POTATO LINK
AUSTRALIAN POTATO INDUSTRY
EXTENSION PROJECT

Hort Innovation
Strategic levy investment
POTATO – FRESH FUND

Webinar

Hort Innovation
Strategic levy investment
POTATO – PROCESSING FUND

Seed Potatoes – Seed Storage & Physiological Age

March 2022

Presented by Dr Jenny Ekman, Maarten van Delden, Dr Nigel Crump

PT20000 Australian Potato Industry Communication and
Extension Project

Introduction of Speakers & Agenda

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- Dr Jenny Ekman- Applied Horticultural Research
  - Seed potato storage post harvest basics
  - Science behind cooling & the dehydration process
- Maarten van Delden- TOLSMA Australia
  - Open ventilation system
  - Stages of seed storage
  - Management of physiological age
  - Case Study- Terry Buckley
- Dr Nigel Crump- Australian Seed Potato Industry Certification Authority (AuSPICA)
  - AuSPICA seed potato certification
  - Key factors for consideration in the field before storage
- Q & A
  - Questions for speakers in the Q & A function

Seed potato storage – Postharvest basics

Potatoes are **ALIVE**

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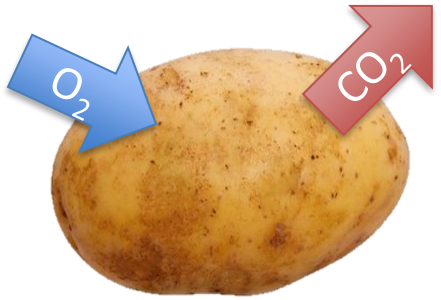
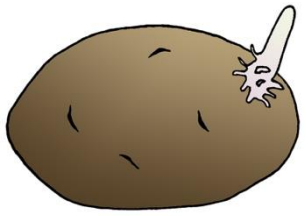
- Respire (Just as we do….)

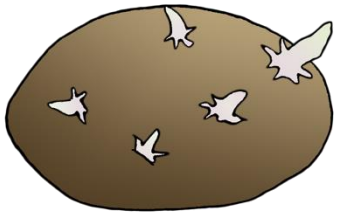
STARCH ⟷ SUGARS + Oxygen ➡ ENERGY + Carbon dioxide + Water



- Interact with their environment
  - Absorb moisture / dehydrate; sprout

- Age


Young

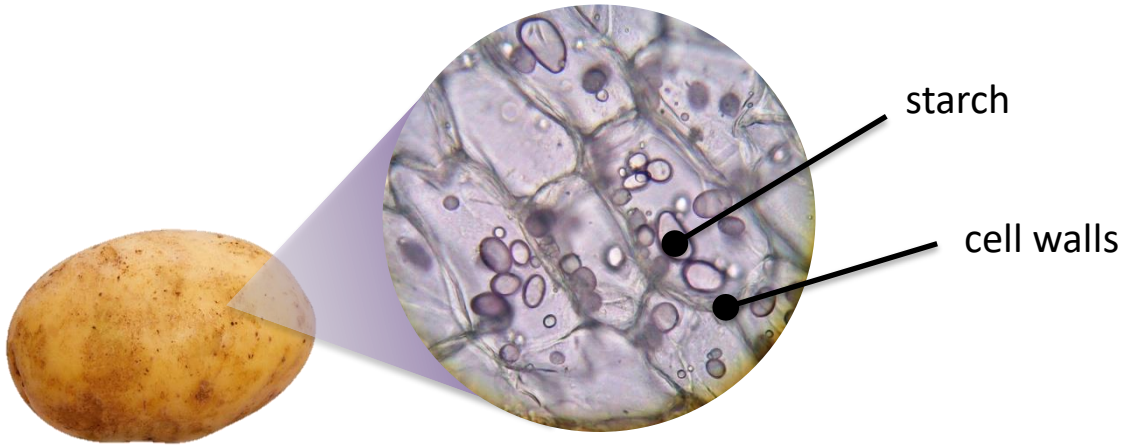

Middle-aged

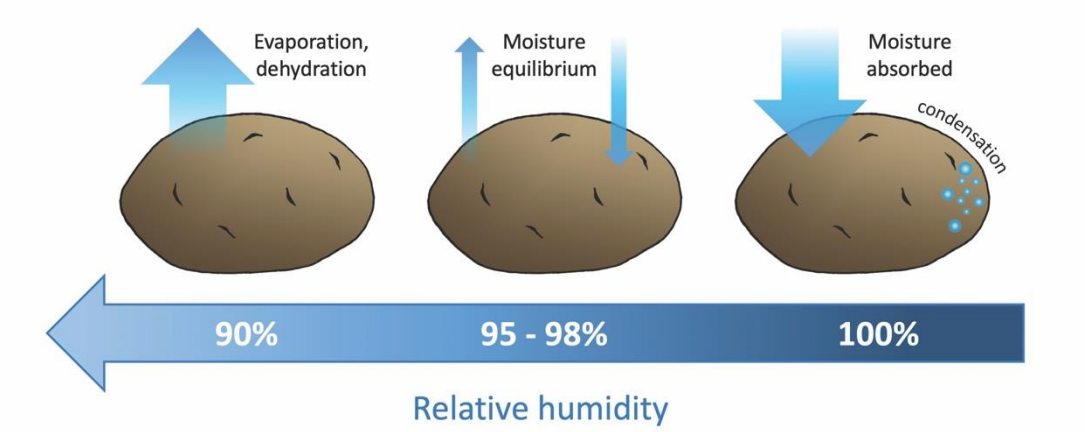

Old

Potatoes are mostly water

Ideally, potatoes should be in equilibrium with the cold room air

- Potatoes are 80% water
- Air spaces within the flesh are nearly **100% RH**





The difference in relative humidity between the inside and outside of the tuber drives moisture loss

(less the barrier created by the skin)

Respiration rate and ageing depend on temperature

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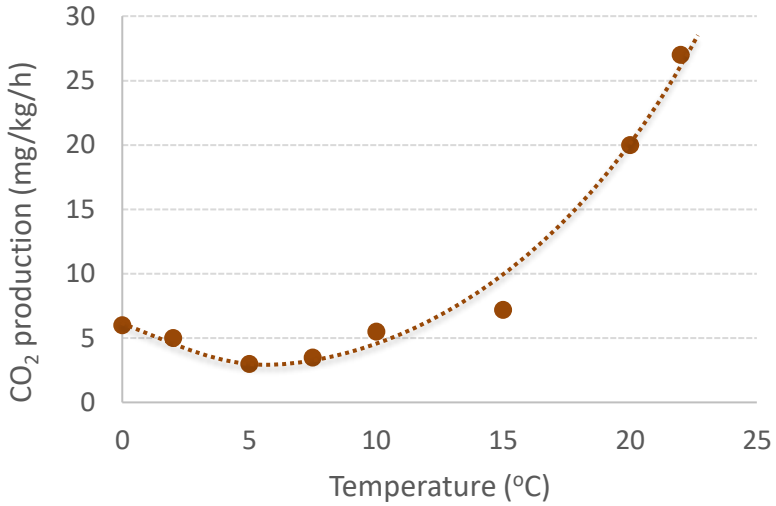
Respiration indicates metabolic activity

