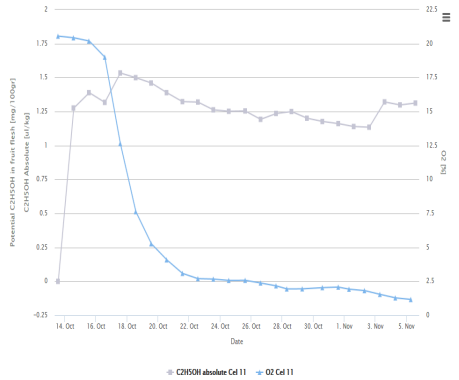
Dynamic Control System for storing fruit at the lowest oxygen level

DCS Automatic for the best fruit quality



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Why DCS Automatic ?

Storing fruit at the lowest O_2 level will provide the best fruit quality (source: FBR Wageningen)

Advantages of DCS automatic

- Better firmness, better shelf life compared to CA.
- DCS Automatic is an alternative for DPA
- Maximum reduction of scald, skin spots and pit rot

Advantages of DCS automatic

- Non chemical treatment
- Natural ripening after storage, better taste!!!
- Better appearance of the product
- **DCS™** represents a quality label
- Guarantees on freshness and quality can be realized on a better way.

Advantages of DCS automatic

- DCS can be used as an alternative for smartfresh / or be used in combination with smartfresh.

DCS -Red Delicious

- Reducing scald
- Preservering the firmness excellent
- Better taste
- Fresher appearance
- Consumers do appreciate the apples better
- DCS against age decay and flesh brown
- Possible detection of decay

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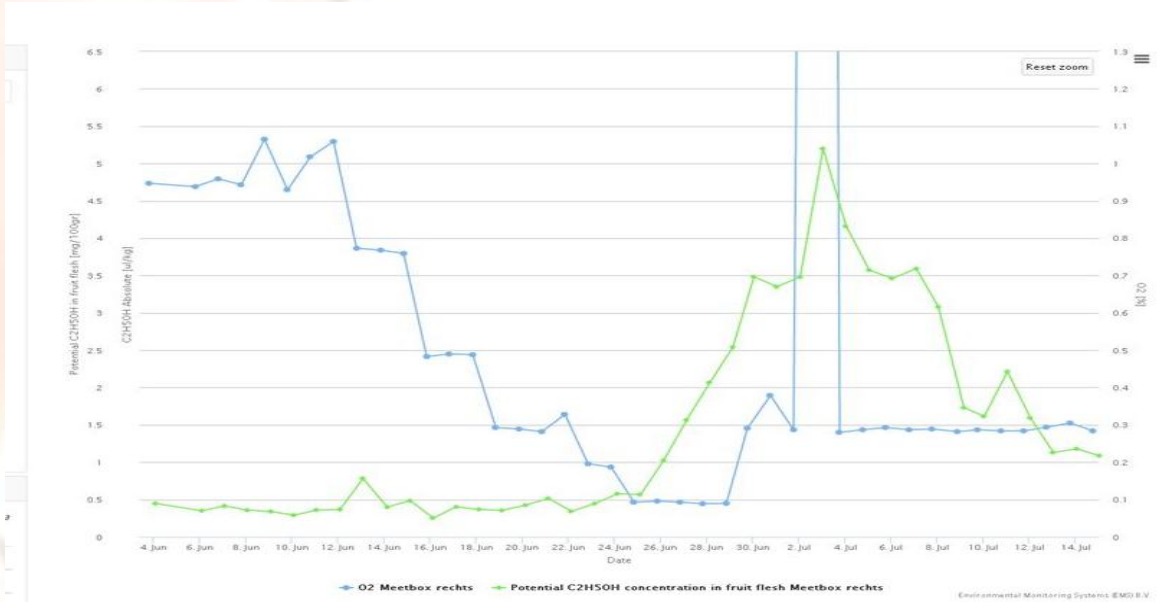
How to come to lowest O_2%?

Select a good marker for the lowest oxygen threshold were fermentation will start.



Ethanol as ‘the marker’

Respiration:

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_20 + \text{energy/volatiles}$$

Fermentation:

$$C_6H_{12}O_6 \rightarrow 2\ C_2H_5OH + 2\ CO_2 + \text{energy/volatiles}$$

The production of ethanol is a direct marker for the start of fermentation.

Alternative markers?

Measuring chlorophyll fluorescence:

- Per sensor only 6 fruits
- Various origins / qualities in a store needs a sensor. Will this be facilitated??
- Relation of chlorophyll stress an fermentation is questioned by researchers and practice.
- An indirect indicators for fermentation and therefore less accurate.

Alternative markers?

Respiration Quotient:

- RQ have to measured rather accurate. This is rather difficult due to varying circumstances
- In case 10% of the fruits are fermenting, the RQ will be ca. 1,03.
- In practice the RQ varies from 0,7 up to 1,8. this is not suitable for finding Low Oxygen Limit

- RQ is an indirect indicators for fermentation and therefore less accurate.

Why DCS Automatic?

"Ethanol is the ***only known direct marker for fermentation***"

(Jan Verschoor Senior CA researcher WUR Wageningen)

For this reason we develop the 'DCS Automatic' system for measuring the start of ethanol production by fruits during a O_2 pull down in steps.

Why DCS Automatic?

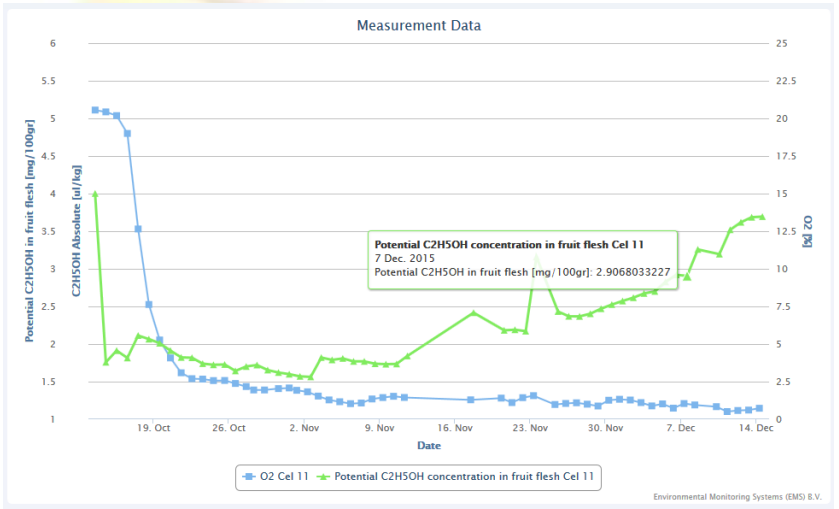
Special features of DCS automatic:

- Accurate readings of produced ethanol in ppb
- Automatic measurement of the O_2 level
- Daily automatic measurement

Why DCS Automatic?

Special features of DCS automatic:

- Readings made of large batch representing the origins in the store
- Very sensitive for measuring the start of ethanol production by the most sensible fruits!!
- Possible indication of start of decay of fruits



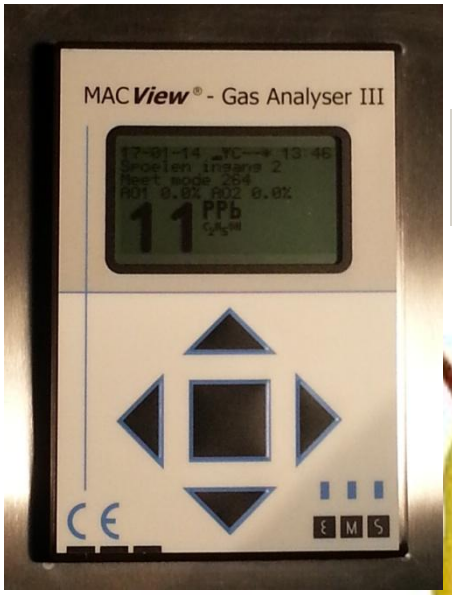
How does it look like

2 pc measuring boxes

The DCS gas analyser

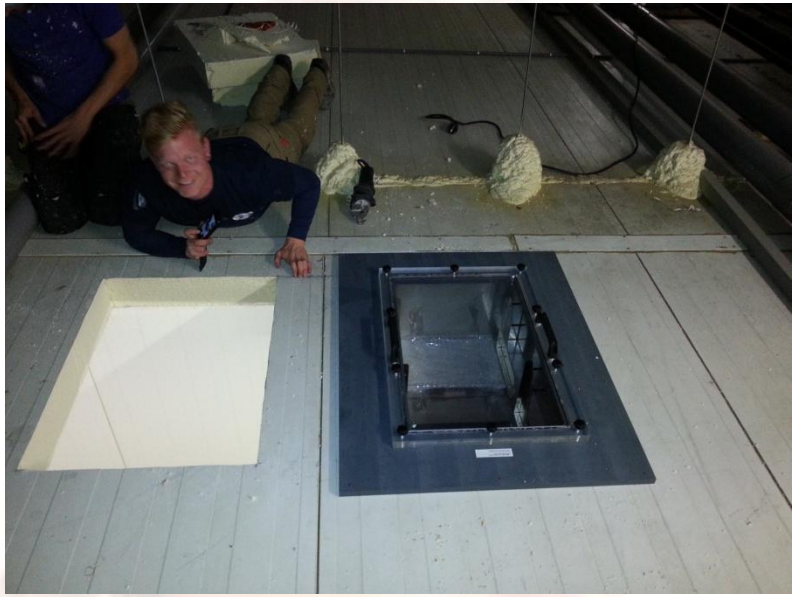
An I/O box

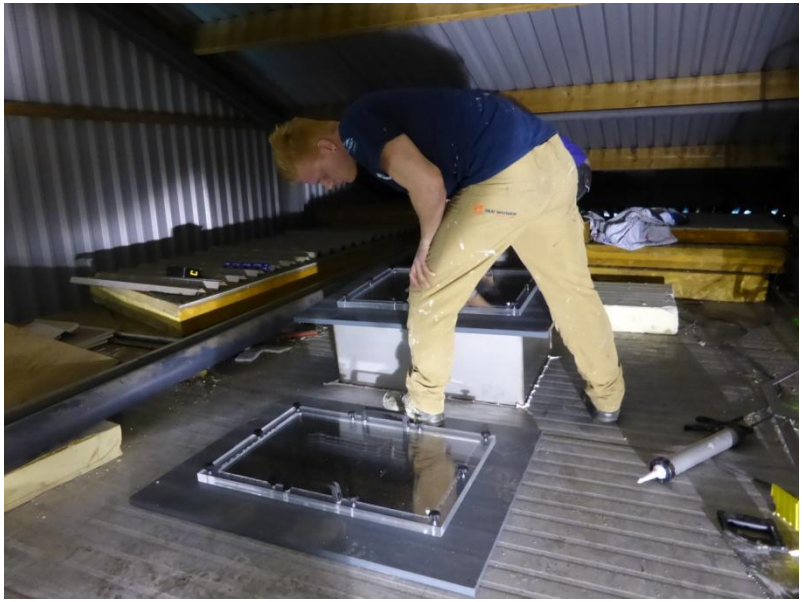
Installation of measuring boxes

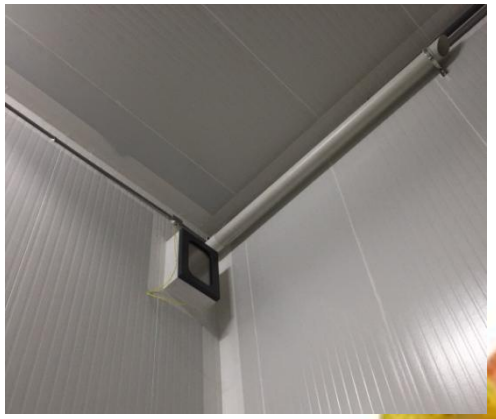


Measuring box

Installation of measuring boxes







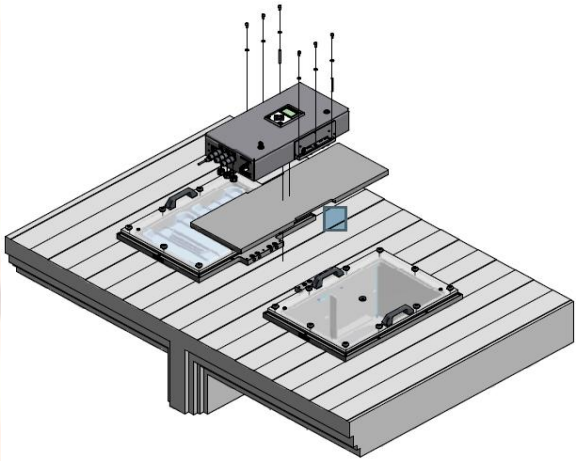
Ventilation opening

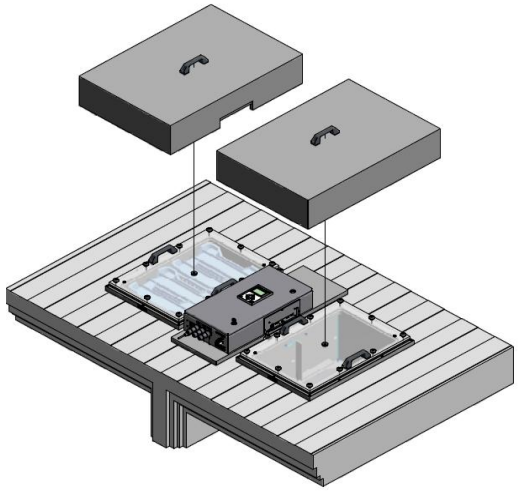
stainless steel bottom plate above opening

Membrame in grove of the PVC bottom for closing /opening

Internal ventilation system in measuring box

Insulation





How does it work

1. A sample of in total 20 kg. fruit in which different origins are equal represented in kg. is being composed and placed in the measuring box.

Important; each origin is represented on an equal level. The most susceptible fruit of an origin will start first with fermentation. This will be measured.

Because of this DCS Automatic controls the O2 level based on the most susceptible origen

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How does it work

2. After cooling down and the regular oxygen pull down the apples will gradually be stored at lower O_2 levels. The target value will be reduced by 0,2 or 0,1 O_2% per 5 days.

