



Best Practice for Long-Term Field Storage of Sugar Beets Under Nordic Climate Conditions

A SLU LivsID project

BT Half-time Seminar. 2020-10-05

William English

Today

- LivsID
- My team
- **NBR & Swedish sugar beet production**
- **Why this project**
- **What is in this project**

LivsID

- **Industridoktorander inom livsmedelsområdet**
- **Part of livsmedelstrategi of 2017**
- **10+ PhDs throughout Sweden and SLU**

- **Search: SLU + LivsID**

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Helene Jönsson Larsson (SLU-LTV-BT)



Joakim Ekelöf (NBR)



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NBR & Sweden's Sugar Beet Industry

- **Nordic Beet Research Foundation**
 - Swedish and Danish
 - Co-funded by farmers and industry
 - ca 3.5 FTEs in Sweden
- **31 000ha, 350 000tn**
- **1200 growers, all around Skåne**
- **1 processor**

Sweden's Sugar Beet Industry's Future

- All beets are harvested, and many stored





Sweden's Sugar Beet Industry's Future

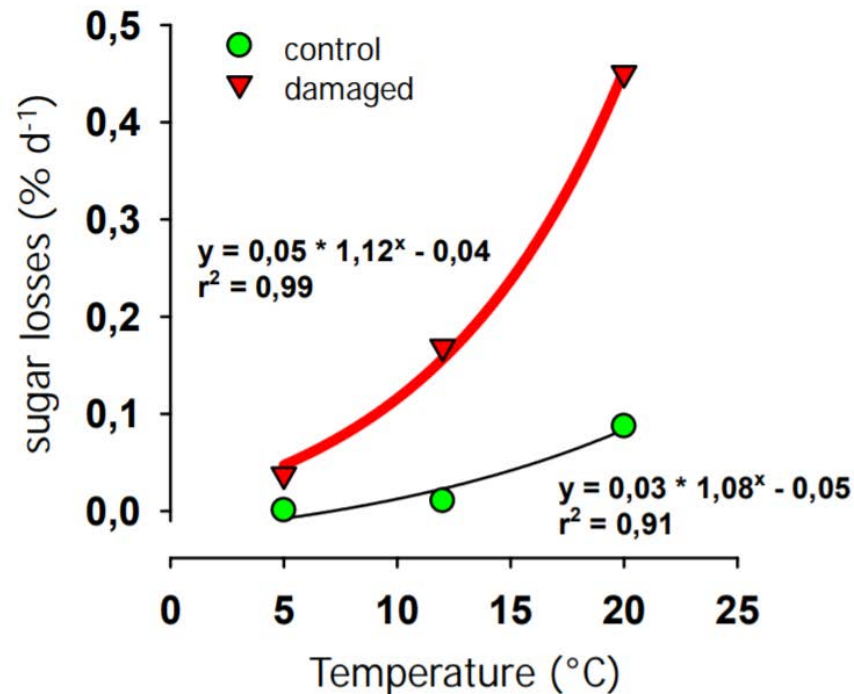
- **All beets are harvested, and many stored**
- **EU market deregulation from 2017**
 - Production quotas removed
- **Large capital investment at the factory**
 - Only active a few months of the year
- **Cold winters will continue**
 - Turn that to our advantage? Active ventilation?

Temperature and damage

Impact of damage on sugar losses during storage

healthy beets, storage for 27 days

100 % = initial amount of sugar



Kenter et al. 2006

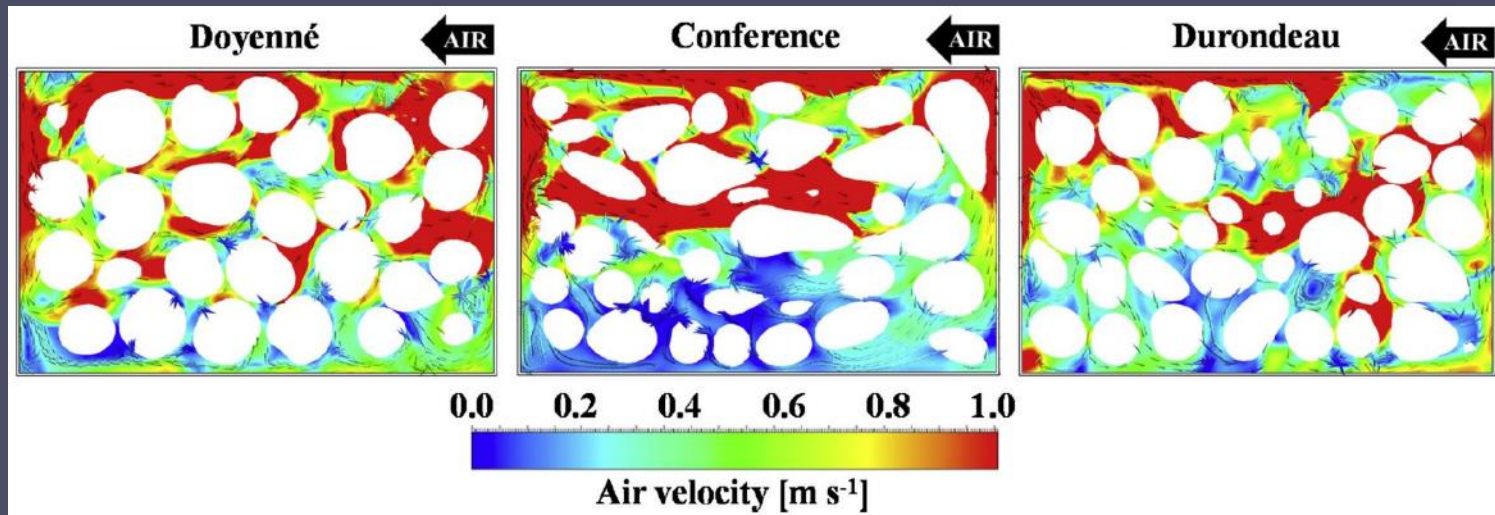
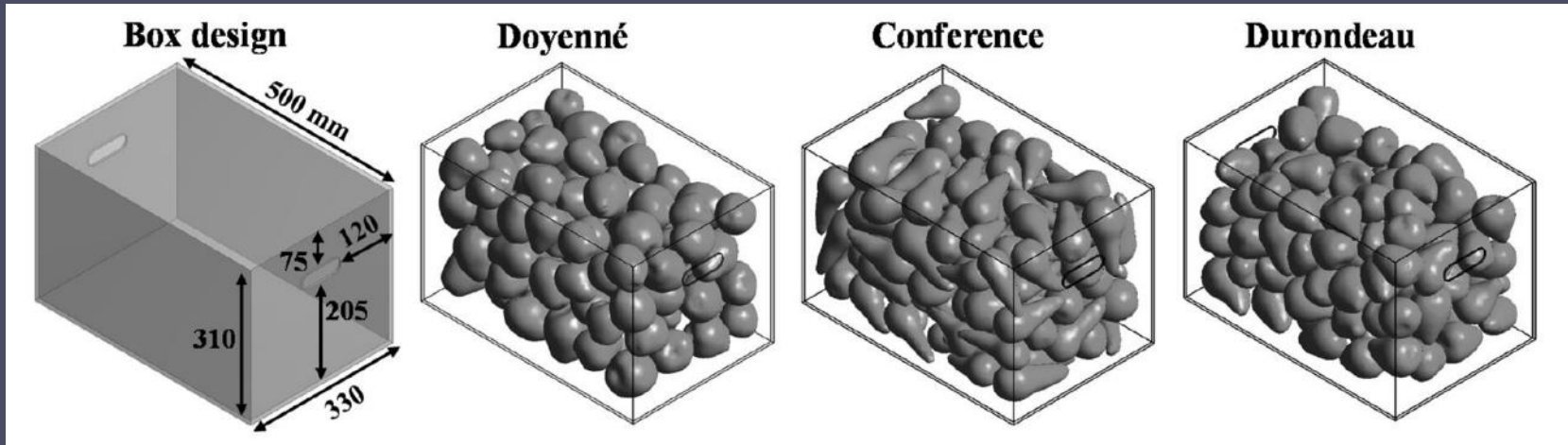
Best practice for long-term field storage...

