Project BigApple

Orchard VIS/NIR scanning of apples:

Moving to non-destructive determination of fruit ripening & quality parameters

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Research on apple, cultivar ‚Braeburn‘

BigApple (2016-2019)

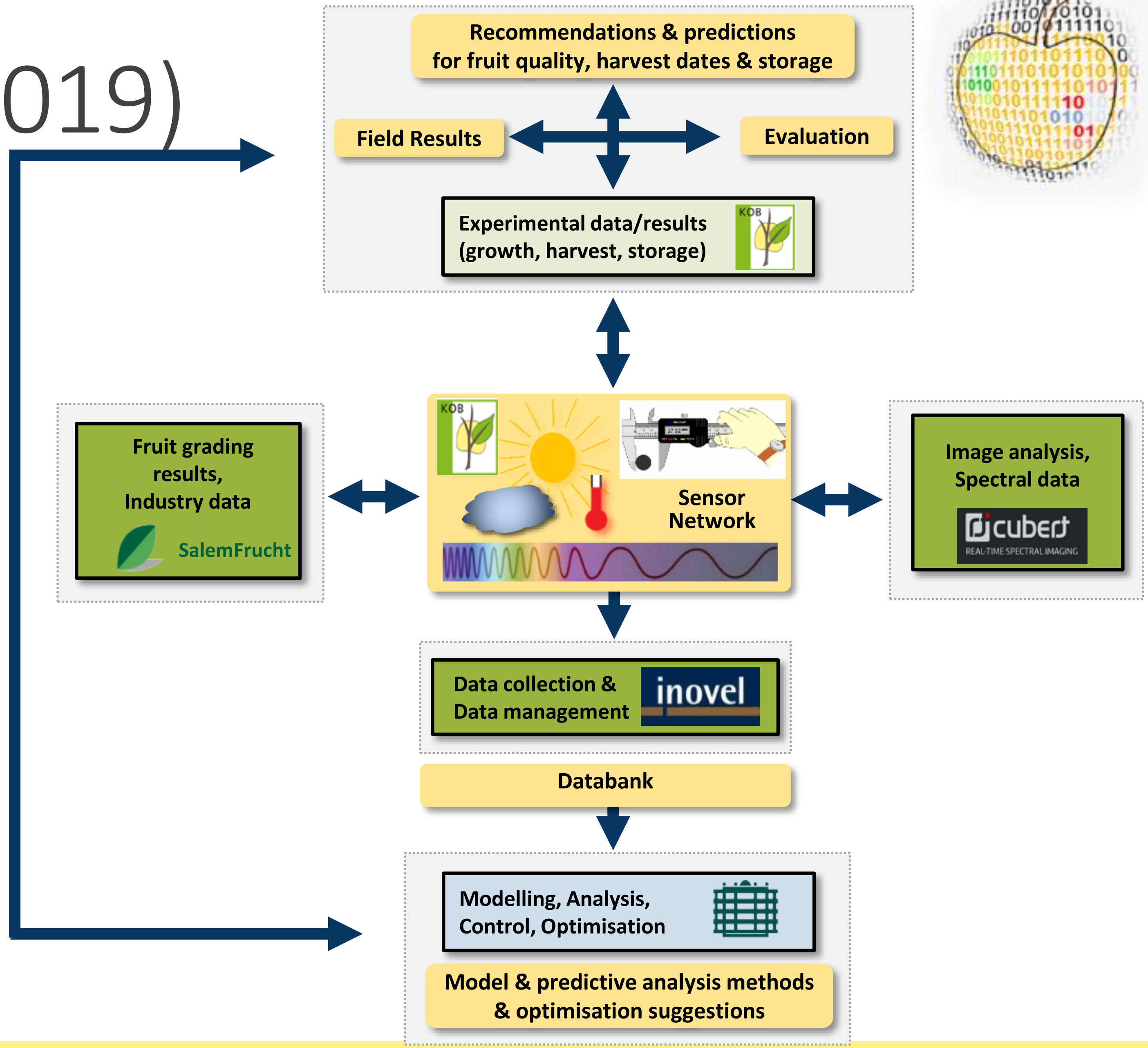
BigData Project to explore the connection between

-development processes in the field

&

-postharvest behaviours in storage

to **predict internal (physiological) disorders before they arise during storage**



Two possible approaches to identify apple fruit quality

Harvest Too Late

High respiration

CO_2 too high , O_2 conc. too low

1

Traditional

Post bloom temperatures

High internal CO_2- and/or low O_2 concentration

Cell division rate changed

Reduced energy metabolism

Large, labile cells

Low Crop load

cellular defence system quickly exhausted

Problems with membrane function & structure

2 BigData

Sensor determination of growth conditions

Prediction of maturity & harvest management

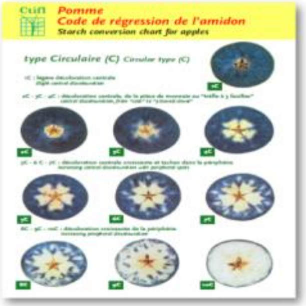
Prediction & optimisation of storage conditions and storage life

