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Nordic Beet Research

STORAGE

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Nordic Beet Research Foundation (NBR)

- **Sweden & Denmark**
- **Approx. 8 full-time equivalents**
- **Mainly funded by farmers and industry**
- **Applied research**

- **Me**
  - Storage (& harvest), remote imaging
  - Accent = Australian

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Overview

- **Context**
  - Production in Sweden
- **Recommendations**
- **Sources of value loss in clamps**
- **Managing these sources of loss**
  - Targets
  - Practices
- **(In-field storage)**
- **(Sensors)**

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Sweden's campaign

- **Begins 26 September**
- **Harvest finished by mid-November**
  - 60 days
- **Factory closes early to mid-January**
  - 110 – 120 days
- **Storage**
  - 50 days

- **Future?**

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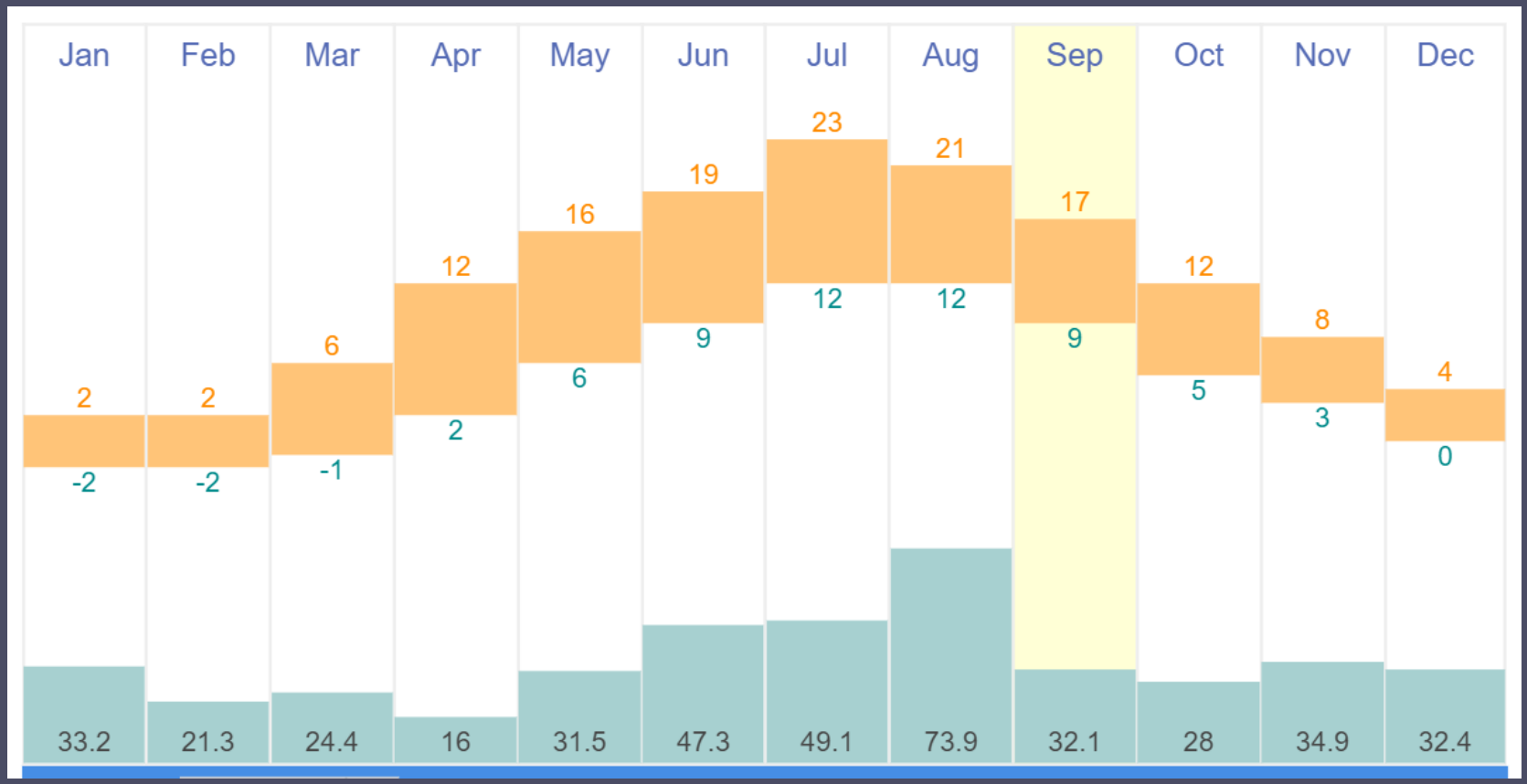
Sweden’s campaign: climate



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Recommendations

- Store hardier beets
- Remove all stem
- Treat stored beets as gently as possible
- Store with the right dimensions and in the right place

- Stay dry
- Target 2-4 degrees in the clamp
- Maximum of 300°D
- Avoid frost

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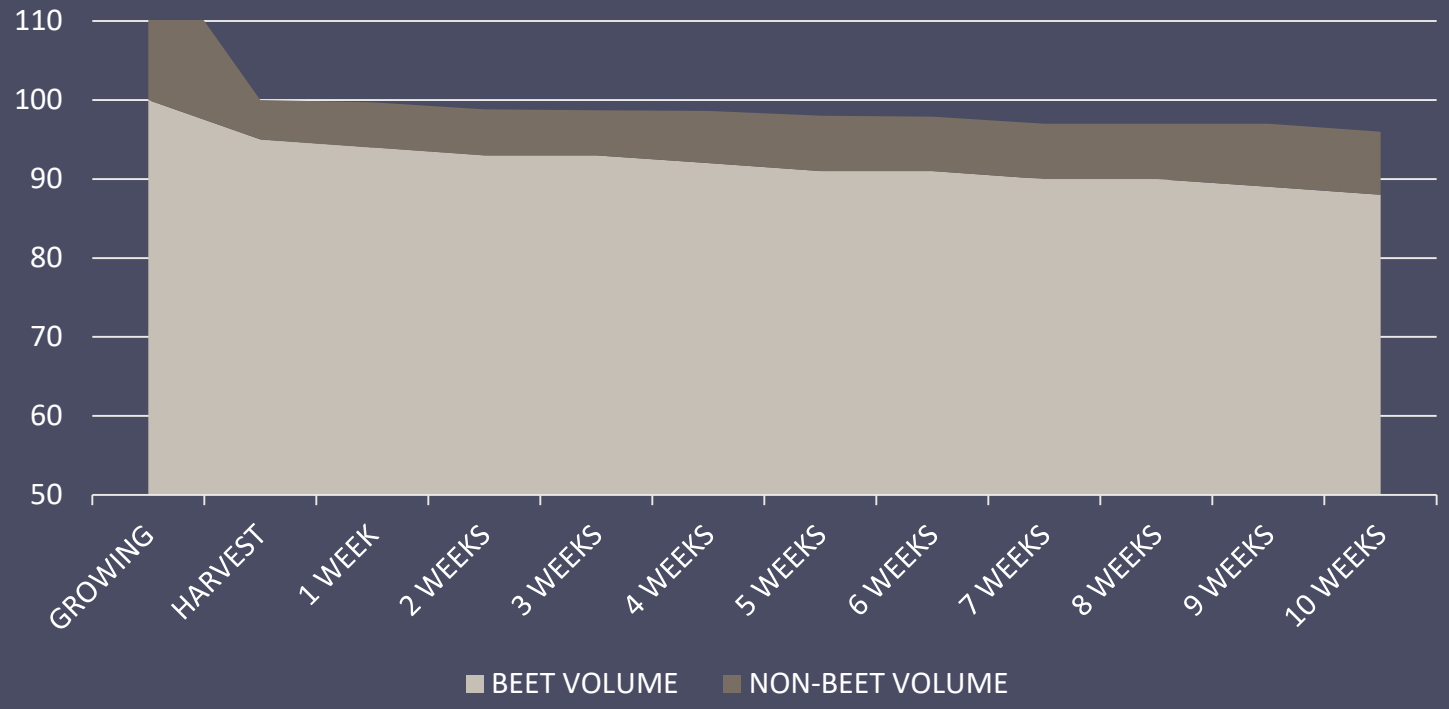
Recommendations

- **Single aim: maintain value**

- **Value = delivered volume x sample quality**



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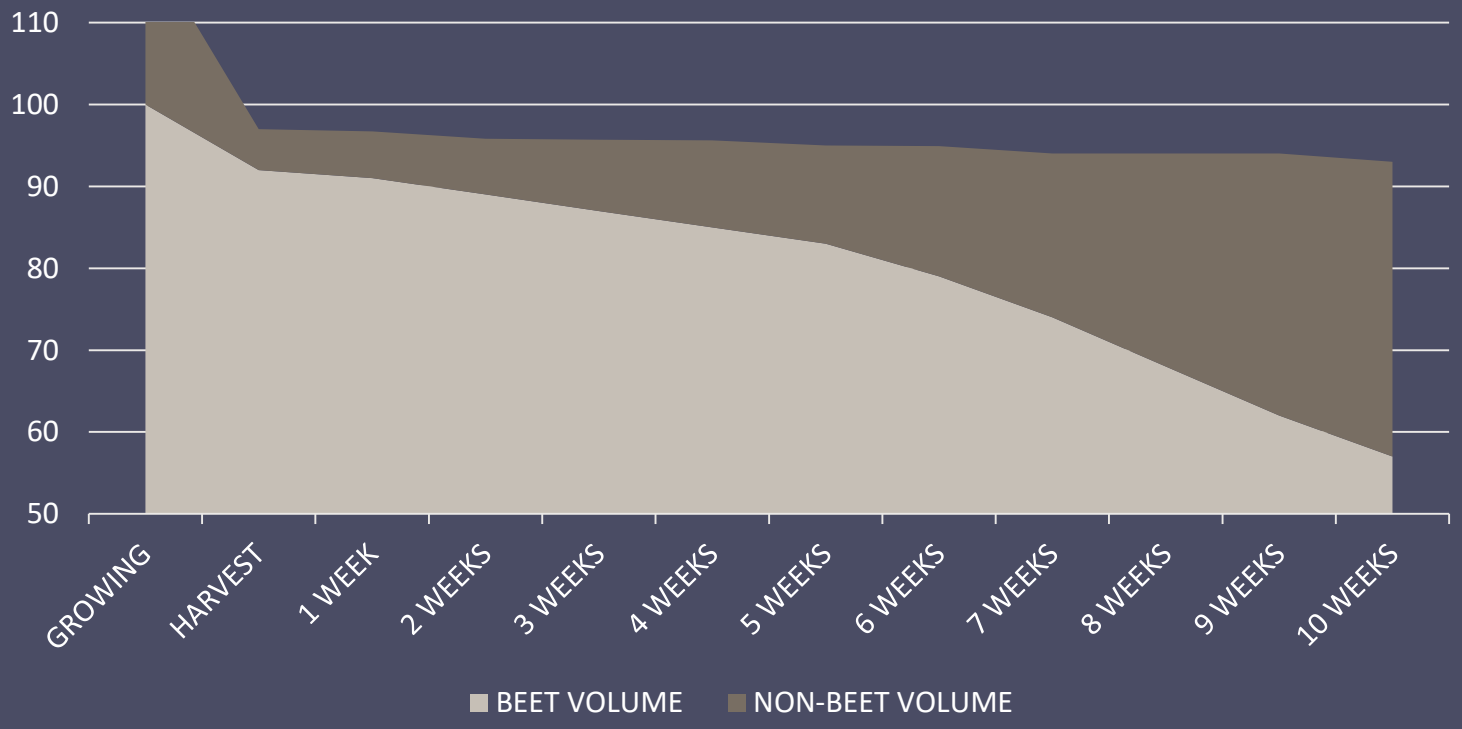

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Value

- **Volume x Sample Quality**

- **Volume**
  - that part of the crop you can and will deliver.

- **Sample quality**
  - [+] sugar content
  - [-] dirt-tare
    - Top
    - Soil
    - Stone
    - Frosted/ rotten beets
    - Weeds
    - Healthy and non-healthy beet fragments
  - [-] Na + K
  - [-] amino N
  - [-] invert sugars

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Volume

- **Beet**
  - 76% Water
  - 18% sugar
  - 6% cell walls and other

- **Respiring beets**
- **Dehydrated beets**
- **Broken-off fragments**
- **Frosted/ rotten/ dead/ collapsed beets**

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Quality

- **Sugar content**
  - Sucrose proportion of beet
- **Dirt tare**
  - Non-beet proportion of sample

  - Wounding
- **Respiration**
- **Moulds and rots**
- **Resprouting**
- **Frost**

- **Soil**
- **Water in soil**
- **Frosted, rotten beets**
- **…**

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Value

- **Maximise maintained value by minimising:**
  - Wounds
  - Respiration
  - Frost
  - Moulds & Rots
  - Added water

  → **PRIOR**

  → **TEMPERATURE**

  → **COVERING**

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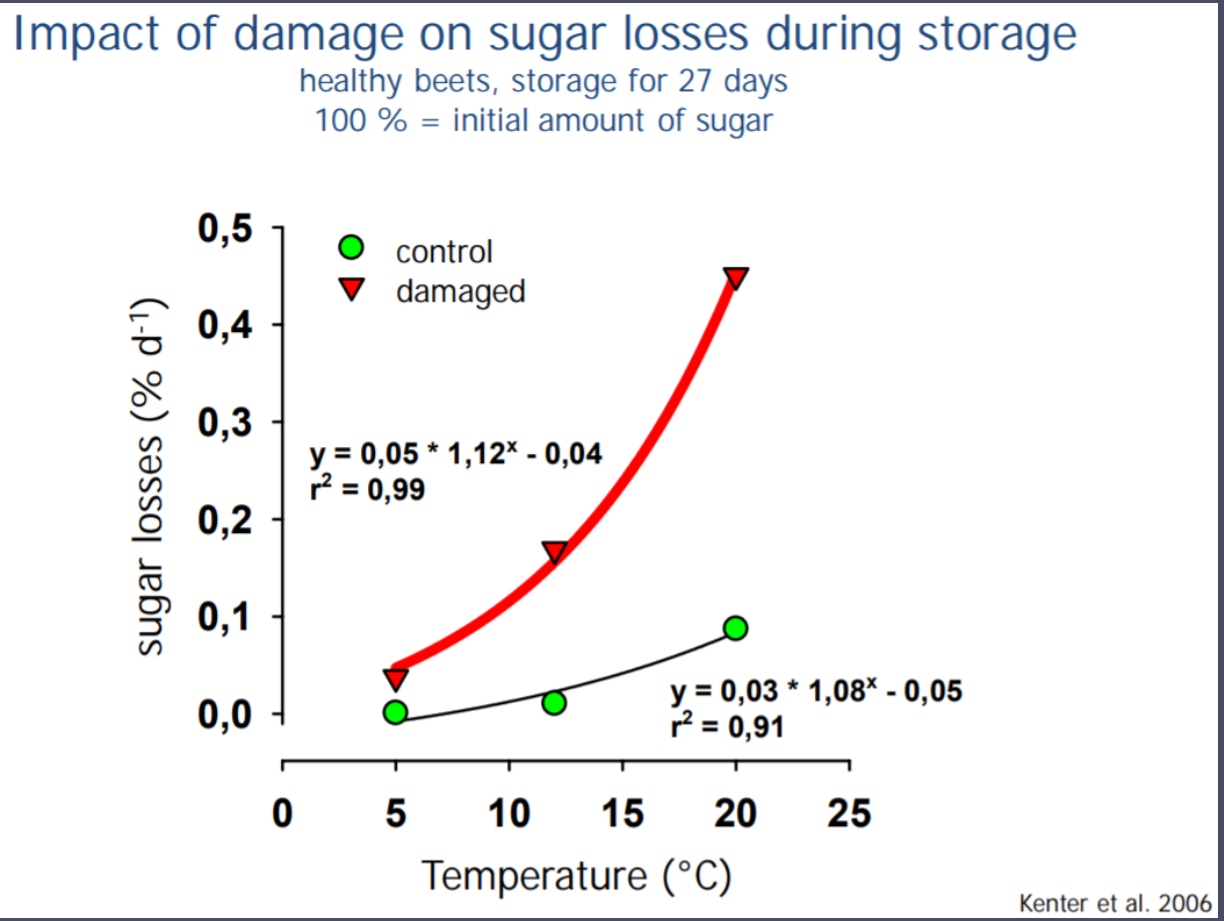
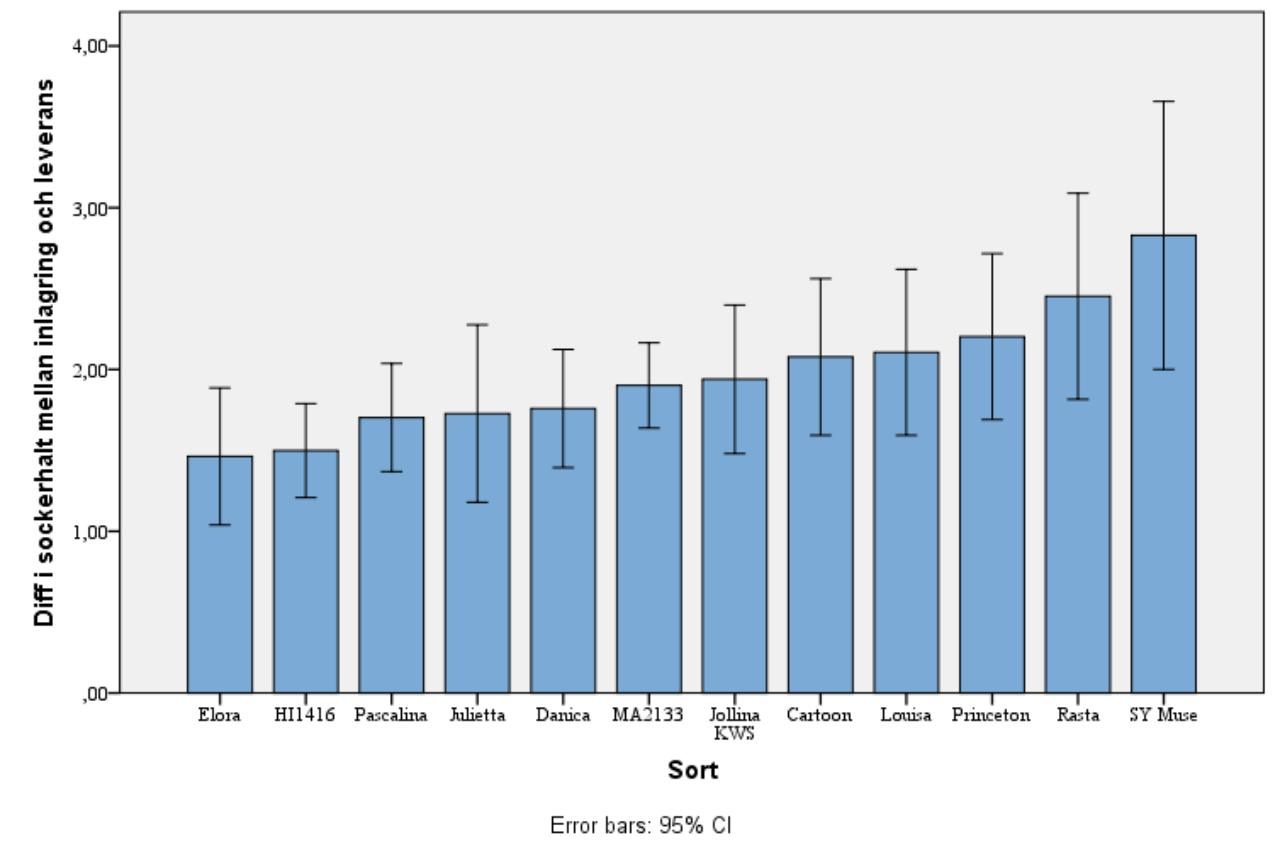
Wounds & Storage