- **1 & 2. Cover types in an extended storage scenario**
 - Computational Fluid Dynamics
- **3. In-store cleaning**
 - Can we substitute harvester cleaning with ventilated cleaning?
 - Drying in the clamp
- **4 & 5. Mechanical properties as predictors of storability**
 - Resistance to penetration & compression
 - Laboratory and field measurements

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1. Computational Fluid Dynamics (CFD)



1. CFD Model

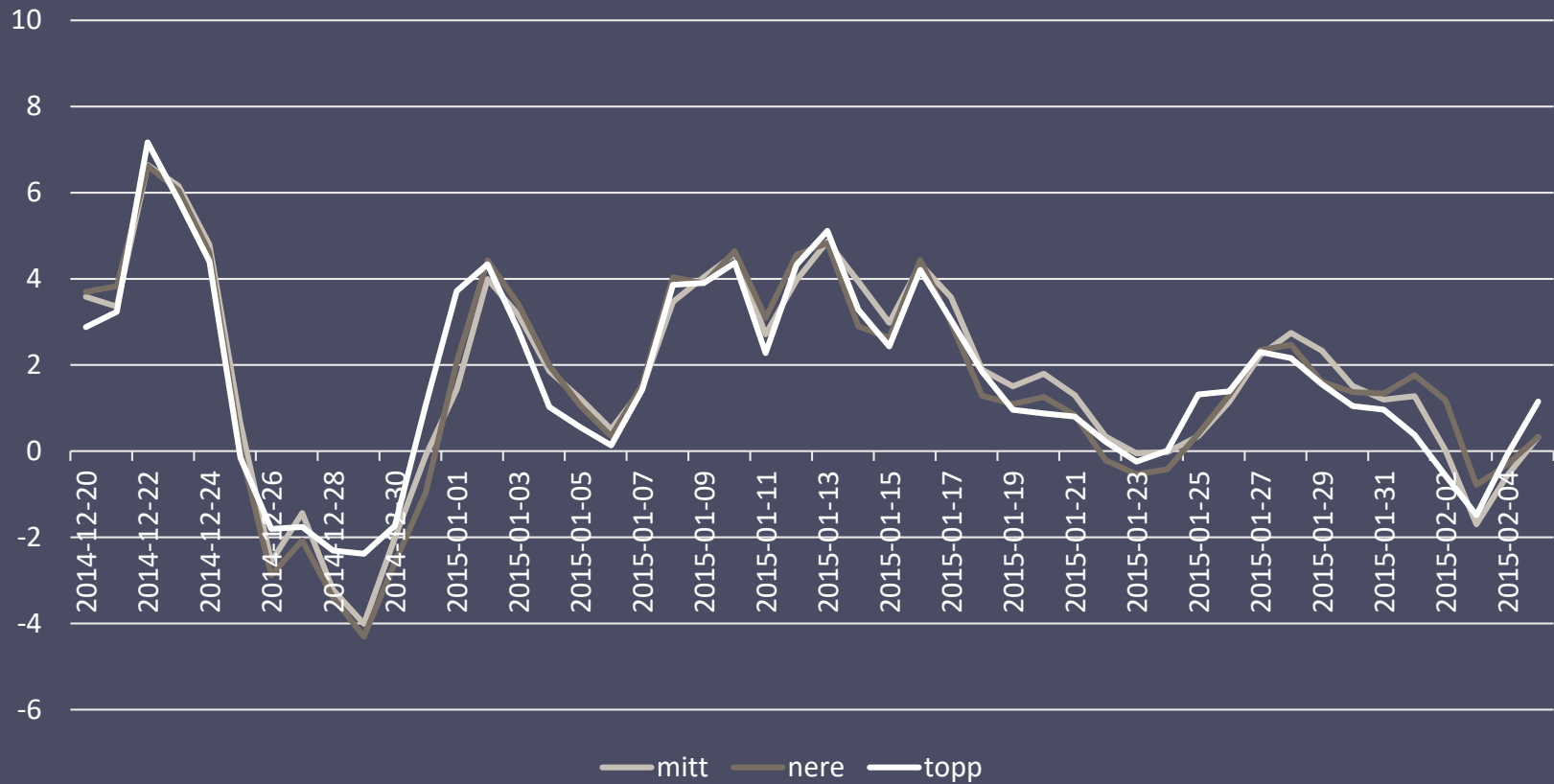
- **Question:**
 - Can we develop an accurate model?
- **Model development:**
 - Framework from introduction paper → CFD Model
 - Collaboration with KU Leuven (?)
 - OpenFOAM open source CFD software
 - Validate season 2021