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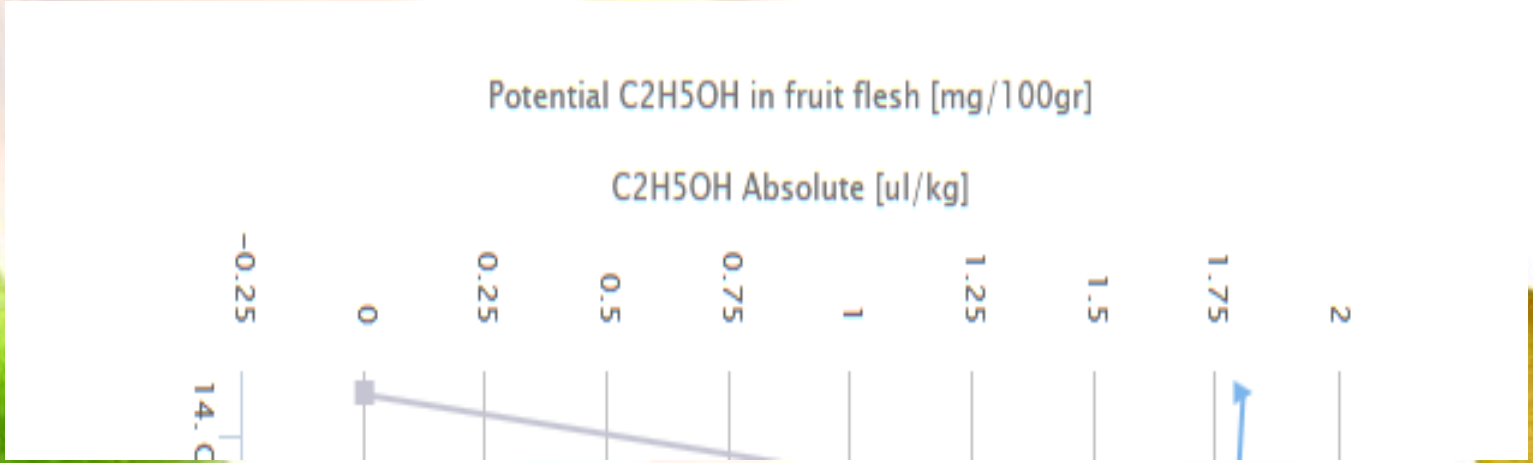
How does it work

3. The gas analyser is measuring each day, during a cycle of ca. 3 hours, the ethanol production of the fruit in the measuring box. The O_2 level in the CA room is also measured.

Measured ethanol is presented as;

Potential ethanol in fruit flesh in mg./100 gr fruit flesh



How does it work

4. The measured ethanol production and O_2 level are are presented on URL Internet page.

Graphs Hoogesteger

Graph selector

05-10-2015 to 05-11-2015

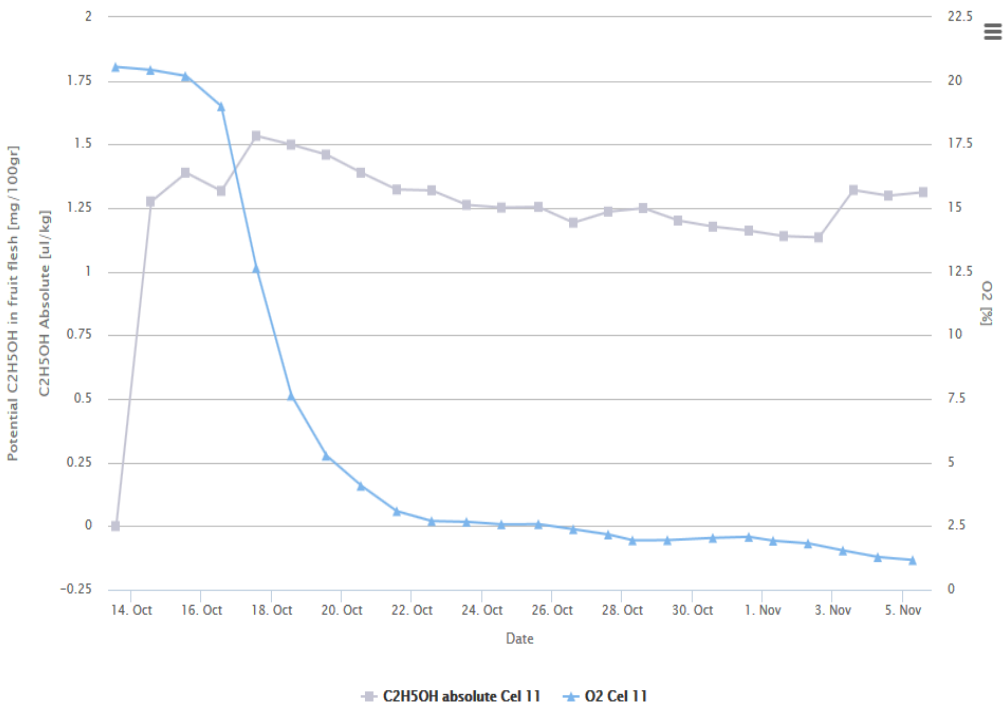
Hoogesteger - Cel 11

- [ ] Potential C_2H_5OH concentration in fruit flesh
- [x] C_2H_5OH absolute
- [x] O_2

Hoogesteger - Cel 12

- [ ] Potential C_2H_5OH concentration in fruit flesh
- [ ] C_2H_5OH absolute
- [ ] O_2

Generate graph



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How does it work

5. The operator will maintain, reduce or increase the O_2 level in this CA store depending on the strategy and the measurement results.

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The DCS Gas analyzer

The Gas analyzer is provided with:

- An ethanol senor on ppb level
- An optical O_2 senor: accuracy 0,001%!!
- Automatic measuring procedure and extensive data storage system on measuring ethanol production and O2 consumption during the measuring procedure.

The DCS Gas analyzer

Measuring procedure;

1. Measuring the O2 level in the CA store
2. Closing of the box
3. Filtering the air in the box.
4. Start measuring ethanol production
5. Start measuring decrease of O_2 = O_2 consumption by the fruit.

The DCS Gas analyzer

Important:

Each day data is collected based on none destructive measurements from the same representing sample of the contents of the CA store.

Day by day the ethanol production and O_2 consumption of the batch in the measurement box is monitored at the present O_2 level.

Main objective

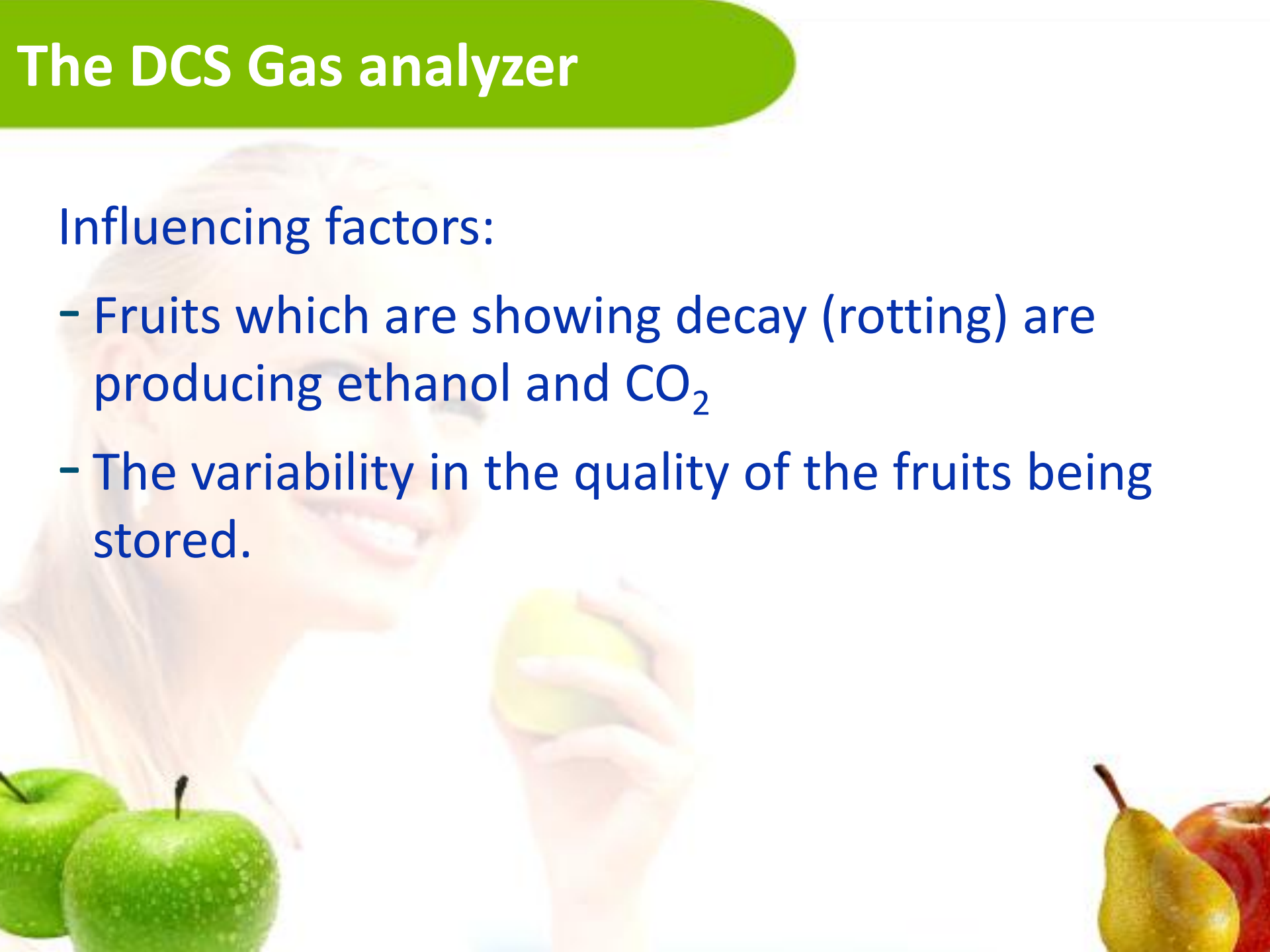
The challenge is to detect from the weakest batch the first signals of fermentation for preventing fruit damage.

At the same time we want to know this accurate in order to store the fruit on the lowest possible O_2 levels for saving the best quality

The DCS Gas analyzer

Influencing factors:

- Fruits which are showing decay (rotting) are producing ethanol and CO_2
- The variability in the quality of the fruits being stored.



Pull down procedure 1

DCS Pull Down:

1. After reaching 1,0 %O_2 decrease the O_2 by 0,2% to a setpoint of 0,8% O_2. Keep a waiting time of 4 days

2. Repeat this step; O_2 DECREASE THE O_2 BY 0,2% TILL 0,6% O_2 AND A WAITING TIME OF 4 DAYS

Pull down procedure 2

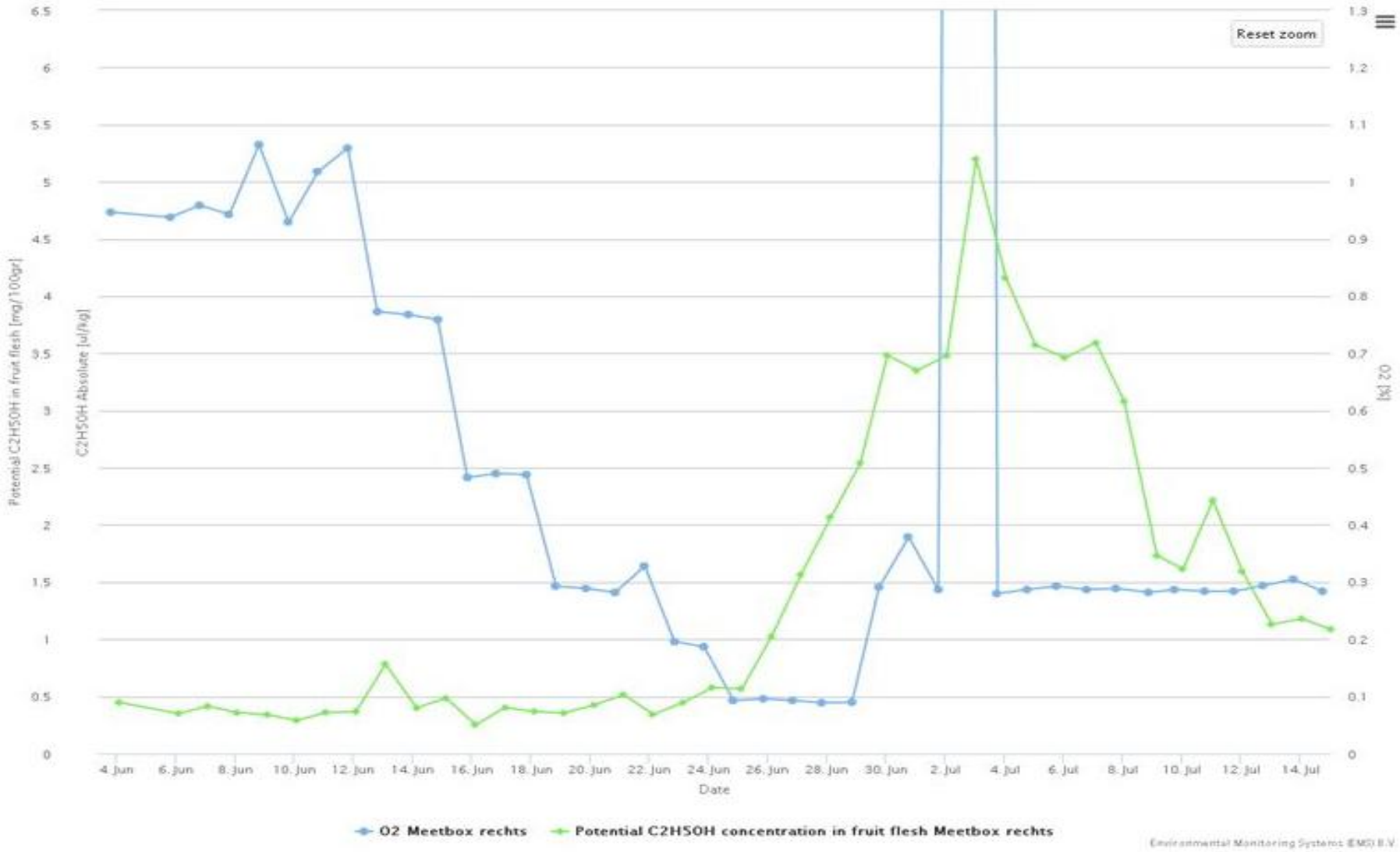
3. Then the decrease of O2 will will be continued by steps of 0,1% and waiting time of 4 days.

- The CO_2 can be decreased depening on the variety

- Observe the production of ethanol.