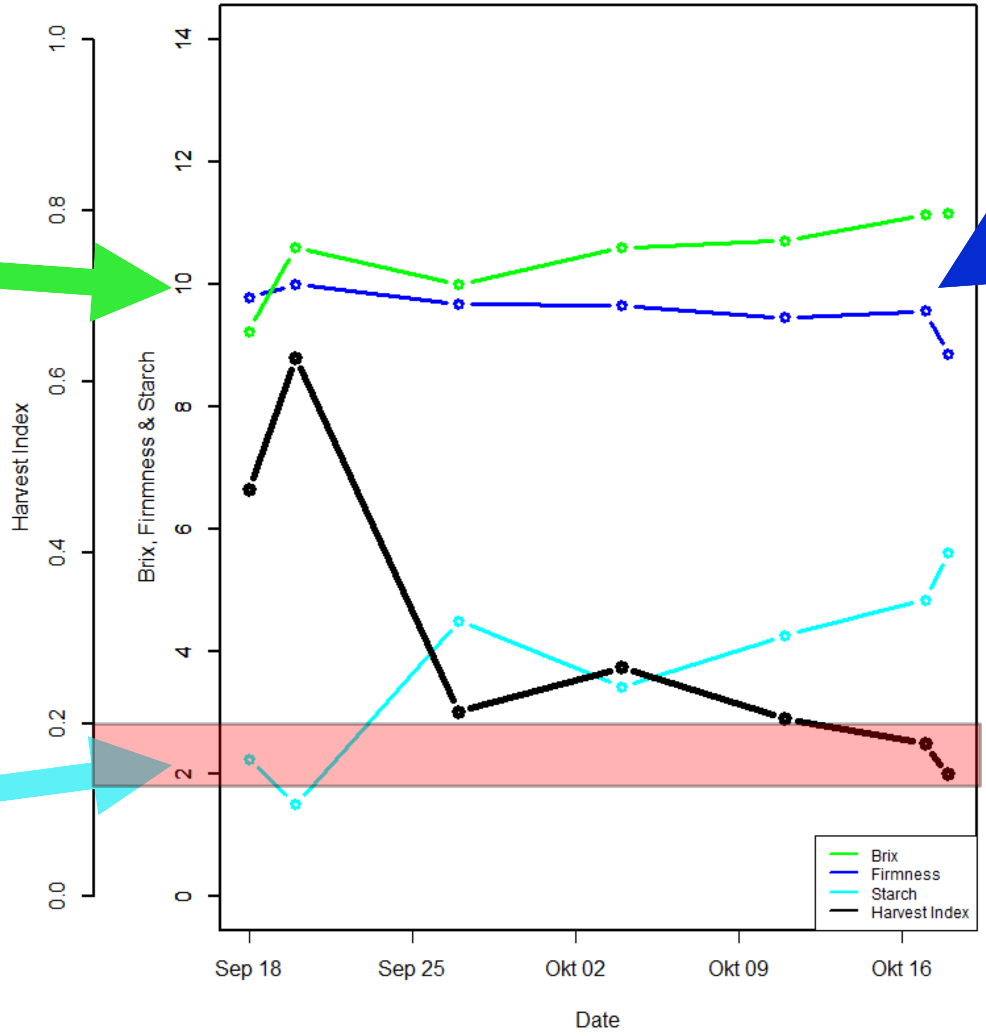
Destructive tests to determine ripening

Typical Braeburn Ripening Development

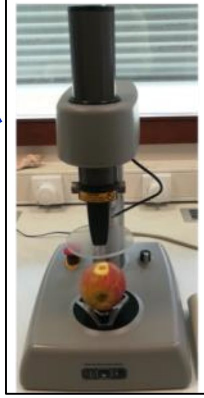
Refractometer
Sugar Content

Starch Pattern Chart
Starch Index





Penetrometer
Fruit Flesh Firmness



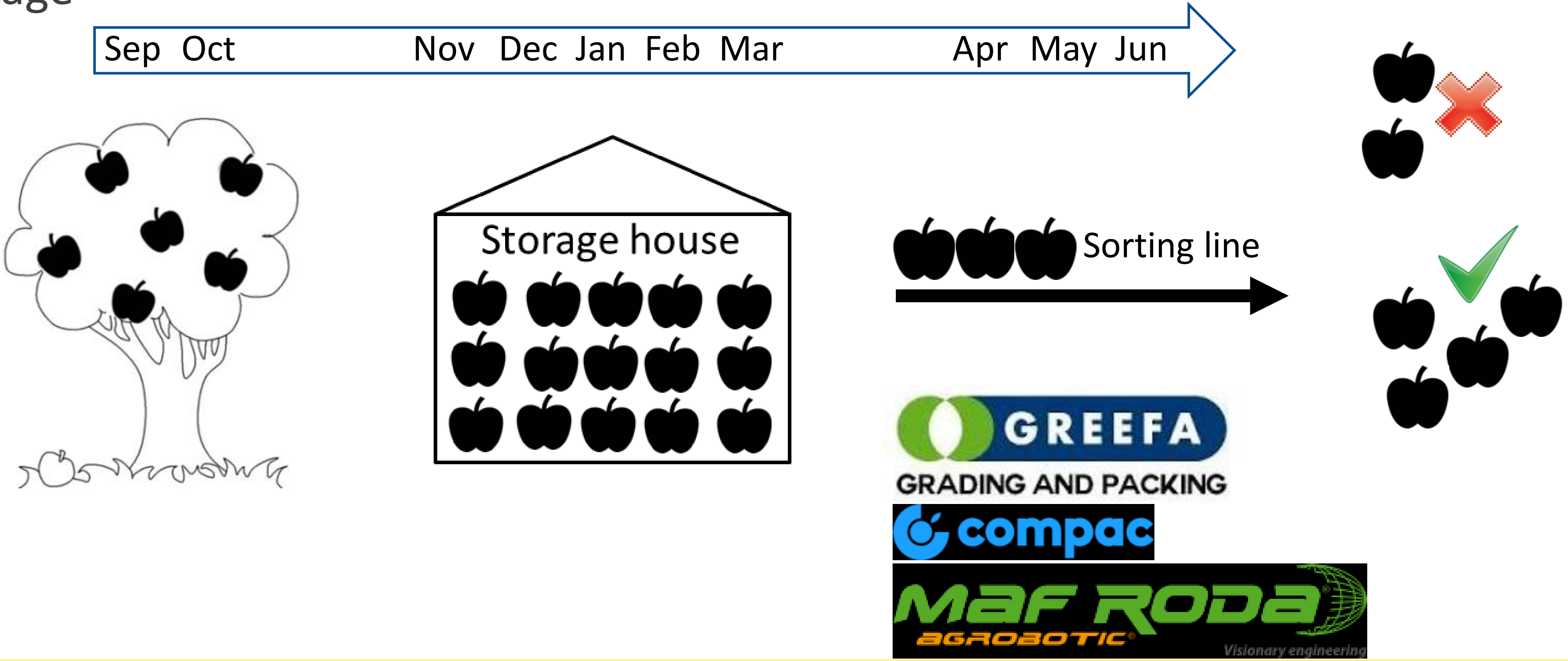
Harvest window for Braeburn
0.20 – 0.14 (Harvest Index)

KOB

Use of NIR technology in fruit quality

Picking of apple fruit is a trade off between ripeness (good taste) and keepability