2. CFD Model – Cover types

- **Question:**
 - How does cover type affect the conductive and convective processes in sugar beet clamps?
- **Model historical NBR data**
 - Apply the CFD model above
 - Use data from NBR trials

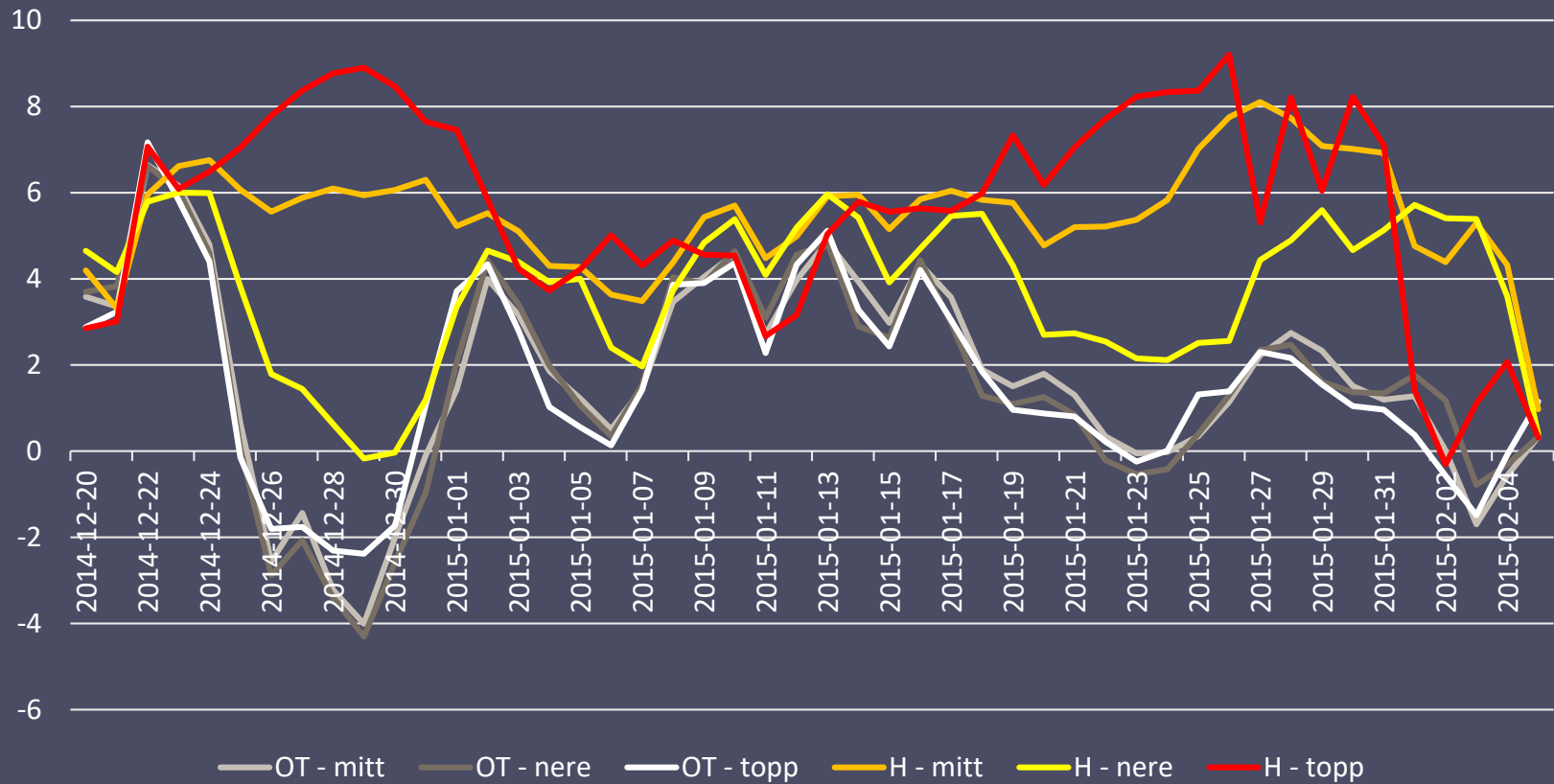
2. CFD Model – Cover types

Uncovered



2. CFD Model – Cover types

Straw



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3. Ventilated cleaning and drying