- **Total damage ∝ root tip damage.**

Storage & varieties



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Wounds & Hardiness

- **Beet**
  - 76% Water
  - 18% sugar
  - 6% cell walls and other
    - 3,5 – 4,5% marc content
    - Marc content: non-soluable component
    - More cell walls = more cell stability
    - Stable factor

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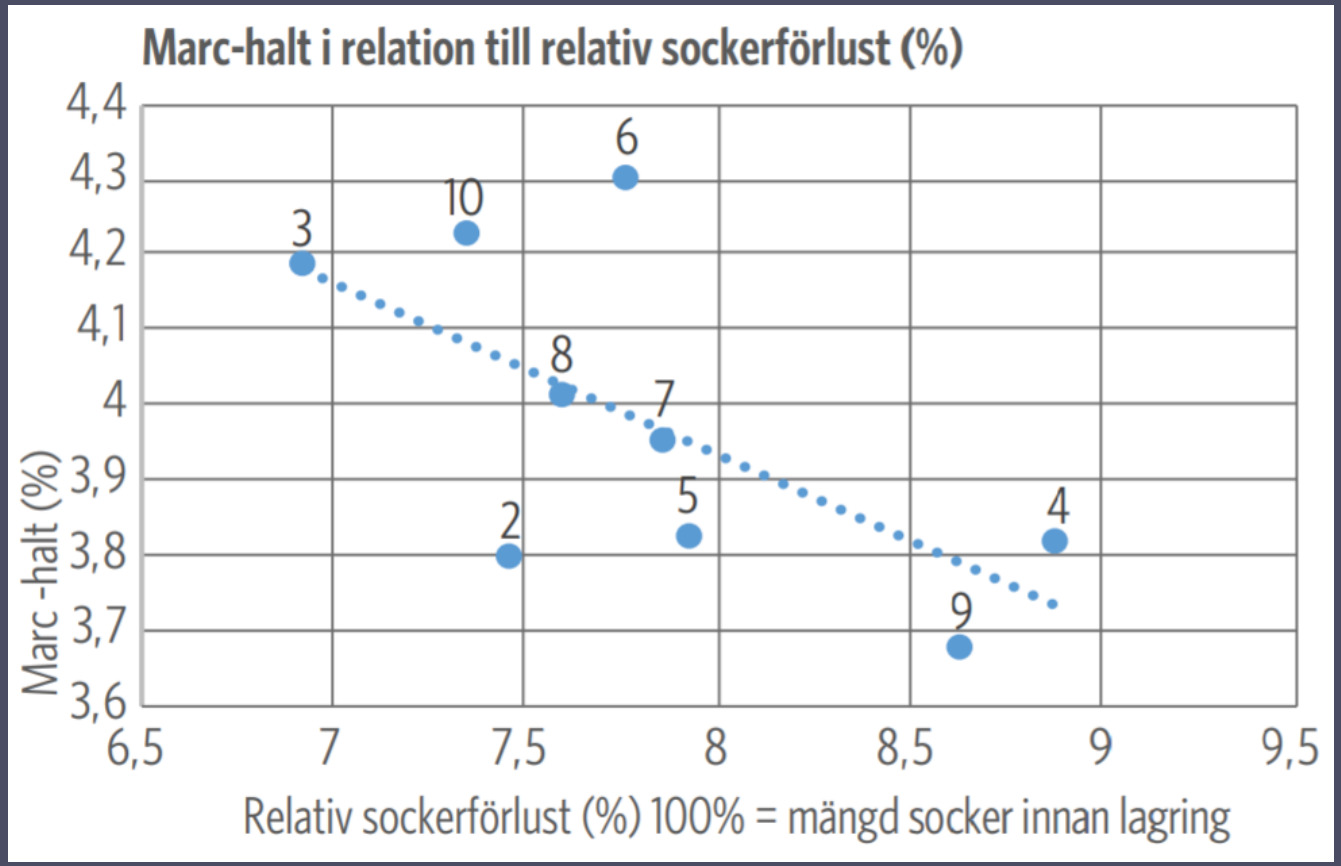
Wounds & Hardiness



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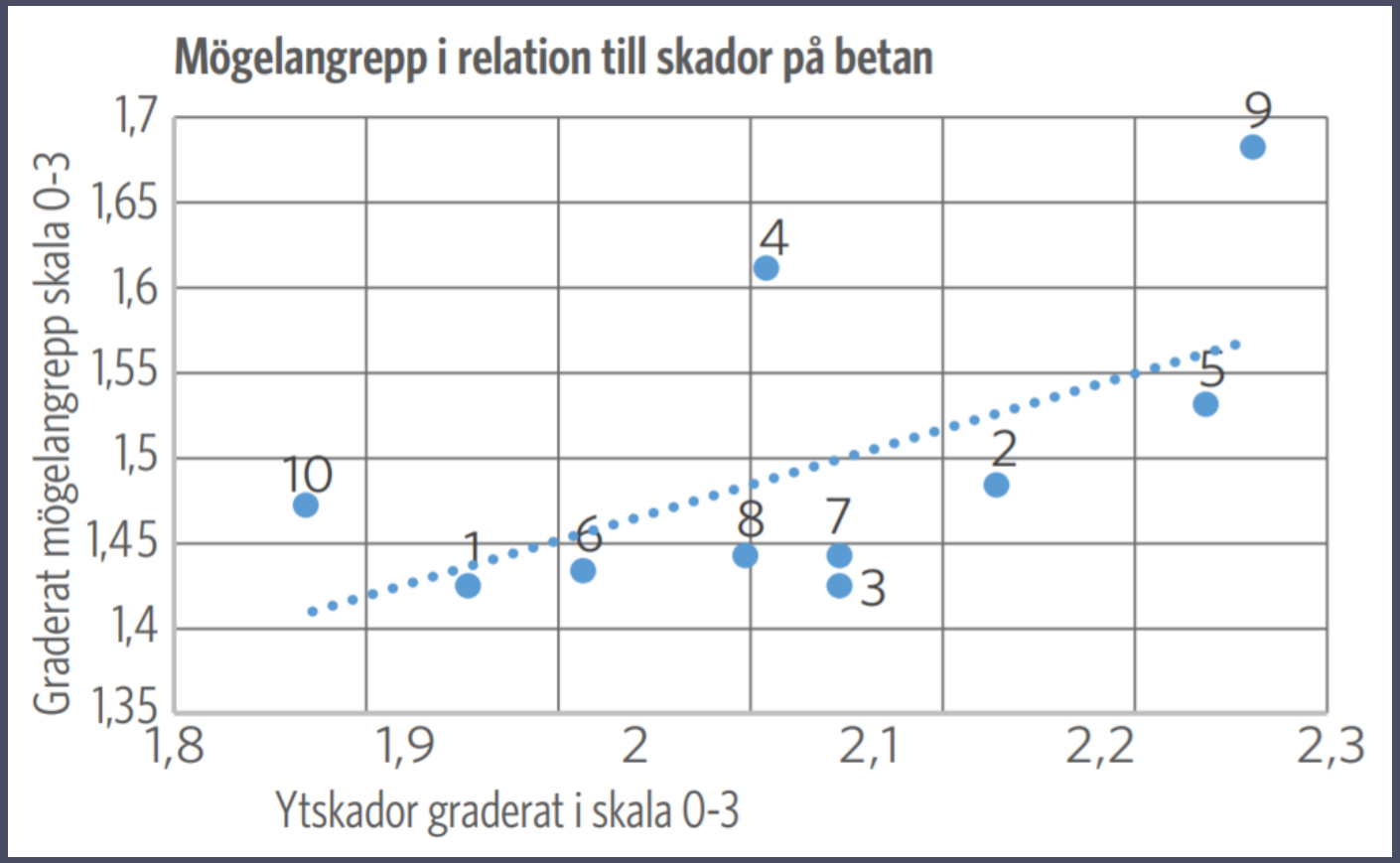
Wounds & Hardiness



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Wounds & Hardiness

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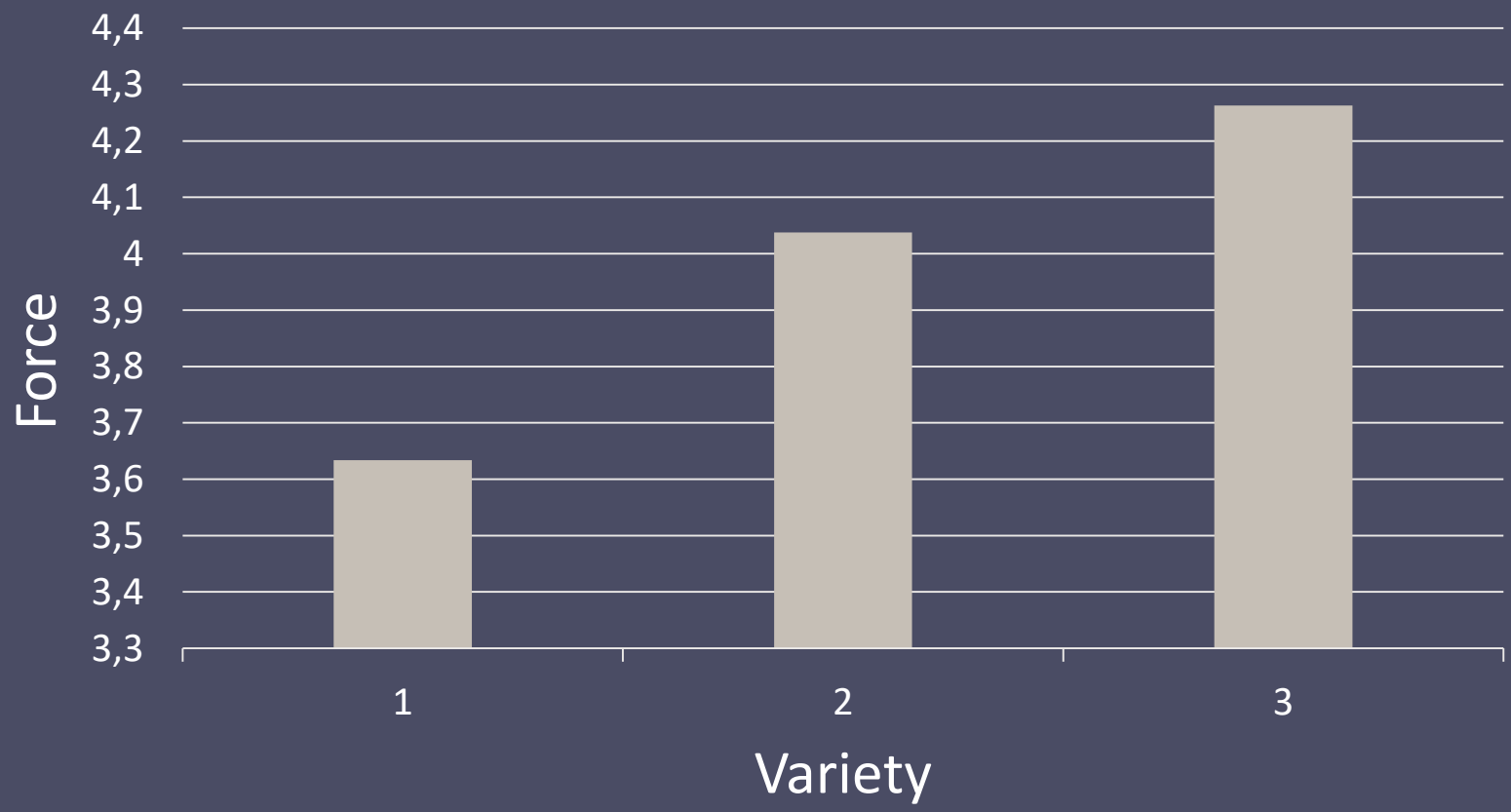
Wounds & Hardiness



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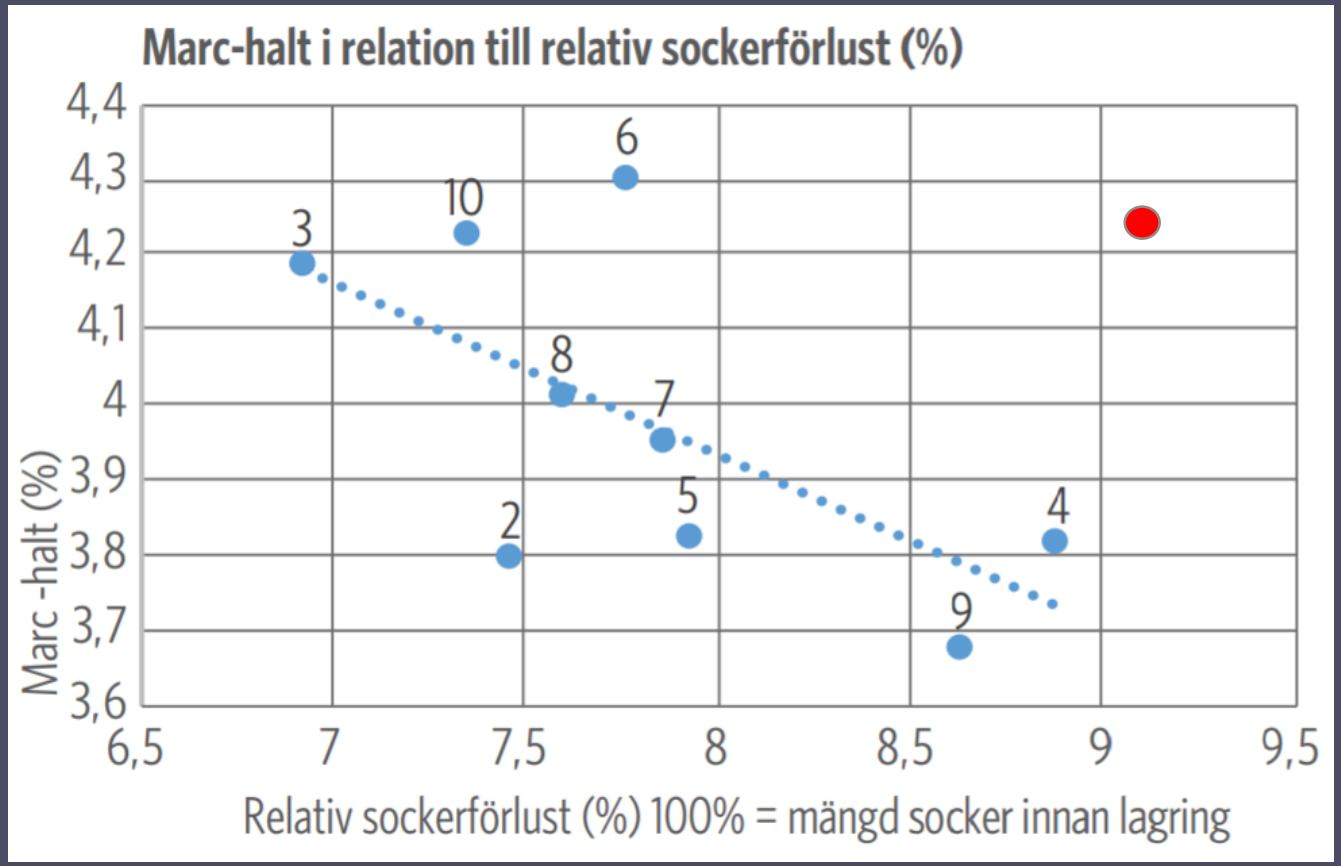
Wounds & Hardiness



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Wounds & Hardiness

Relation mellan marc-halt och skördevariabler, data är sorterad efter fallande marc-halt. Genomsnitt av 23 försök 2015–2016

Sort	Marc-halt (%)	Sockerhalt (%)	Rotskörd (t/ha^{-1})	Sockerskörd (t/ha^{-1})
9	3,67	17,17	85,22	14,53
2	3,79	17,60	88,34	15,49
4	3,81	17,79	83,28	14,73
5	3,82	17,56	83,92	14,62
7	3,95	17,87	82,18	14,58
8	4,01	18,37	80,83	14,77
3	4,18	18,09	76,66	13,82
10	4,22	17,52	81,15	14,11
1	4,25	18,86	80,19	15,08
6	4,30	18,61	69,29	12,84
Medel	4,00	17,94	81,1	14,5
LSD	0,09	0,15	2,77	0,51

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Water

- **Under-rated factor?**
- **Impacts**
  - Operability in the field

FOTO: ROBERT OLSSON.