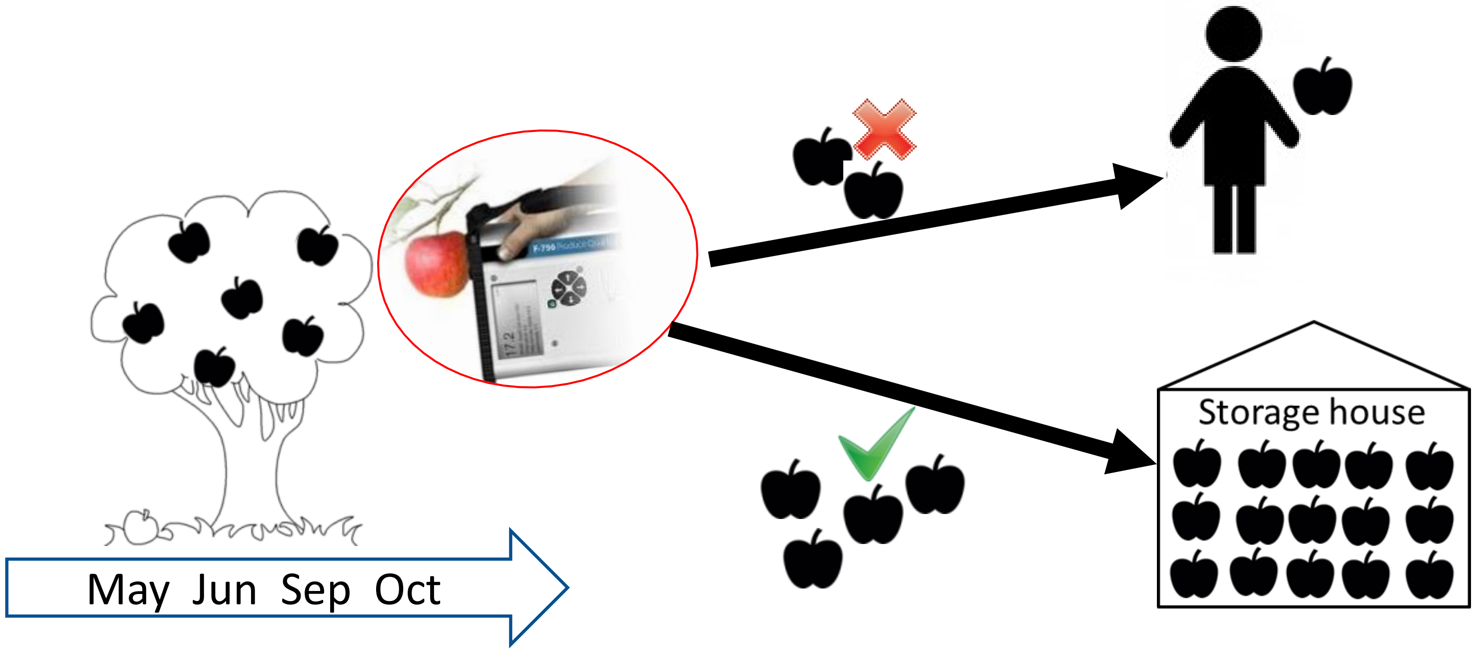
Up to date quality meassurements with spectrometers are being made after picking & storage



Aim of the study

Prediction of the optimal harvest time for apples based on VIS/NIR time series scans

We want to predict the apple quality one step earlier at the tree!



Experimental setup

- Weekly scans of ~400 apples with Felix F-750 (VIS-NIR)
- Scan position is marked on apple at the equatorial region
- PLS models for soluble solid & dry matter content
- Indices for changes in plant pigments from the visible spectrum
- Treatments in the field
  1. Three temperature regimes in spring time (Δ-36 °F, ambient, Δ+36 °F)
  2. Three cropload levels (no. apples) on tree (light, standard, heavy)

Destructive reference samples for non-destructive NIR calculations

Lab setup for soluble solid (sugar) and dray matter content analysis

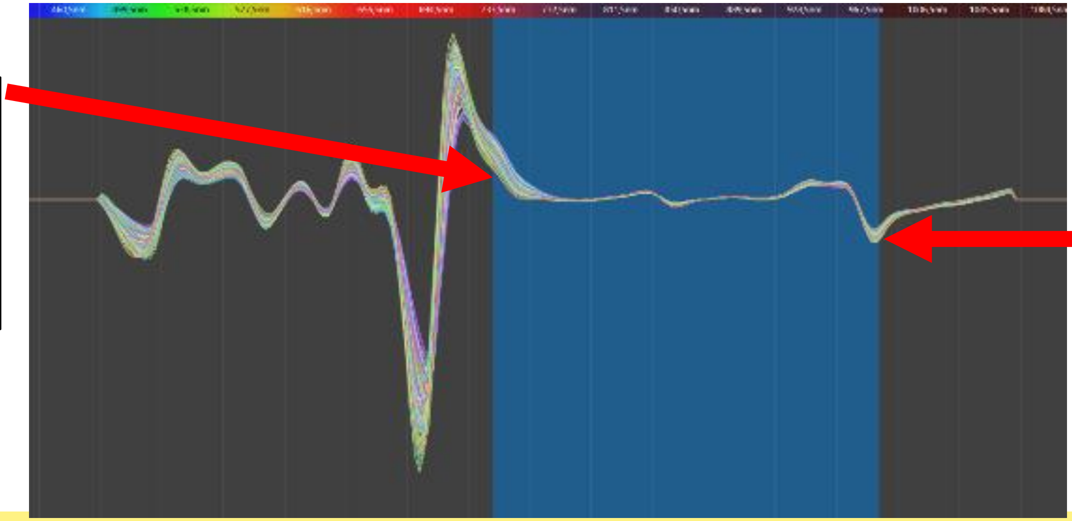
-~200 fruit over the duration of one season

-Scans at three temperatures to overcome temperature effect in the NIR region

-PLS (Partial Least Square) Model for one variety (Braeburn), one site & one season

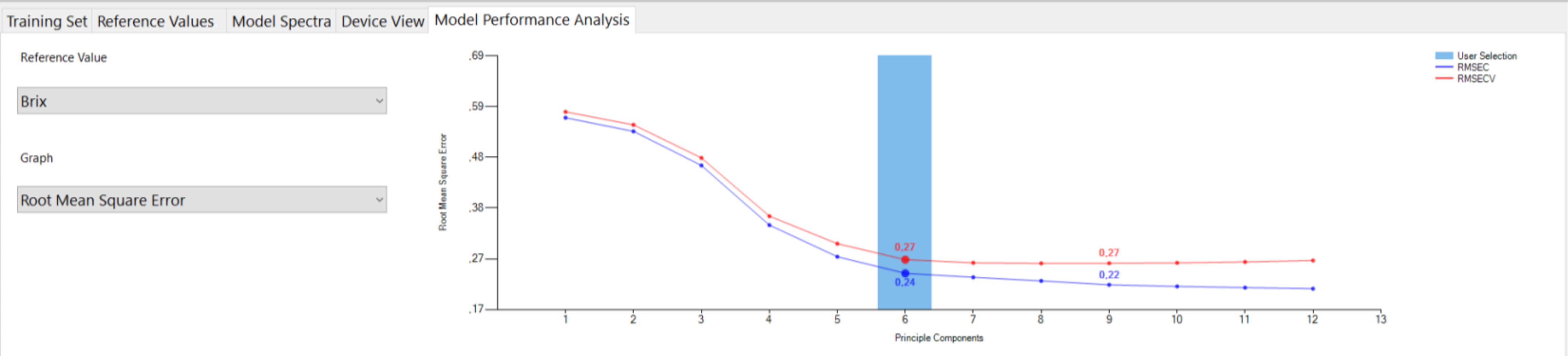
-> Local (specific) model: not useable for other Braeburn orchards / blocks Formula