- If there is an increase of 0,5-1,0 mg ethanol/100 gr fruit/ day during 3 days, then increase the O2 level

Example ethanol production



2nd example of fermentation

Graph Selector

12/27/2015 to 01/07/2016

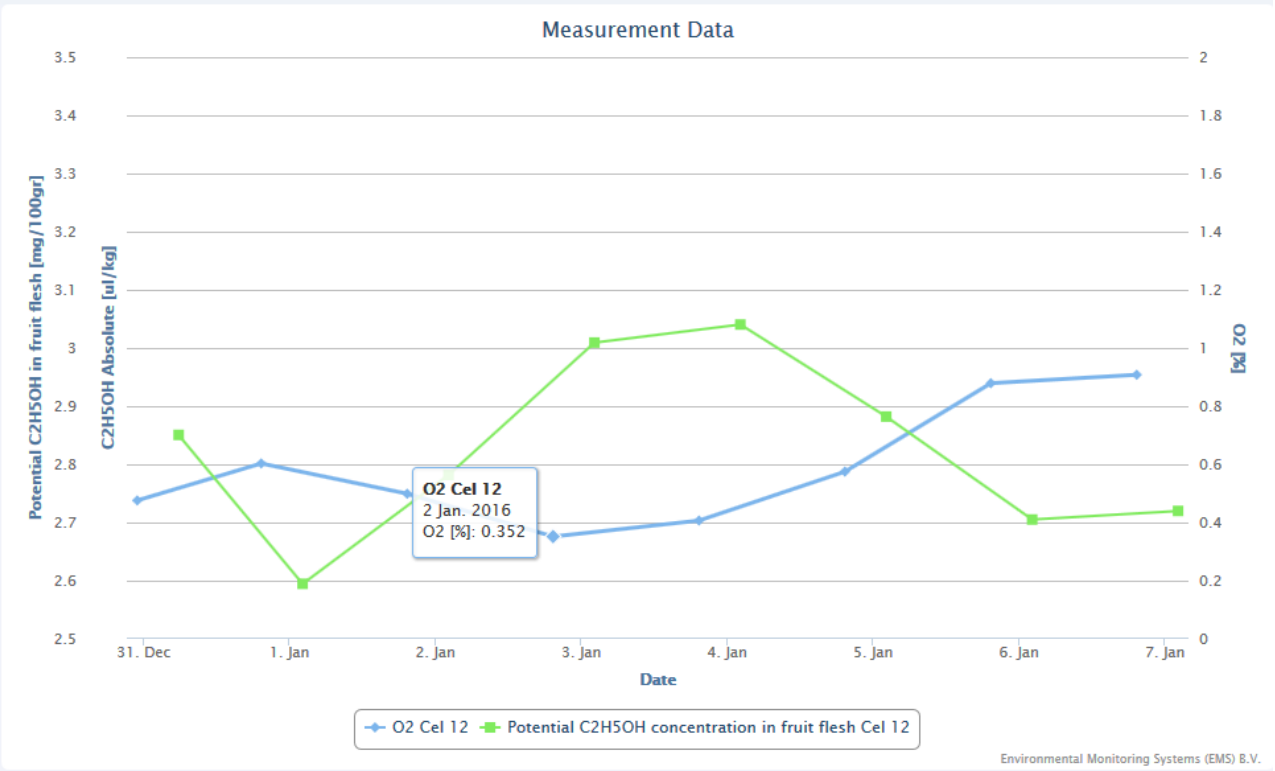
Generate Graph

Hoogesteger - Cel 11

- [ ] Potential C_2H_5OH concentration in fruit flesh
- [ ] C_2H_5OH absolute
- [ ] O_2

Hoogesteger - Cel 12

- [x] Potential C_2H_5OH concentration in fruit flesh
- [ ] C_2H_5OH absolute
- [x] O_2



Hoogesteger, Junami, O2 reduction from 0,6%O2to 0,352%O2 caused an ethanol production increase from 2.6mg to 3 mg in 2 days. After increasing the O2 level to 0,8% the ethanol production decreased to 2.7mg.

Important feature 1

- It have to be noted that there can be a ‘Ground level of ethanol production’ in the sample
- This is caused by the presence of bruised fruit flesh texture or internal diseases causing decay / rotting fermentation.
- It is characterized by daily stable low production of ethanol on a level of ca. 0,1 – 1-2 mg. Ethanol/100gr fruit flesh

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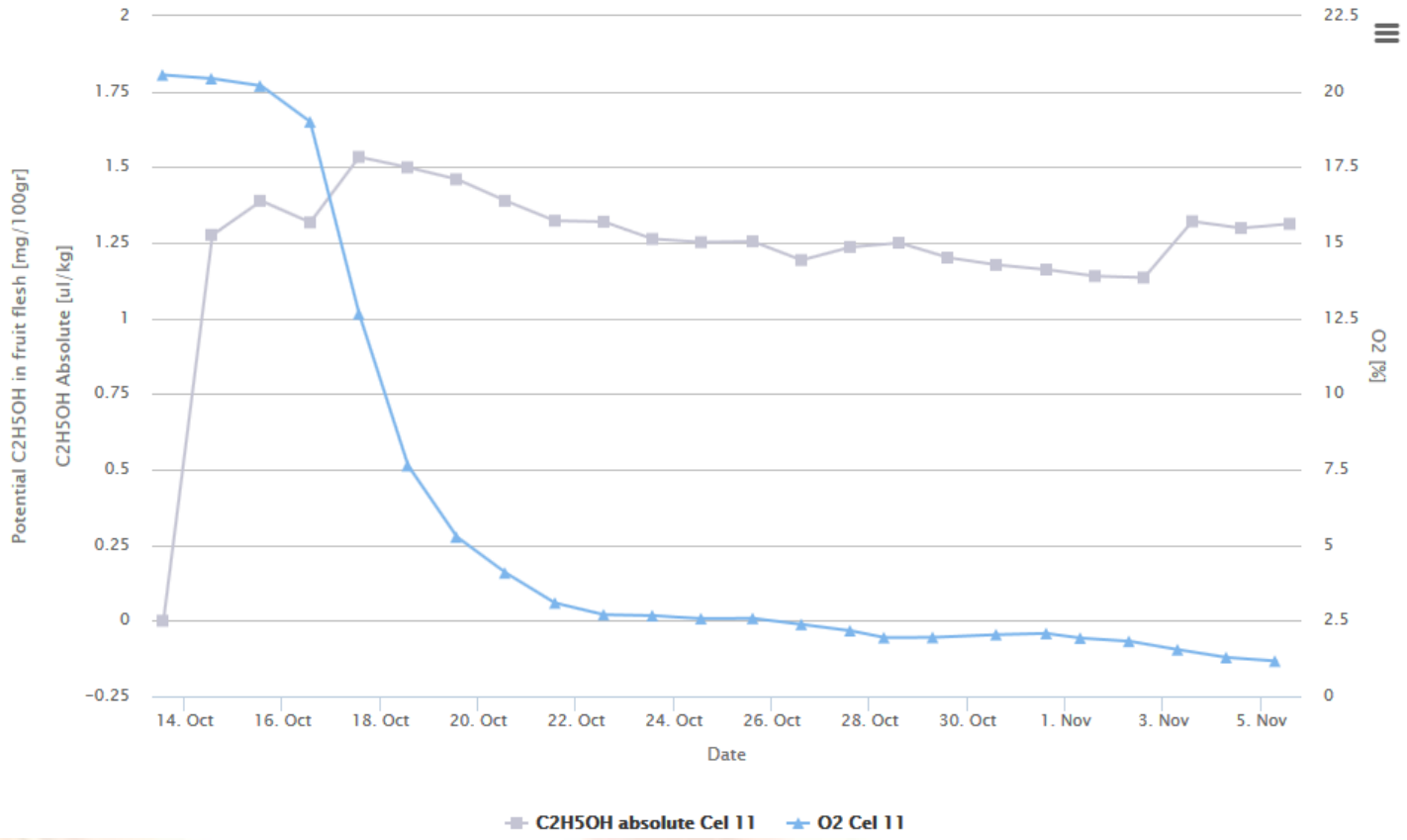
Example of basic production



Hoogesteger; Example of basic prodduction of ethanol at a level of 1,25 mg at an O2 level of 2,5% Oxygen

Example of basic production

Graphs

Switch Company

Graph Selector

09/01/2015 to 11/27/2015

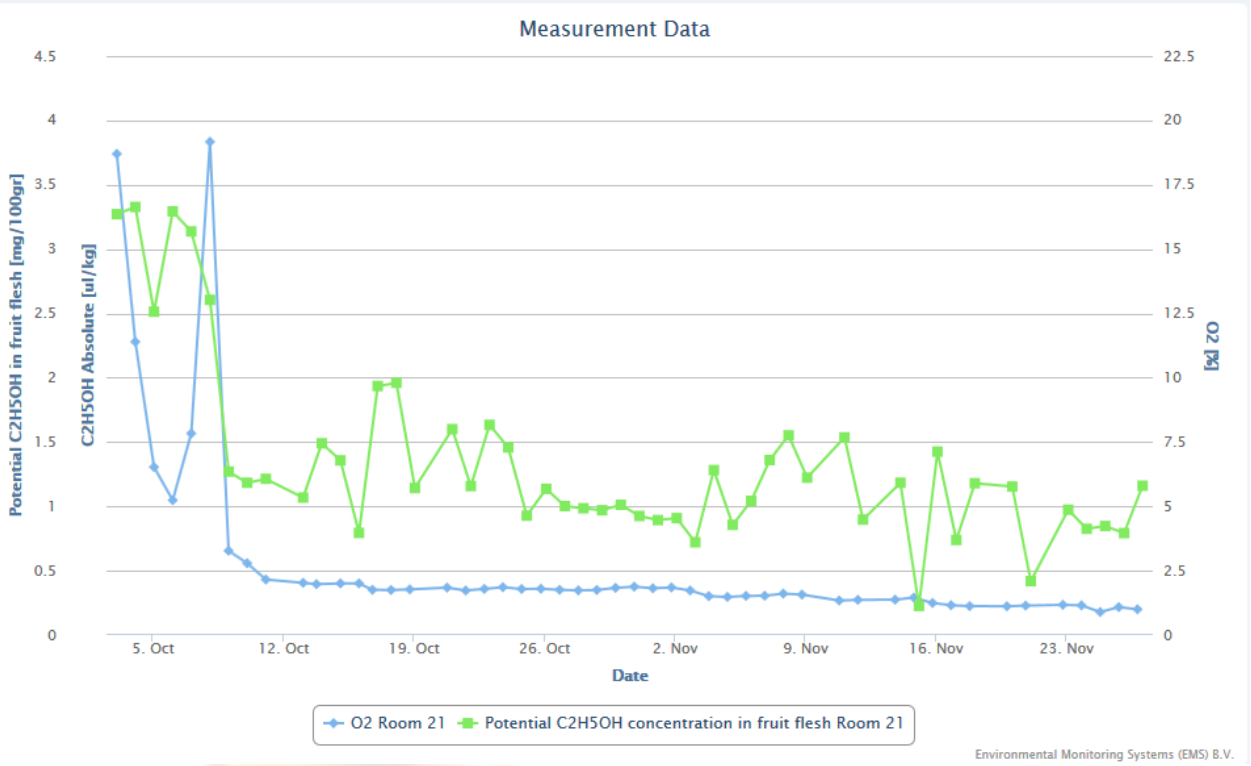
Generate Graph

Van Meekeren Farms - Kentville - Room 22

- [ ] Potential C_2H_5OH concentration in fruit flesh
- [ ] C_2H_5OH absolute
- [ ] O_2

Van Meekeren Farms - Kentville - Room 21

- [x] Potential C_2H_5OH concentration in fruit flesh
- [ ] C_2H_5OH absolute
- [x] O_2



Van Meekeren, O2 ca.1% basis production of ethanol ca. 1-1,5mg.

Important feature 2

- Detection of decay of one or more fruits in the sample.
- When a gradually slow increase of ethanol is detected of ca. 0,1-0,2 mg ethanol/100 gr. Fruit flesh/day this is an indicator for developing decay /rotting

- We provide 3 examples

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Example of fermentation by decay

Graph Selector

10/01/2015 to 12/15/2015

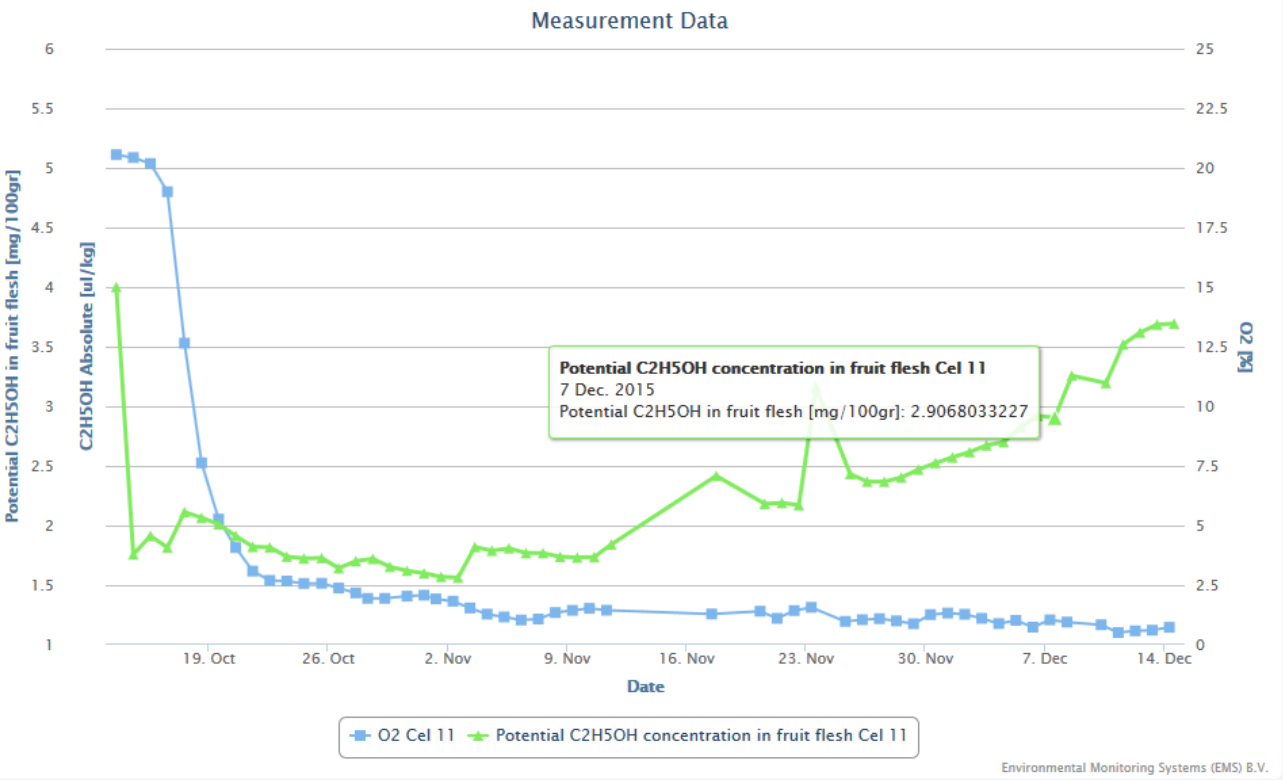
Generate Graph

Hoogesteger - Cel 11

- [x] Potential C_2H_5OH concentration in fruit flesh
- [ ] C_2H_5OH absolute
- [x] O_2

Hoogesteger - Cel 12

- [ ] Potential C_2H_5OH concentration in fruit flesh
- [ ] C_2H_5OH absolute
- [ ] O_2



Hoogesteger; Jonangold. Room 11, was hold on O2 level above 1%. The ethanol production increased gradually by 0,1-0,2 mg per day. In december we checked 3x a sample of over 100 fruits and found 3x time fungis in the pit.

Example of fermentation by decay

Hoogesteger Fungi in pit, followed by decay in a singel fruit.