Potato respiration rate

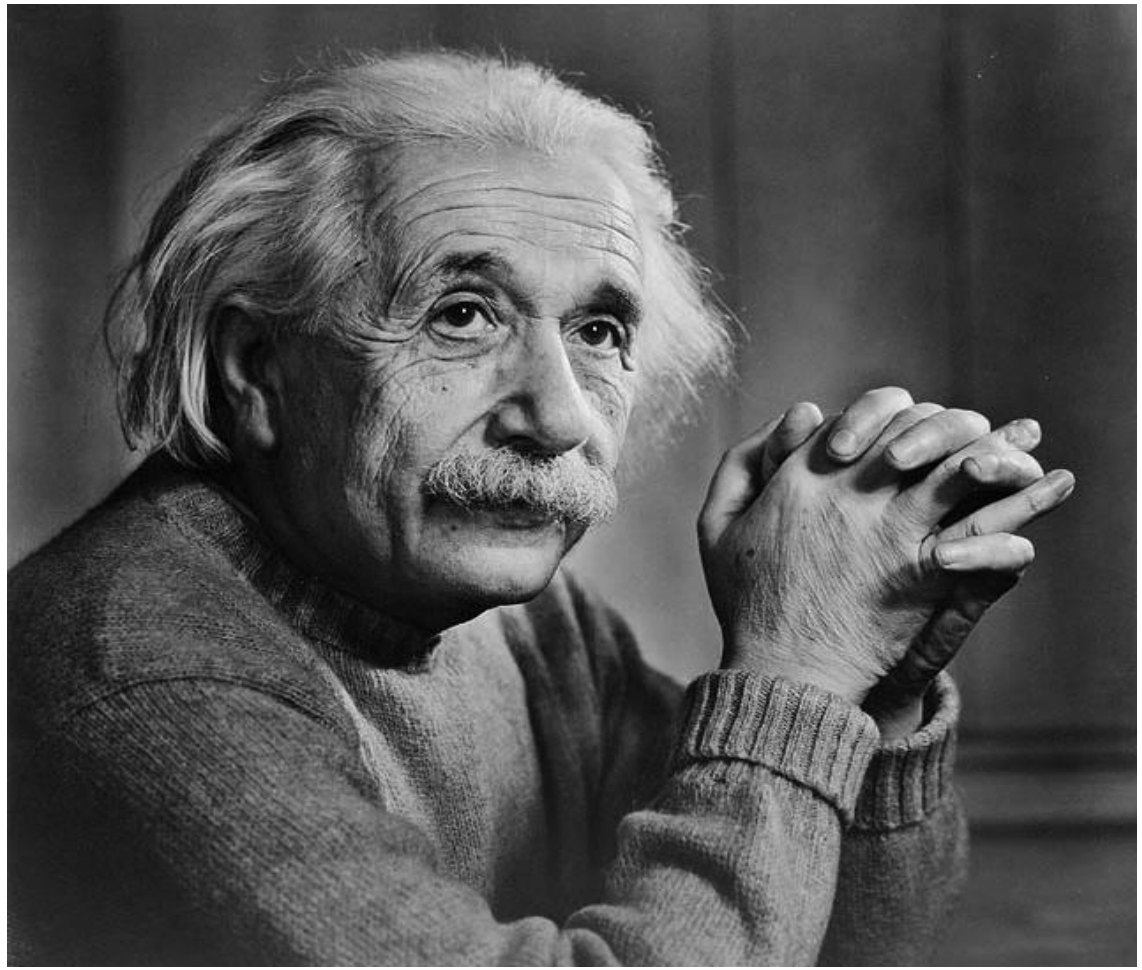


Seeds need to **BREATHE!**

High CO_2 can

- Cause black heart
- Affect seed vigour
- As little as 0.4% CO_2 may have negative impacts
- Workplace limit = 0.5% CO_2

What is cooling?



"Energy cannot be created or destroyed, it can only be changed from one form to another."

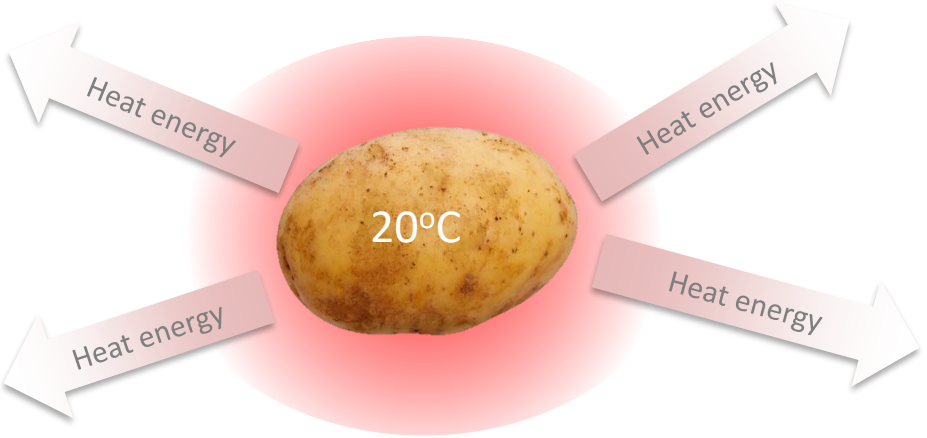
What is cooling?

HEAT is thermal energy

COOLING involves moving thermal energy elsewhere

- Into air
- Into water
- Into other materials

Warm potatoes cool because heat transfers from them into the surrounding air (or water)



What is cooling?

Water conducts heat 24x faster than Air

Air is a poor conductor of heat

Water is a good conductor of heat

Most products are cooled as FAST as possible

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While product remains warm it is…

- Burning through stored energy reserves
- Ageing (more on this later)
- Likely to develop rots and disease
- Producing more CO_2 + depleting oxygen
- Losing moisture into the cold room air

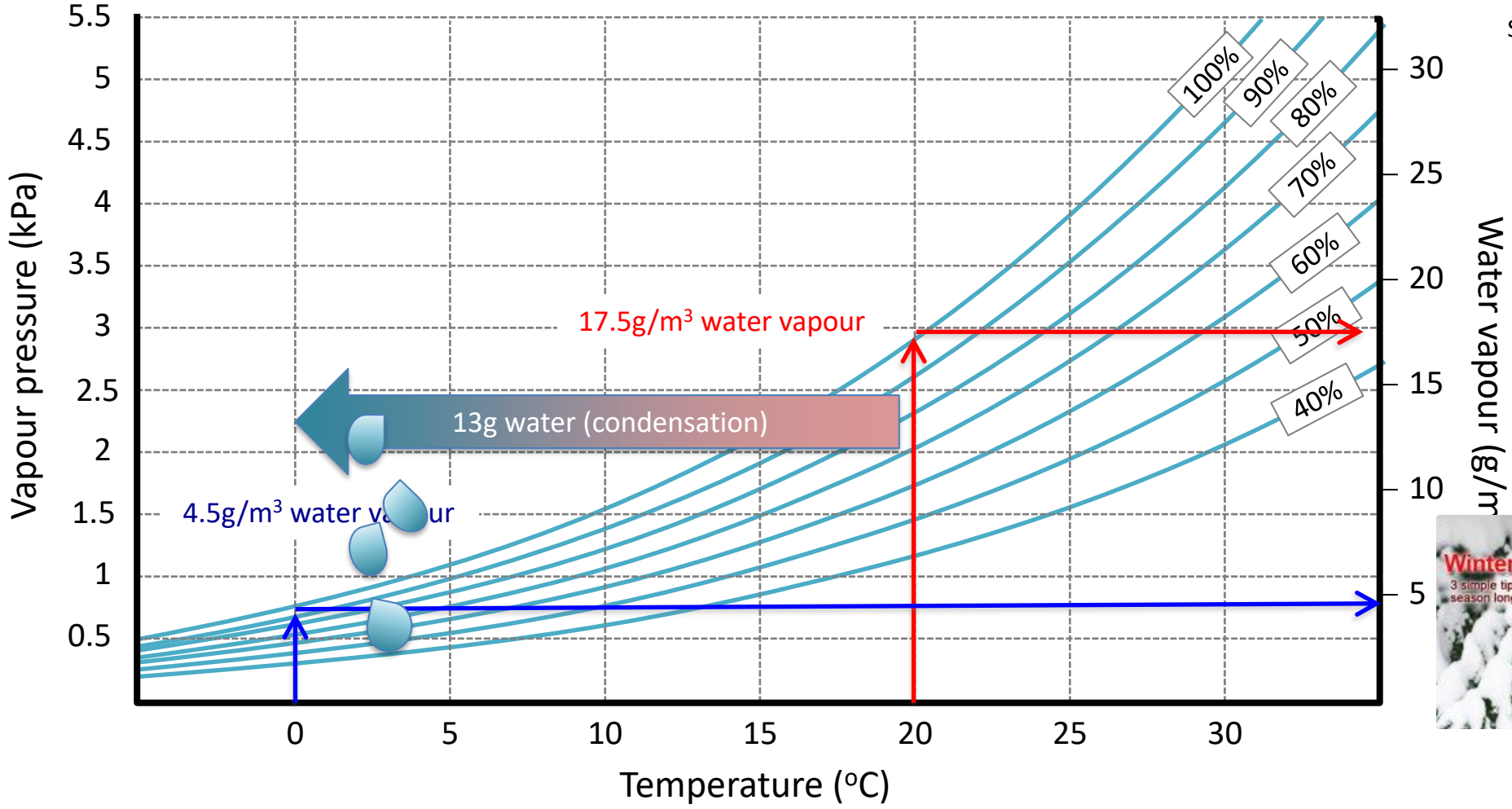
But for seed potatoes, **condensation** is a major risk

Don’t Panic

The psychrometric chart….