Some information coming from the chlorophyll tail ~729-780 nm



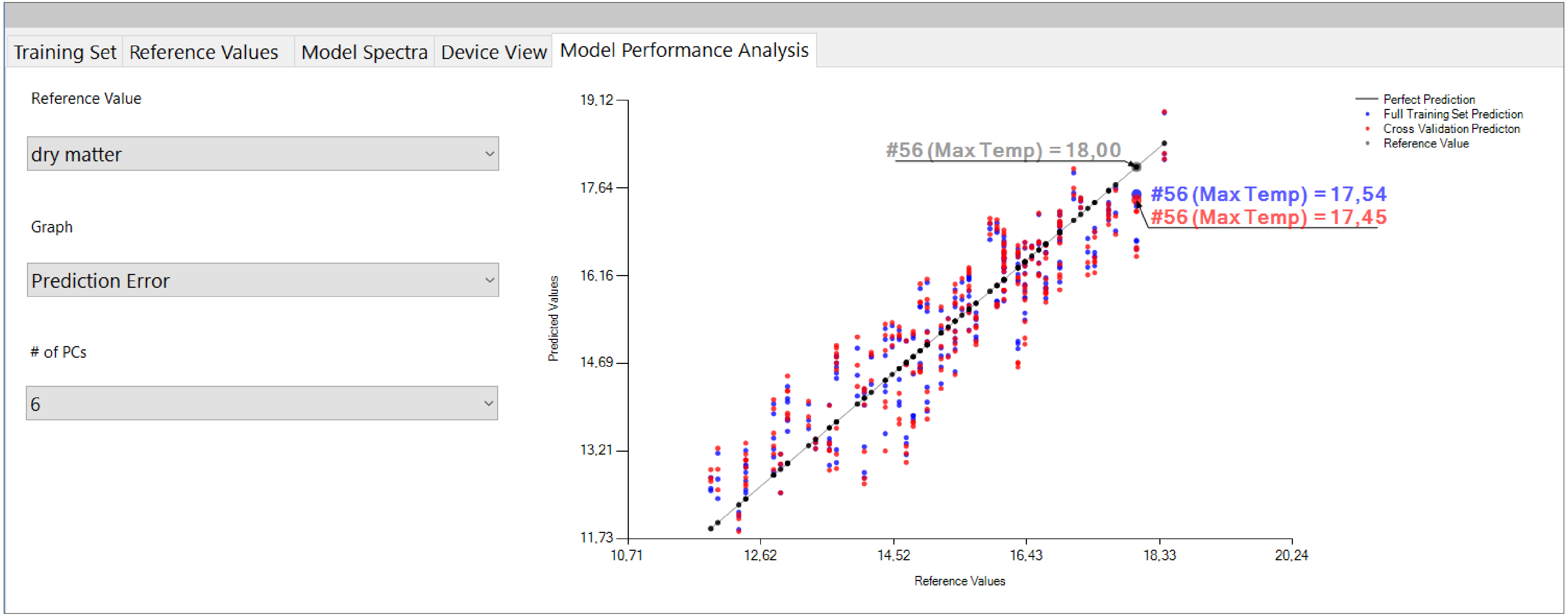
Most information coming from the wobbles in the R-OH bonds around the water absorbance peak

2018 Brix & Dry Matter Models Model Performance Analysis



Parameter	Brix Model (6 PCs) / 90 ref. Fruit	DM Model (6 PCs) / 90 ref. fruit
RMSE (RMSECV)	0.24 (CV = 0,27)	0.61 (CV = 0,69)
Coefficient of variance (estimate. for dest. lab ref. method)	~ 1.5%	~ 4.2%
Explained variance	81% (CV = 78%)	82% (CV = 77%)
Model Linearity (R2)	86% (CV= 83%)	85% (CV= 81%)

Experimental setup



Results (Season 2017)
Time-series data

Spring temperature treatment

Hypothesis:

For ~3 weeks after bloom the apple is in the cell-division period, afterwards the cells mostly elongate.

Colder spring temperatures will result in a longer period of cell-division.

Warmer temperatures will favor a shorter cell division period with more time before harvest for cell-elongation (larger fruit at-harvest).

Larger cells are more labile to show problems in storage (weaker or leaky membranes).

Cropload treatment

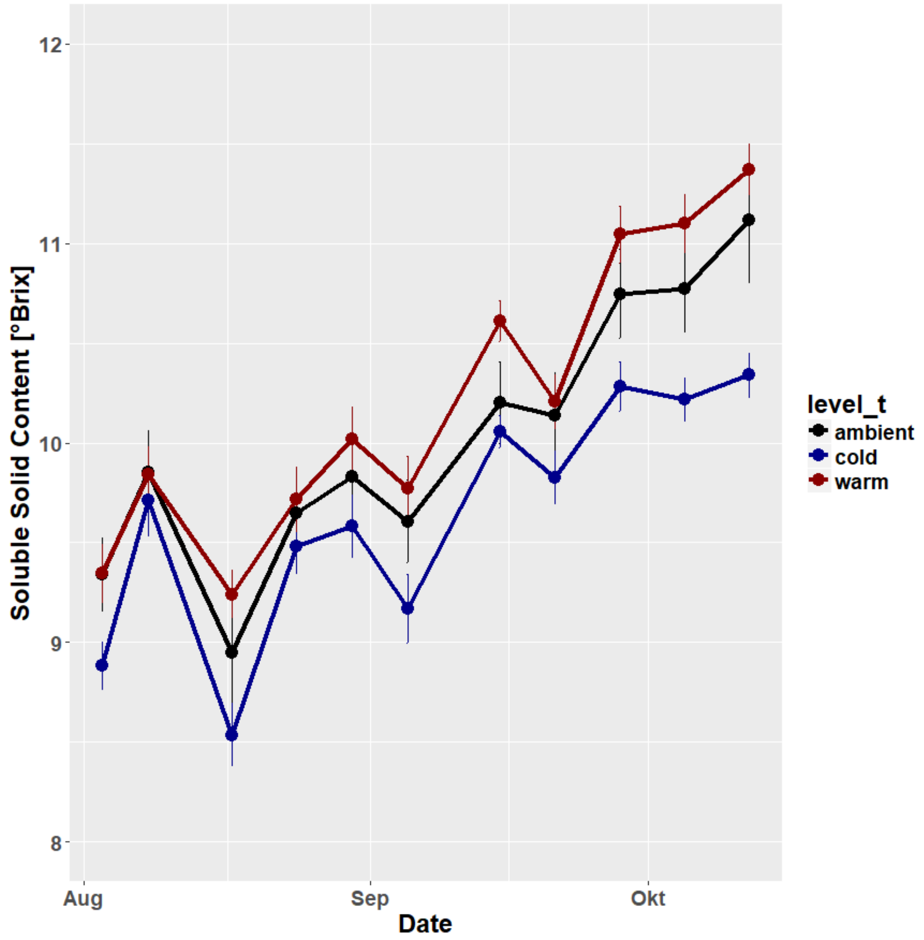
Hypothesis:

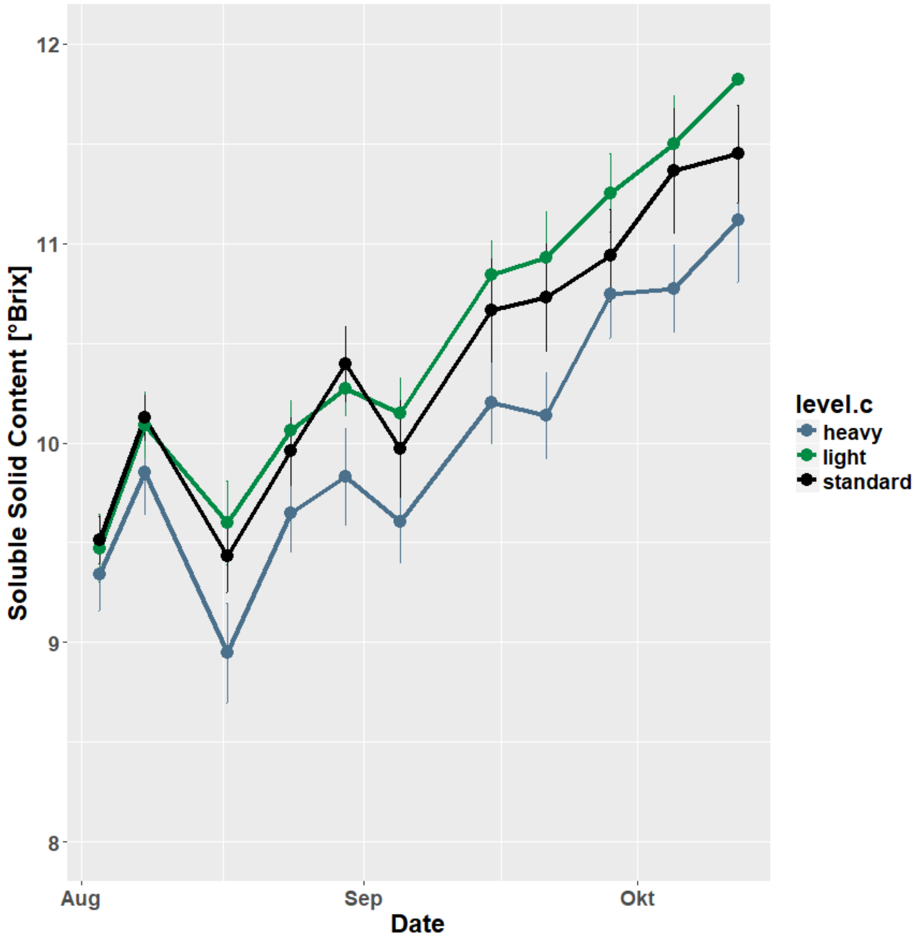
A balanced amount of leaves and apples is required to achieve good quality.

Light croploads result in more energy supply and few energy sinks.

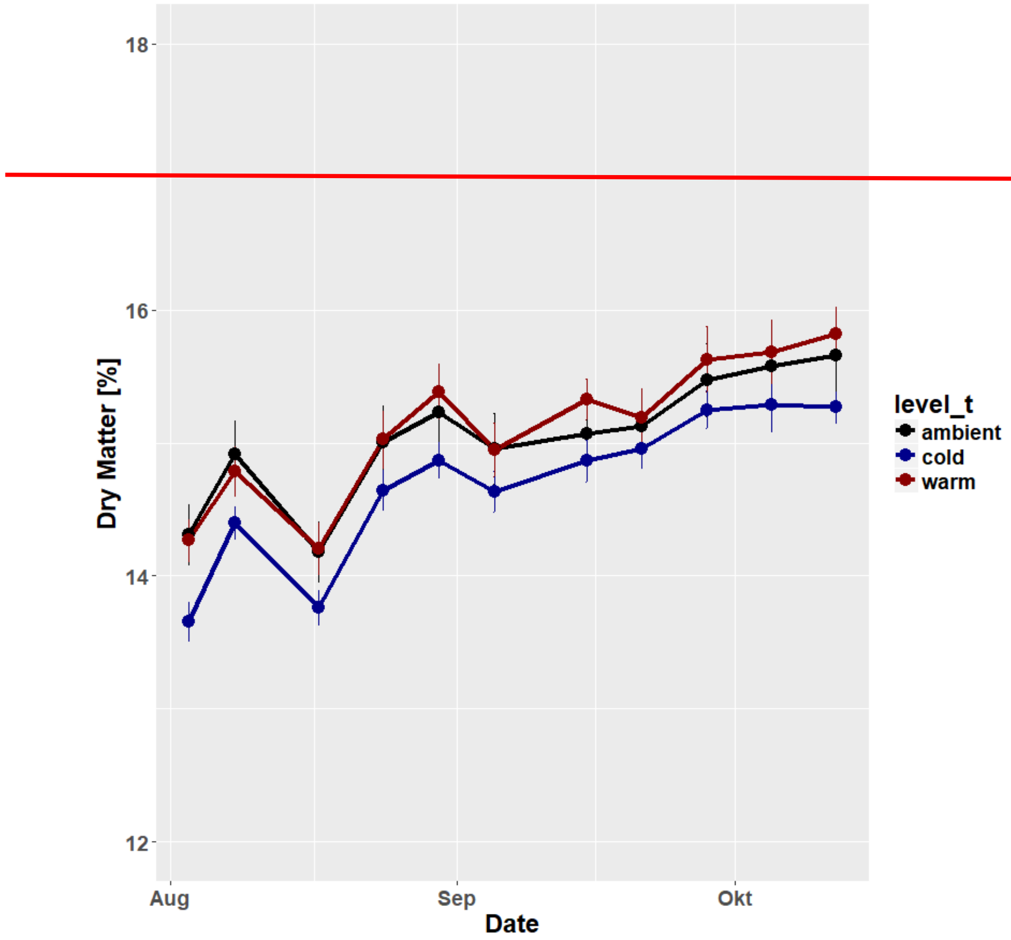
Apples that grow with an excess of carbohydrate supply, grow quickly and have large cells that are very prone to show problems in storage.