Upptagning under blöta betingelser.

Water

- **Under-rated factor?**
- **Impacts**
  - Operability in the field
  - Volume (± 76%)

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Dehydrated beets

- **Seems unlikely to be a problem**
  - Nearly always high humidity and low temp
- **12% drop in weight at 15° with active humidity reduction**
  - 7 days
- **Maybe even a positive:**
  - Ca. 1% increase in pol at edges of clamp under TopTex
    - Less transport
    - Higher weight equivalents
    - But maybe still decreased profitability?

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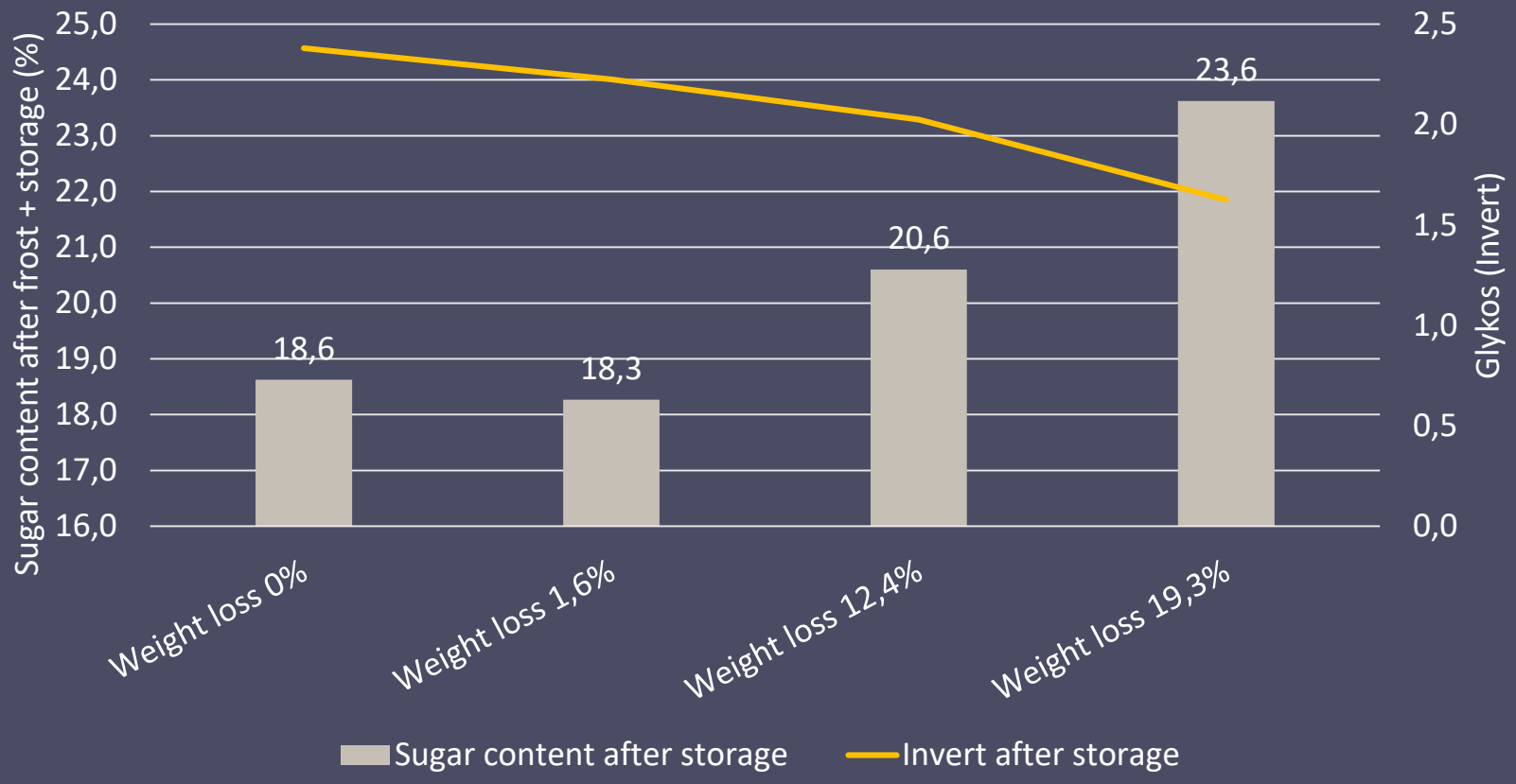

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Water

- **Under-rated factor?**
- **Impacts**
  - Operability in the field
  - Volume (± 76%)
  - Dirt-tare
    - Direct and in storage

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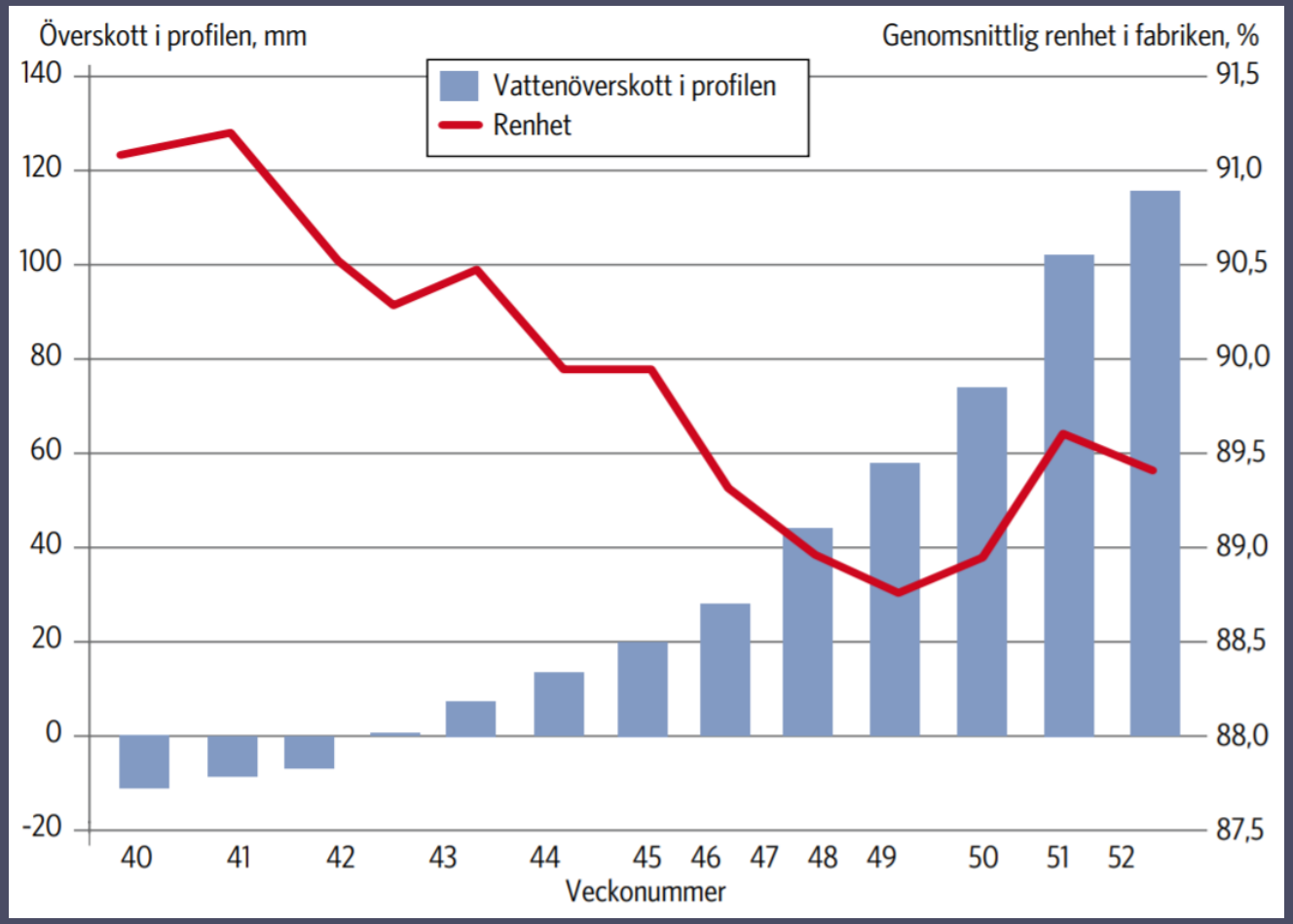
Water – dirt tare



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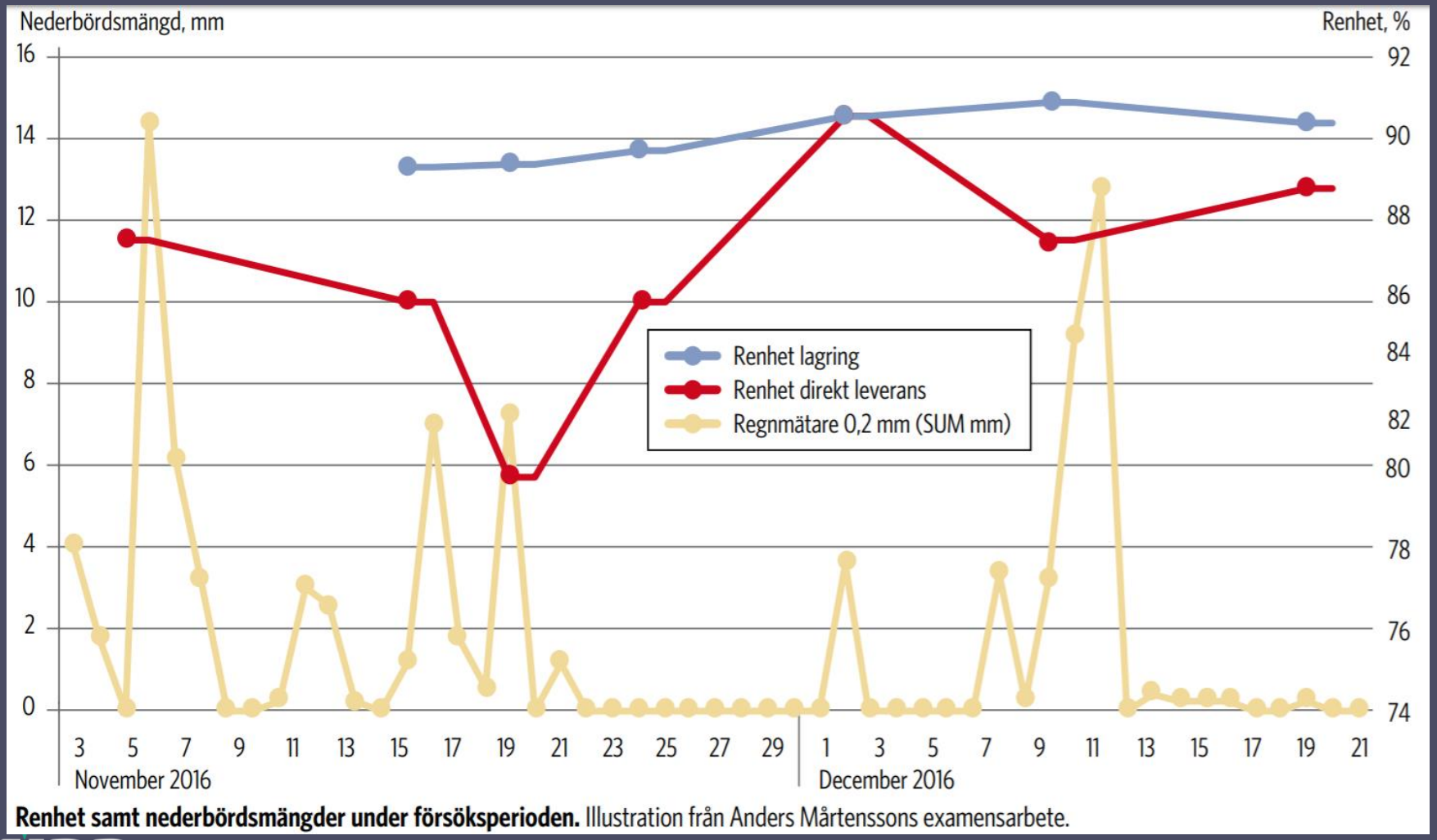
Water – actually, do store



Renhet samt nederbördsmängder under försöksperioden. Illustration från Anders Mårtenssons examensarbete.

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Water

- **Under-rated factor?**
- **Impacts**
  - Operability in the field
  - Volume (± 76%)
  - Dirt-tare
    - Direct and in storage
  - Cooling effect
    - Amplifies frosting events

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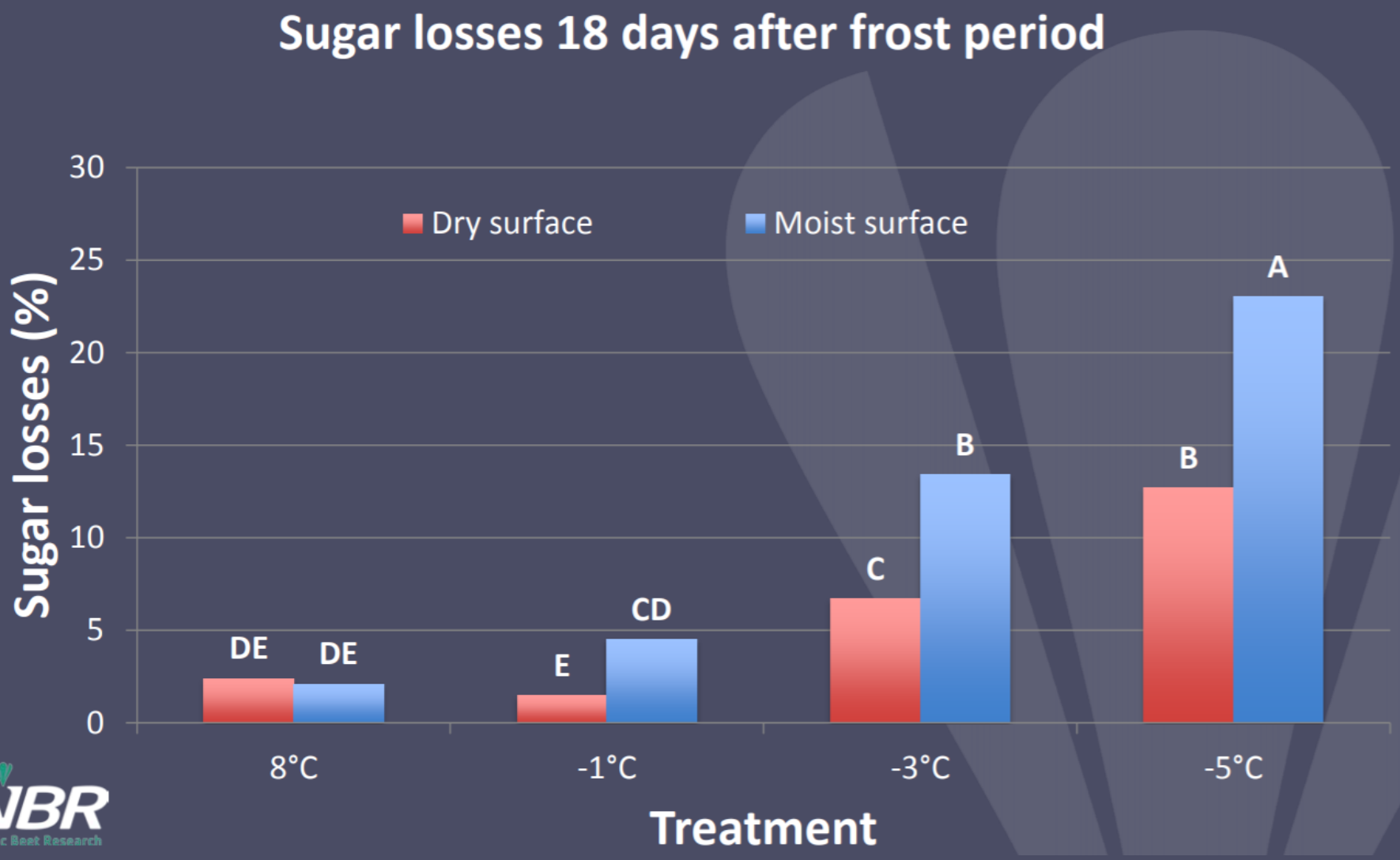
Water



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Water

- **Under-rated factor?**
- **Impacts**
  - Operability in the field
  - Volume (± 76%)
  - Dirt-tare
    - Direct and in storage
  - Cooling effect
    - Amplifies frosting events
  - Mechanical properties
    - Turgor

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Temperature

- **Can't really *stop* the**
  - respiration rate of a beet
  - presence of rot causing fungi and bacteria
  - occurrence of a frost outside