- **Questions:**

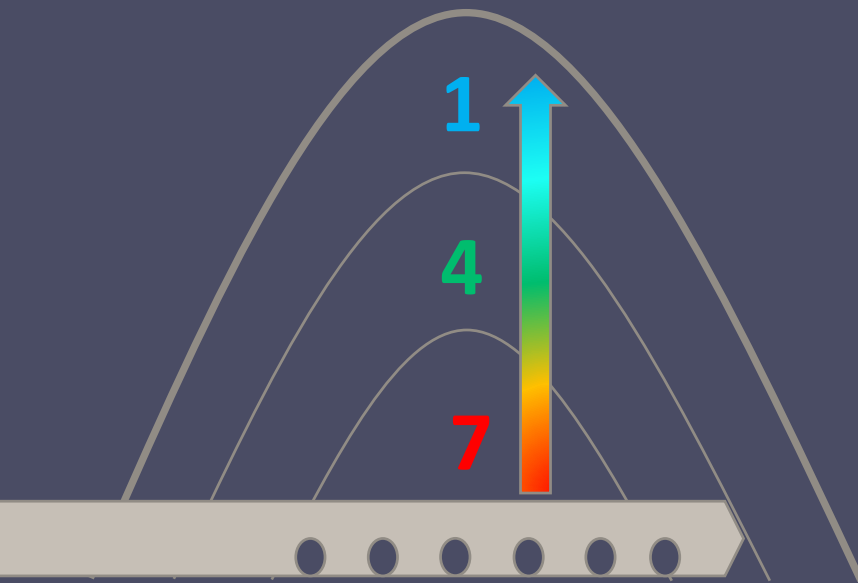
- Can sample dirt tare be decreased through ventilated drying?
- What are the possible drying rates under active ventilation?
- Can excessive drying of the beet be economic?

- **Method:**

- 4 x air speeds (0,1,4,7 ratio)
- 4 x delivery times (0,1,4,7 days)