Example of fermentation caused by decay

Example Hoogesteeger; Serious infection by fungis in clockhouse

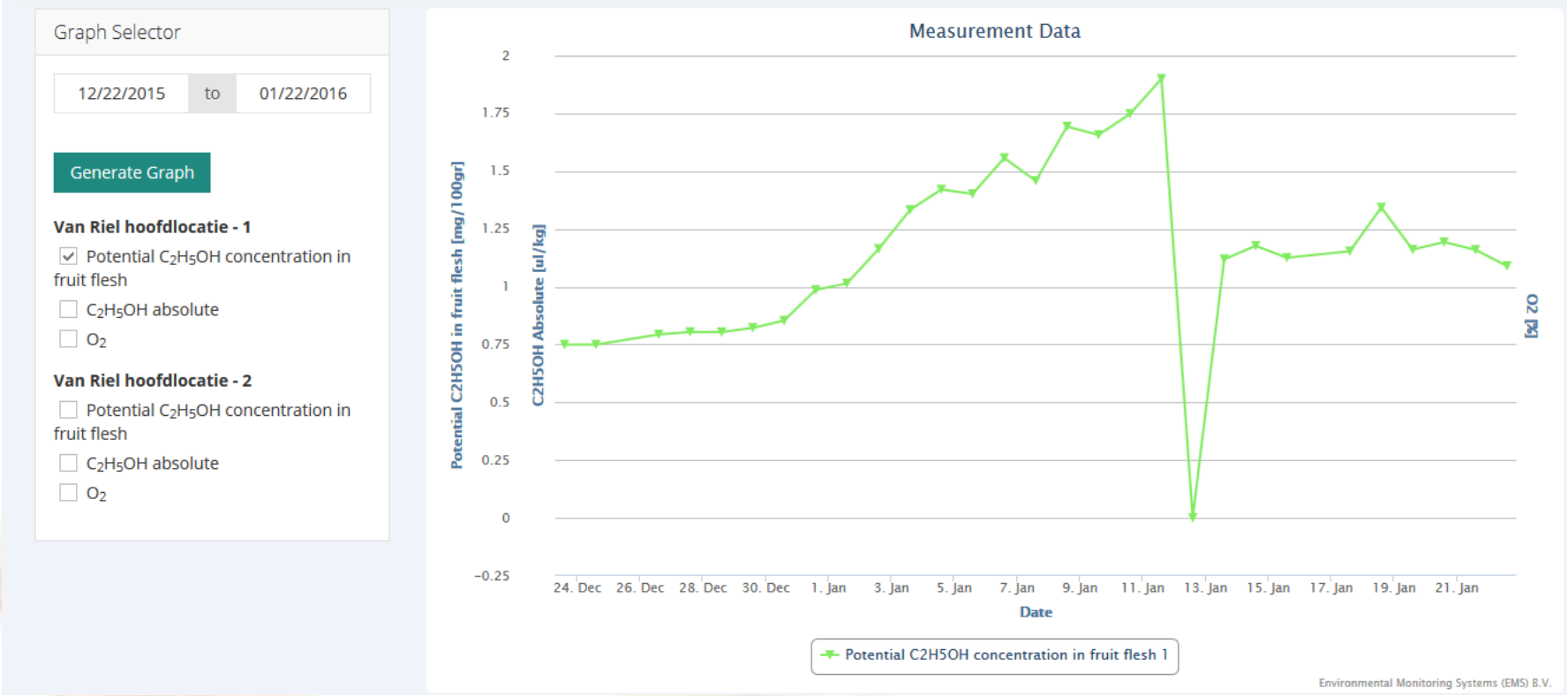
DCS system noticed a continuous slow increase of 1-2 mg. Ethanol per day up to 3,5 mg/100gr fruit.

The grower did 3x a test by cutting the sample of the box and found in 10-20% of the apple fungis

He came to the conclusion that the infection was too serious and decided to market the fruit earlier.

(Due to weather conditions he could not spray in time during blossom time)

Example of fermentation caused by decay



Van Riel, Elstar, slow increase of ethanol by 0,1-0,2 mg./100gr per day from 0,75 mg up to 1,75 mg.
On the 11th of january removal of 1 decayed fruit.

Example of fermentation by decay

- Case Van Riel
- Level of fermentation increased to a level of 1,8 mg. Only one apple was found which caused the ethanol production.

Example of fermentation caused by decay

Graph Selector

12/14/2015 to 01/22/2016

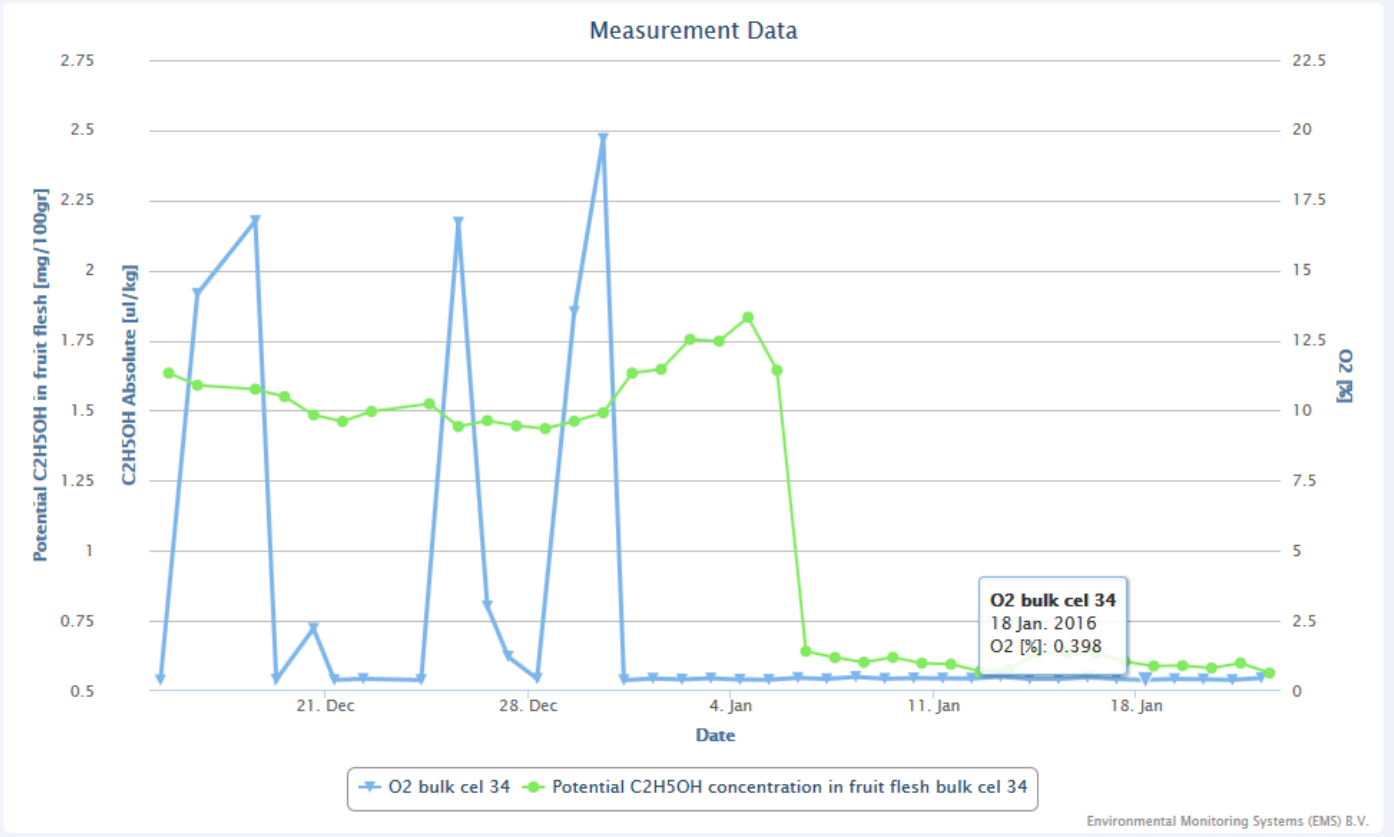
Generate Graph

Gebr. Peters Bulksestraat - bulk cel 34

- [x] Potential C_2H_5OH concentration in fruit flesh
- [ ] C_2H_5OH absolute
- [x] O_2

Gebr. Peters Bulksestraat - bulk cel 33

- [ ] Potential C_2H_5OH concentration in fruit flesh
- [ ] C_2H_5OH absolute
- [ ] O_2



Peters, Elstar, room 34 stored at 0,4%O2. Ethanol production increased gradually from 1,4 mg up to 1,8 mg. After removal of 2 decayed fruits on the 5th of january the production dropped down to ca. 0,6mg.

Example of fermentation caused by decay

Example Peters; Increase of ethanol to a level of 1,8 mg.

On the 7th of january, 2 rotting fruits were detected and elimitated. The fermentation level reduced.

Characteristics

- The lowest O_2% will vary;
  - per origin / variety
  - per season
- The lowest O_2% can change during the storage season. (dynamic)
- Faster to the lowest oxygen levels (GALA)

  Within 2 weeks lower then 0,7% O2 after finishing cooling down.

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Characteristics

- A daily measurement provide allows a good follow up and security.

- DCS Automatic can be used as:
  - A watchdog system
  - A dynamic system for storage at the lowest oxygen levels

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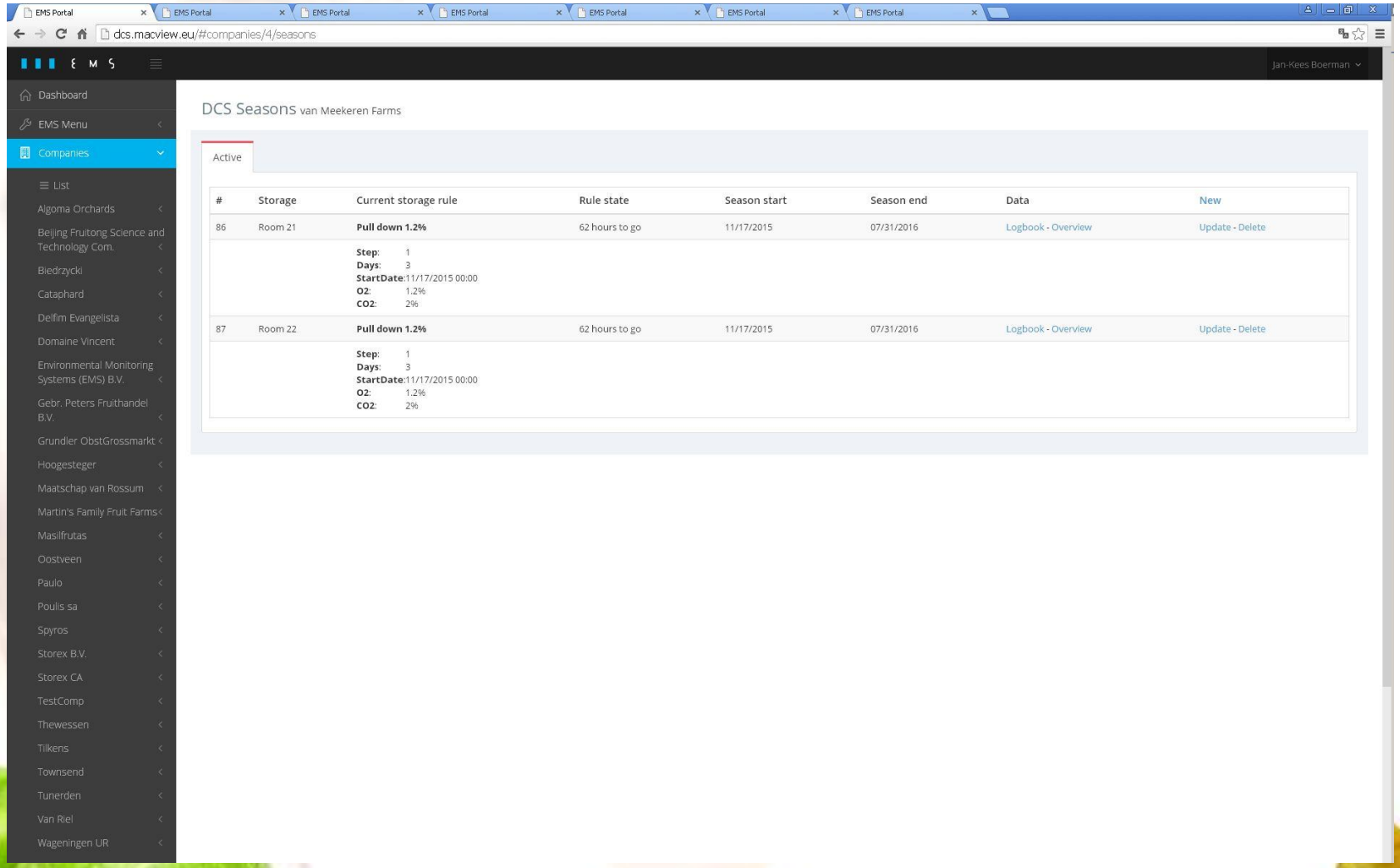
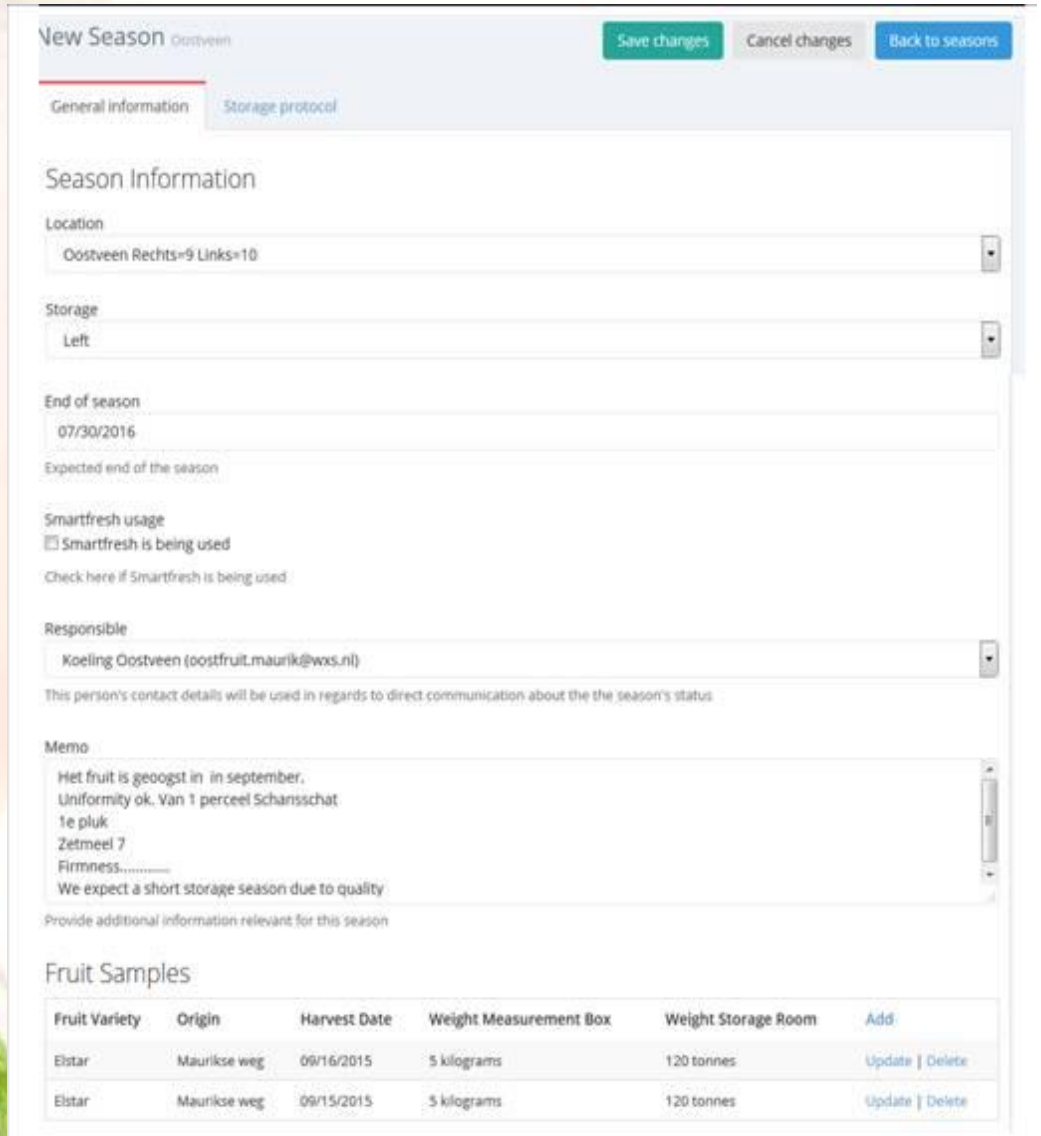
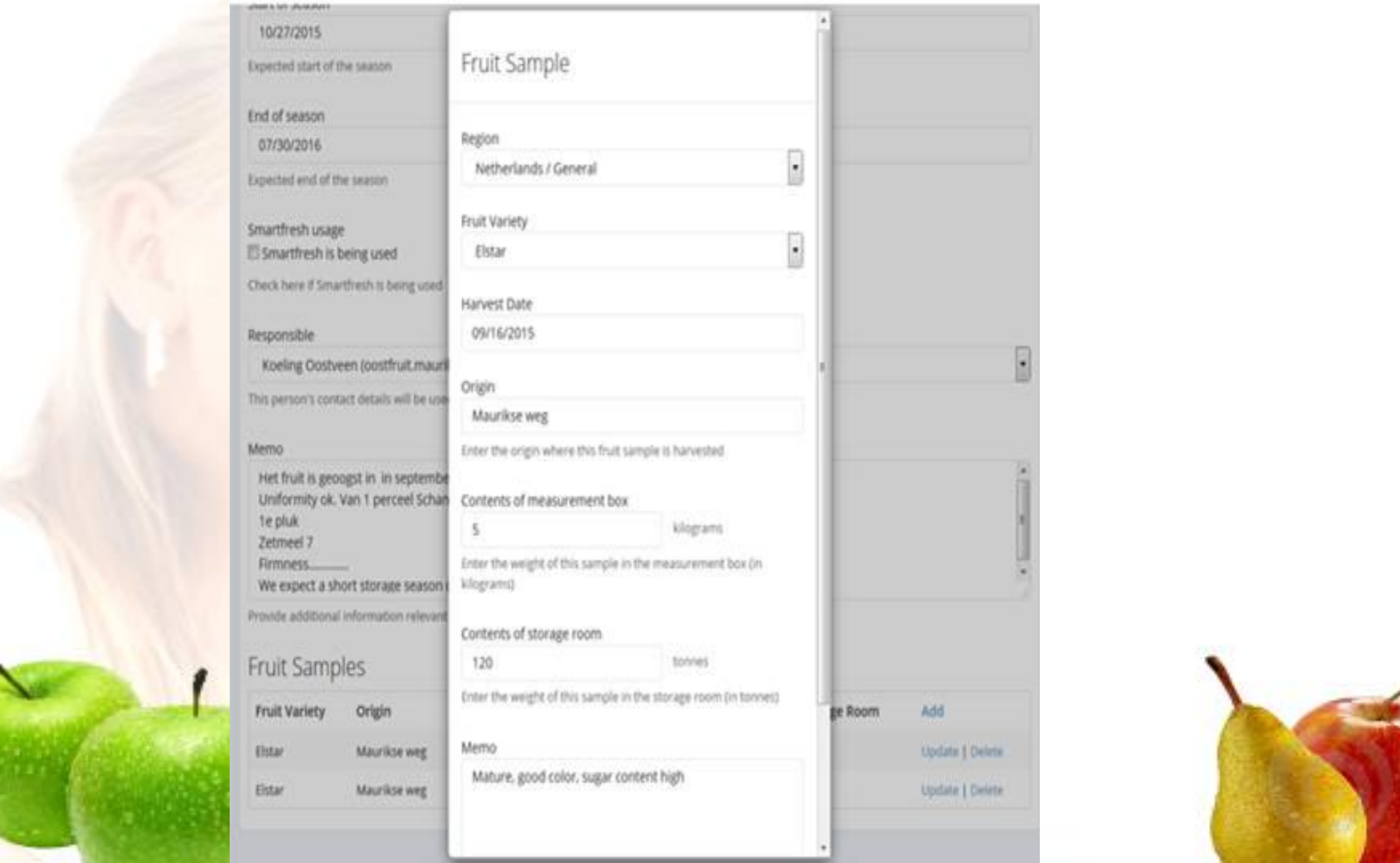
DCS Portal