- **But we can *slow* the**
  - beets metabolism
  - fungal and bacterial activity
  - incursion of negative temperatures into the clamp

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Temperature

- **Ideal**
  - 2-4°C
    - Approach as quick as possible
    - Healing time?
  - Maximum 300°D
    - 0,02% /day /degree

- **Alt. Ideal**
  - Freeze at average -9°
  - Avoid thawing

Clamp temp	Days to 300°D
10°	30
8°	37
6°	50
4°	75

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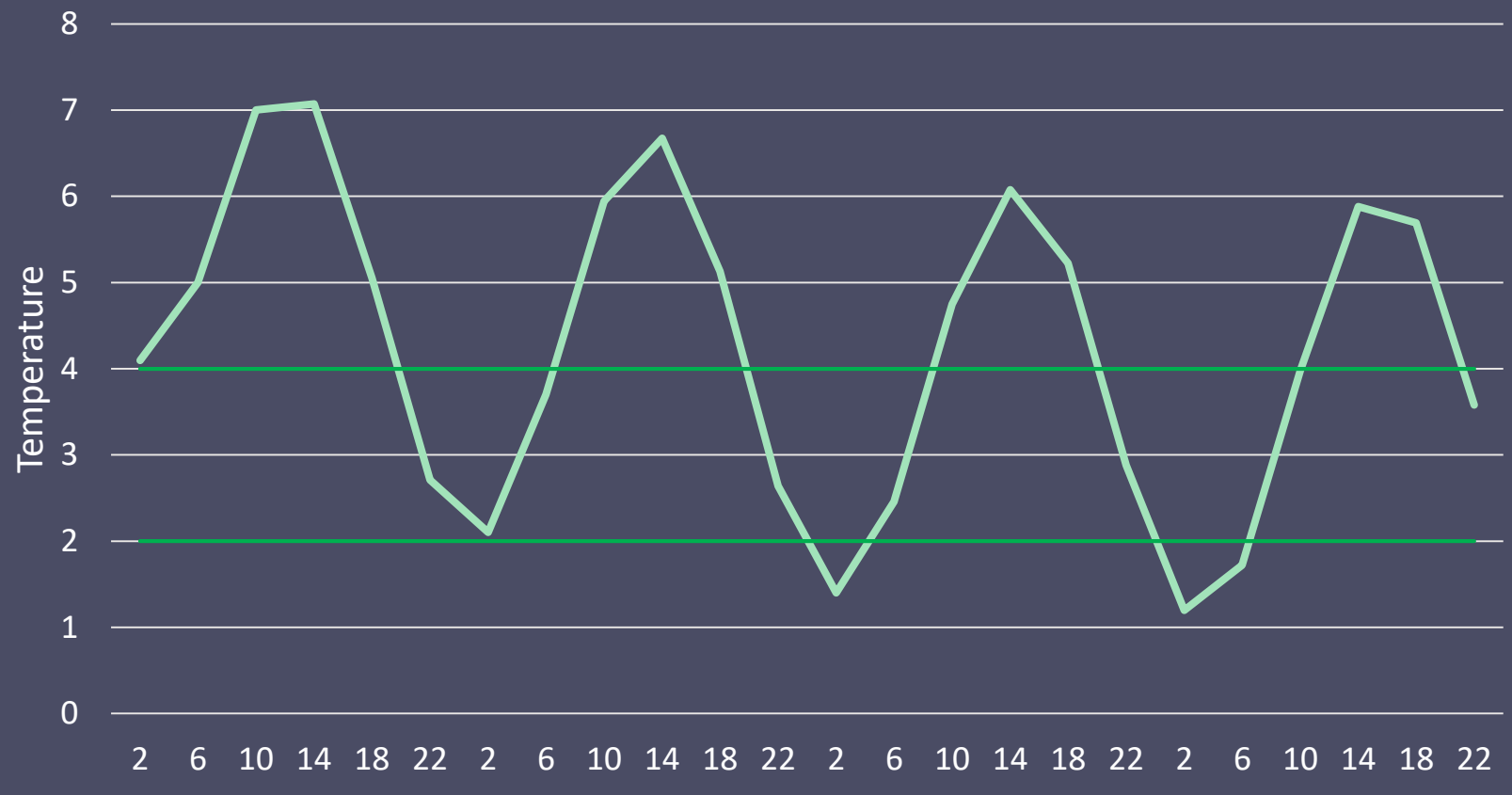
Temperature – targeting the ideal



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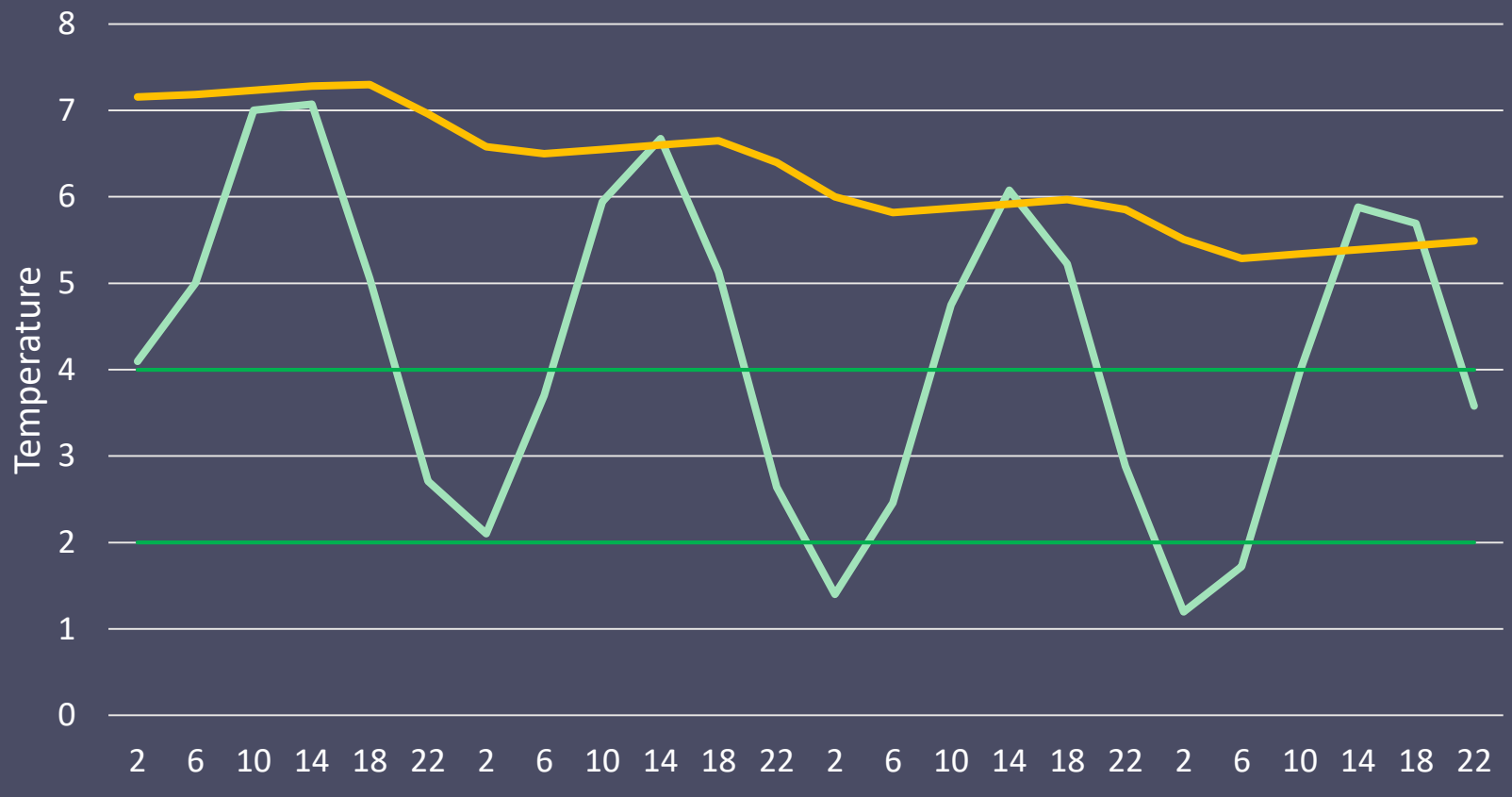

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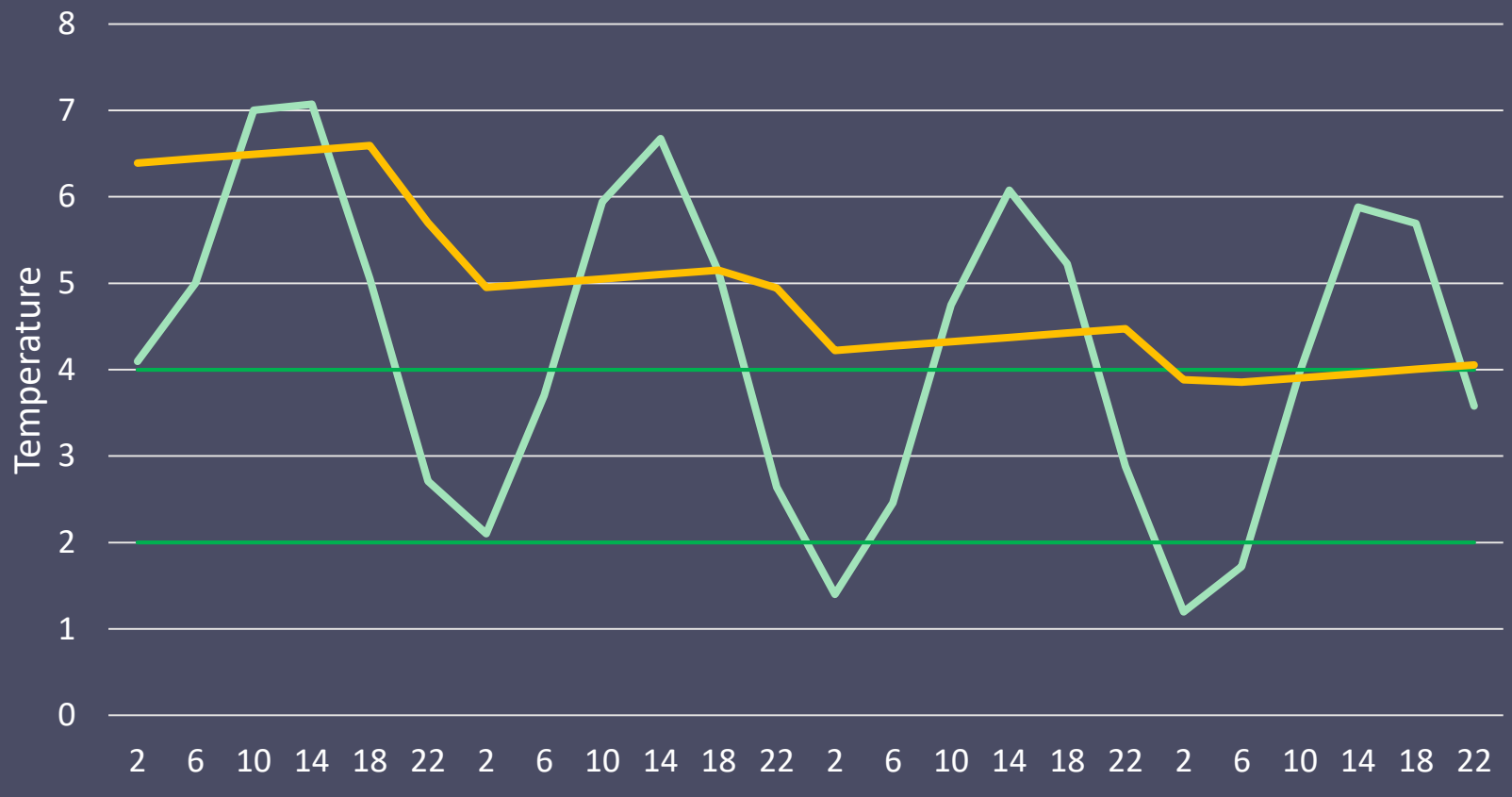

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Temperature – targeting the ideal

		Clamp temp		
		< Target	= Target	> Target
Outside temp	< 0	Close	Close	Open (carefully)
	< Clamp	Close	Open (carefully)	Open
	= Clamp	Open	Open	Open
	> Clamp + heat	Open	Close	Close

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Temperature – dealing with reality

- How hot can we get?
- How bad is a frost?

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Temperature in clamps

- **Heat production vs heat exchange**

- **Beets can produce heat equivalent to…**

  one 2000W heater per 100tn (@ 5°C)

  - 60% of metabolised sugar lost as heat

- **Heat exchange depends upon**
  - Temperature differential
  - Mixing rate of air
    - Nearly all heat exchange = convection

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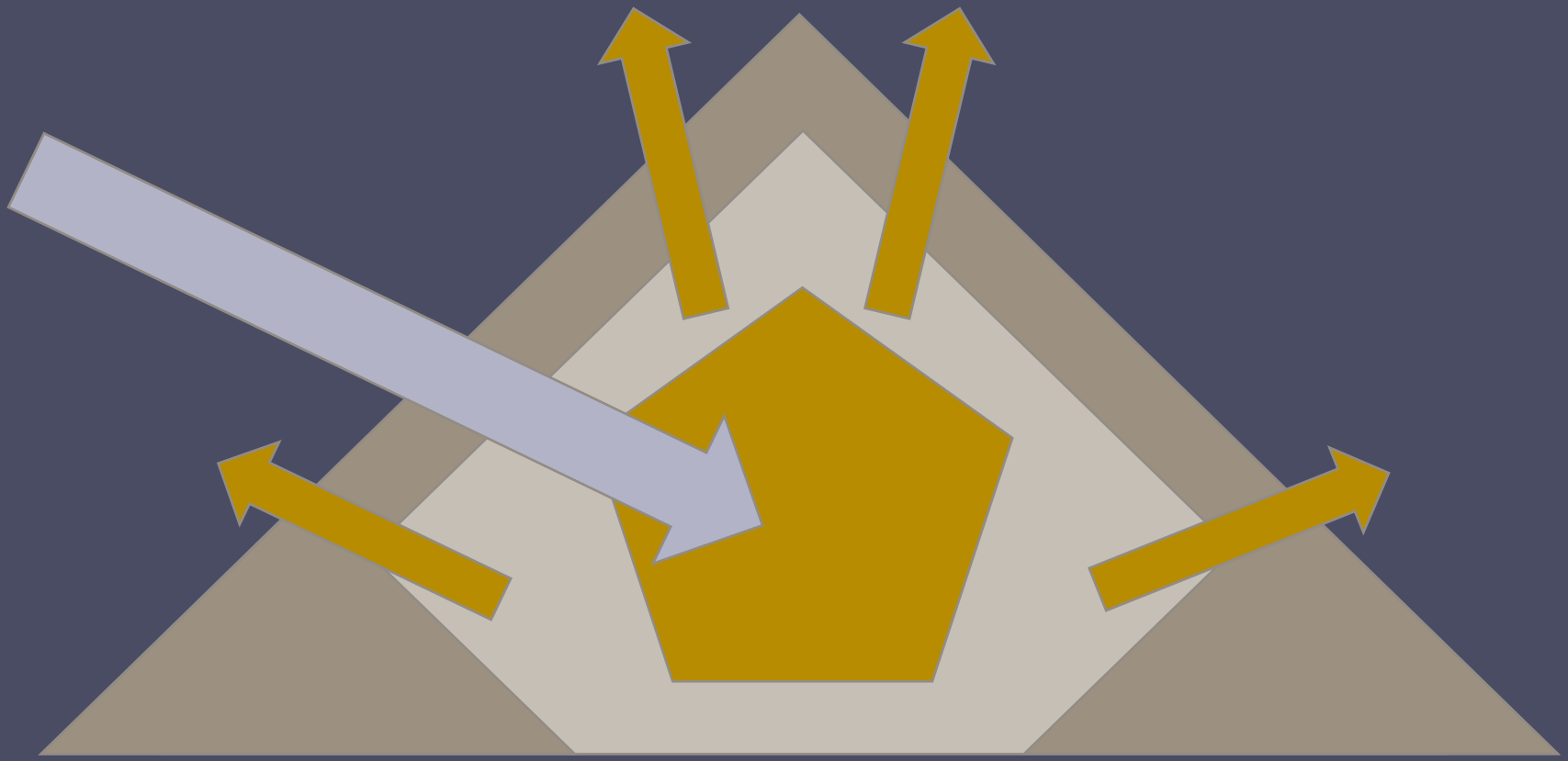
Temperature – heat exchange