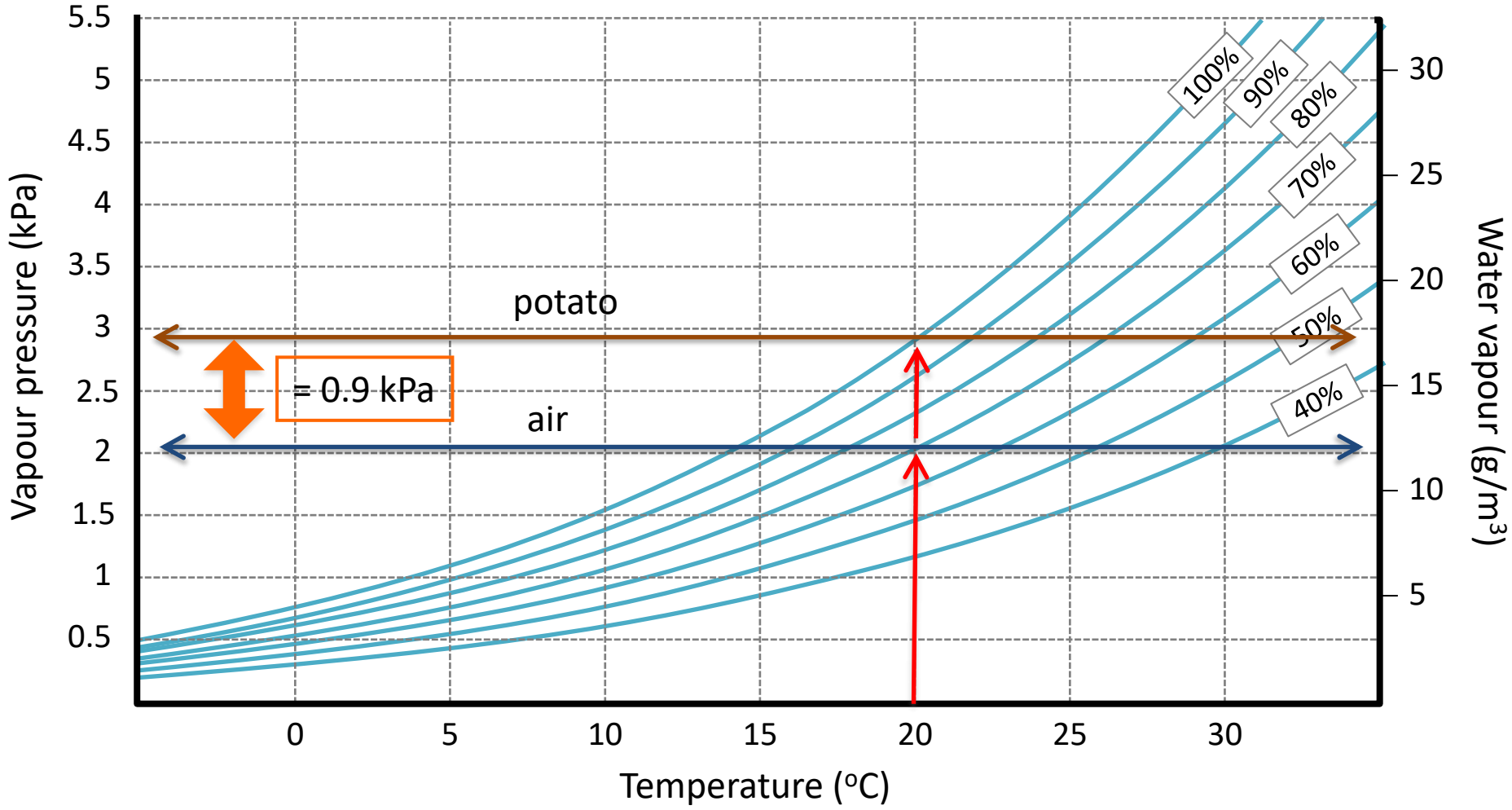
Humidity is the amount of water vapour in the air

Relative humidity is the amount of water vapour in the air *compared to what it COULD hold*