EMS Portal
dcs.macview.eu/#companies/4/seasons
EMS
Jan-Kees Boerman
Dashboard
EMS Menu
Companies
List
Algoma Orchards
Beijing Fruitong Science and Technology Com.
Biedrzycki
Cataphard
Delfim Evangelista
Domaine Vincent
Environmental Monitoring Systems (EMS) B.V.
Gebr. Peters Fruithandel B.V.
Grundler ObstGrossmarkt
Hoogesteger
Maatschap van Rossum
Martin's Family Fruit Farms
Masilfrutas
Oostveen
Paulo
Poulis sa
Spyros
Storex B.V.
Storex CA
TestComp
Thewessen
Tilkens
Townsend
Tunerden
Van Riel
Wageningen UR
DCS Seasons van Meekeren Farms
Active
Storage Current storage rule Rule state Season start Season end Data New
86 Room 21 Pull down 1.2% 62 hours to go 11/17/2015 07/31/2016 Logbook - Overview Update - Delete
Step: 1
Days: 3
StartDate: 11/17/2015 00:00
O2: 1.2%
CO2: 2%
87 Room 22 Pull down 1.2% 62 hours to go 11/17/2015 07/31/2016 Logbook - Overview Update - Delete
Step: 1
Days: 3
StartDate: 11/17/2015 00:00
O2: 1.2%
CO2: 2%

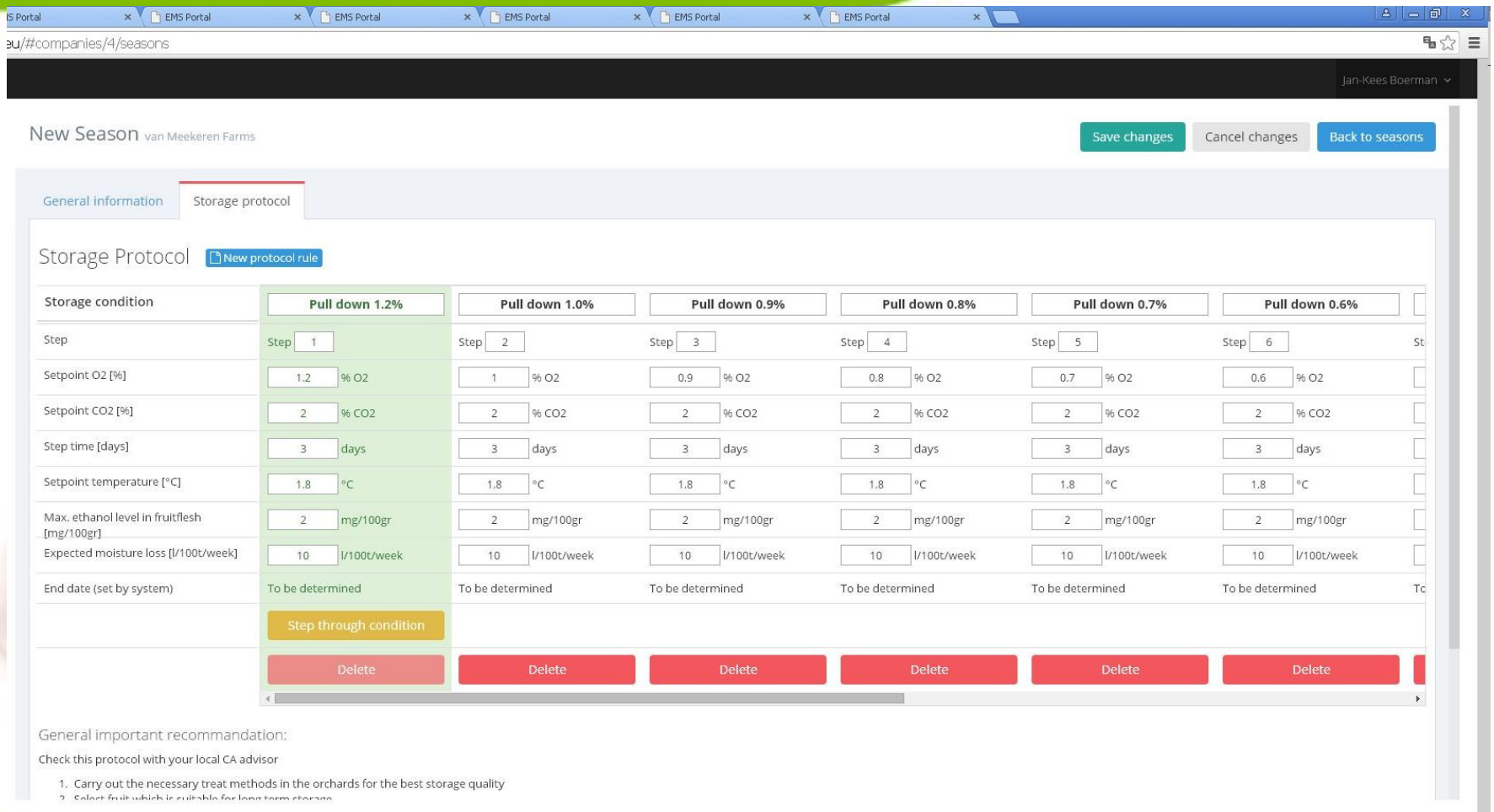
General Information



Information on samples



Storage protocol



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Option for reminders

Message from DCS portal

Notification	: Reminder
Date	: 11/06/2015 9:12 AM
Location	: JKB Home R&D Lab
Storage	: Left Box
Message	: WAITINGTIME STORAGE PROTOCOL RULE HAS PASSED. 46.9 hour(s) overdue
Item(s)	: Step:3 (3th KJ pull down 0.2%)
Todo	: Goto next DCS step (4th pull down 0.2%)
Confirmation	: By pressiting this button I confirm that for Left Box I have set the oxygen concentration to 1.5 % O2 for DCS step 4

Confirm now

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Example DCS protocol for Red Delicious

Protocol for automatic DCS: 'Variety Red Delicious'

Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7
Cooling down of the Red Delicious till 1 ºC	Oxygen Pull down with N_2 to 3% O_2	Decrease by respiration to 1.0% O_2	DCS: 0.2% O_2 decrease by respiration to 0.8% O_2	DCS: 0.2% O_2 decrease by respiration to 0.6% O_2	DCS: 0.1% O_2 decrease by respiration to 0.5% O_2	DCS Safeguard strategy: 0.1% O_2 decrease by respiration to 0.4% O_2
5 days	3 days	2 a 3 days	5-6 days	5-6 days	5-6 days	Rest of the storage period
1 ºC, O_2 > 20.0 %, CO_2 < 1.0%	O_2 = 3.0 %,	O_2 = 1.0 %, CO_2= 1.8%	O_2 = 0.8 %, CO_2= 1.4%	O_2 = 0.6 %, CO_2= 1.1%	O_2 = 0.5 %, CO_2= 1.0%	O_2 = 0.4 %, CO_2= 0.9%

Cooling down
5 days

- Cooling down temperature of Red Delicious (1 ºC).
- Period: 5 days after loading of the last bins.

Oxygen pull down with N_2
3 days

- Oxygen pulldown with nitrogen to 3% O_2.

Decrease by respiration to 1% O_2
2 -3 days

- Program Target values in the CA room O_2 = 1.0%, CO_2 = 1.8%
- The O_2 have to decrease by respiration in 2 a 3 days to 1% O_2
- Observe the ethanol production during this period.
- When the ethanol value is < 3,0 mg C_2H_5OH,/100gr fruitflesh you can continue with the next step.

DCS: 0.2% O_2 decrease by respiration
5-6 days

- Program Target values in the CA room O_2 = 0.8%, CO_2 = 1.4%
- The O_2 have to decrease by respiration in a day to 0.8%
- Observe the ethanol production during the next three or four days.
- When the ethanol value is < 3,0 mg C_2H_5OH,/100gr fruitflesh you can continue with the next step

DCS: 0.2% O_2 decrease by respiration
5-6 days

- Program Target values in the CA room O_2 = 0.6%, CO_2 = 1.1%
- The O_2 have to decrease by respiration in a day to 0.6%
- Observe the ethanol production during the next three or four days.
- When the ethanol value is < 3,0 mg C_2H_5OH,/100gr fruitflesh you can continue with the next step

DCS: 0.1% O_2 decrease by respiration
5-6 days

- Program Target values in the CA room O_2 = 0.5%, CO_2 = 1.0%
- The O_2 have to decrease by respiration in a day to 0.5%
- Observe the ethanol production during the next three or four days.
- When the ethanol value is < 3,0 mg C_2H_5OH,/100gr fruitflesh you can continue with the next step

DCS Safeguard strategy: 0.1% O_2 decrease by respiration to 0.4% O_2
Rest of the storage period

- Program Target values in the CA room O_2 = 0.4%, CO_2 = 0.9%
- The O_2 have to decrease by respiration to 0.4%.
- Observe the ethanol production during the next days.
- When the ethanol value remains < 3,0 mg C_2H_5OH,/100gr fruitflesh, the target of 0.4% O_2 has been reached without producing excessive ethanol.
- The O_2 level of 0.4% is the lowest point for using DCS based on the safeguard DCS strategy.
- For the rest of the storage time O_2 = 0.4% and CO_2= 0,9% will be the target values. Keep checking the ethanol production.
- Carry out quality inspections according DCS manual.

Example DCS protocol for Gala

Protocol for DCS automatic: ' Variety Gala'

Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7
Cooling down of the Gala till 1 ºC	Oxygen Pull down with N_2 to 3% O_2	Decrease by respiration to 1.0% O_2	DCS: 0.2% O_2 decrease by respiration to 0.8% O_2	DCS: 0.2% O_2 decrease by respiration to 0.6% O_2	DCS: 0.1% O_2 decrease by respiration to 0.5% O_2	DCS Safeguard strategy: 0.1% O_2 decrease by respiration to 0.4% O_2
4 days	2-3 days	2 days	4 days	4 days	5 days	Rest of the storage period
1 ºC, O_2 > 20.0 %, CO_2 < 1.0%	O_2 = 3.0 %,	O_2 = 1.0 %, CO_2= 2.0%	O_2 = 0.8 %, CO_2= 1.8%	O_2 = 0.6 %, CO_2= 1.4%	O_2 = 0.5 %, CO_2= 1.3%	O_2 = 0.4 %, CO_2= 1.2%

Cooling down
5 days

- Cooling down temperature of Gala (1 ºC).
- Period: 5 days after loading of the last bins

Oxygen pull down with N_2
2-3 days

- Oxygen pulldown with nitrogen to 3% O_2.