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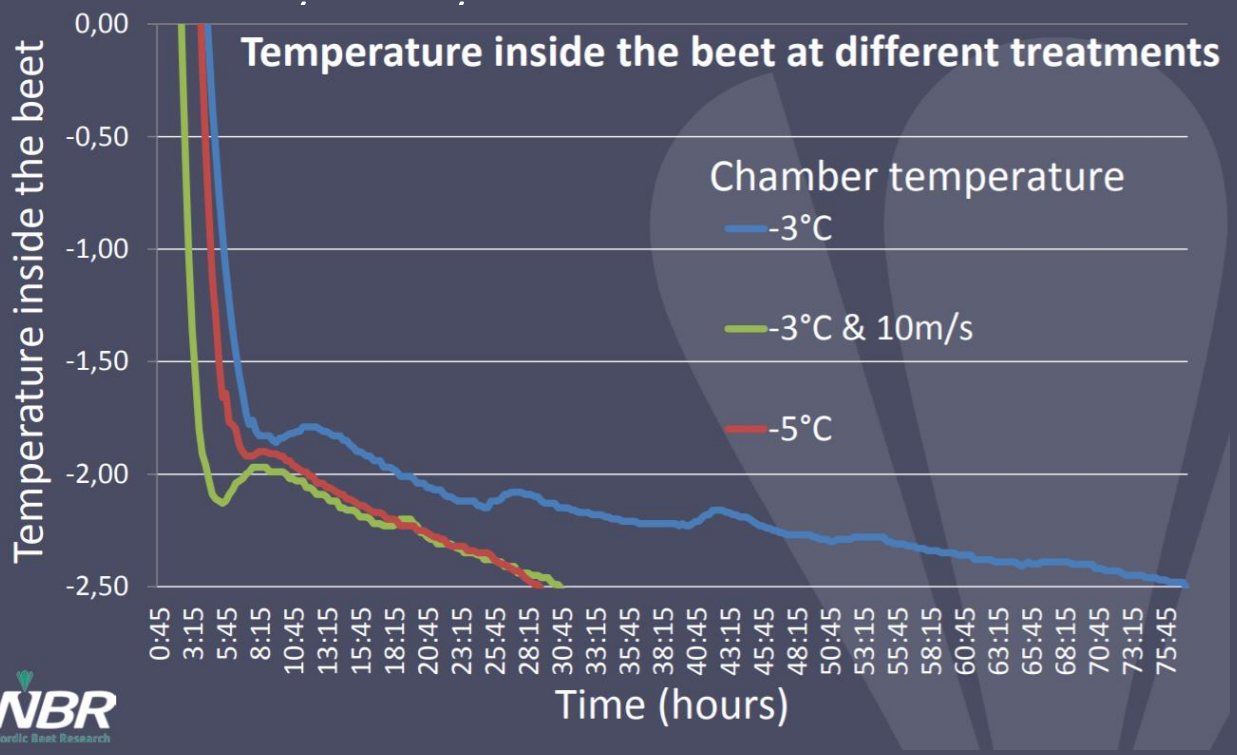
Heat exchange - Wind

- **Fluid dynamics of clamps: big unknowns in storage**
- **Two things are certain**
  - Wind accelerates heat exchange



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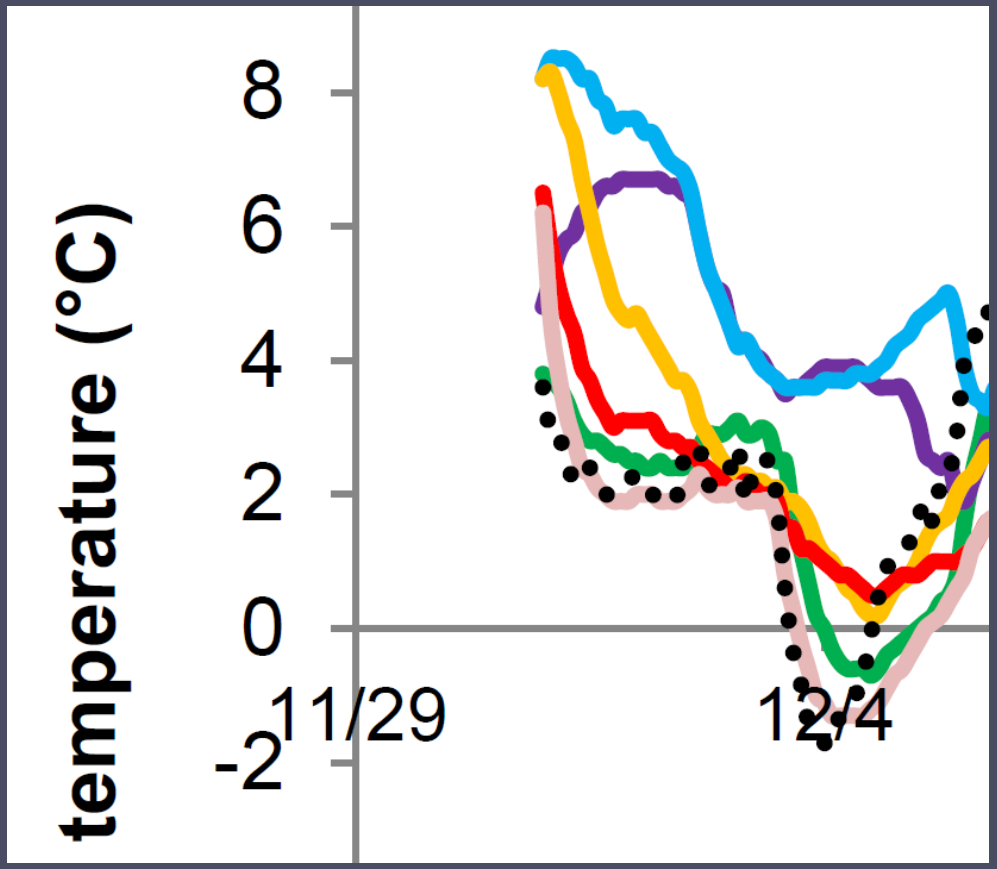

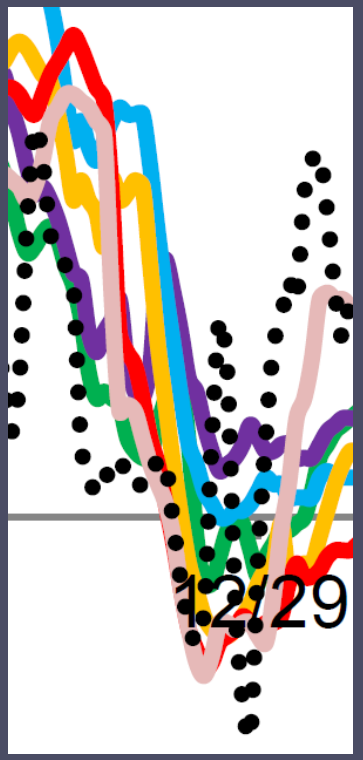

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Heat exchange - Wind

- **Fluid dynamics of clamps: big unknowns in storage**
- **Two things are certain**
  - Wind accelerates heat exchange
    - 2 x at 10m/s v 0m/s
    - -3°C + 10m/s ≈ -5°C
  - Covering can slow the wind
    - TopTex ≈ 90% air flow reduction
    - Plastic ≈ 99.5% air flow reduction (in and out!)
    - Plastic + straw ≈ 99.5% air flow reduction + low conduction

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Heat exchange - Wind

- **TopTex**

Angle	Before (m/s)	After (m/s)	Difference
45°	4,50	0,42	9%
45°	5,50	0,50	9%
45°	11,43	1,40	12%
90°	4,47	0,59	13%

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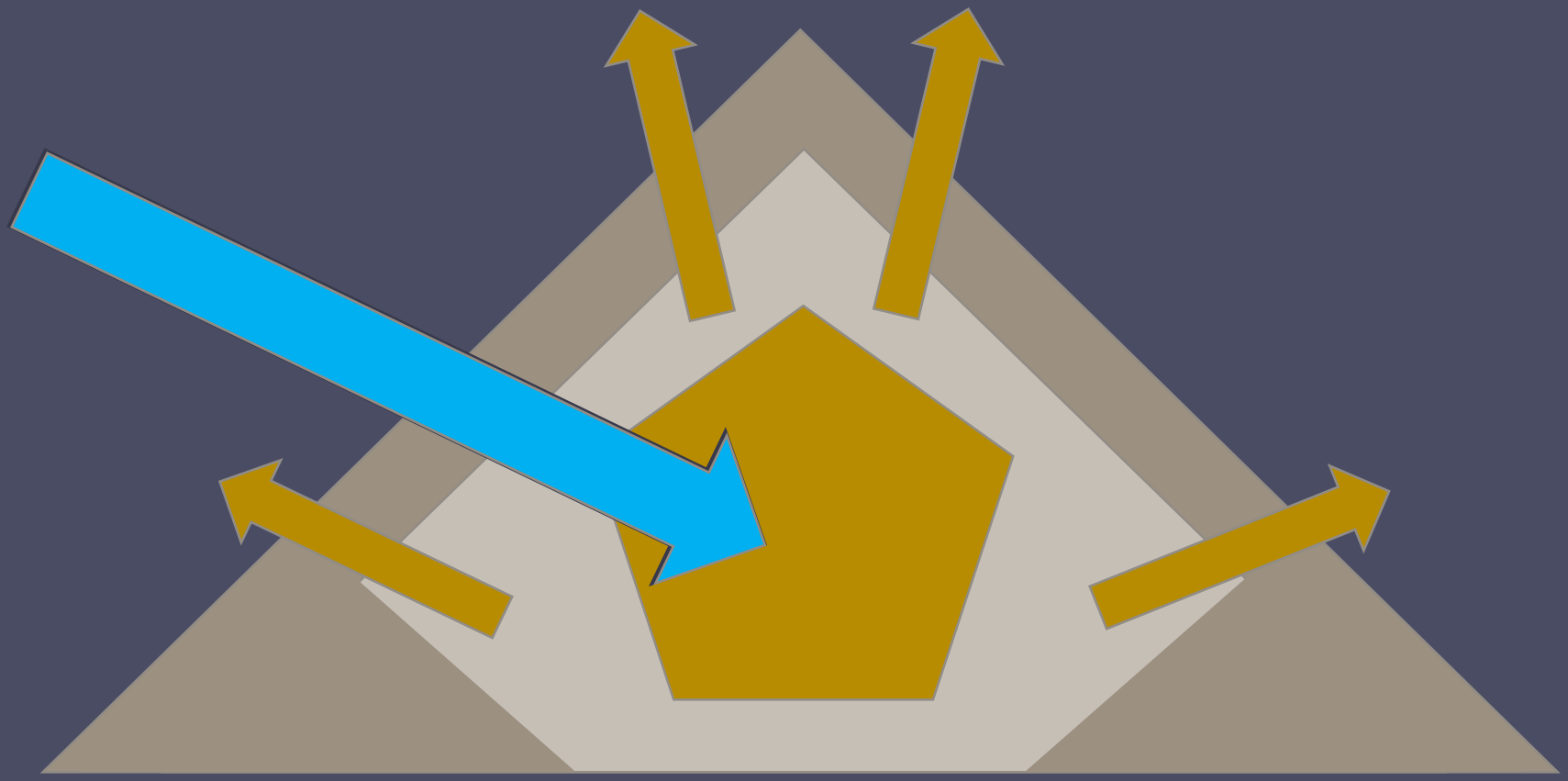
Temperature – heat exchange



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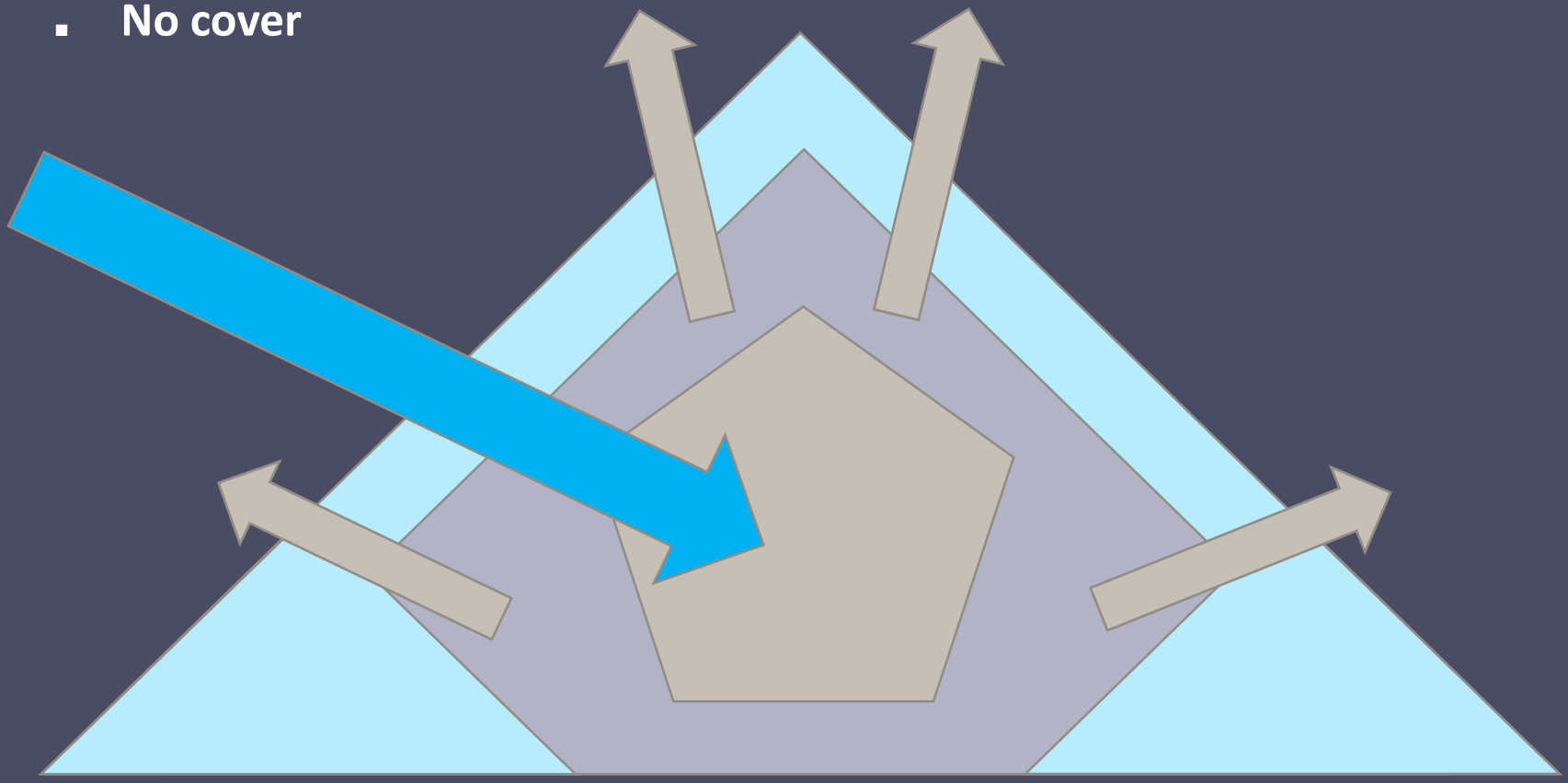
Temperature – heat exchange

- No cover



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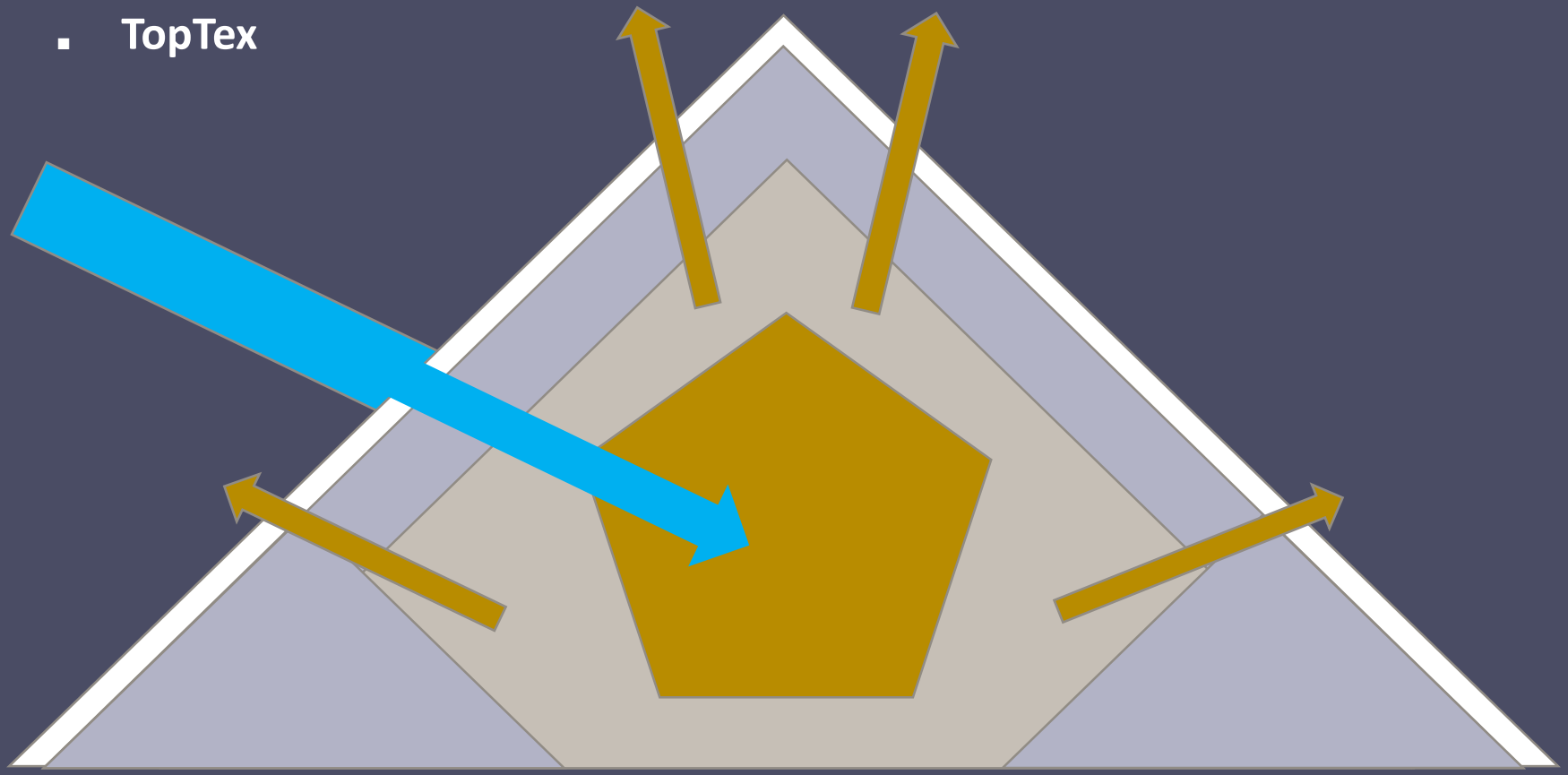
Temperature – heat exchange