- 3 x humidity
- 2 x temperature

3. Ventilated cleaning and drying



$$1 = 2.0 \text{ m} = 0.2 \text{ m/s}$$

$$4 = 1.0 \text{ m} = 0.8 \text{ m/s}$$

$$7 = 0.5 \text{ m} = 1.5 \text{ m/s}$$

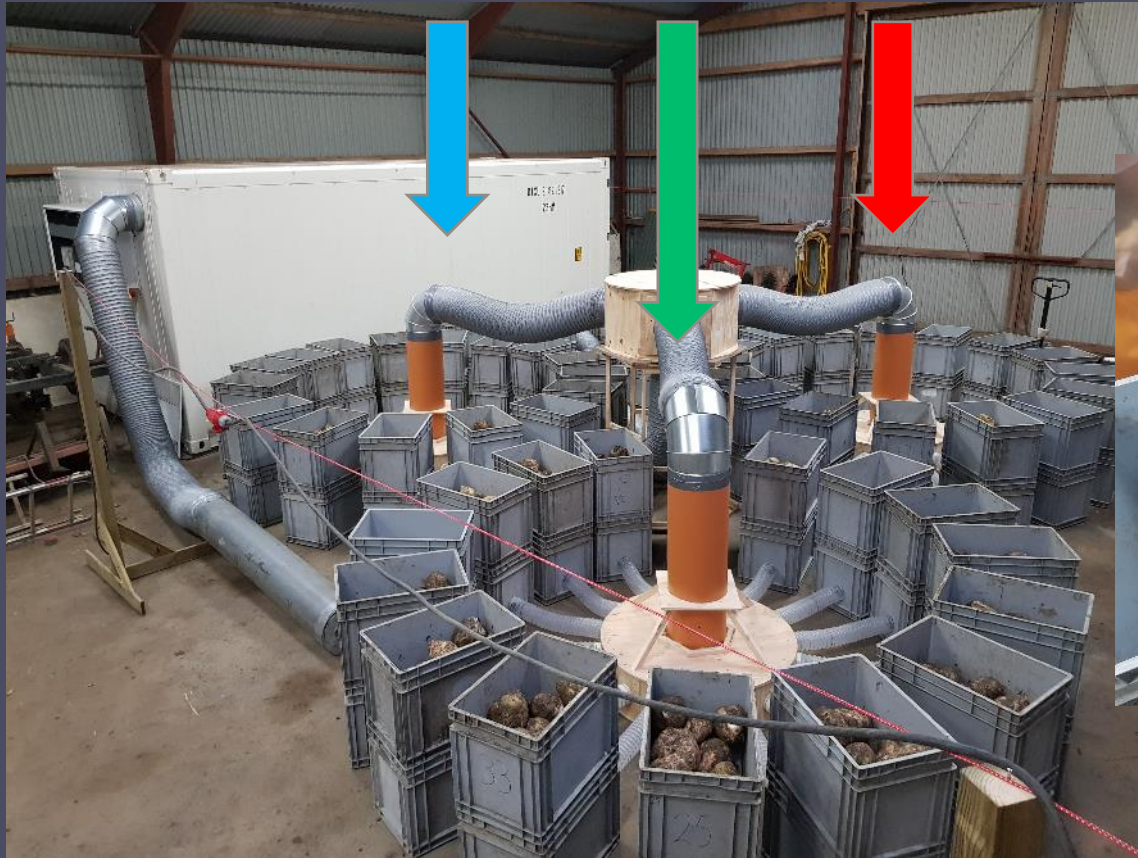
3. Ventilated cleaning and drying

1

4

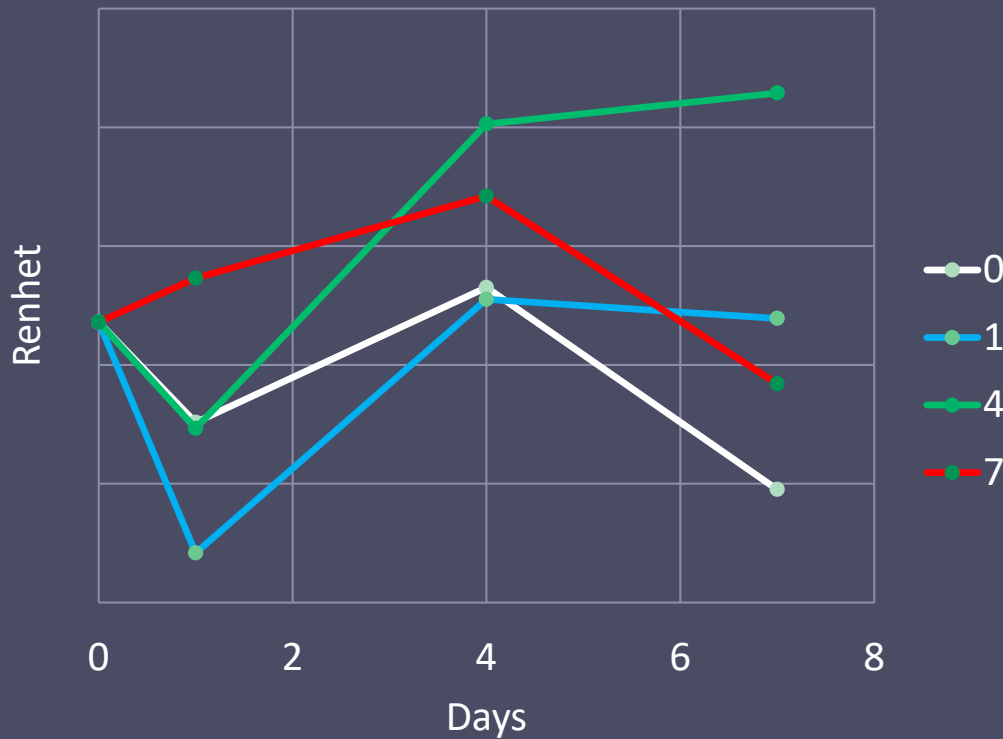
7

0

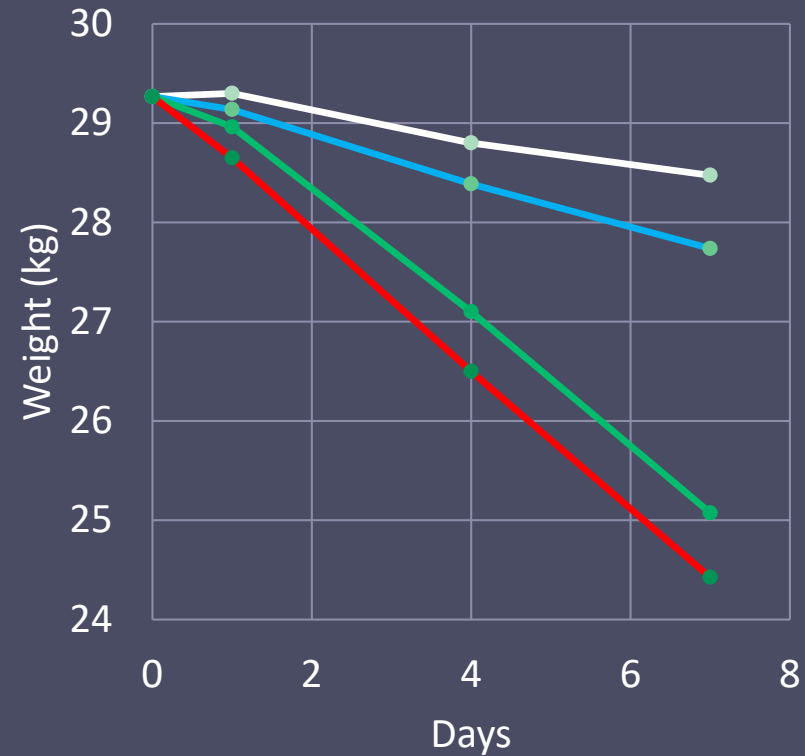