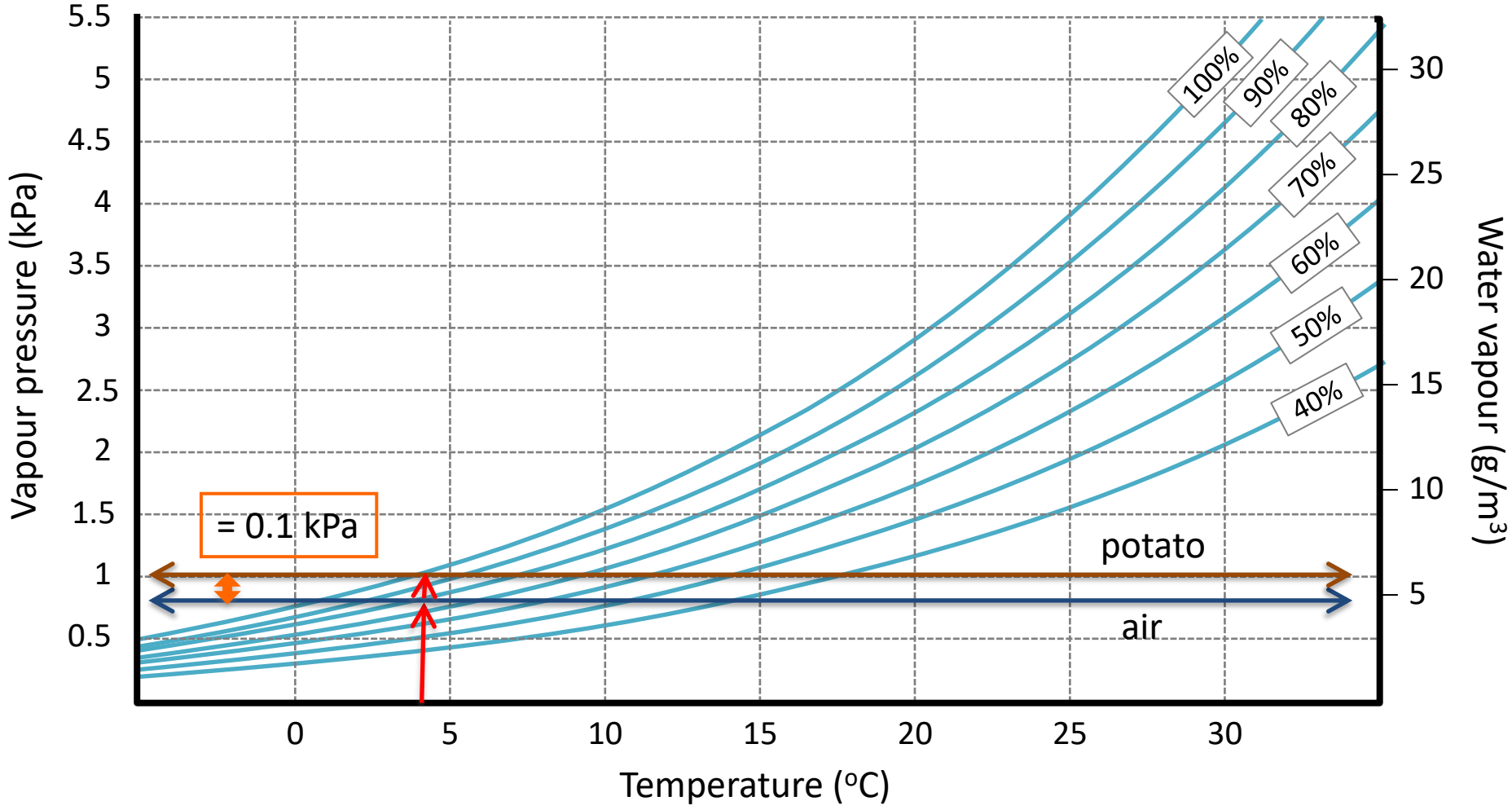


Same as Mollier chart

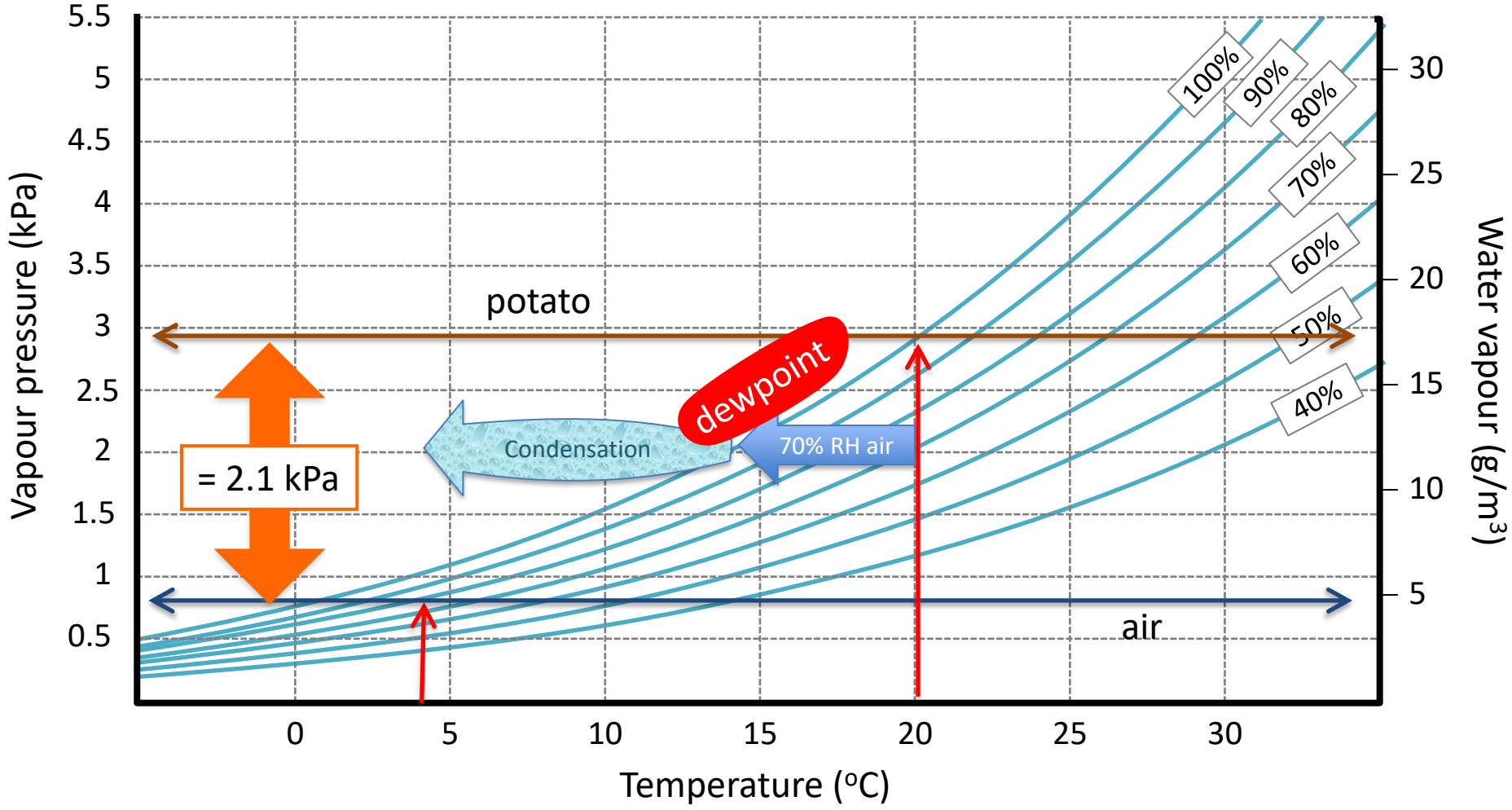
Harvest on a warm, dry day in SA



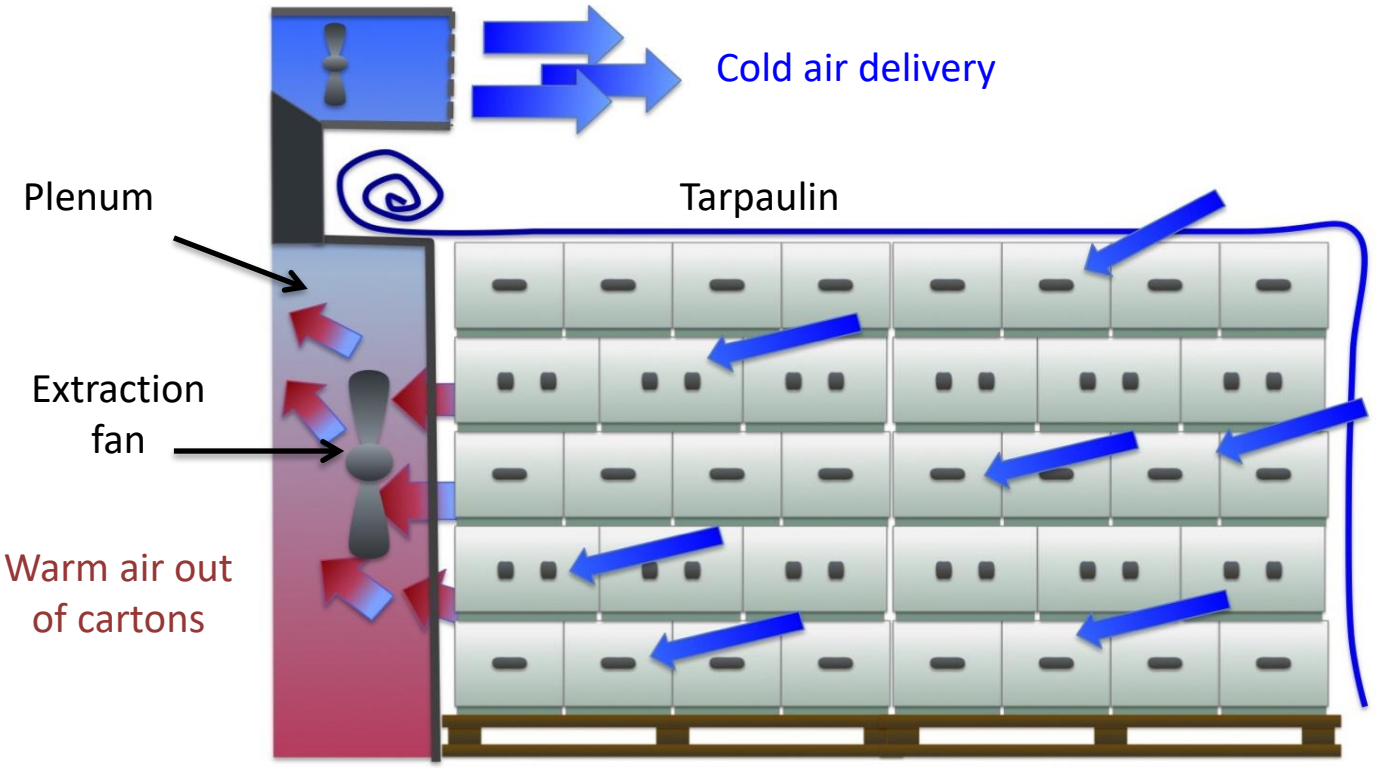
Potatoes fully cooled in storage



Harvest on a warm, dry day in SA



The solution?