Decrease by respiration to 1% O_2
2 days

- Program Target values O_2 = 1.0%, CO_2 = 2.0%
- The O_2 have to decrease by respiration in 2 a 3 days to 1% O_2
- Observe the ethanol production during this period.
- When the ethanol value is < 3,0 mg C_2H_5OH,/100gr fruitflesh, you can continue with the next step.

DCS: 0.2% O_2 decrease by respiration
4 days

- Program Target values O_2 = 0.8%, CO_2 = 1.8%
- The O_2 have to decrease by respiration in a day to 0.8%
- Observe the ethanol production during the next 5 days.
- When the ethanol value is < 3,0 mg C_2H_5OH,/100gr fruitflesh, you can continue with the next step.

DCS: 0.2% O_2 decrease by respiration
4 days

- Program Target values O_2 = 0.6%, CO_2 = 1.6%
- The O_2 have to decrease by respiration in a day to 0.6%
- Observe the ethanol production during the next 5 days.
- When the ethanol value is < 3,0 mg C_2H_5OH,/100gr fruitflesh, you can continue with the next step.

DCS: 0.1% O_2 decrease by respiration
5 days

- Program Target values O_2 = 0.5%, CO_2 = 1.3%
- The O_2 have to decrease by respiration in a day to 0.5%
- Observe the ethanol production during the next 5 days.
- When the ethanol value is < 3,0 mg C_2H_5OH,/100gr fruitflesh, you can continue with the next step.

DCS Safeguard strategy: 0.1% O_2 decrease by respiration to 0.4% O_2
Rest of the storage period

- Program Target values O_2 = 0.4%, CO_2 = 1.2.%
- The O_2 have to decrease by respiration to 0.4%.
- Observe the ethanol production during the next days.
- When the ethanol value remains < 3,0 mg C_2H_5OH,/100gr fruitflesh, we reached the target of 0.4% O_2 without producing ethanol.
- The O_2 level of 0.4% is the lowest point for using DCS based on a safeguard DCS strategy.
- For the rest of the storage time O_2 = 0.4 % and CO_2= 1.2% will be the target values.
- Carry out quality inspections according DCS manual
- Temperature remains on 1 ºC

Example DCS protocol for Granny Smith

Protocol for DCS Automatic: 'Variety Granny Smith'

Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7
Cooling down of the Granny Smith till 1 ºC	Oxygen Pull down with N_2 to 4% O_2	Decrease by respiration to 1.0% O_2 CO_2 < 1.0%	DCS: 0.2% O_2 decrease by respiration to 0.8% O_2	DCS: 0.2% O_2 decrease by respiration to 0.6% O_2	DCS: 0.1% O_2 decrease by respiration to 0.5% O_2	DCS Safeguard strategy: 0.1% O_2 decrease by respiration to 0.4% O_2
5 days	2/3 days	2 - 3 days	5 days	5 days	5 days	Rest of the storage period
1 ºC, O_2 > 20.0 %, CO_2 < 1.0%	O_2 = 4.0 %, 1,%CO_2	O_2 = 1.0 %, CO_2 < 1.0%	O_2 = 0.8 %, CO_2= 1,0%	O_2 = 0.6 %, CO_2= 1,0%	O_2 = 0.5 %, CO_2= 1.0%	O_2 = 0.4 %, CO_2= 0,9%

Cooling down
5 days

- Cooling down the temperature of the Granny Smith (1 ºC).
- Period: 5 days after loading of the last bins.

Oxygen pull down met N_2
3 days

- Oxygen pulldown with nitrogen to 4% O_2.

Decrease by respiration to 1% O_2
5 days

- Program Target values O_2 for the CA room= 1.0%, CO_2 = 1,0%
- The O_2 have to decrease by respiration in 2 a 3 days to 1.0% O_2
- Observe the ethanol production during this period.
- When the ethanol value is < 3 mg / 100gr fruitflesh, you can continue with the next step.

DCS: 0.2% O_2 decrease by respiration
5 days

- Program Target values O_2 for the CA room= 0.8%, CO_2 = 1,0%
- The O_2 have to decrease by respiration in a day to 0.8%
- Observe the ethanol production during this period.
- When the ethanol value is < 3 mg / 100gr fruitflesh, you can continue with the next step.

DCS: 0.2% O_2 decrease by respiration
5 days

- Program Target values for the CA room O_2 = 0.6%, CO_2 = 1,0%
- The O_2 have to decrease by respiration in a day to 0.6%
- Observe the ethanol production during this period.
- When the ethanol value is < 3 mg / 100gr fruitflesh, you can continue with the next step.

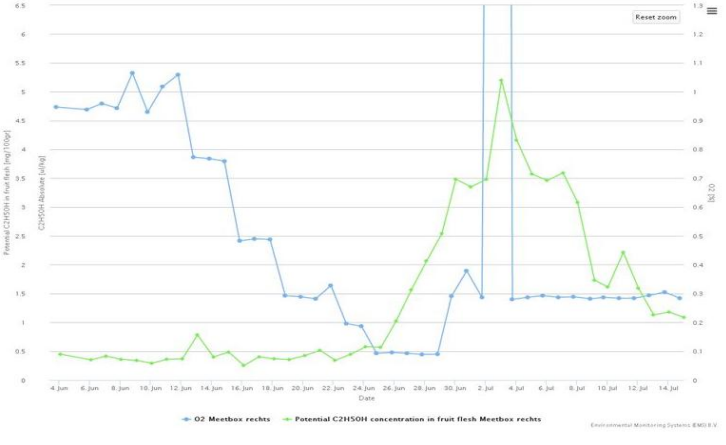
DCS: 0.1% O_2 decrease by respiration
5 days

- Program Target values for the CA room O_2 = 0.5%, CO_2 = 1,0%
- The O_2 have to decrease by respiration in a day to 0.5%
- Observe the ethanol production during this period.
- When the ethanol value is < 3 mg / 100gr fruitflesh, you can continue with the next step.

DCS safeguard strategy: 0.1% O_2 decrease by respiration to 0.4% O_2
DCS active strategy, further decrease of the O_2

- Program Target values for the CA room O_2 = 0.4%, CO_2 = 0,9%
- The O_2 have to decrease by respiration in a day to 0.4%
- Observe the ethanol production during this period.
- When the ethanol value remains < 3 mg / 100gr fruitflesh, we reached the target of 0.4% without proding ethanol.
- The O_2 level of 0.4% is the lowest point for using DCS based on a safeguard DCS strategy.
- In case of a DCS active strategy, you have to continue the same procedure to decrease the oxygen level till the level of fermentation.
- For the rest of the storage time O_2 = 0.4% and CO_2= 0,9% will be the target values.
- Carry out quality inspections according DCS manual
- Temperature remains on 1 ºC

DCS Automatic Test Unit

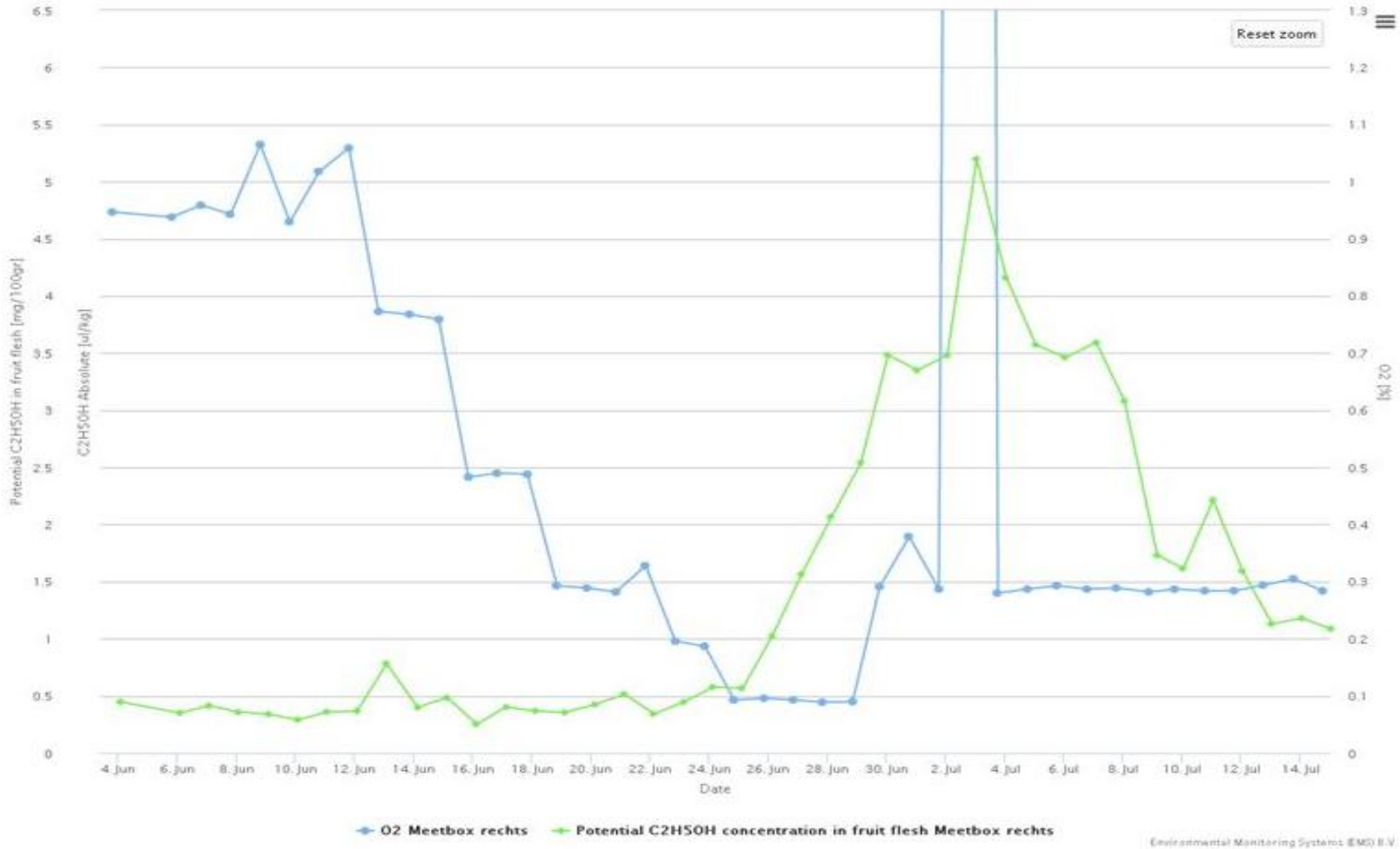


Automatic determination of Low Oxygen Limiet

DCS Automatic Test Unit

- 2 refrigerators containing a DCS Automatic system
- Automatic integrated O_2/CO_2 + temperature control system
- N_2 and CO_2 injection by gas from bottles.
- DCS pull down runs automatically for deterimining the Oxygen Low Limit
- Automatic storage of data

Automatic pulldown for finding the Low Oxygen Limit



DCS Automatic Test Unit

- Stand alone determination of the fermentation level
- Specific batches can be tested from various rooms / origins
- Determined O2 levels can be applied to DCS rooms

DCS Automatic Resarch unit

DCS Automatic Resarch unit

This unit is equipped with an automatic filling station for gas sampling tubes for a gas chromatograph

The DCS Automatic system is tested by EMS and Wageningen University on its accuracy.

EMS analysers

The MACView®-Ethylene Postharvest Analyser can be integrated to practically every climate control system, varying from greenhouse climate computers until multi cell sampling with Ultra Low Oxygen control systems for storage.

TECHNICAL SPECIFICATIONS

MACView®-Greenhouse Gas Analyser

Type of Gas Analyser	MACView®-Greenhouse Gas Analyser
Type of Sensors	NO (Nitric Oxide) measurement range 0-5.000 ppb
	NO_2 (Nitrogen Dioxide) measurement range 0-5.000 ppb
	C_2H_4 (Ethylene) measurement range 0-5.000 ppb
	CO (Carbon Oxide) measurement range 0-5.000 ppb
	CO_2 (Carbon Dioxide) level 0-2.000 ppm
Resolution:	1 ppb for NO, NO_2, C_2H_4 and 10 ppm for CO_2
	Minimum inaccuracy ±1% below a level of 200 ppb
	Maximum inaccuracy ±2% between the 200 and 5000 ppb

Facts about DCS

- DCS and DCS Automatic are tested for many years.
- After the introduction of DCS in 1997, alternative systems are introduced under the name of DCA (Dynamic Controlled Atmosphere)
- DCS gives in comparison with the regular ULO storage systems better results.
- DCS can be used as a alternative of Smartfresh, or in combination with Smartfresh

History of DCS™

- DCS is developed and introduced by Wageningen UR, Food & Biobased Research, Netherlands since 1997.
- Since 1997 more than 15 years of research
- DCS Standard is applied in ca. 200 cells.
- Checking the apples on the presence of ethanol is carried out manually by a pulp analysis

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History of DCS™

- A number of attempts to automate the DCS system has failed
- Due to the labour-intensive method, the semi DCS Automatic application is used very limited. This despite the enormous advantages
- Due to the labour-intensive DCS storage, most oxygen values are not reached as soon as possible

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DCS - History

Before DCS Automatic, there was no reliable measurement for ethanol in a cold store. Why?

- Ethanol has to be measured on ppb scale
- Measuring ethanol is difficult, because of the presence of, for example, ethylene and other gasses.
- Ethanol dissolves easily in water
- Also rotting fruit produces ethanol

Because of the developed procedure with the measuring box this problems have been solved.

History of the DCS Automatic

Since 2009 there is a cooperation between:

- Wageningen UR, Food & Biobased Research, Nederland
- Storex B.V.
- EMS B.V. (Manufacturer of analytic sensor technics)
- Since 2009 we have developed the DCS Automatic system, based on new modern sensor techniques
- Since 2013 the system is ready for be use

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WAGENINGEN UR
For quality of life

EMS
MACView
MEASUREMENT
TECHNOLOGY

Research results

Table 2: Fruit quality of 'McIntosh' apples from Nova Scotia treated with or without SmartFresh and held in standard control atmosphere (SCA – 2.5% O2), low oxygen (LO – 1.2% O2), or dynamic control (DCS – 0.6-12% O2) for 8 months at 3°C, plus 1 and 7 days at room temperature (~25°C).

