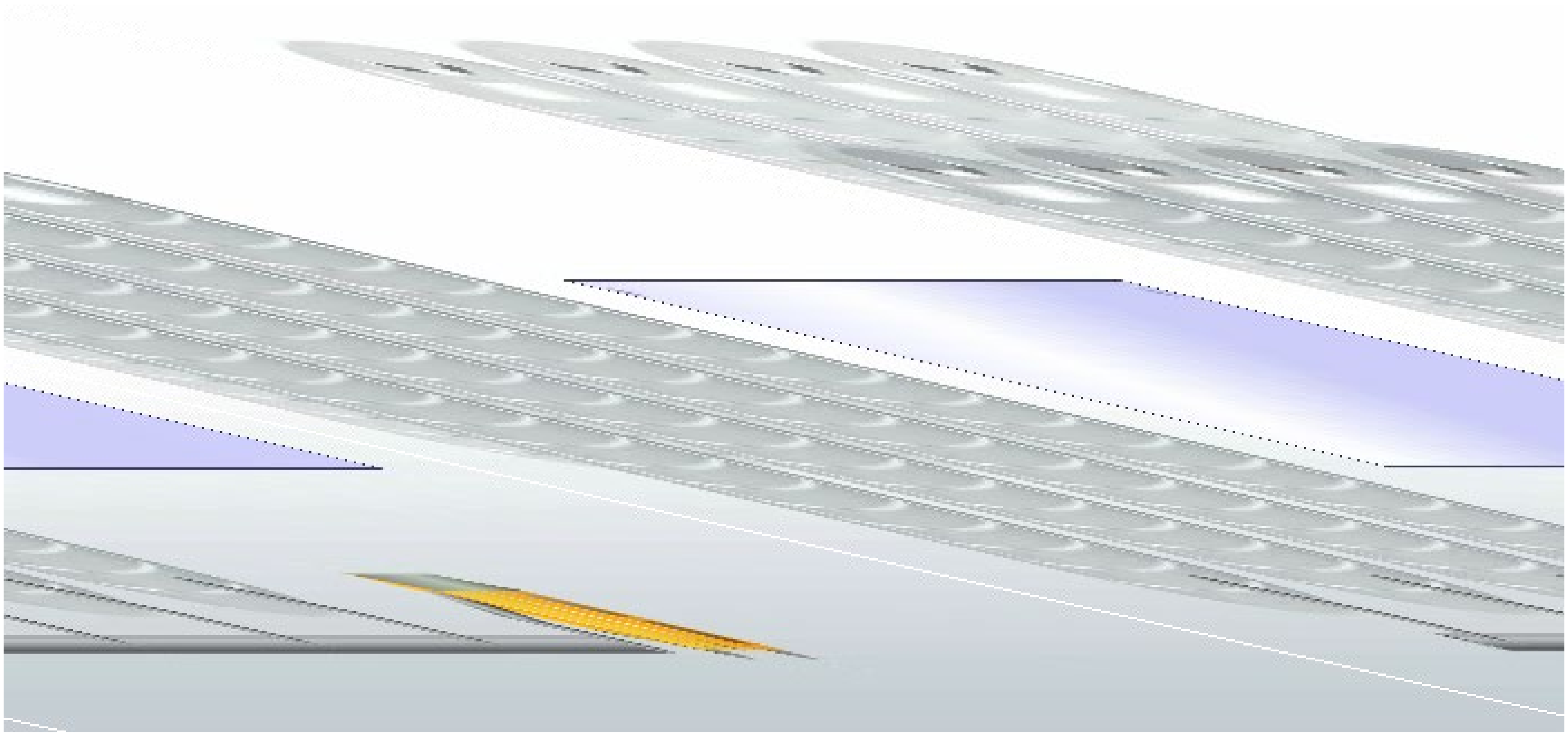
1 Fusarium culmorum
2 Penicilium rugulosum
3 Penicilium cyclopidum
4 Aspergillus versicolor
5 Aspergillus glaucus
6 Absidia Rhizopus arrihzus
7 Streptomyces altus
8 Aspergillus candidus
9 Penicilium capsulatum
10 Talaromyces thermophilus

Storage time for grain (days)



Guidelines for grain cooling!