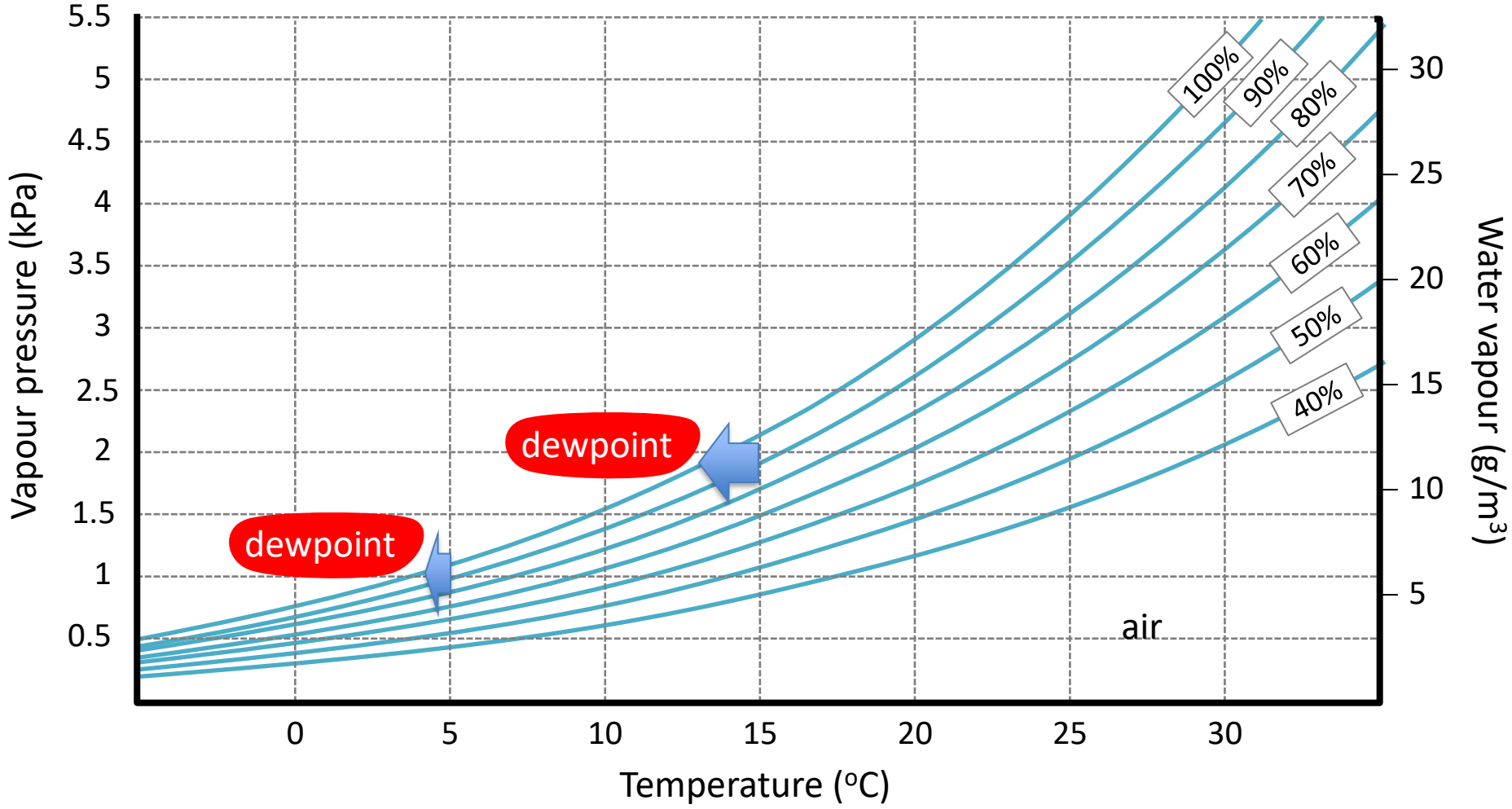
Forced air cooling

- Air always moves from cold to warm, so no condensation occurs
- Product cools 10x faster, reducing moisture loss
- Not usually used for potatoes…. But could be in some circumstances

The solution for potatoes then?

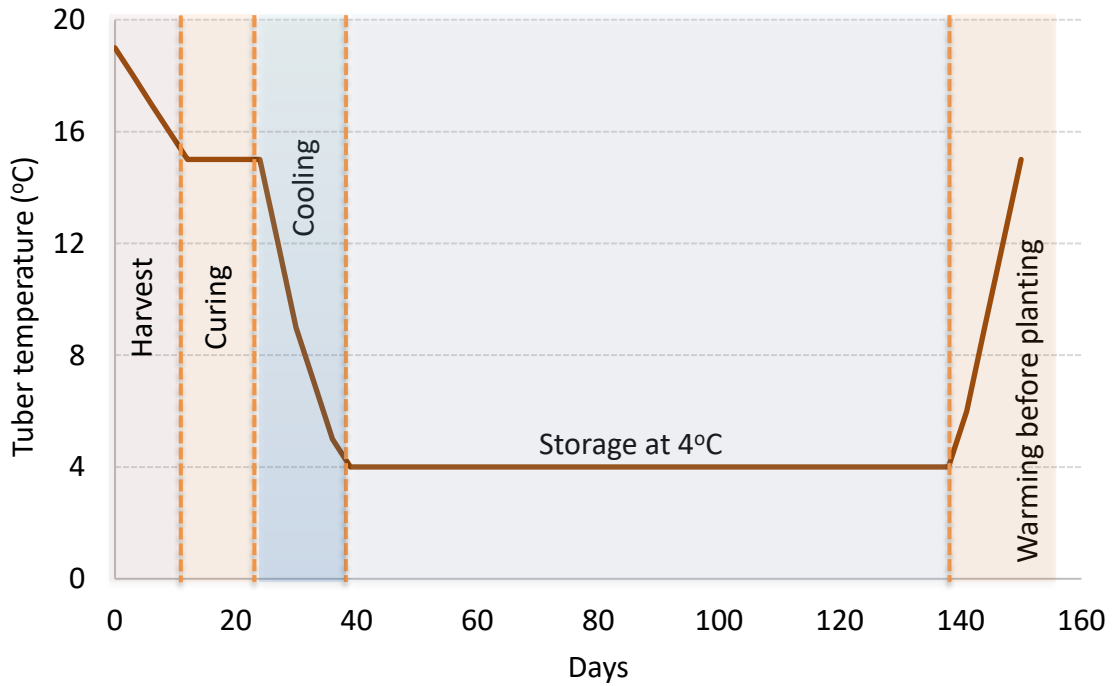
Cool slowly, so as to maintain high RH

Temperature dropped more slowly as the tubers approach 4°C



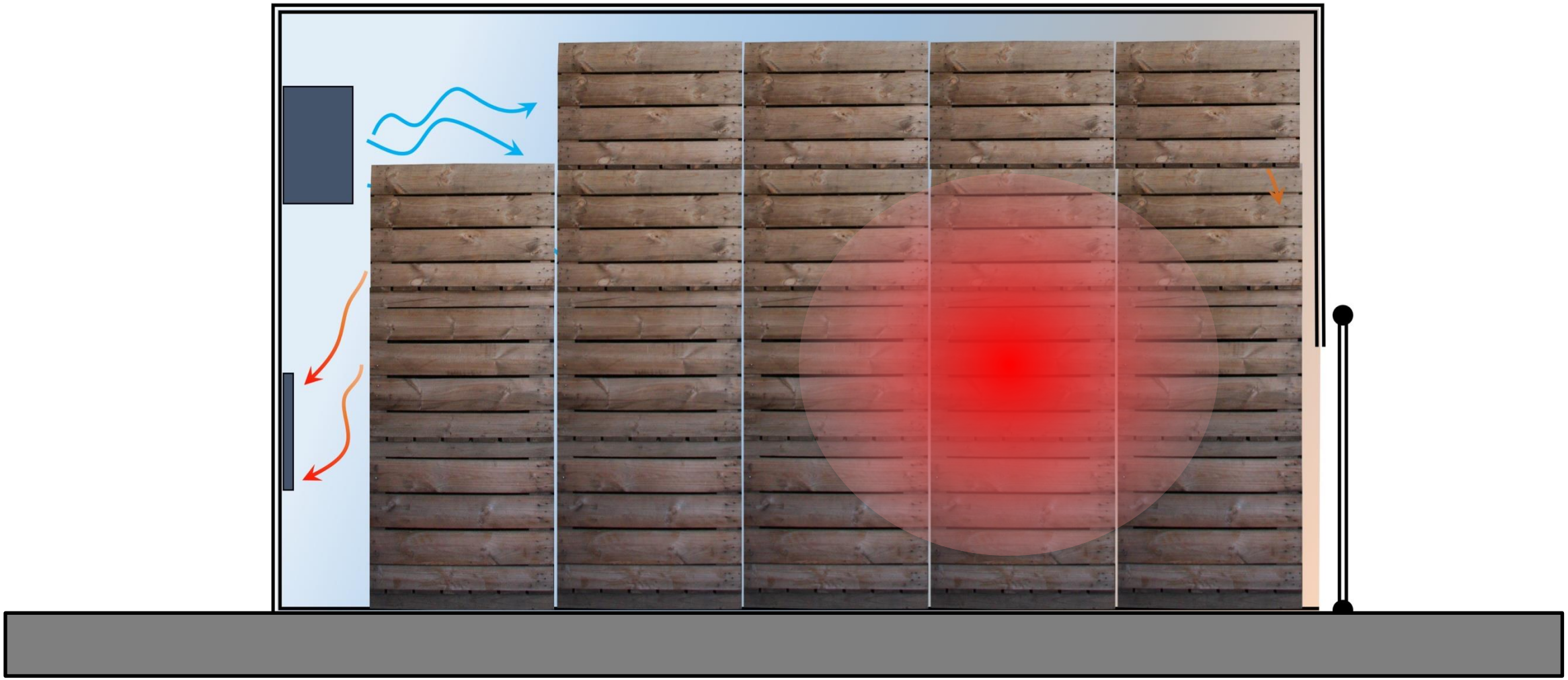
Seed potatoes are usually cooled slowly

Temperatures dropped by 0.5 to 2°C/day to avoid condensation while maintaining high relative humidity