Fruit Soluble Solids Content (°Brix)

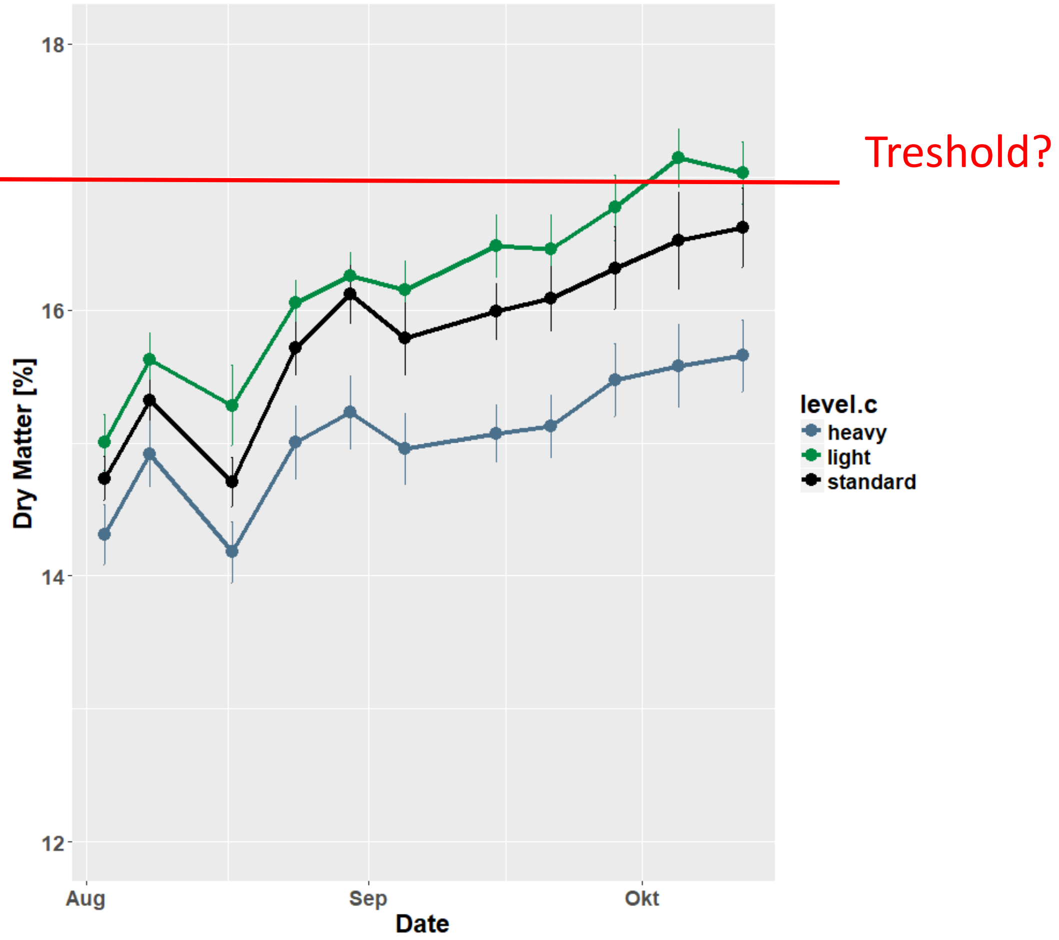




Dry matter



18
16
14
12
Dry Matter [%]
Aug
Sep
Okt
Date
level_t
ambient
cold
warm



18
16
14
12
Dry Matter [%]
Aug
Sep