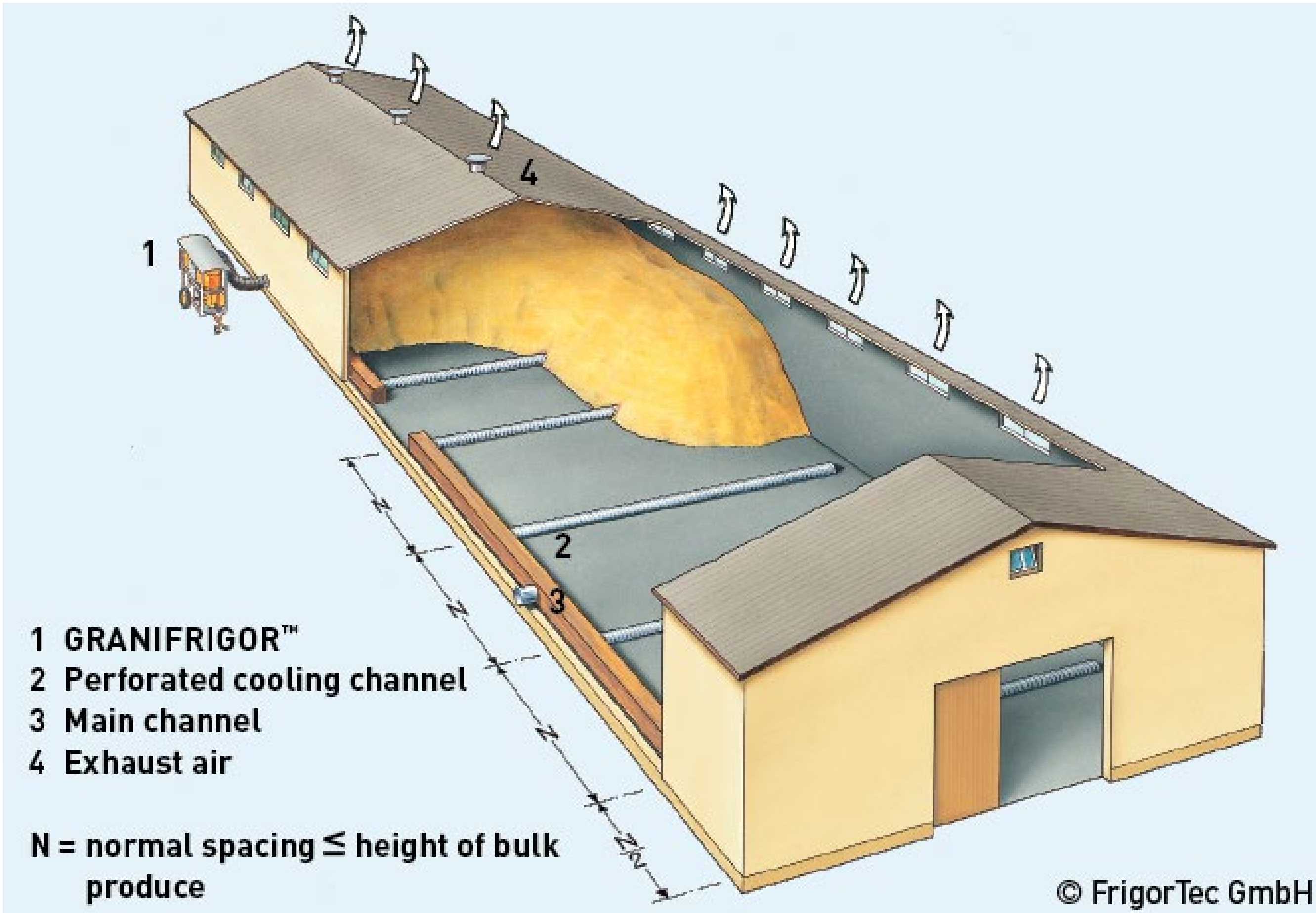
The storage time and treatment measures depend on the results of continuous controls.