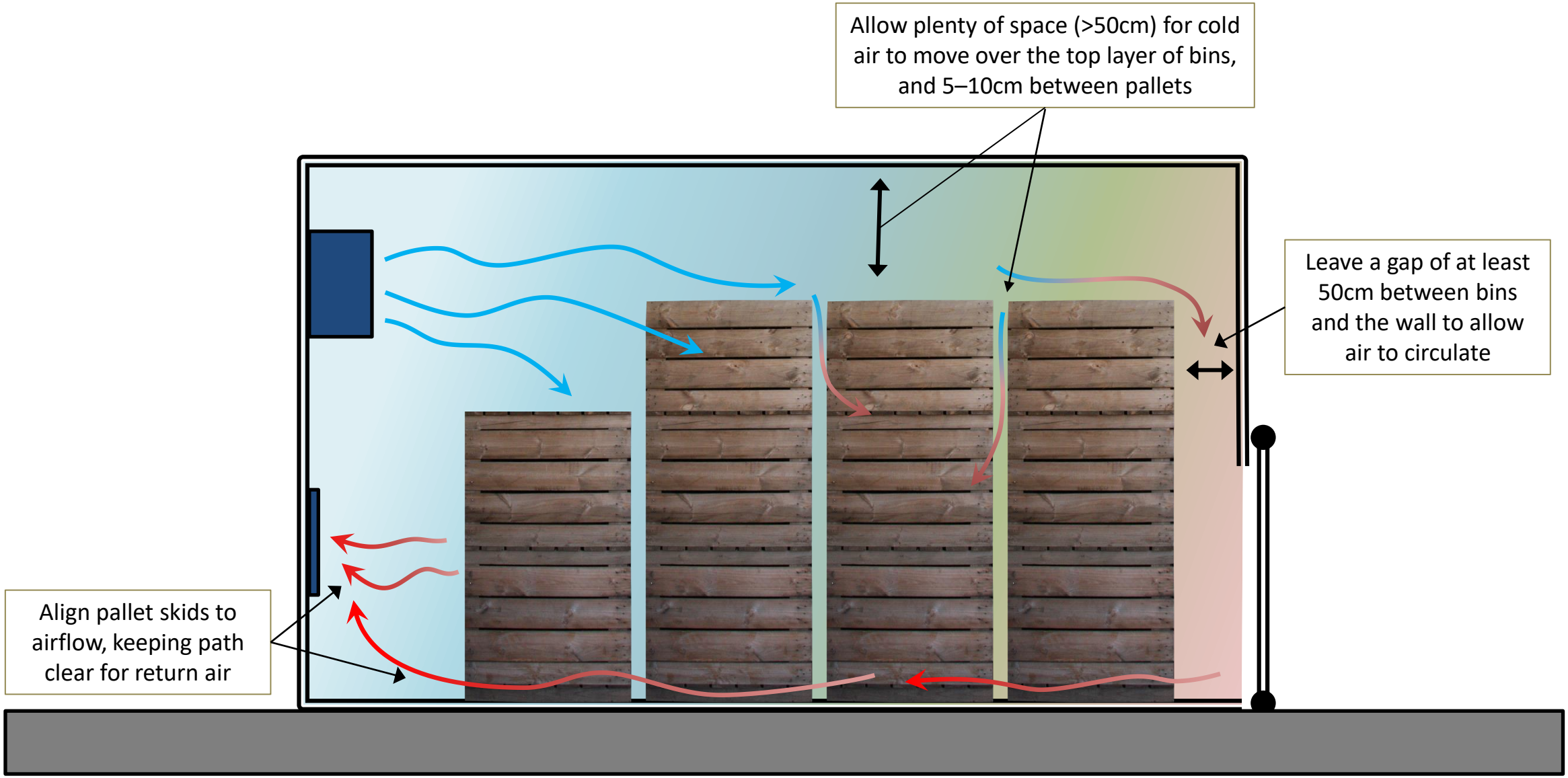


But this requires good air circulation

Air needs to remove respiration heat from stored potatoes



Air circulation is critical



Minimise temperature fluctuations

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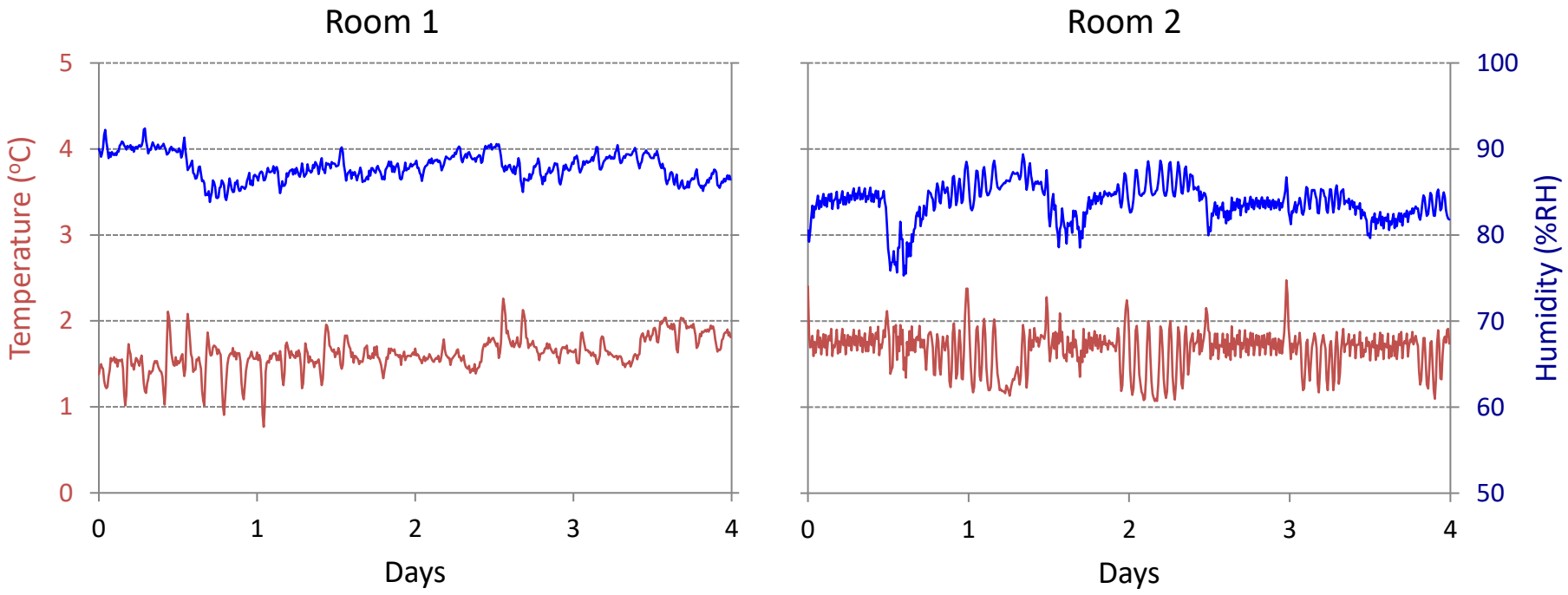
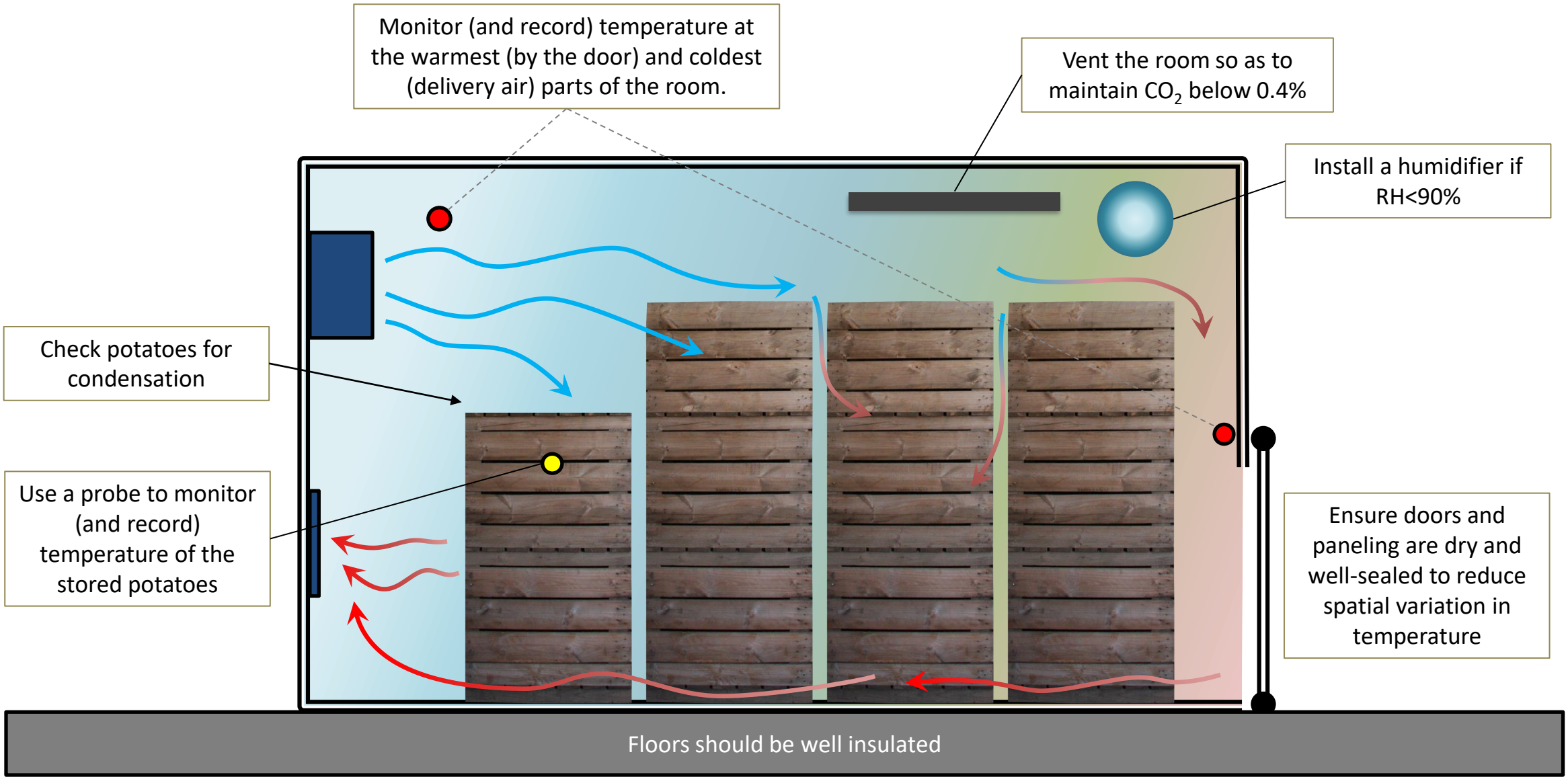
Constant temperatures = higher RH and less chance of condensation