3. Ventilated cleaning and drying

Cleanness, by air speed

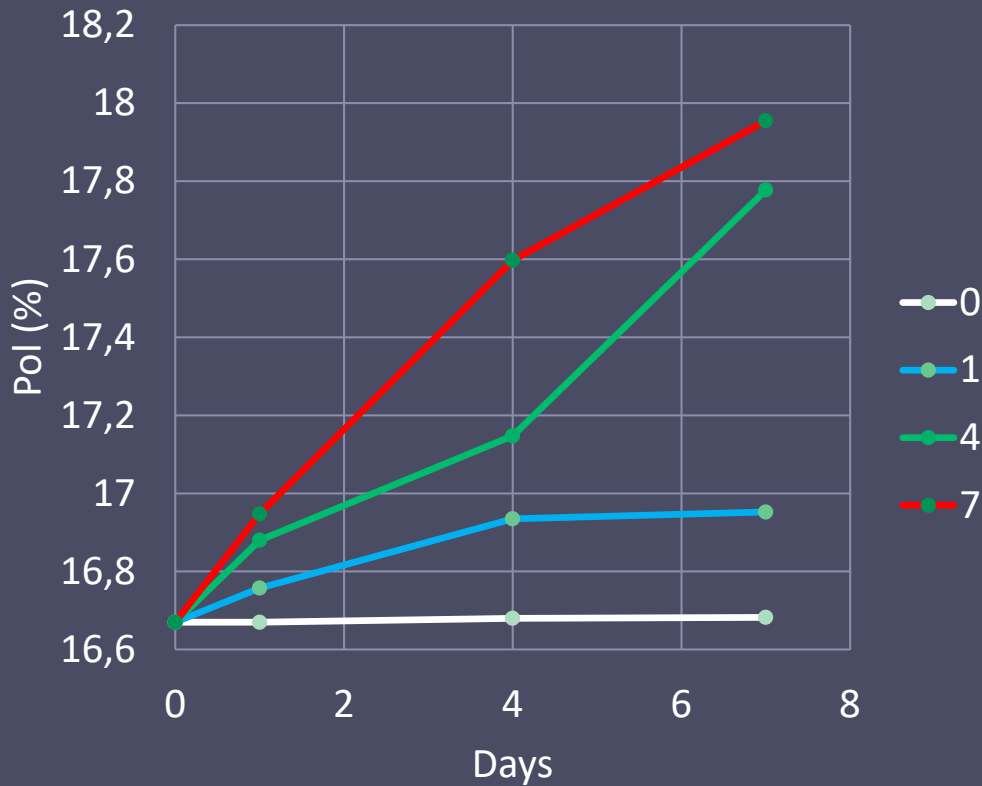


Beet weight, by air speed



3. Ventilated cleaning and drying

Pol, by air speed



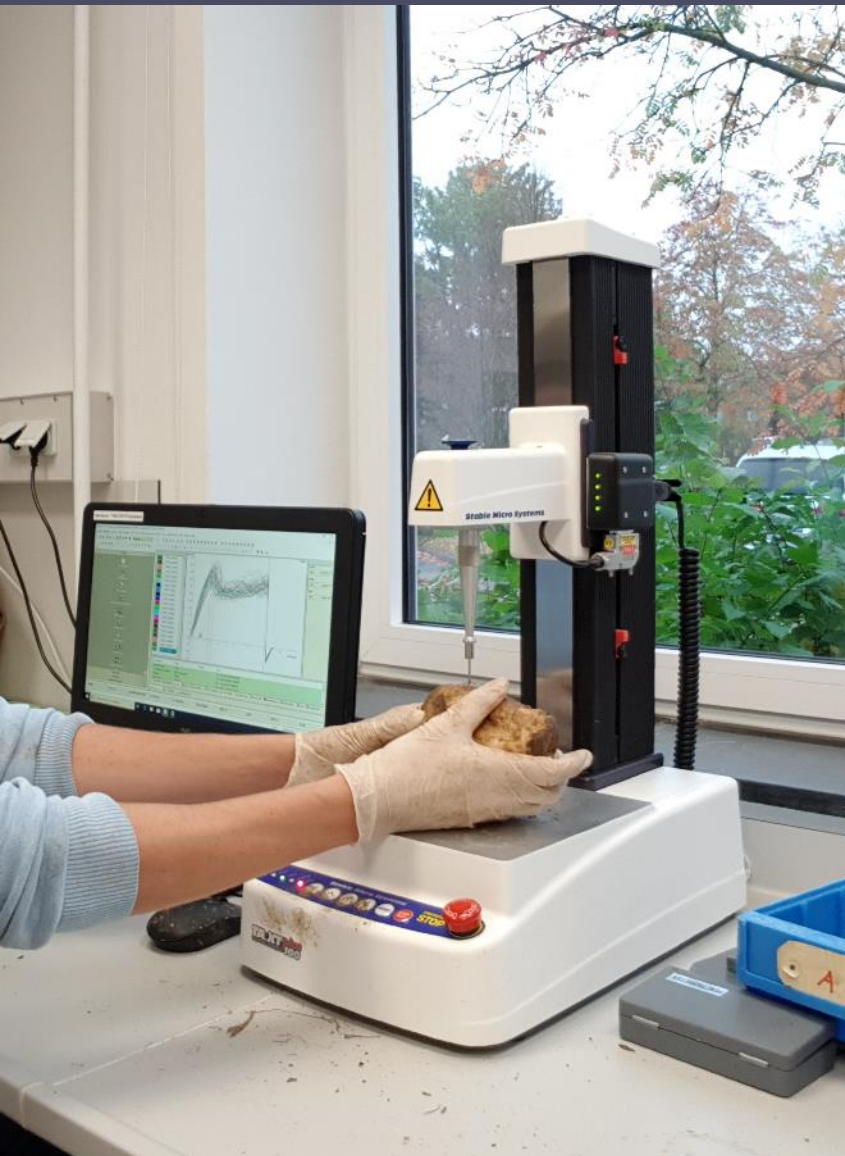
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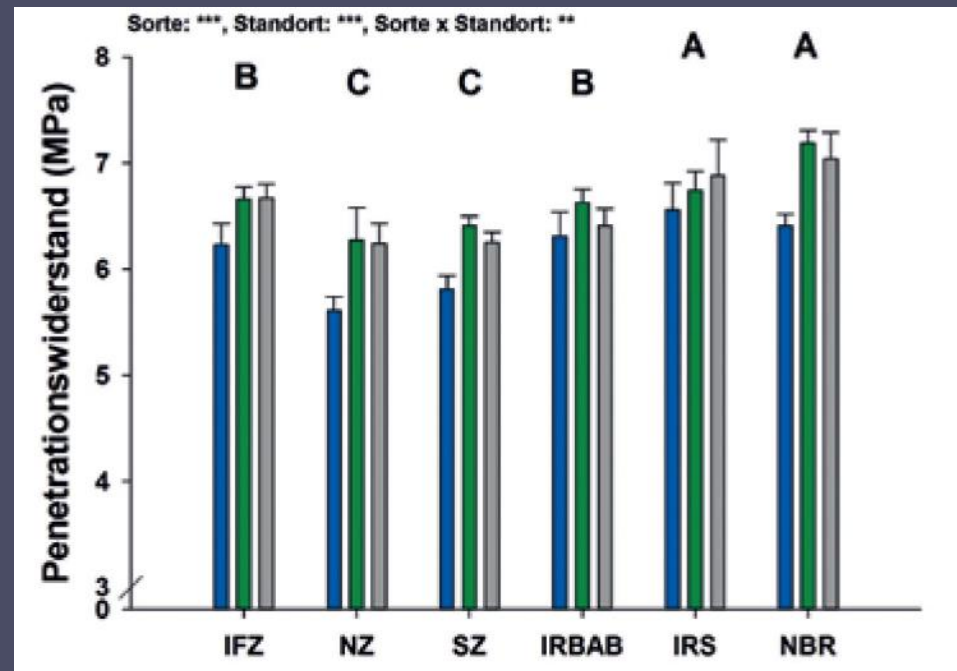
4. Mechanical properties