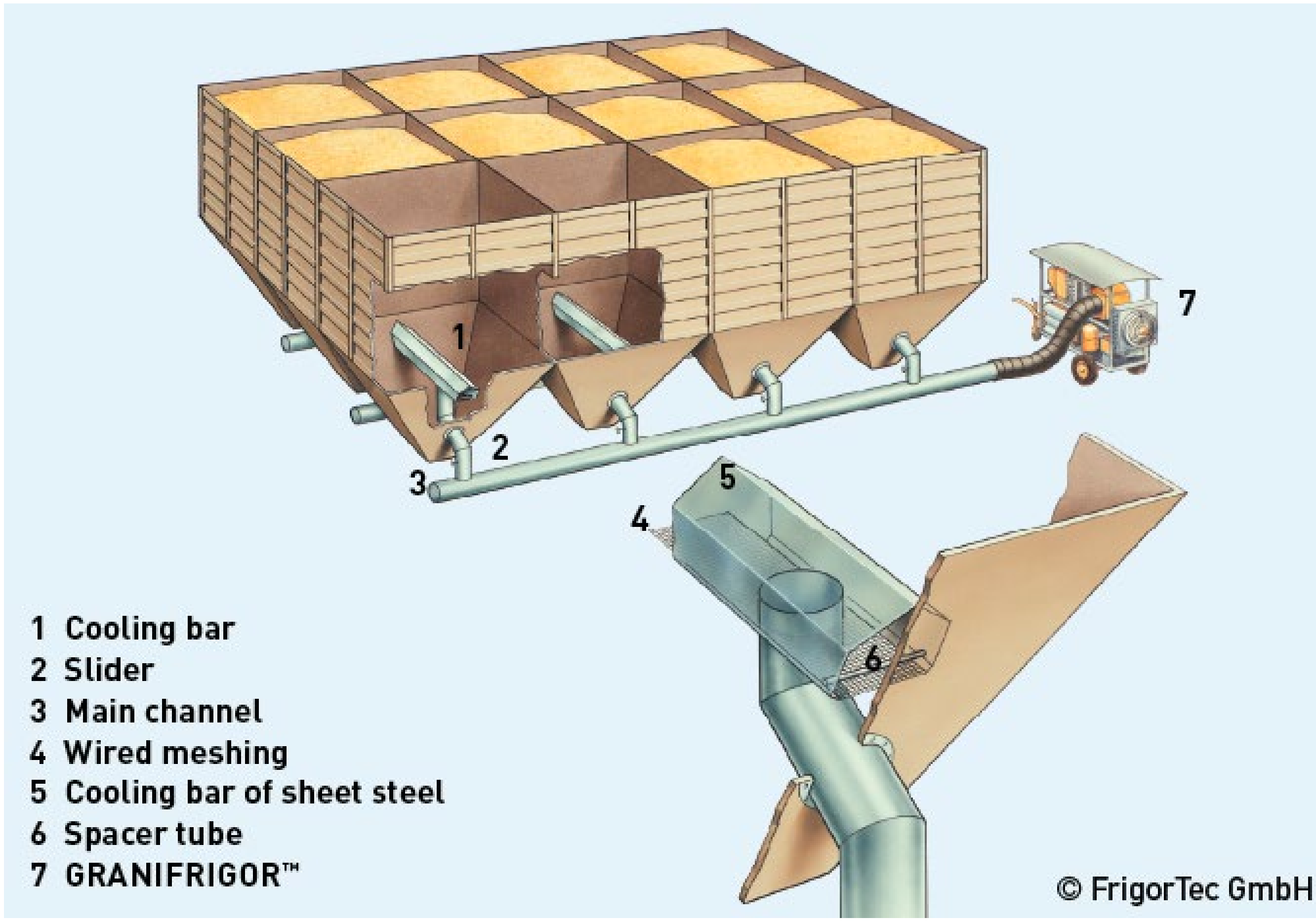
GRANIFRIGOR™

GRANIFRIGOR™ installation in Sri Lanka since 1980

Warehouse cooling



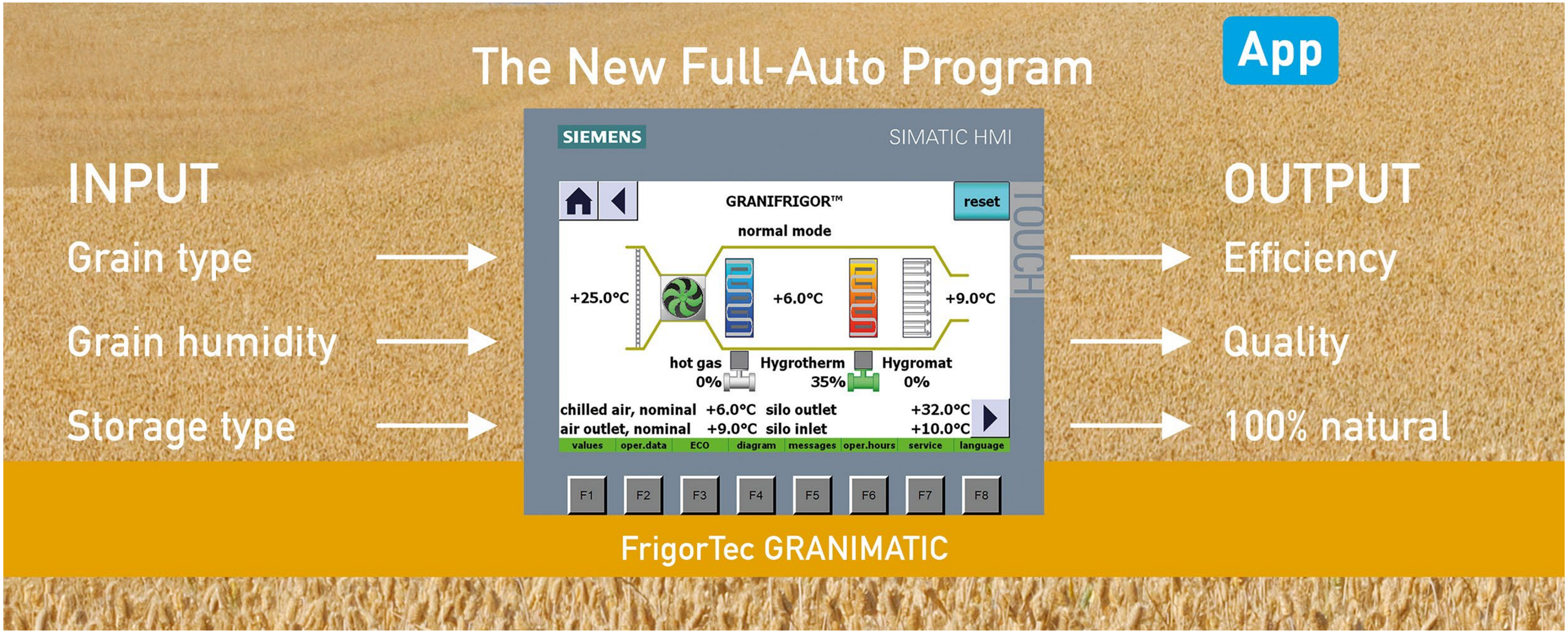
Air distribution (In silo cells with conical outlet)