Maintain constant conditions during storage



Summary

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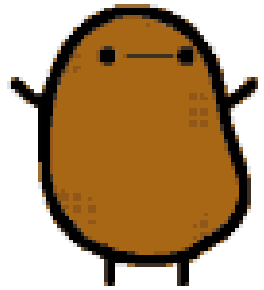
- Potatoes are **alive**
  - The rate of respiration and therefore ageing, is mainly determined by temperature
- Cold temperatures are critical to maintain quality during storage
- BUT it is equally important to avoid condensation
  - Risk of rots likely outweighs benefits of cooling quickly
- To avoid condensation
  - Maintain airflow around stored bins
  - Avoid reducing temperature below dewpoint
  - Monitor temperature in the tubers (not just the air)
  - Ensure room is well insulated
- But also, vent the room enough to keep CO_2 below 0.4%



TOLSMA GRISNICH Group

Worldwide market leader in innovative storage and handling solutions for potatoes, onions, garlic, carrots and other root crops.
Two factories in Emmeloord, the Netherlands.

TOLSMA Australia: 2018 based in Geelong
What to control in your store for the highest product quality:

- Airflow
- Air Speed
- Temperatures
- Humidity level / dehydration
- CO_2 level
- Running hours

Seed potato storage is not difficult...

- Potatoes breathe and produce CO_2
- Potatoes consists of 80% water

Control dehydration

- How much water in the storehouse?
- How much water in the air?

Storage = knowledge about:

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- Moisture content of the product & outside air.
- Temperature of the product & outside air.
- If needed:
  - cooling system
  - heating system

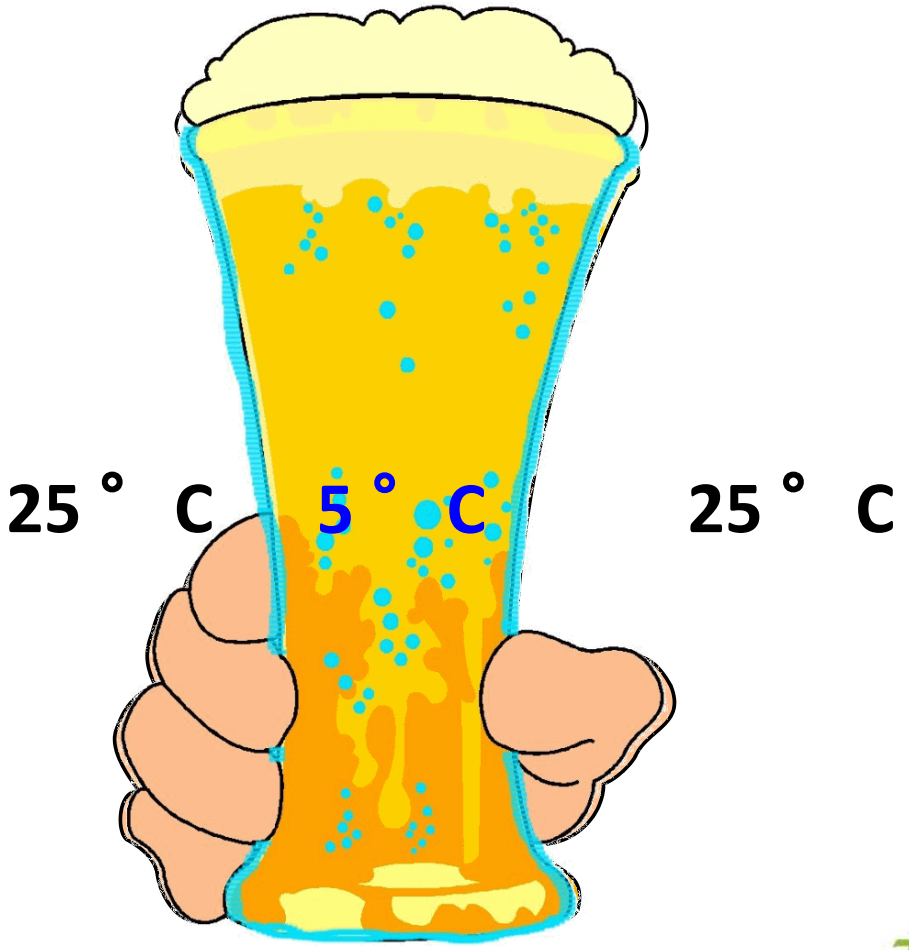
- In combination with an active ventilation system designed for your type of bins.

- Airflow by Open Space Ventilation System is minimum 50 m^3 to 60 m^3 per m^3 potatoes at 50Pascal.
- Air Speed between 4 and 6 meter/sec.