- TopTex



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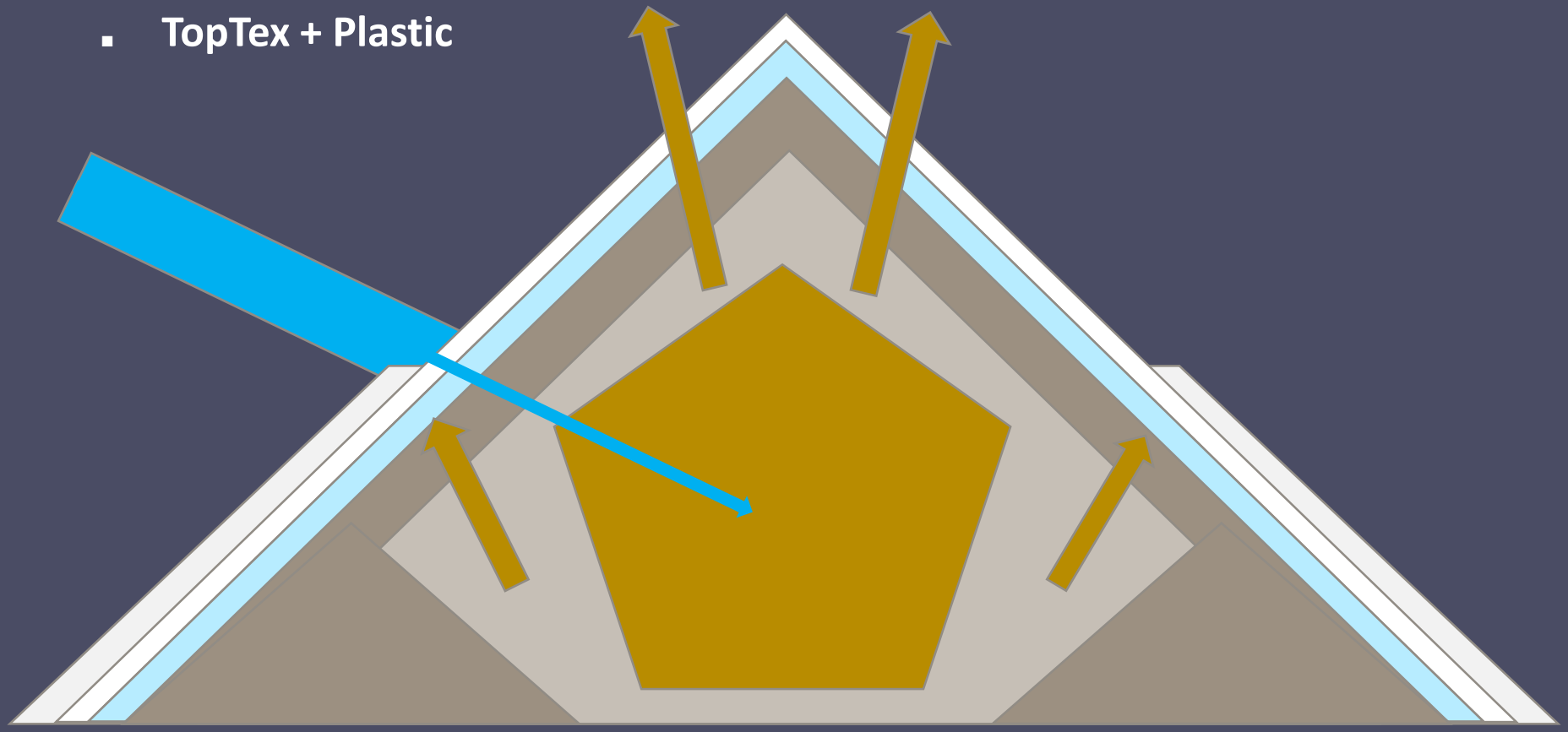
Temperature – heat exchange

- TopTex + Plastic



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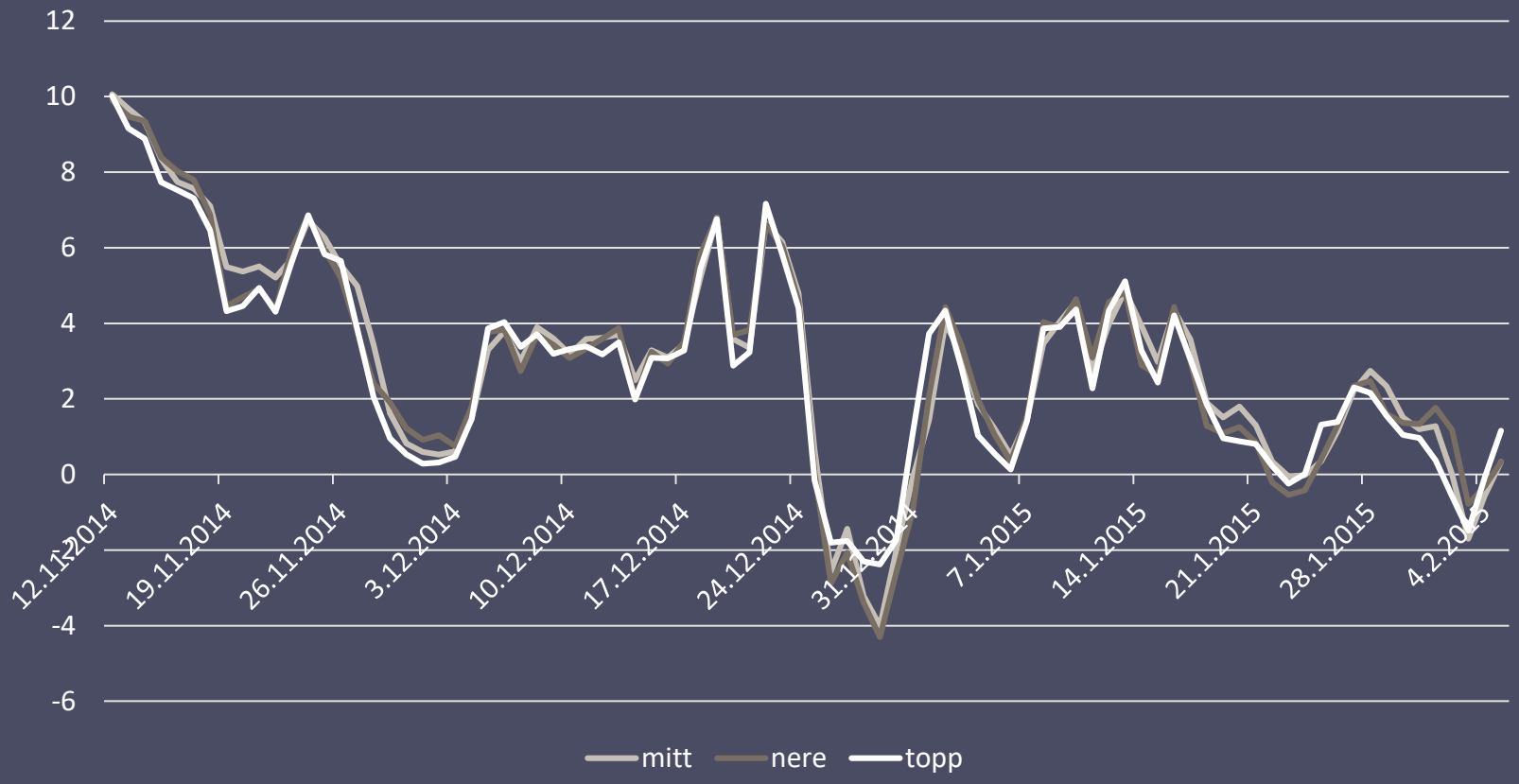
5T clamp data - uncovered



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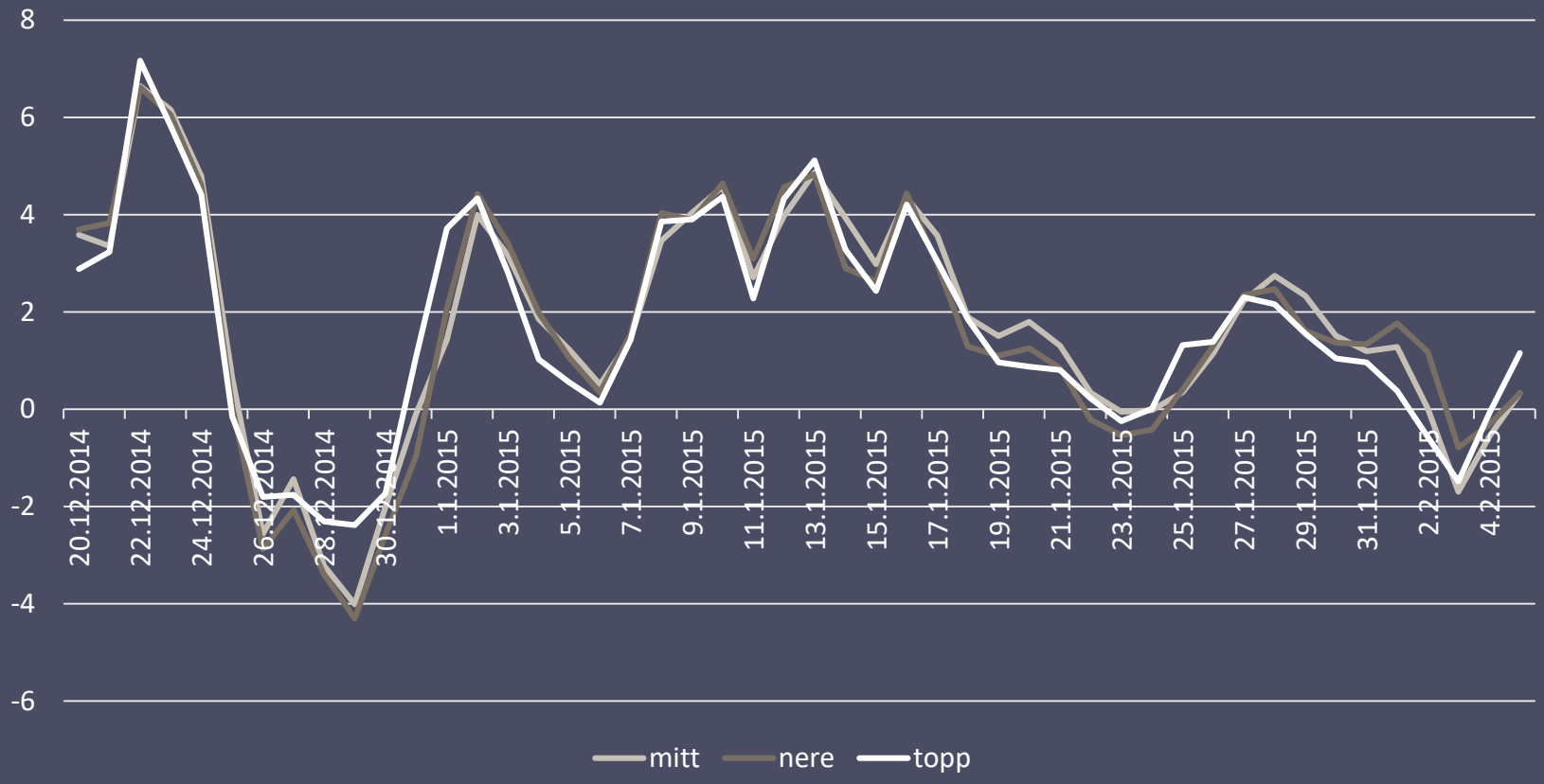

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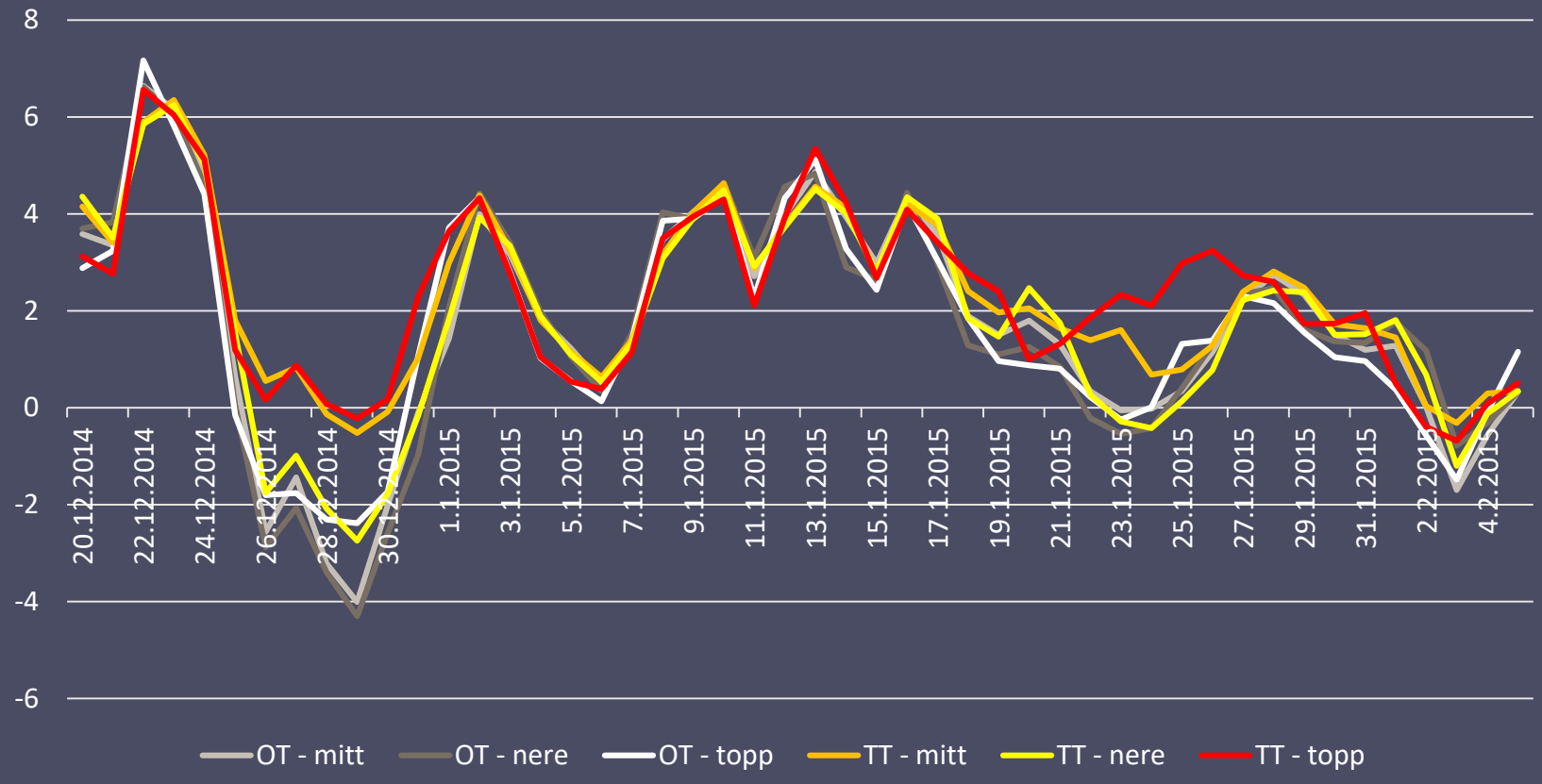
5T clamp data - TopTex