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

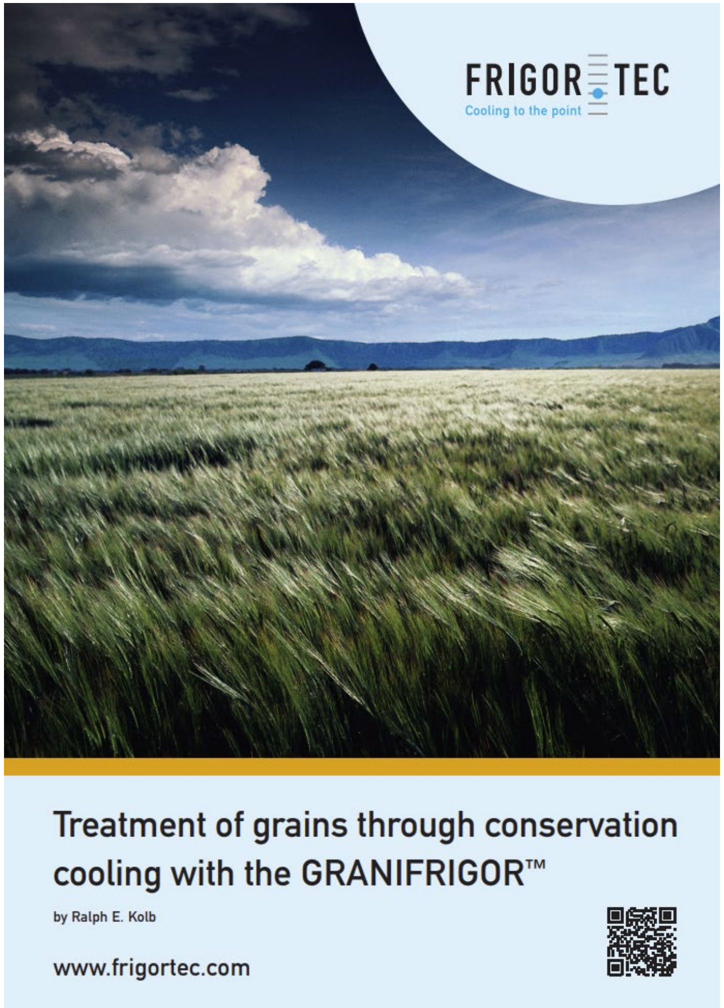

The New Full-Auto Program
App
INPUT
Grain type
Grain humidity
Storage type
SIEMENS
SIMATIC HMI
GRANIFRIGOR™
reset
normal mode
TOUCH
+25.0°C
+6.0°C
+9.0°C
hot gas
0%
Hygrotherm
35%
Hygromat
0%
chilled air, nominal +6.0°C
air outlet, nominal +9.0°C
silo outlet +32.0°C
silo inlet +10.0°C
values
oper.data
ECO
diagram
messages
oper.hours
service
language
F1
F2
F3
F4
F5
F6
F7
F8
OUTPUT
Efficiency
Quality
100% natural
FrigorTec GRANIMATIC

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

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



https://media.graphassets.com/fLhVcNSdQ5SBgDQNJp5I

https://media.graphassets.com/NAVkfdQ7T0S5Yj4an9ul

Stay cool!

Thank you for your attention!

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