- **Are mechanical properties, damage, and storability related?**
- **COBRI: DE, NL, BE, SE/DK**
- **2018-19**
- **3 Yield formation types**
 - High root yield
 - High sugar concentration
 - In the middle
- **3 field treatments**
 - NL & BE: available N
 - SE: available H₂O
- **6 repetitions**
- **Assessment of**
 - Mechanical properties
 - Damage
 - Storability

4. Mechanical properties



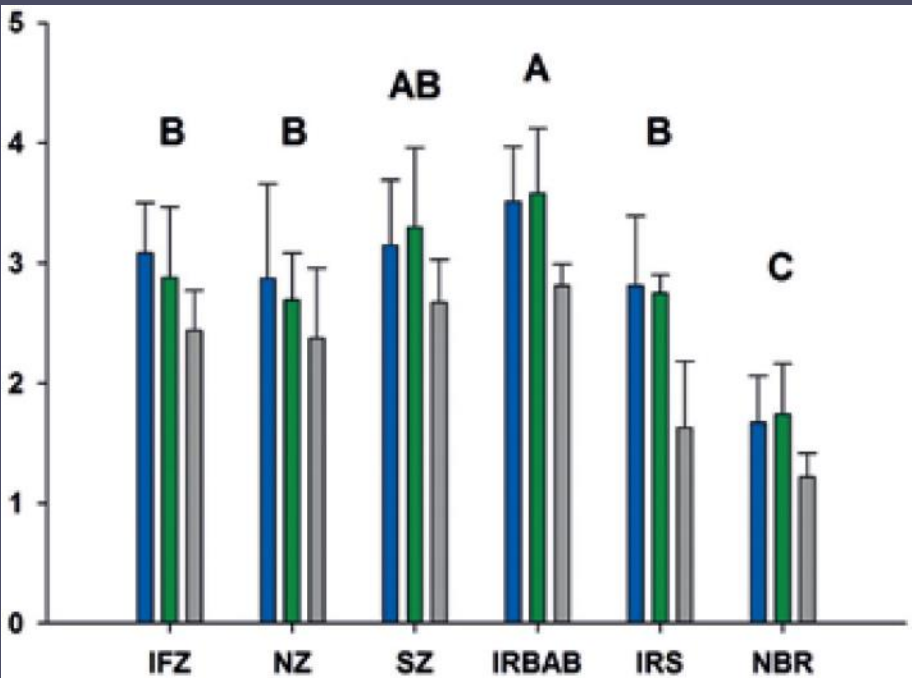
Resistance to penetration (MPa)



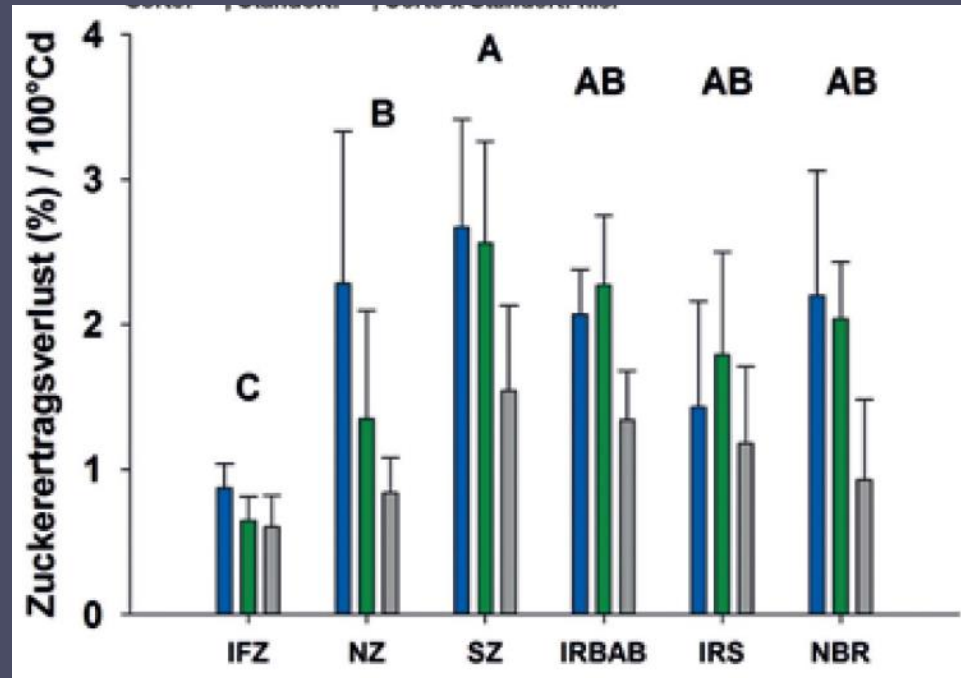
Kleuker, G. and C. M. Hoffmann (2019). "Einfluss der Festigkeit der Rübe auf Beschädigung und Lagerungsverluste von Zuckerrüben." Zuckerindustrie. Sugar industry **144**(Sonderheft 14. Göttinger Zuckerrübenagung (2019)): 89-97.