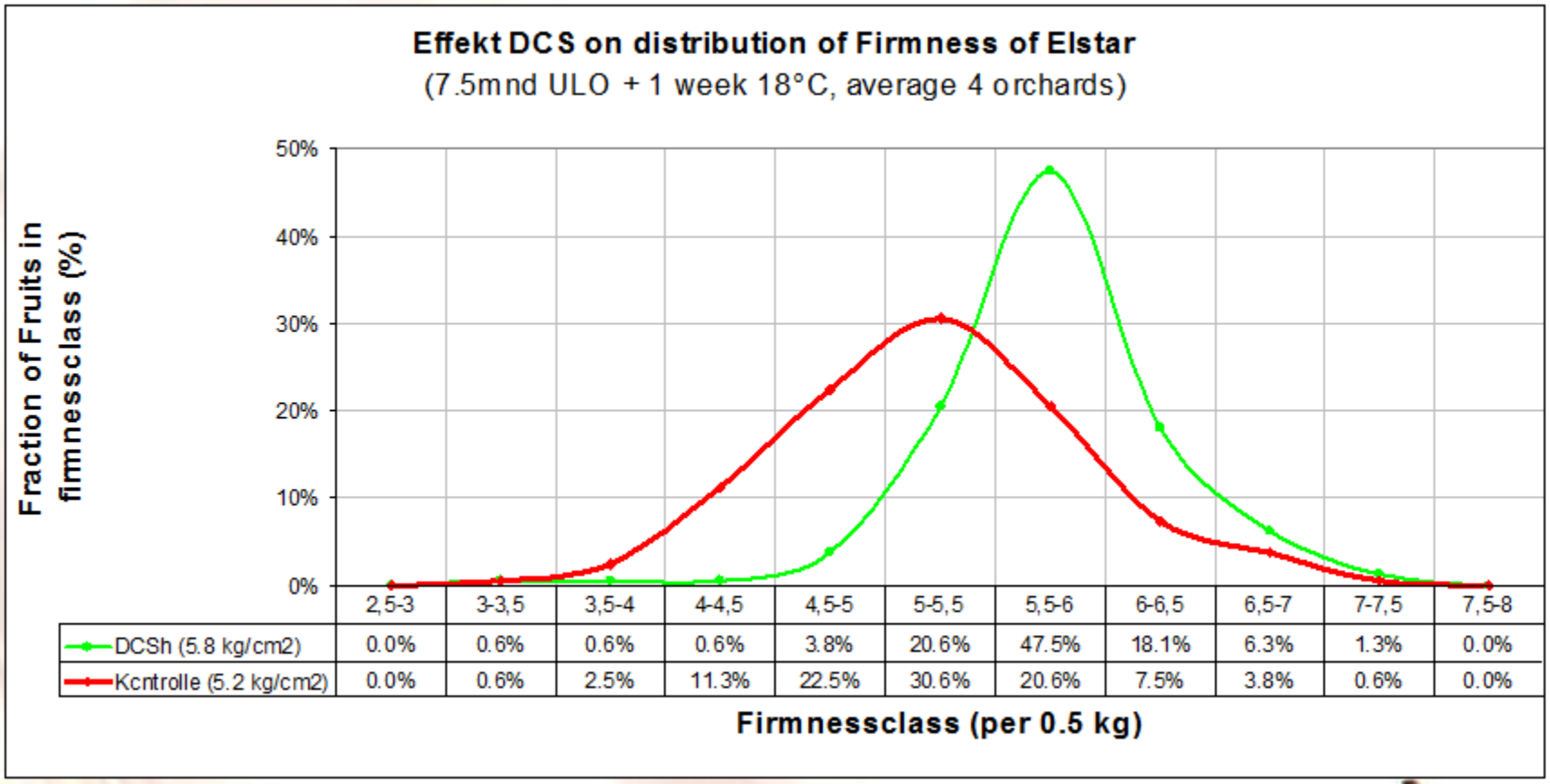
	Firmness (lb)	Internal ethylene (ppm)	Soluble solids (%)	Malic acid (mg/100 ml)	Senescent breakdown (%)	Core browning (%)	Storage rots (%)
1 day at RT							
No SmartFresh							
DCS	11.9 ^{C}	84 ^{CD}	11.5 ^{A}	343 ^{BC}	0 ^{F}	0 ^{C}	3 ^{CD}
LO	12.1 ^{C}	84 ^{CD}	11.1 ^{AB}	366 ^{AB}	7 ^{EF}	0 ^{C}	0 ^{D}
SCA	9.7 ^{E}	221 ^{C}	11.4 ^{A}	380 ^{A}	19 $^{A-C}$	1 ^{C}	1 ^{D}
+ SmartFresh							
DCS	14.1 ^{A}	64 ^{D}	11.5 ^{A}	359 ^{AB}	0 ^{F}	0 ^{C}	0 ^{D}
LO	13.1 ^{B}	79 ^{CD}	10.7 ^{BC}	377 ^{A}	3 ^{F}	0 ^{C}	1 ^{D}
SCA	11.9 ^{C}	158 ^{CD}	11.5 ^{A}	381 ^{A}	16 $^{B-D}$	0 ^{C}	0 ^{D}
7 days at RT							
No SmartFresh							
DCS	10.7 ^{D}	1164 ^{B}	11.2 ^{AB}	339 ^{BC}	12 ^{DE}	0 ^{C}	9 ^{AB}
LO	10.3 ^{D}	1232 ^{AB}	11.2 ^{AB}	302 ^{D}	20 ^{AB}	0 ^{C}	11 ^{AB}
SCA	8.8 ^{F}	1221 ^{AB}	11.4 ^{A}	340 ^{BC}	25 ^{A}	11 ^{A}	6 ^{BC}
+ SmartFresh							
DCS	11.7 ^{C}	1209 ^{AB}	11.6 ^{A}	365 ^{AB}	13 $^{C-E}$	0 ^{C}	9 ^{B}
LO	10.7 ^{D}	1342 ^{A}	10.4 ^{C}	323 ^{CD}	11 ^{DE}	0 ^{C}	16 ^{A}
SCA	9.2 ^{F}	1258 ^{AB}	11.1 ^{AB}	335 ^{BC}	16 $^{B-D}$	4 ^{B}	6 ^{BC}
Significance	****	****	***	****	****	****	****

Means within the same column with the same letter are not significantly different at $P < 0.05$.
, * = significant at $P < 0.001$ or $P < 0.0001$, respectively.
Each value represents the average of 30 apples, plus another 75 for disorders on Day 7.

Remarkable results of research in Canada 2013/2014 with McIntosch

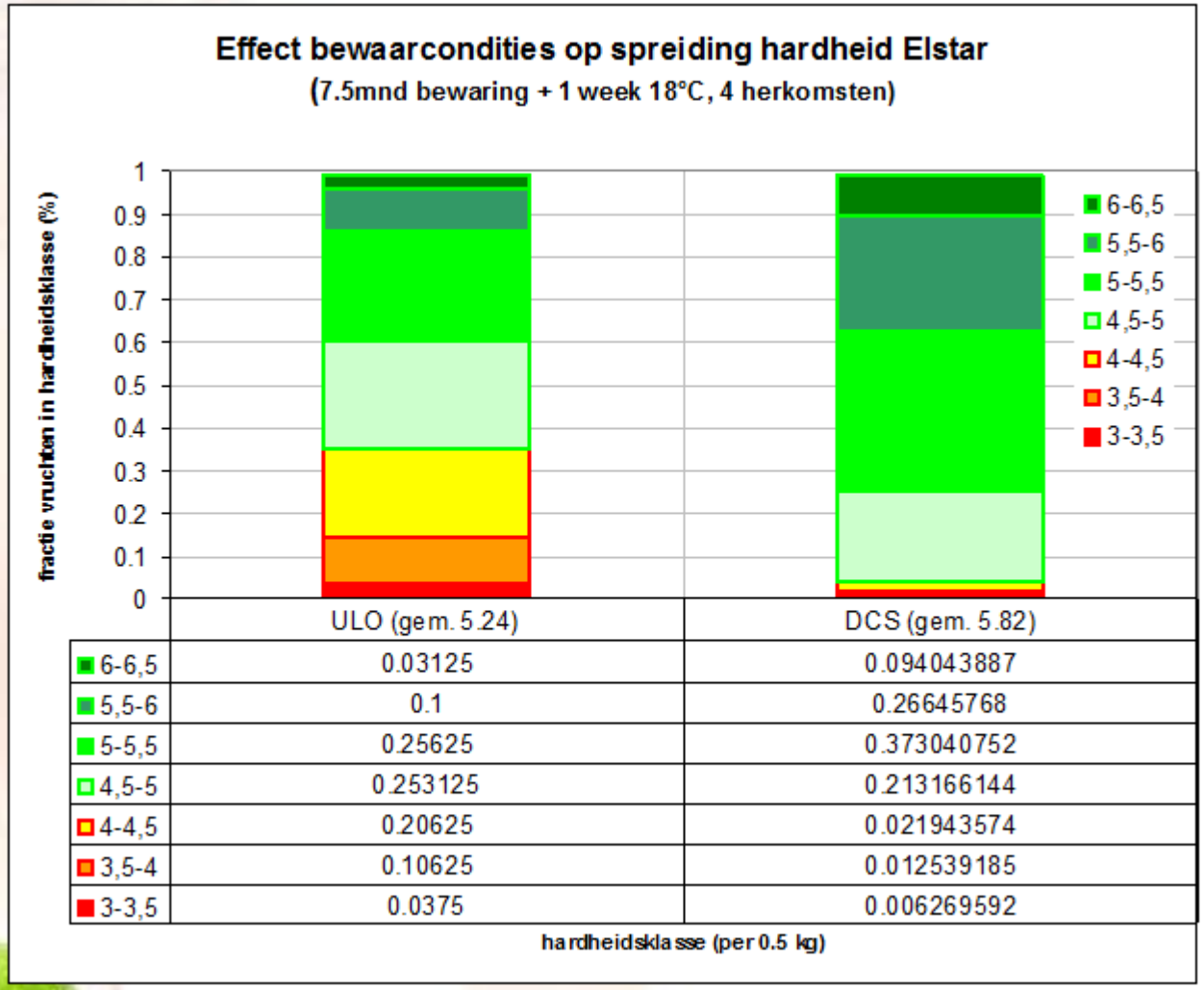
After 7 days on room temperature, apples stored with DCS maintain the same firmness as apples stored with ULO and Smartfresh.

Firmness ULO versus DCS™



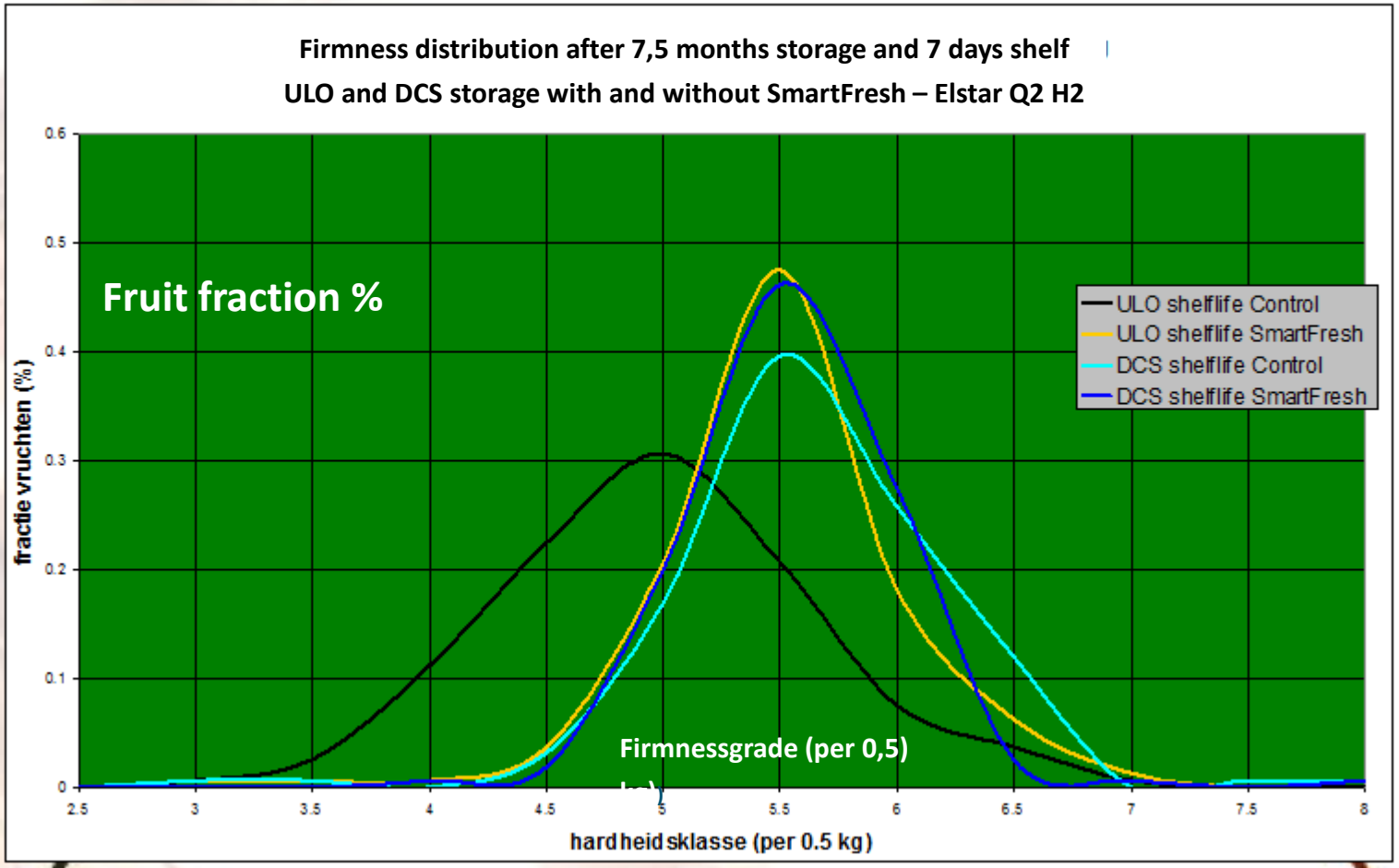
	2,5-3	3-3,5	3,5-4	4-4,5	4,5-5	5-5,5	5,5-6	6-6,5	6,5-7	7-7,5	7,5-8
DCSh (5.8 kg/cm2)	0.0%	0.6%	0.6%	0.6%	3.8%	20.6%	47.5%	18.1%	6.3%	1.3%	0.0%
Kcntrolle (5.2 kg/cm2)	0.0%	0.6%	2.5%	11.3%	22.5%	30.6%	20.6%	7.5%	3.8%	0.6%	0.0%