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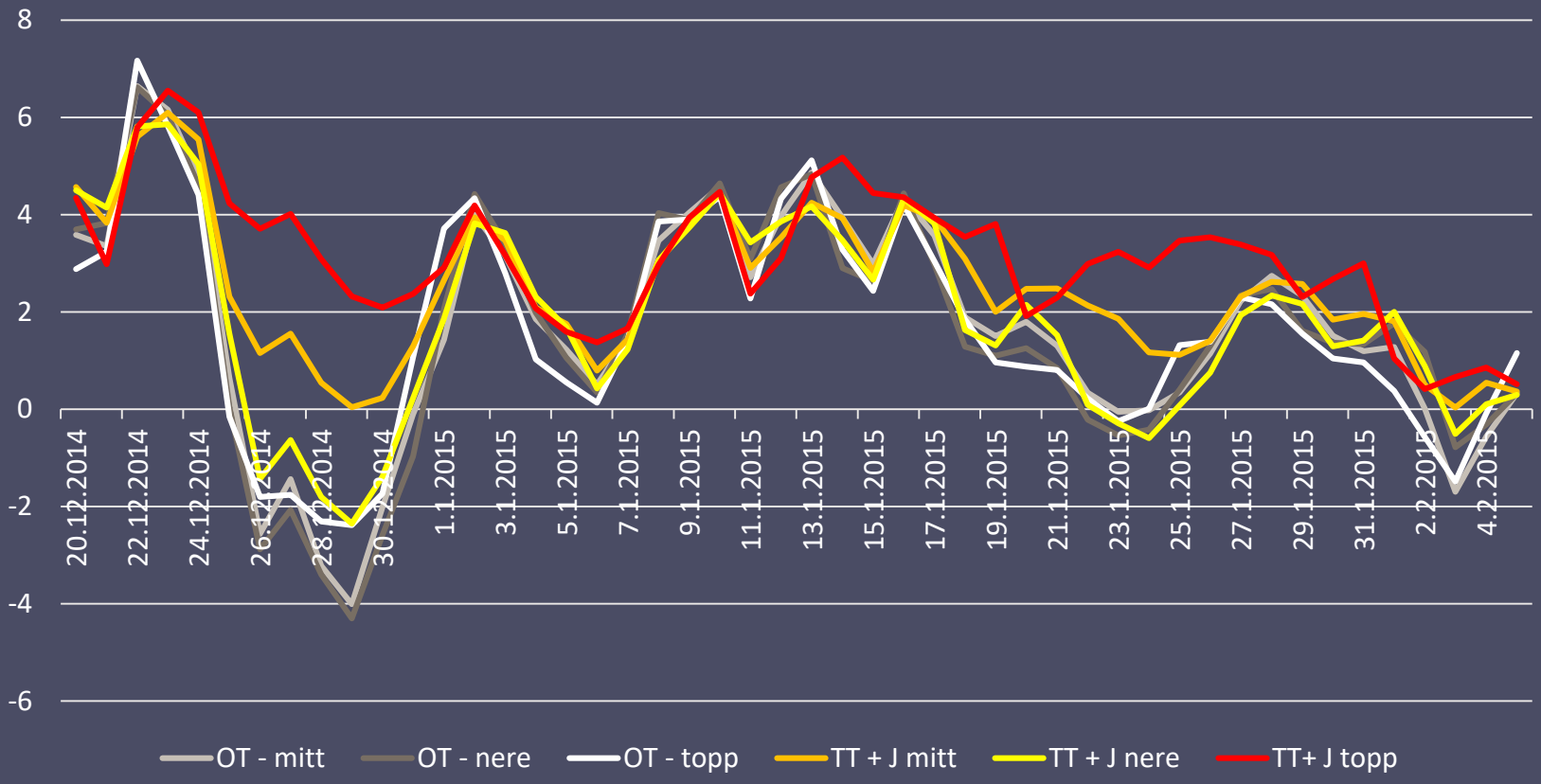
5T clamp data – TopTex + 3m Jupette



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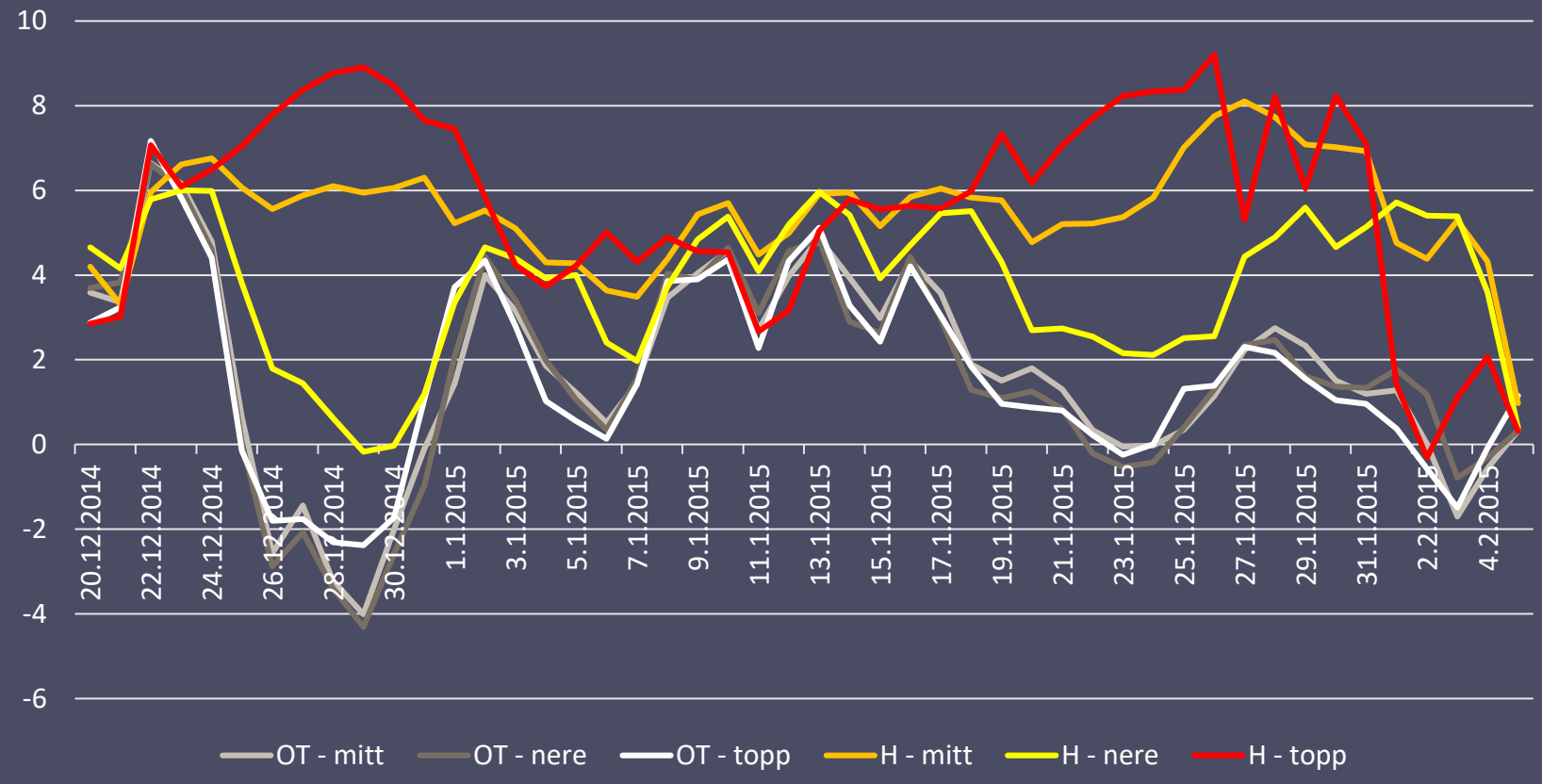
5T clamp data - straw



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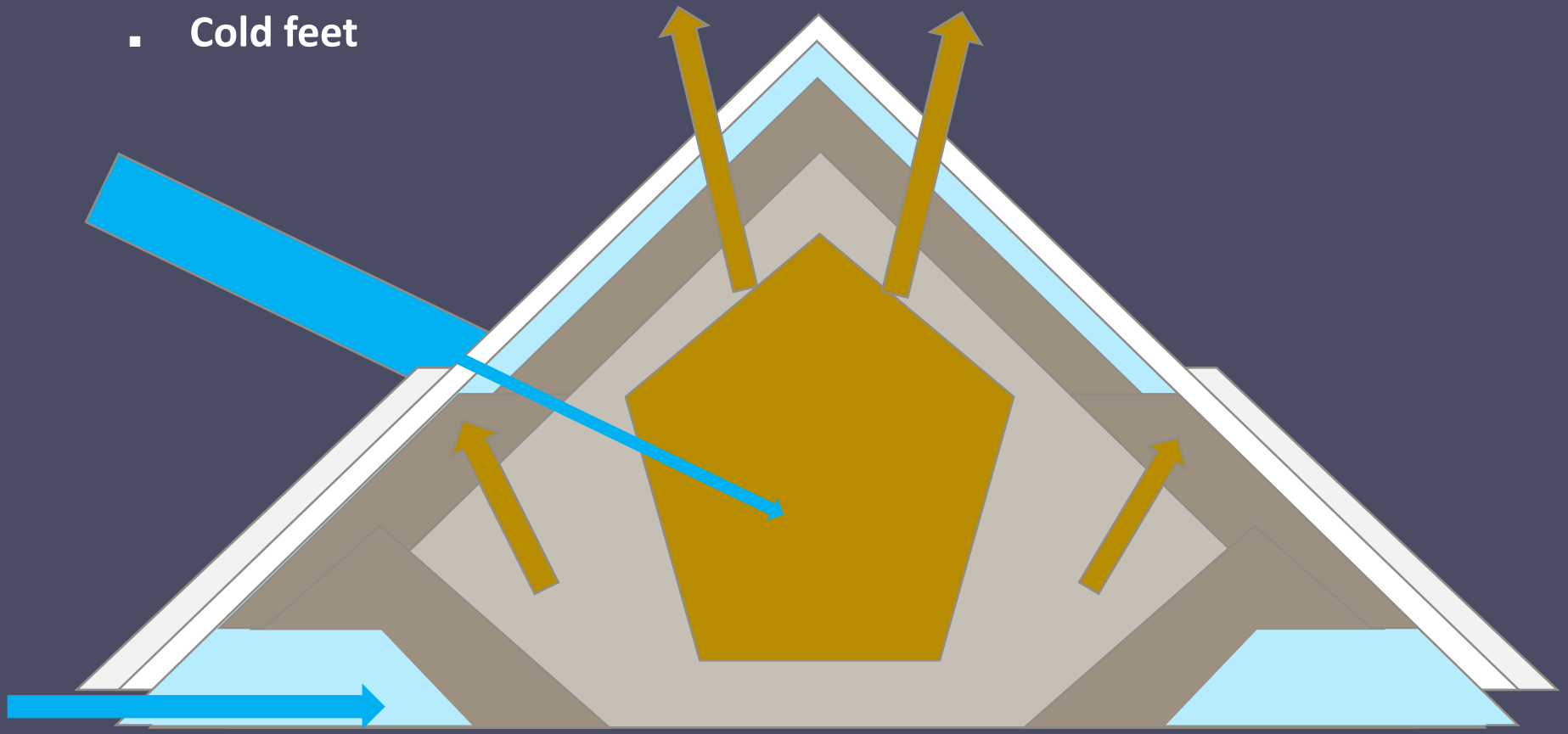
Temperature – heat exchange

- Cold feet



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Temperature – too cold?

- **Heat exchange most critical**
  - Wind accelerates this
  - Covering slows this
- **Moisture of clamp critical**
- **Mechanical damage further multiplies the effect**

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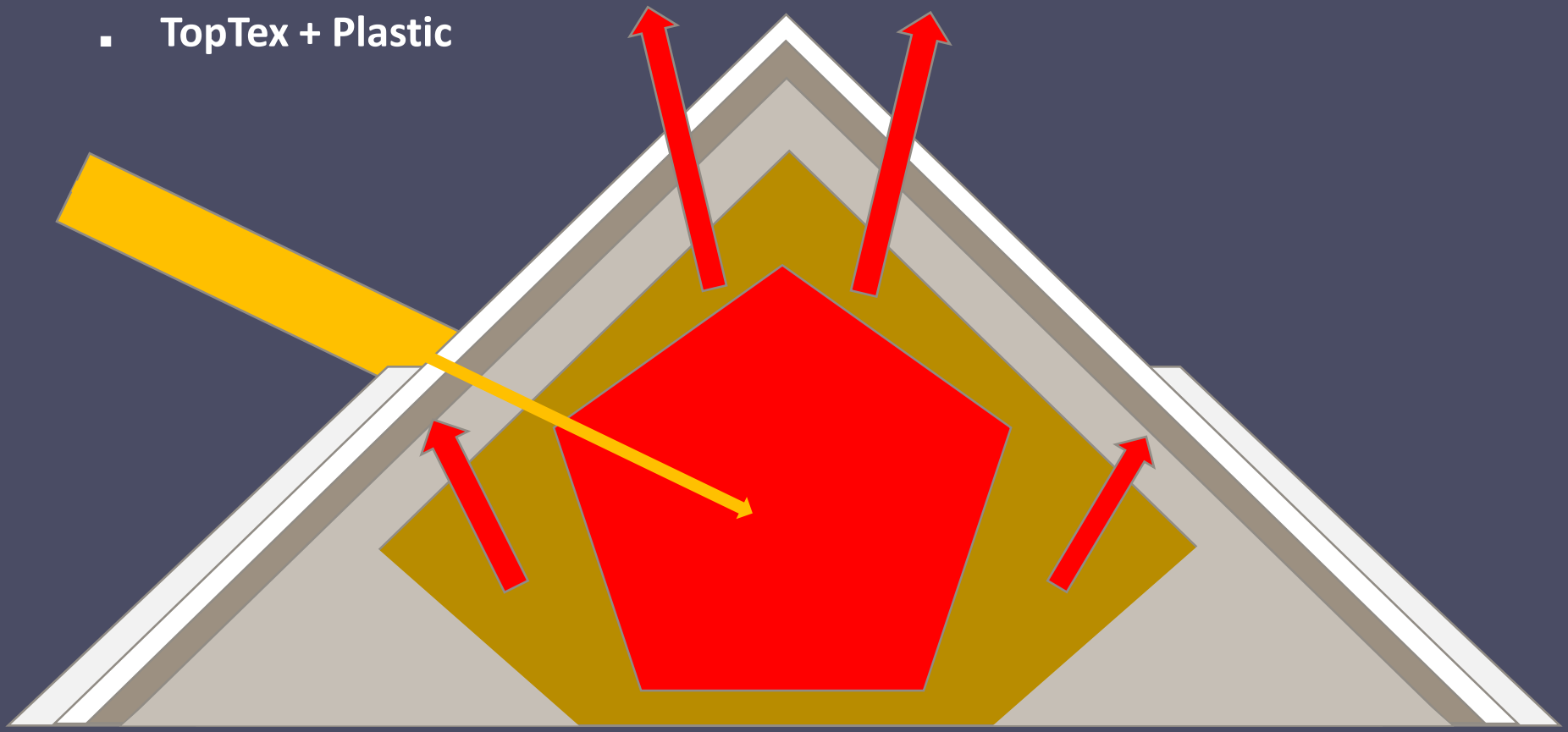
Temperature – heat exchange

- TopTex + Plastic



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Temperature – too hot?

- **Heat production vs heat exchange balance critical**
- **Less of a problem than too cold (?)**
- **Can easily occur when air-flow is blocked.**
  - Local hot-spots
  - Too much cover

- **300°D only holds between 2 - 15°**
  - At 35°, 10% can be lost in 36 hours

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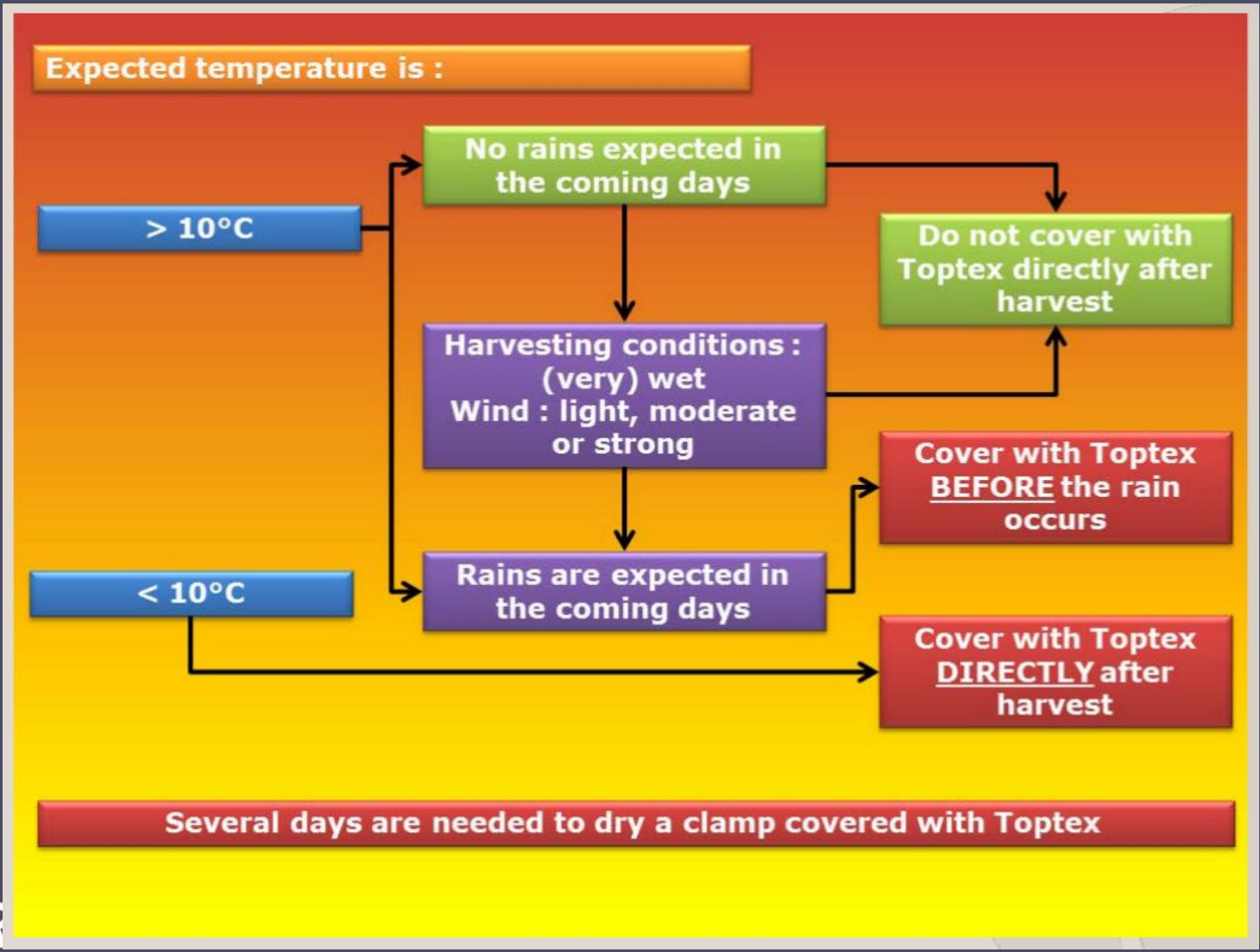
Recommedations – covering