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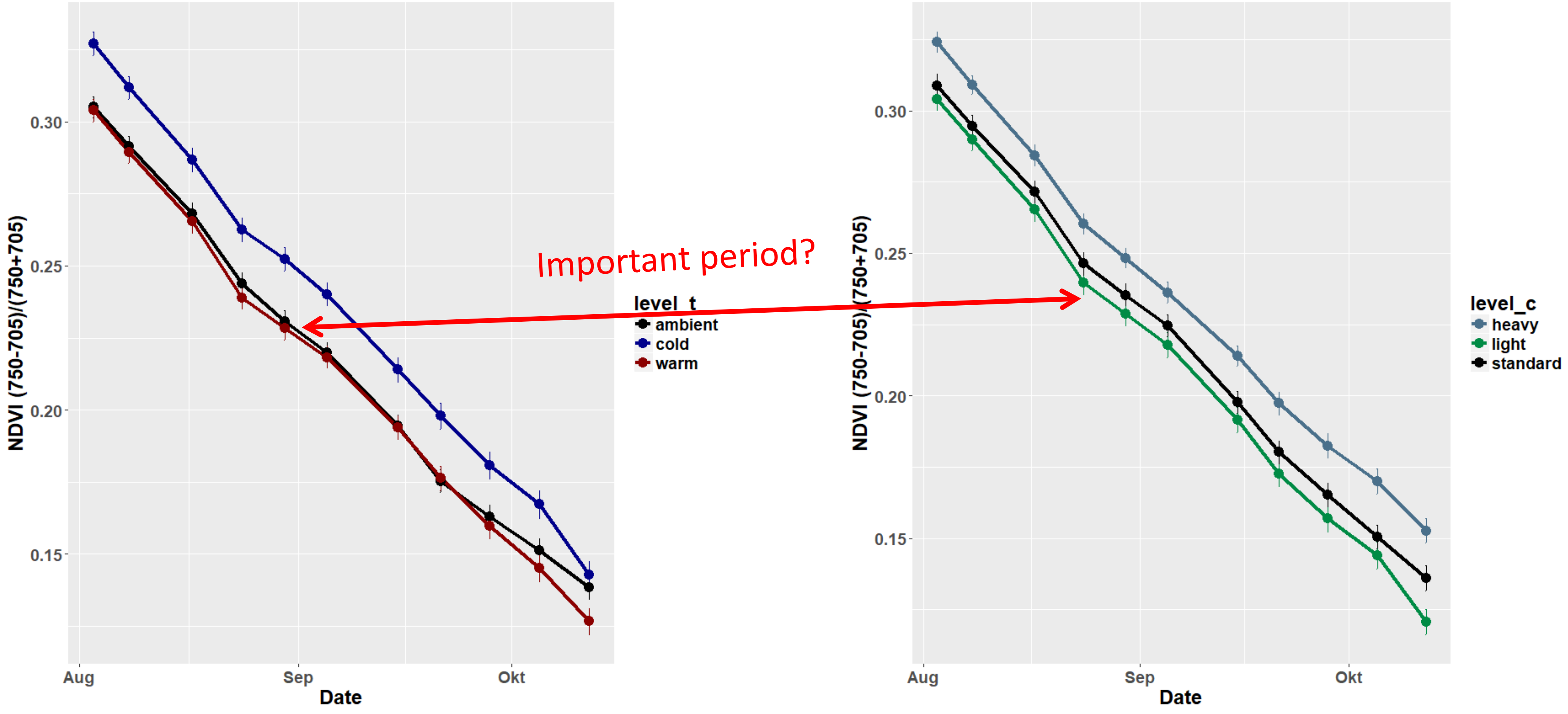
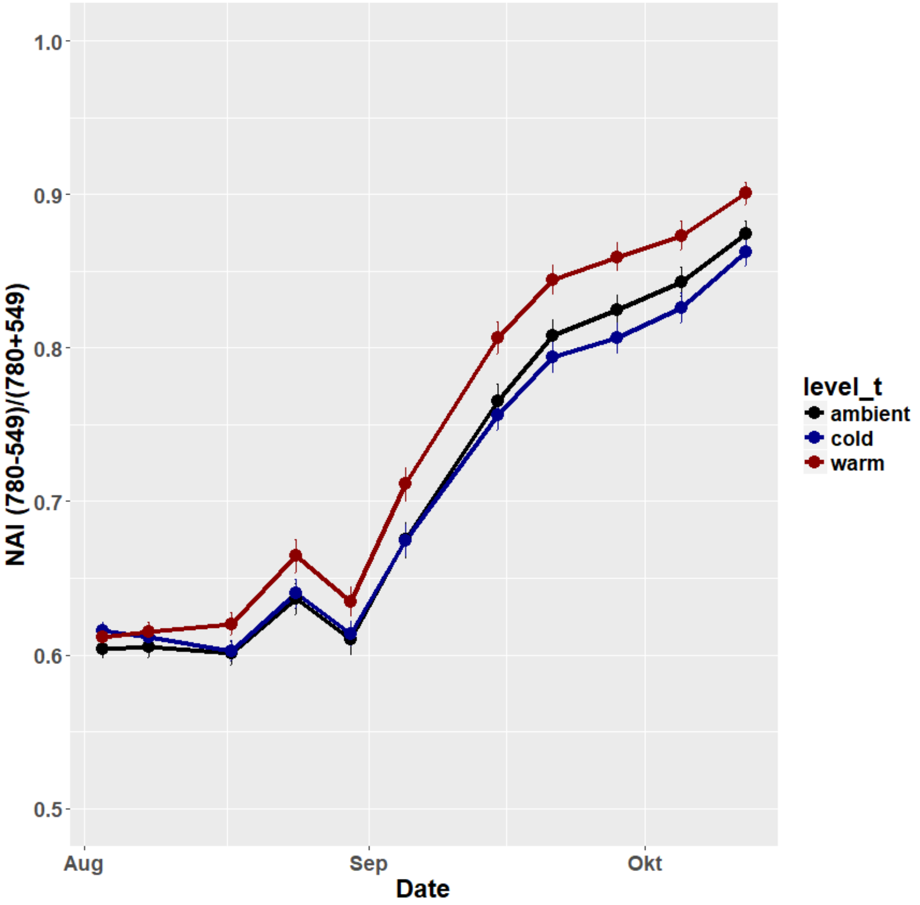
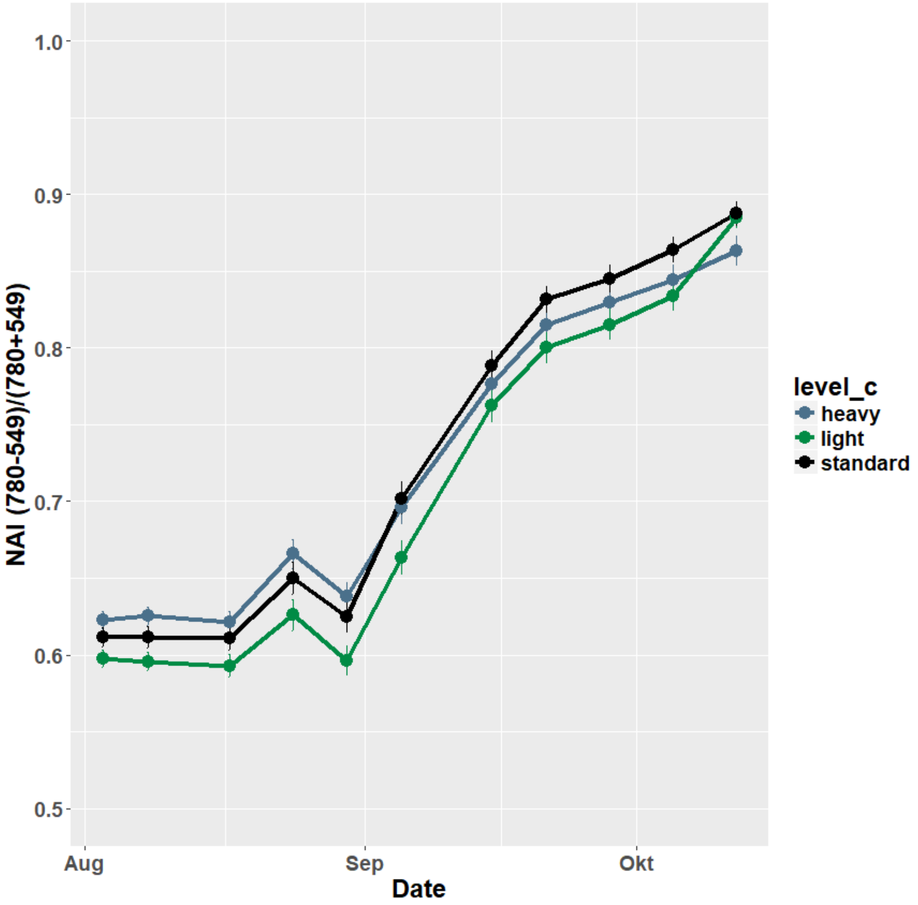
level.c
heavy
light
standard
Treshold?