Distribution of firmness ULO versus DCS™

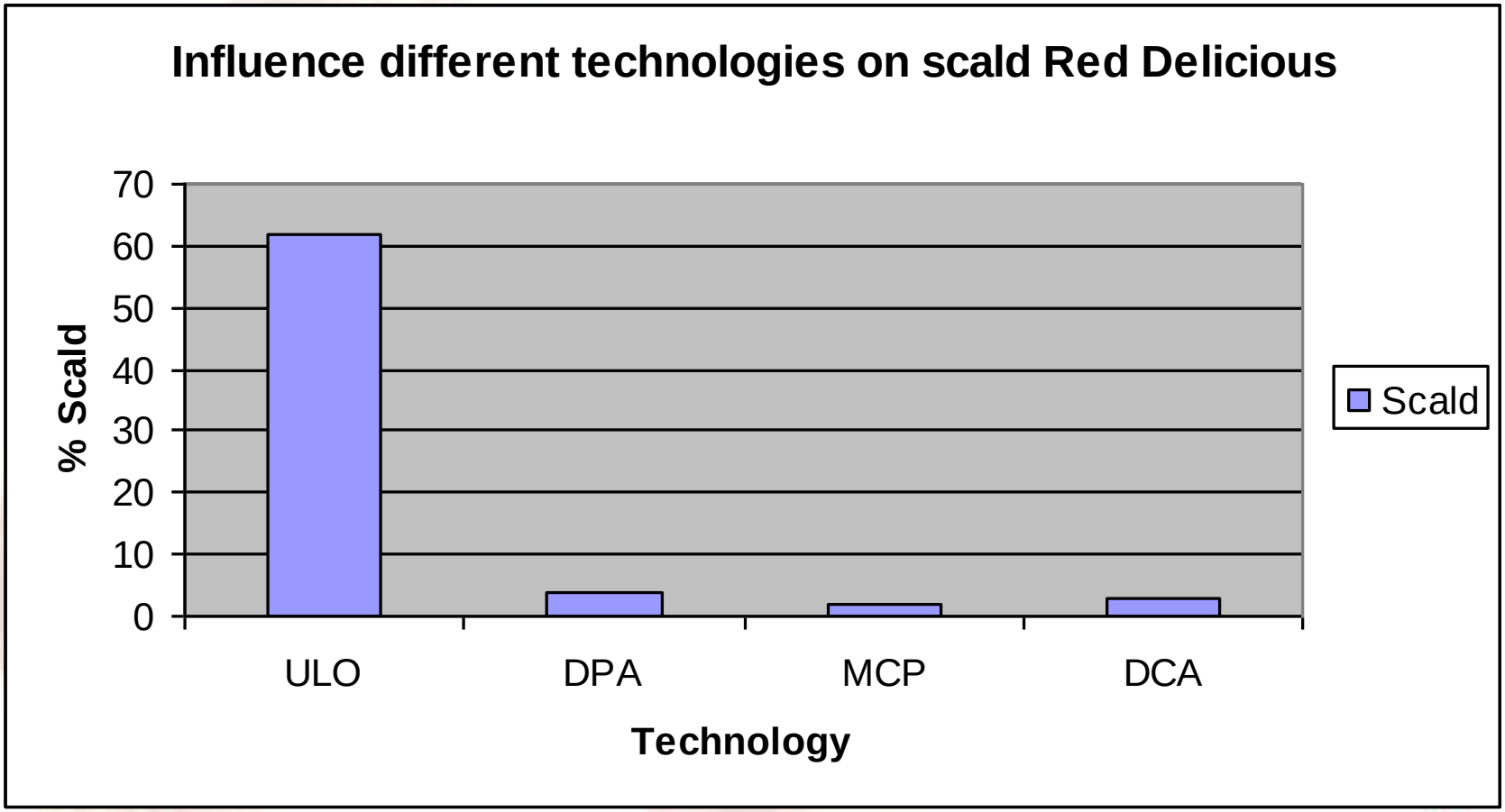


	ULO (gem. 5.24)	DCS (gem. 5.82)
6-6,5	0.03125	0.094043887
5,5-6	0.1	0.26645768
5-5,5	0.25625	0.373040752
4,5-5	0.253125	0.213166144
4-4,5	0.20625	0.021943574
3,5-4	0.10625	0.012539185
3-3,5	0.0375	0.006269592

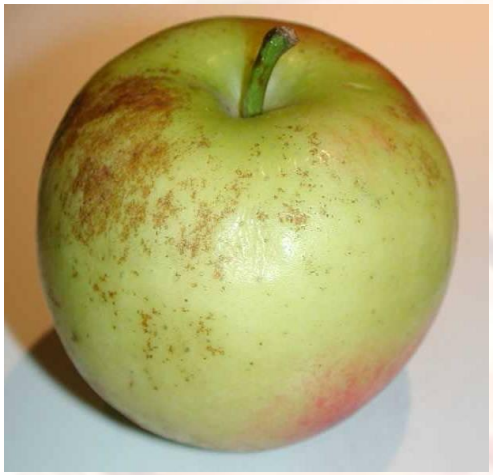
DCS™ versus SmartFresh

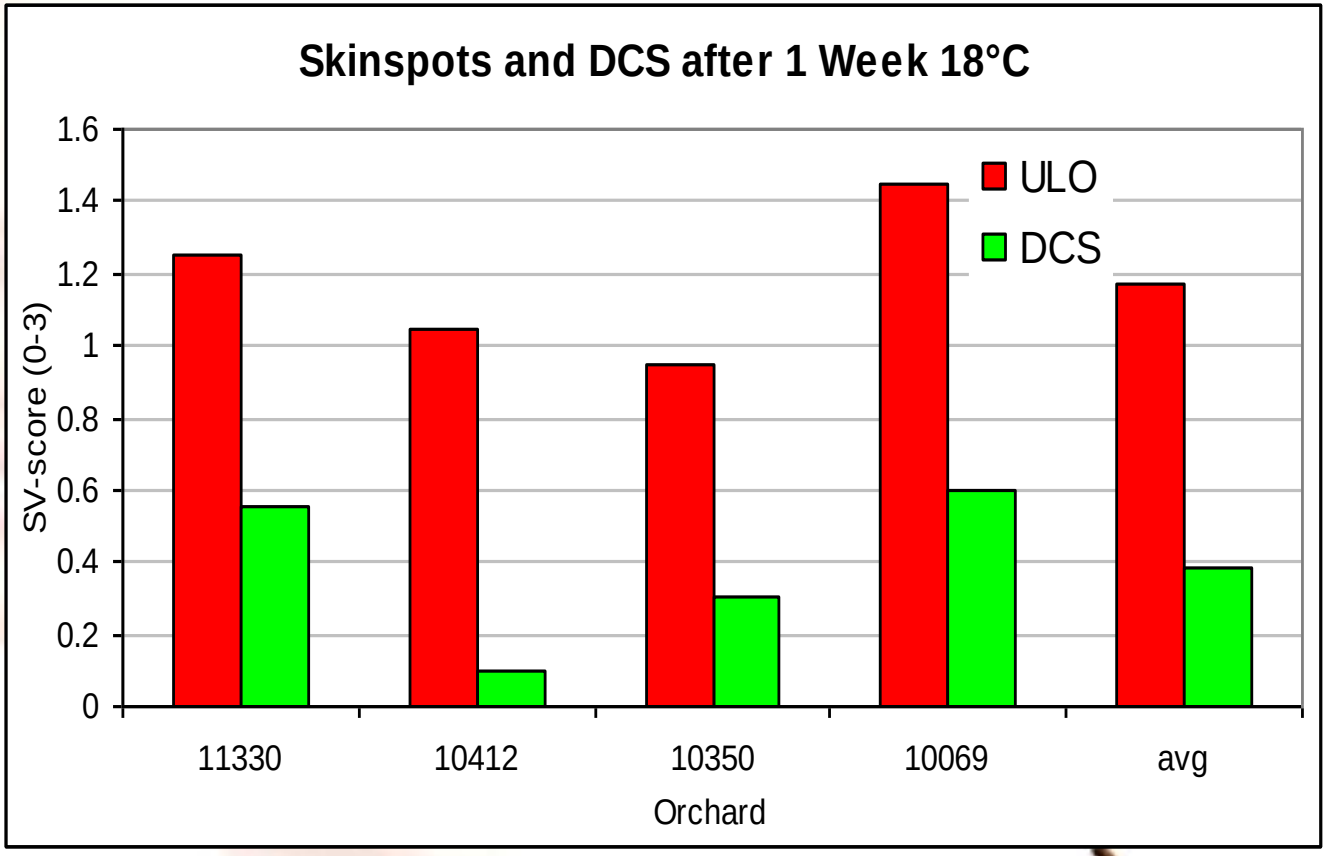


Scald control

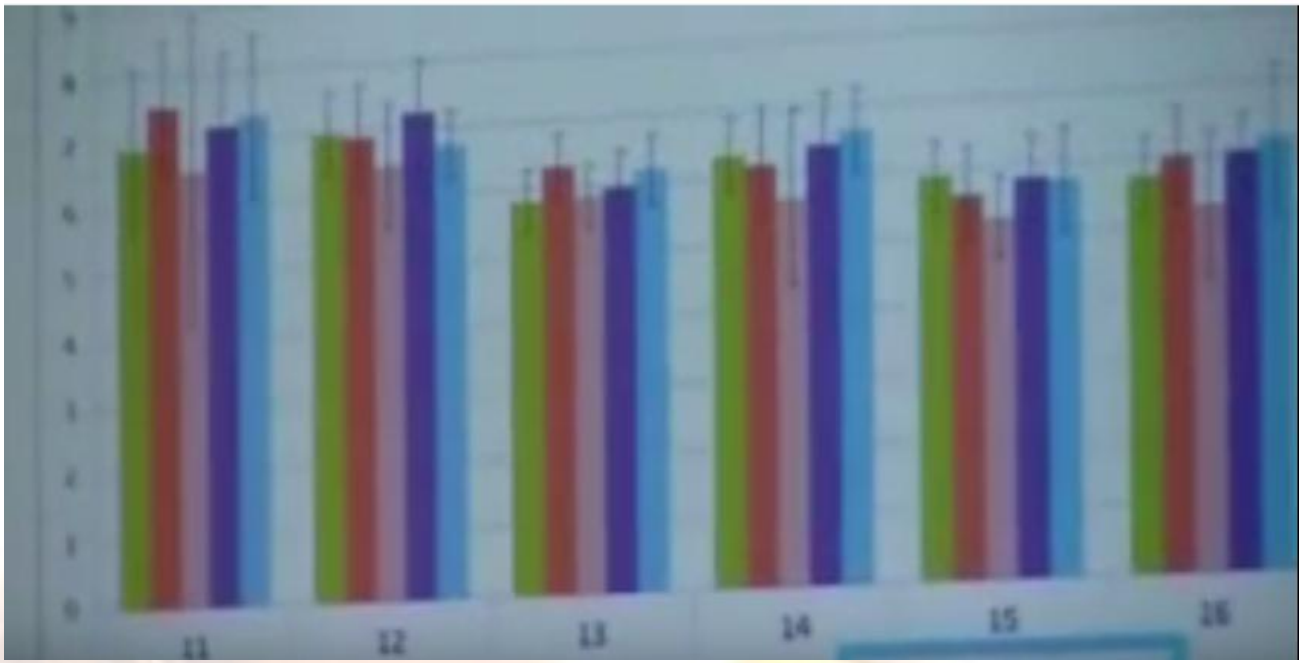


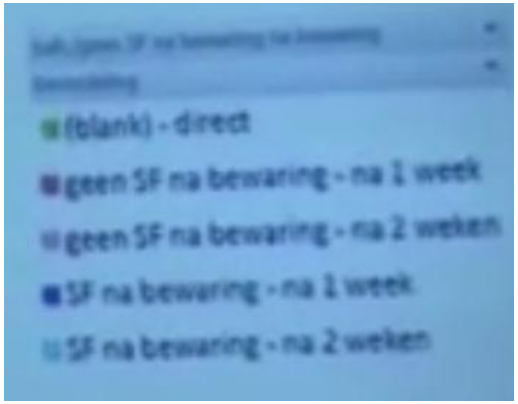
Reduction of skin spots





Firmness retention after DCA



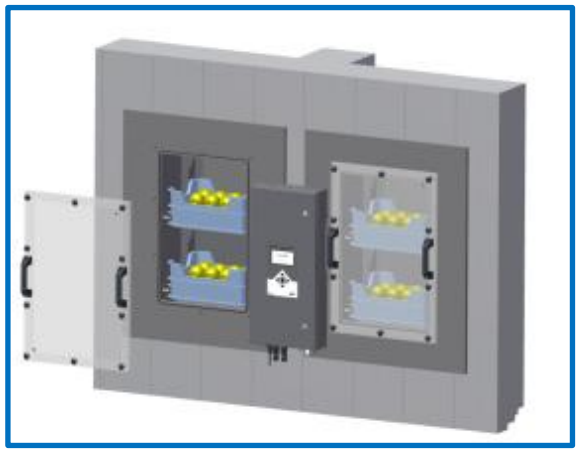


Research carried out by FBR Wageningen and Agrofresh on DCS stored apples. A comparison between no smartfresh treatment and none smartfresh treatment after DCA storage. Result: without smartfresh treatment after DCA storage the firmness remained after 1 and 2 weeks above 5,5 kg.

Configuration

DCS ANALYZER

DCS Sample box



O2 / CO2 SENSORS

ETHANOL

DATA-LOGGING

O2 / CO2 CONTROL

OPTIMAL O2

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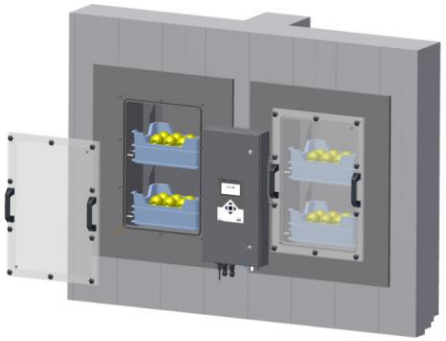
DCS™ components



The sample boxes

- Two pieces of solid sample boxes
- Transparant perspex lid for visual inspection and accessibility
- Sample boxes can be built into the ceiling and side wall of the cold store
- Equipped with a ventilation opening which can be closed with a membrane

DCS Automatic is now available

- DCS Automatic is now available to use.
- The offer in 2015 consists for each system:
  - 2 pcs. of sample boxes
  - The DCS ethanol measuring system
  - A license-free use of the system

When you are interested, we would be happy to plan a meeting with you. During this meeting we will make the DCS system available for your company. So you can benefit of the advantages of the DCS automatic system.

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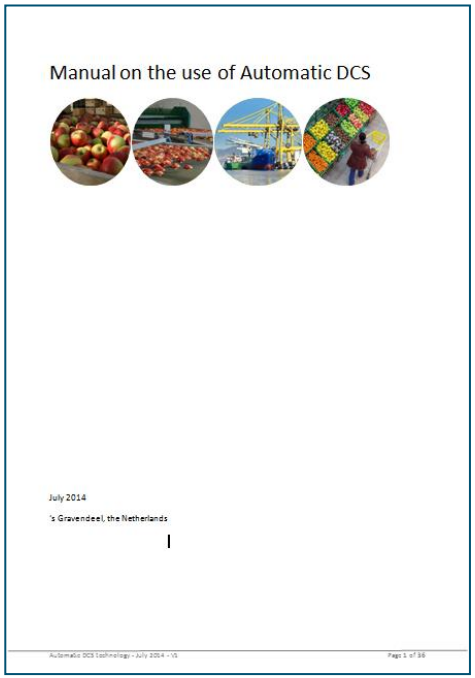
Manual + guidance

- Extensive manual available
- Specific storage protocol available for a variety of fruit

- Consultancy is optional



Thank you for your attention!

DCS Automatic: The best method for fruit storage.

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Our partners :

WAGENINGEN UR
For quality of life

EMS
MACView
MEASUREMENT
TECHNOLOGY