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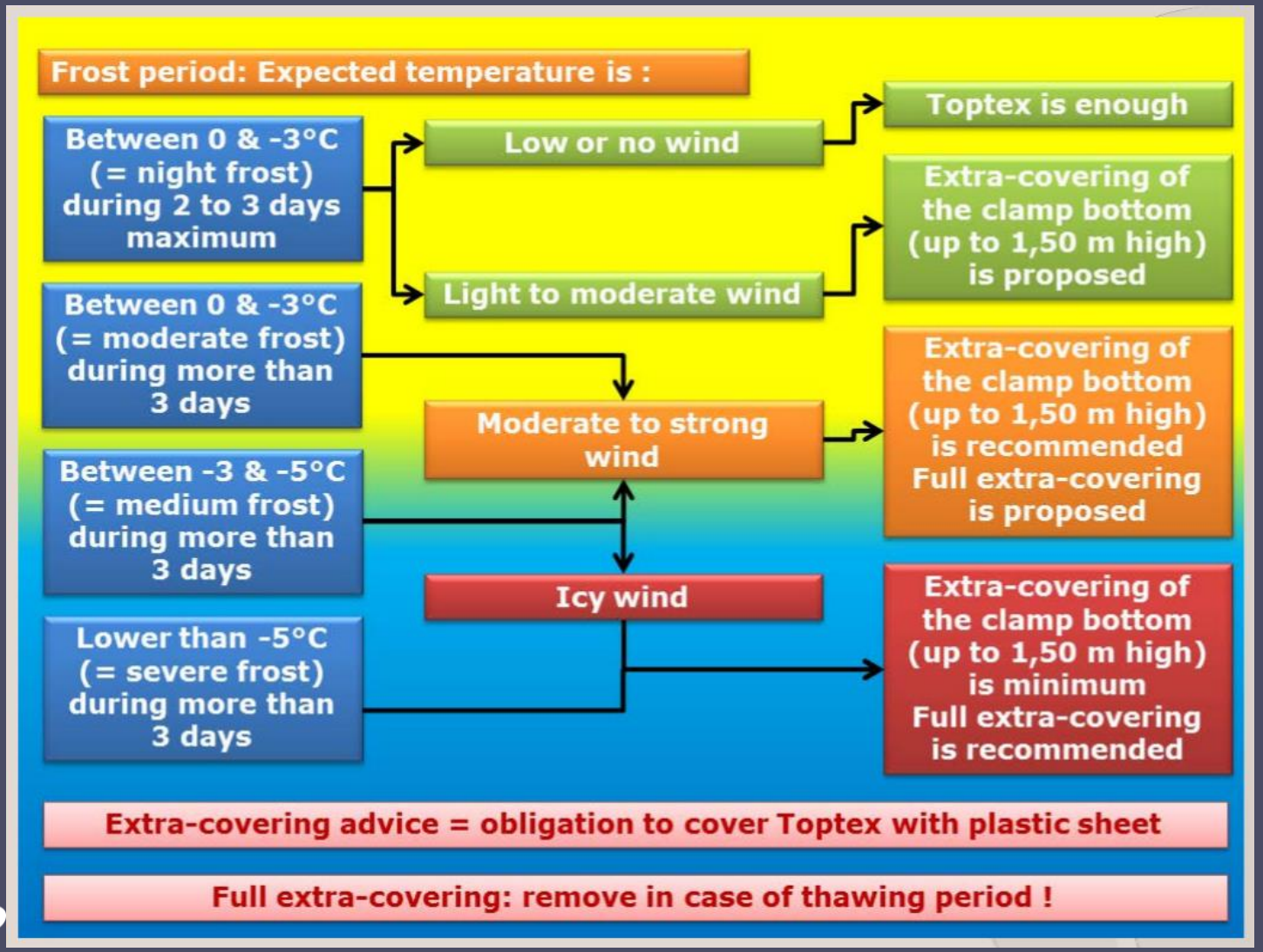

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In-field storage

- **Frost risk?**

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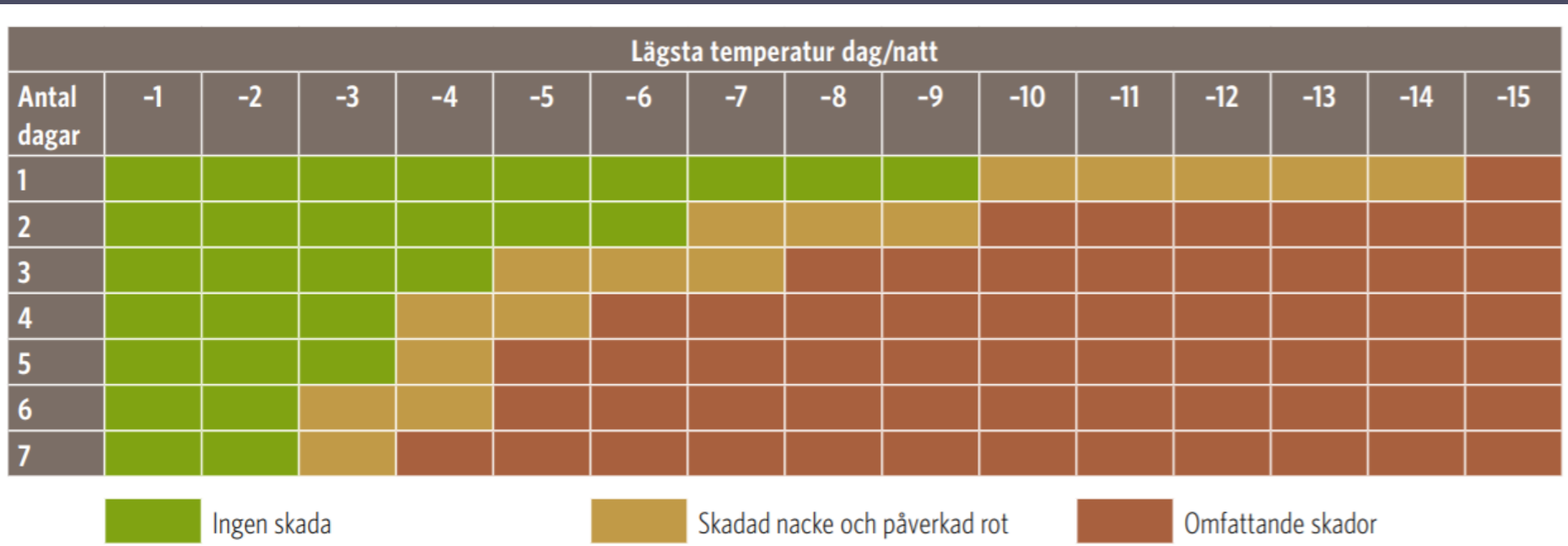
In-field storage

- **Frost risk?**



Så mycket frost tål betorna. Tabell som visar när betorna som står kvar i marken tar skada vid olika temperaturer. Omarbetad efter Milford et al. 2002.

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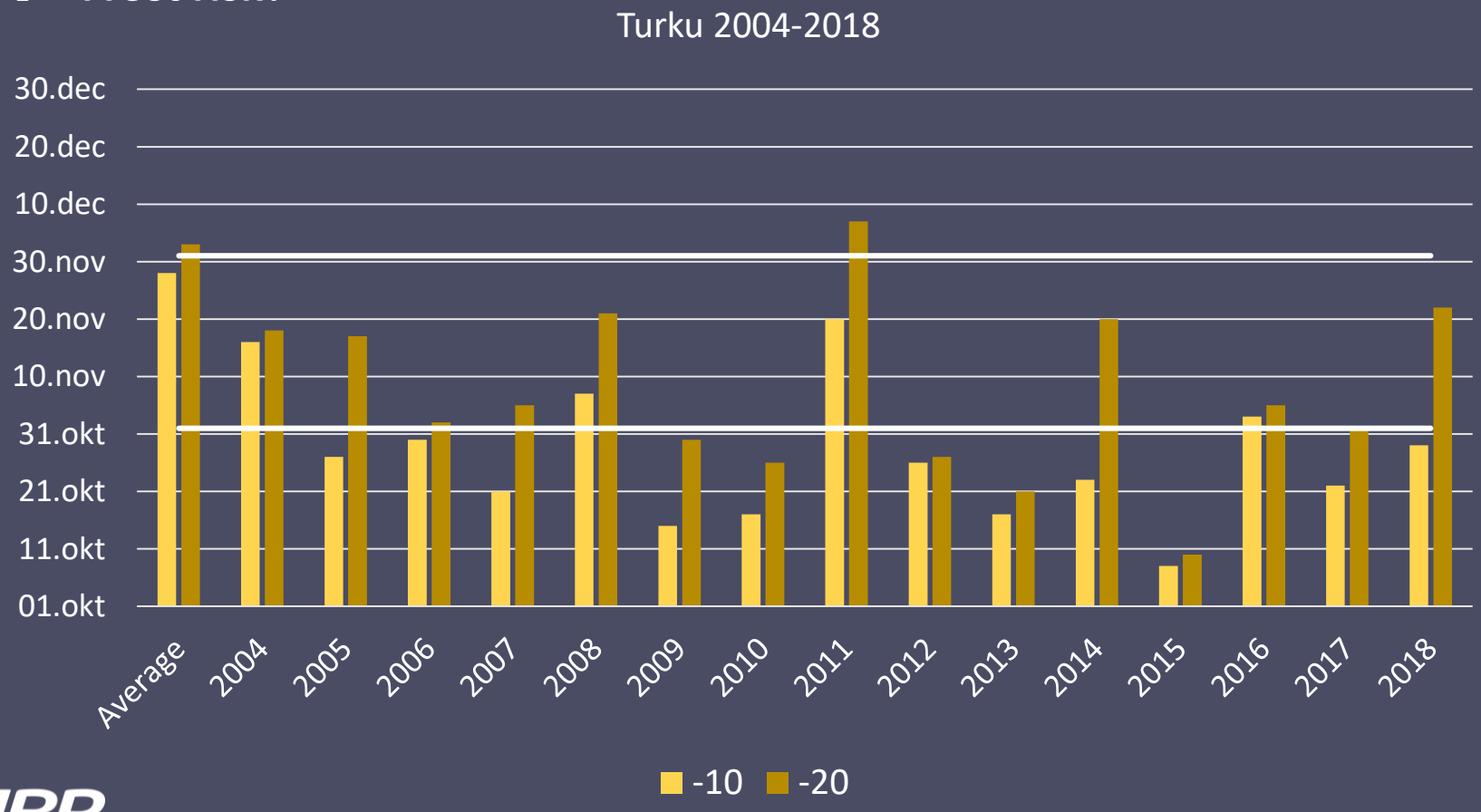
In-field storage

- **Frost risk?**



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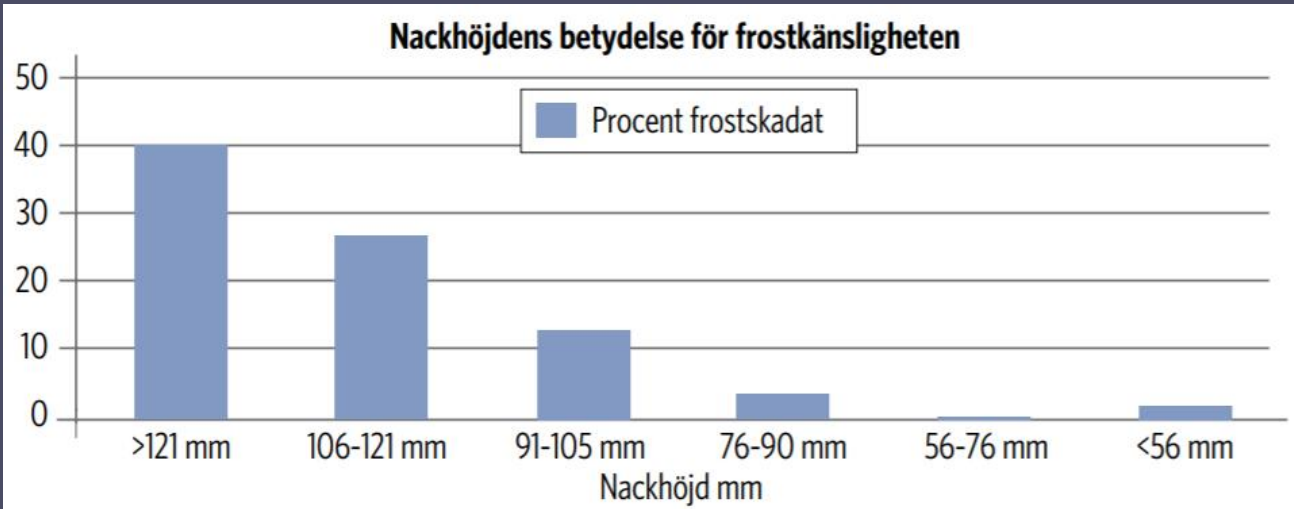
In-field storage

- **Frost risk?**
- **Rain risk?**
- **Factors**
  - Beet neck-height
  - Leaf cover



Betor som står högt tar större skada. Diagrammet visar hur stor del av betan som skadats av frosten beroende av betans höjd. Medeltal av mätningar på 160 individuella betor på fyra platser som upplevt kraftig frost 2016.

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	Hardier beets	Correct Topping	Treat gently	Dimensions & Place
Respiration	✓	✓✓		✓
Frost				
Rots				
Added water				
Wounds	✓✓		✓✓✓	

	Stay dry	Avoid frost	Target 2-4 °C	Max 300 °D
Respiration		✓	✓✓✓	✓✓✓
Frost		✓✓✓	✓✓	
Rots	✓	✓✓	✓✓	
Added water	✓✓✓			
Wounds				

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Thank-you!
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623

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Sensor techniques

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Values

- €31/tn, base = 17.0% pol, 89,5% cleanness

- Sugar concentration: €1,4/ %/ tn
- Dirt tare: €0,5/ %/ tn
- Late delivery: €0,1/ tn/ day 30-Nov to 23-Dec.
  €0,15 from 24-Dec
- TopTex: €1.5/tn

- 2,65% weight is deemed as top
- Na + K, invert sugar: not in the current contract.

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Storage. Easier decisions. Less loss.

▪ 604 – EIP Active ventilation	JE	2019
▪ 603 – Cleaning with ventilation	WE	2019 - 20
▪ 631 – COBRI mechanical properties	WE + JE	2018 - 19
▪ 632 – COBRI penetrometer	WE + JE	2019 - ?
▪ 632 – COBRI impact assessment (ex-jobb)	WE + MN	2019 - ?
▪ 650 – Clamp modelling	WE	2019 - 23
▪ 666 – Dirt-tare modelling	WE	2019 - 20

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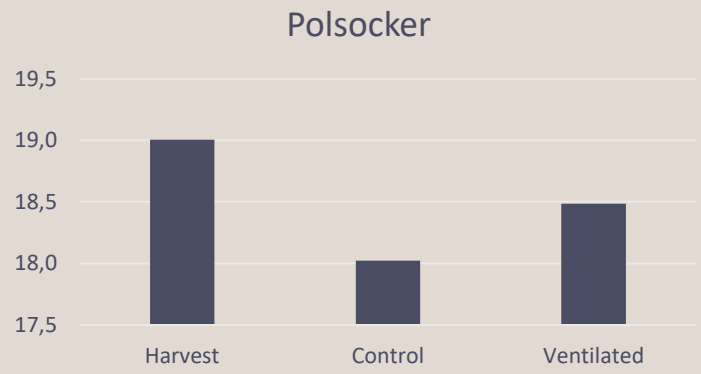
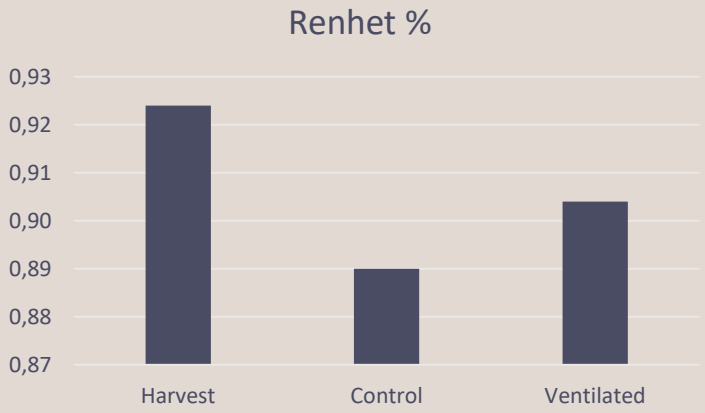
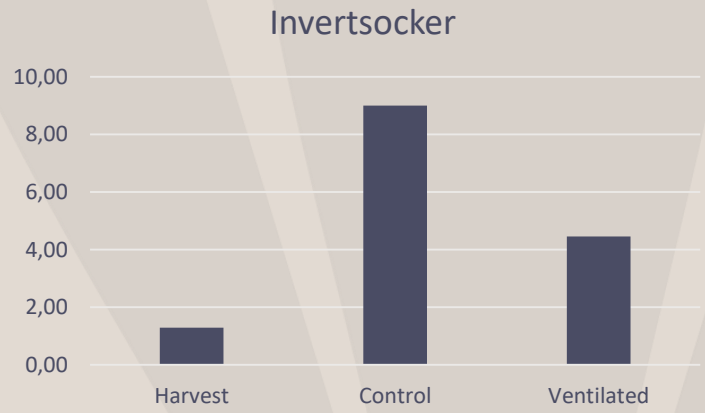
604 – EIP Active ventilation







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631 – COBRI mechanical properties

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