4. Mechanical properties

Root tip breakage (cm)



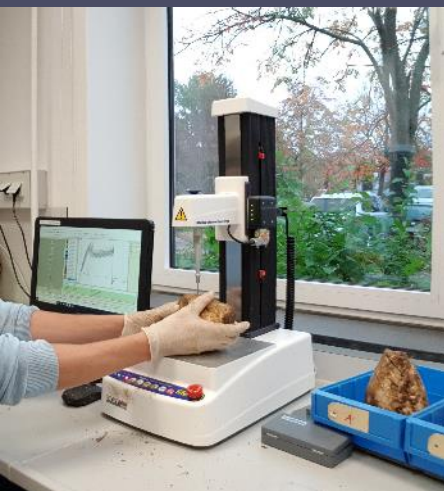
Sugar loss in storage (% / 100 °Cd)



5. Mechanical properties - handheld



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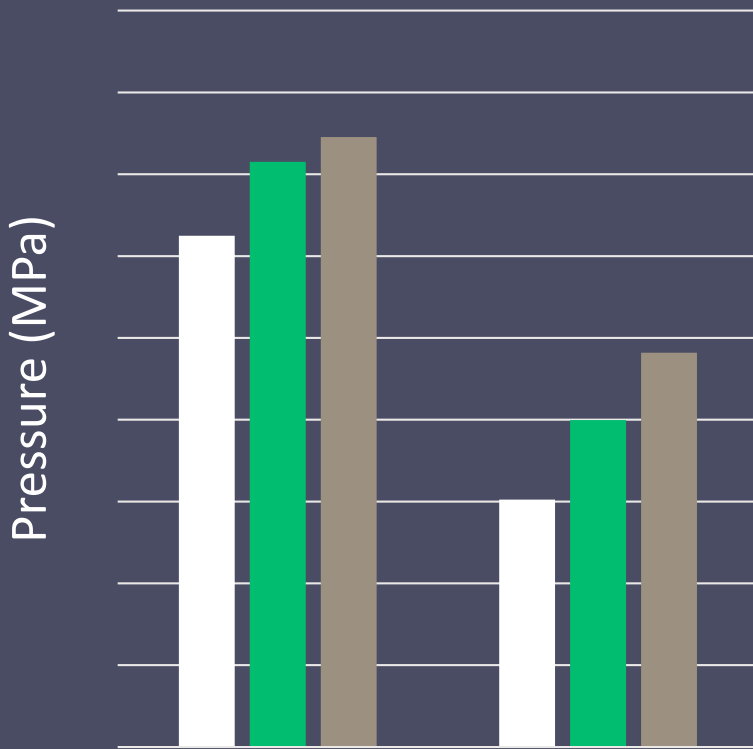


LABORATORY	HANDHELD
VERY HIGH ACCURACY	ACCEPTABLE ACCURACY
MULTIPLE METRICS - Penetration resistance - Tissue firmness - Compression	SINGLE METRIC - Max to 5mm
HIGH COST	€300
POST-HARVEST	PRE- & POST-HARVEST
Ø 2MM FLAT TIP	Ø 2MM FLAT TIP

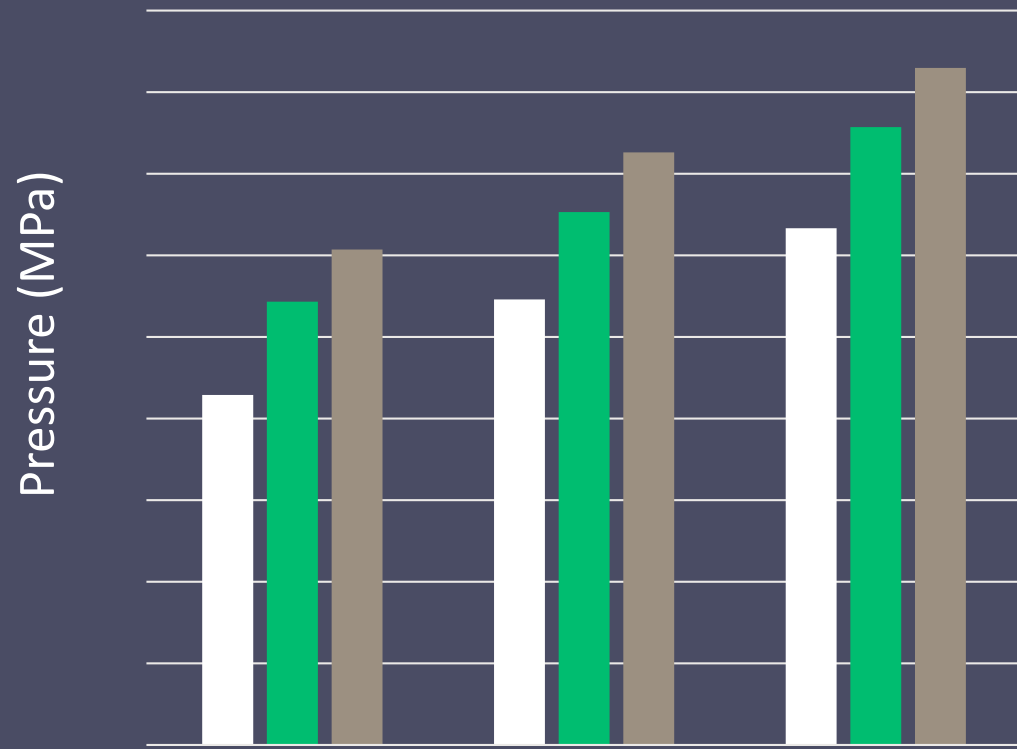


5. Mechanical properties - handheld

Lab (SE 2019)



Handheld (SE 2019)



Penetration
resistance

Tissue
firmness

August

September

October

■ Variety 1

■ Variety 2

■ Variety 3

Summary

- **Temperature x damage = loss**
- **Moisture an important third component**
- **Novelty:**
 - Fullest exploration of the thermodynamics of sugar beet clamps
 - Sound additions to the literature on mechanical properties
- **Practicality:**
 - Tools that farmers and industry can use



Rising questions

- **Beet size**
 - Relationship to damage owing to machine design
 - Damage per unit area (not included in COBRI trial)
 - Impact on air flow
- **Clamp size**
 - Does it change over time?
- **Respiration rates**
 - Complement to mechanical properties?
- **Rot**
 - Dominance in late storage