Normalized Difference Vegetation Index



Normalized Anthocyanin Index





Conclusions & Next Steps

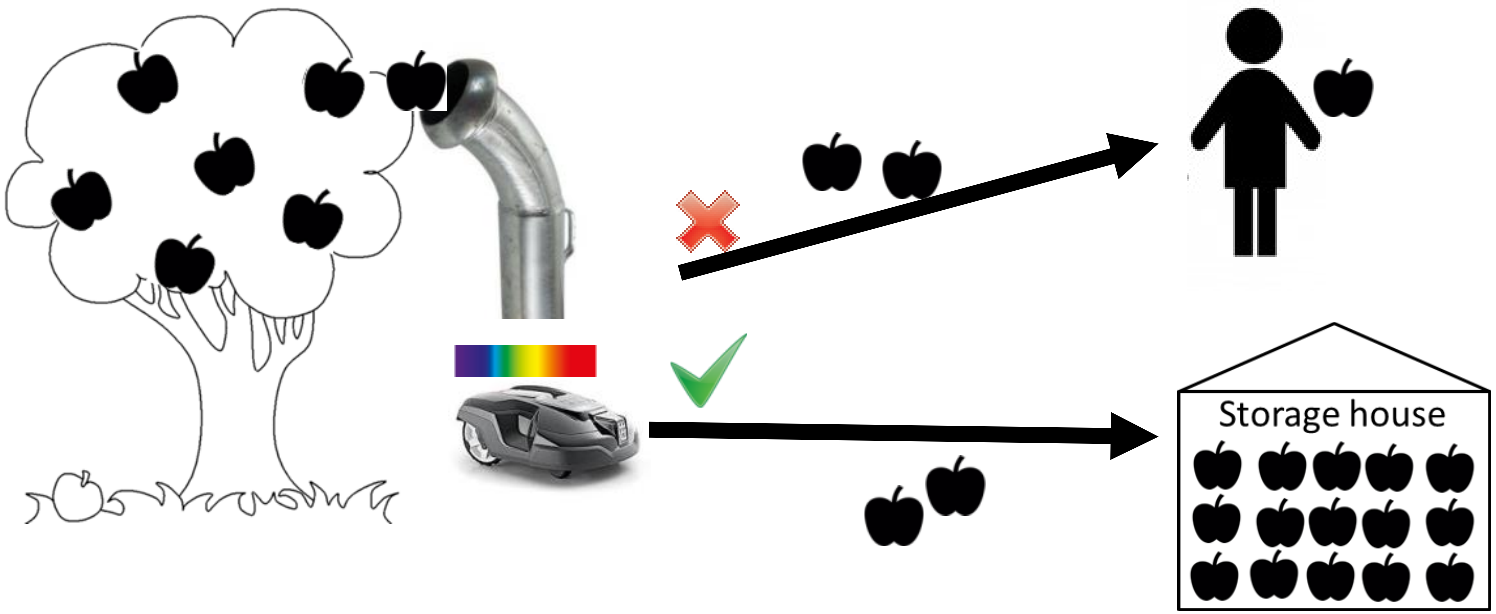
- We are able to obtain information about the effect of the environment and cropload on fruit quality processes.

- Orchard time-series data are being used in a black-box classification to predict storage outturn quality with promising results.

- We are particularly interested in determining changes in fruit cell-structure and carbohydrates using non-destructive VIS/NIR spectroscopy.

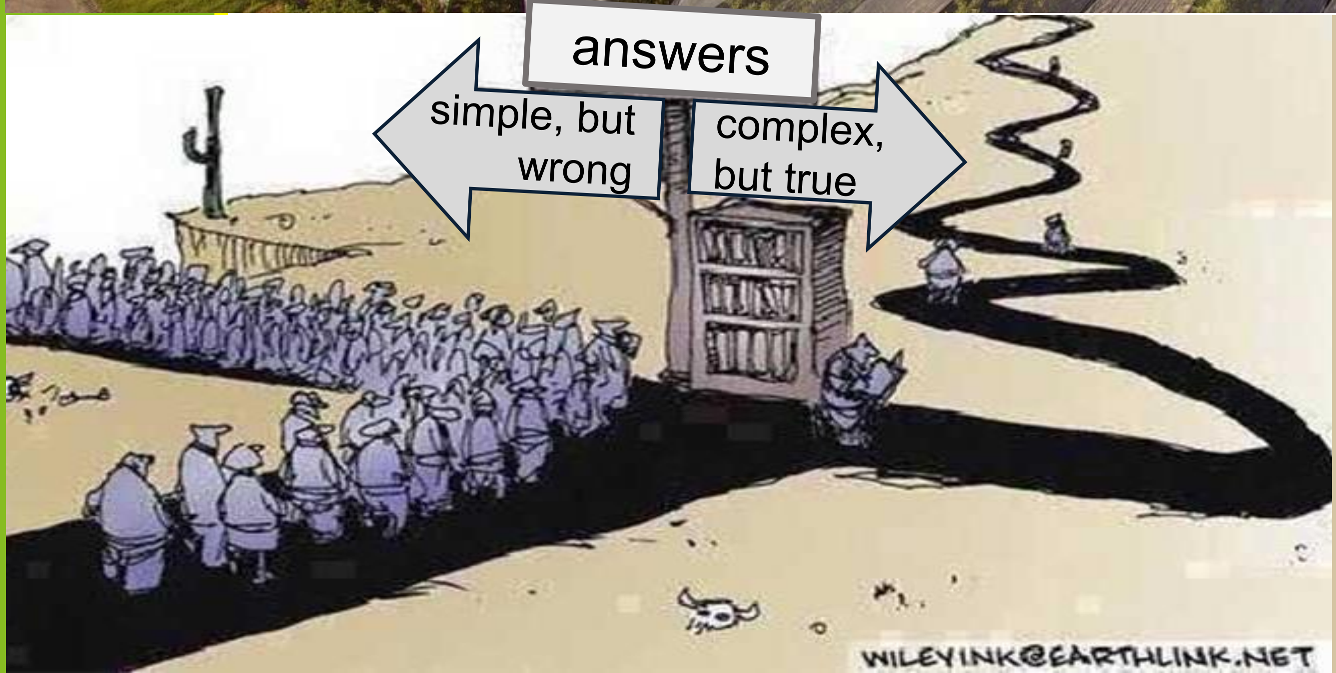
Future Outlook

E.g. Automated harvest machines will be able to classify fruit at the tree and can pick it according to its quality in different bins.



http://www.freshplaza.de/artikel/9349/Firmen-wollen-bis-2019-Roboter-f%C3%BCr-die-Apfelernte-auf-den-Markt-bringen

Risk of 'Braeburn' browning disorder based on weather and orchard factors. R.J. McCormick, K. Biegert, and J. Streif. CAMA2017 ISHS Proceedings 18-22 June, 2017. Warsaw, Poland (In Press)



Thank you for your attention!

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