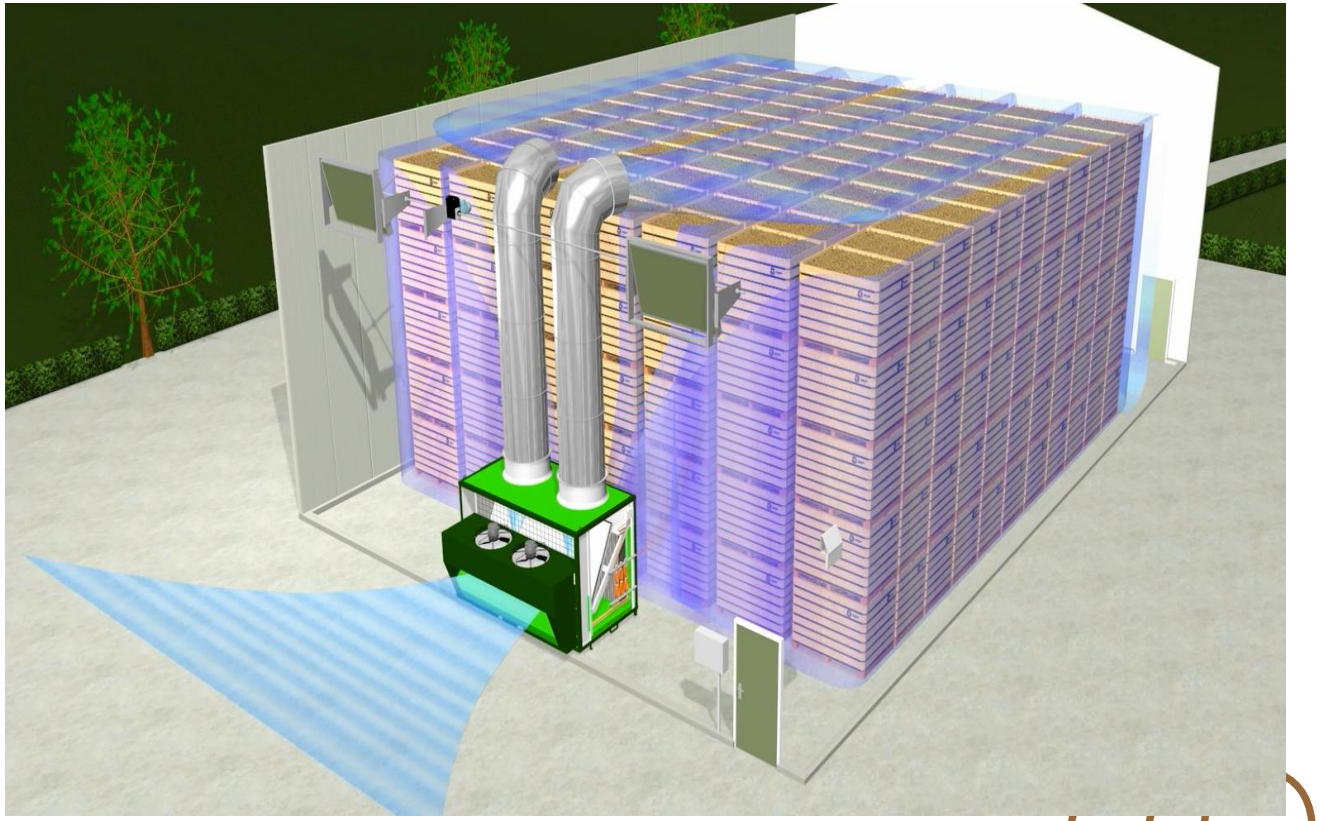
MOLLIER DIAGRAM

Air temp.		Relative humidity (%)							
°C	F	30	40	50	60	70	80	90	100
2,4	36	1,7	2,3	2,9	3,4	4,0	4,6	5,1	5,7
3,5	38	1,8	2,5	3,1	3,7	4,3	4,9	5,6	6,1
4,6	40	2,0	2,7	3,3	4,0	4,7	5,3	6,0	6,6
5,7	42	2,1	2,9	3,6	4,3	5,0	5,7	6,5	7,1
6,8	44	2,3	3,1	3,8	4,6	5,4	6,2	6,9	7,7
7,9	46	2,5	3,3	4,1	5,0	5,8	6,6	7,5	8,2
9,0	48	2,7	3,6	4,4	5,3	6,2	7,1	8,0	8,8
10,2	50	2,9	3,8	4,8	5,7	6,7	7,7	8,6	9,5
11,3	52	3,1	4,1	5,1	6,2	7,2	8,2	9,3	10,2
12,4	54	3,3	4,4	5,5	6,6	7,7	8,8	10,0	10,9
13,5	56	3,5	4,7	5,9	7,1	8,3	9,5	10,7	11,7
14,6	58	3,8	5,0	6,3	7,6	8,9	10,2	11,4	12,6
15,7	60	4,0	5,4	6,8	8,1	9,5	10,9	12,3	13,4
16,8	62	4,3	5,8	7,2	8,7	10,2	11,7	13,1	14,4
17,9	64	4,6	6,2	7,7	9,3	10,9	12,5	14,1	15,4
19,0	66	4,9	6,6	8,3	10,0	11,6	13,3	15,0	16,4
20,2	68	5,3	7,1	8,9	10,6	12,5	14,3	16,1	17,6
21,3	70	5,6	7,5	9,5	11,4	13,3	15,2	17,2	18,7
22,4	72	6,0	8,1	10,1	12,1	14,2	16,3	18,4	20,0
23,5	74	6,4	8,6	10,8	13,0	15,2	17,4	19,6	21,3
24,6	76	6,8	9,2	11,5	13,8	16,2	18,5	20,9	22,7
25,7	78	8,2	10,9	13,7	16,5	19,3	22,2	25,0	27,2
26,8	80	8,7	11,7	14,7	17,7	20,7	23,7	26,8	29,0
27,9	82	9,3	12,5	15,7	18,9	22,1	25,4	28,7	31,0
29,0	84	10,0	13,3	16,7	20,2	23,6	27,1	30,6	33,1
30,2	86	10,6	14,2	17,9	21,5	25,2	29,0	32,7	35,4

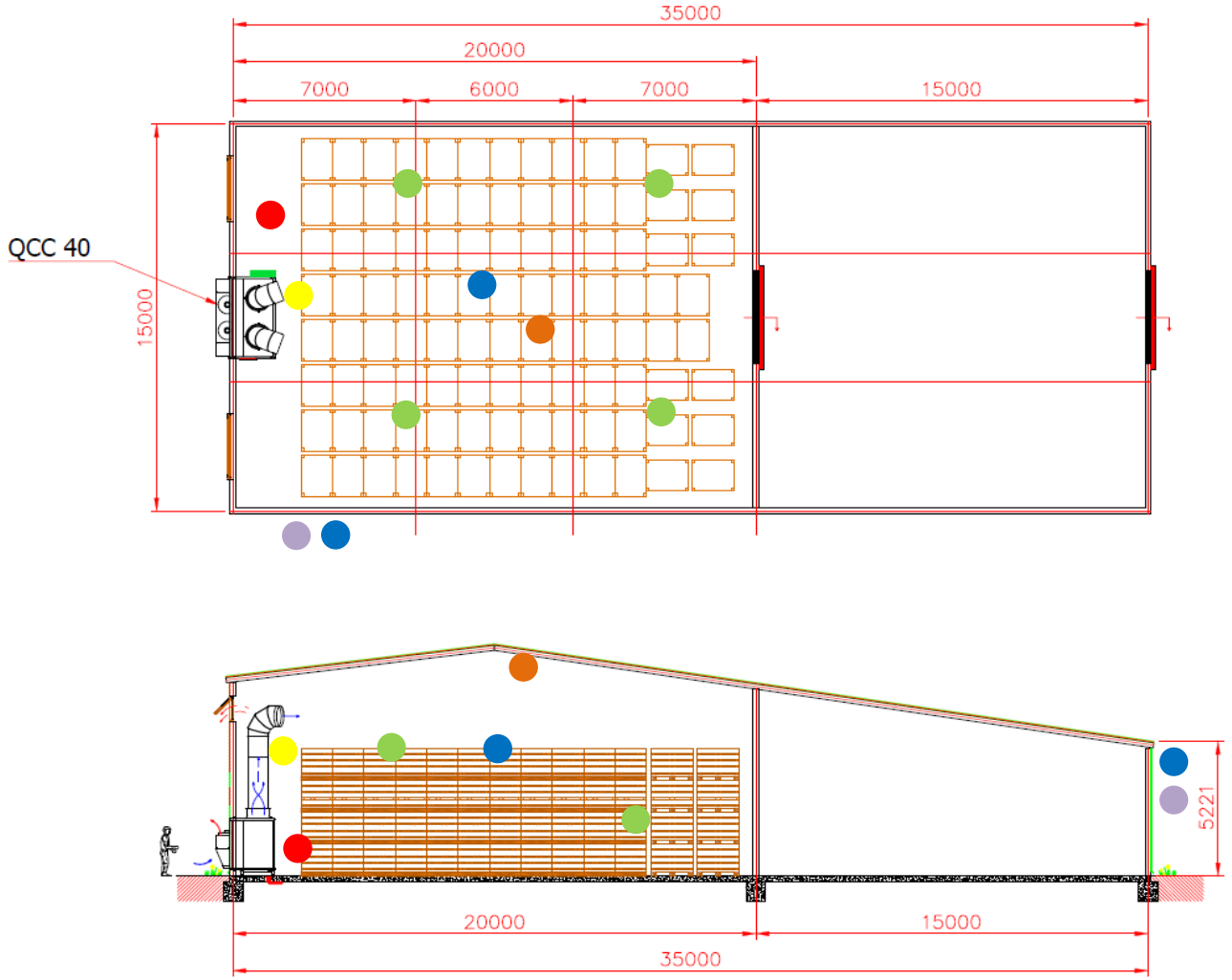
Condensation:



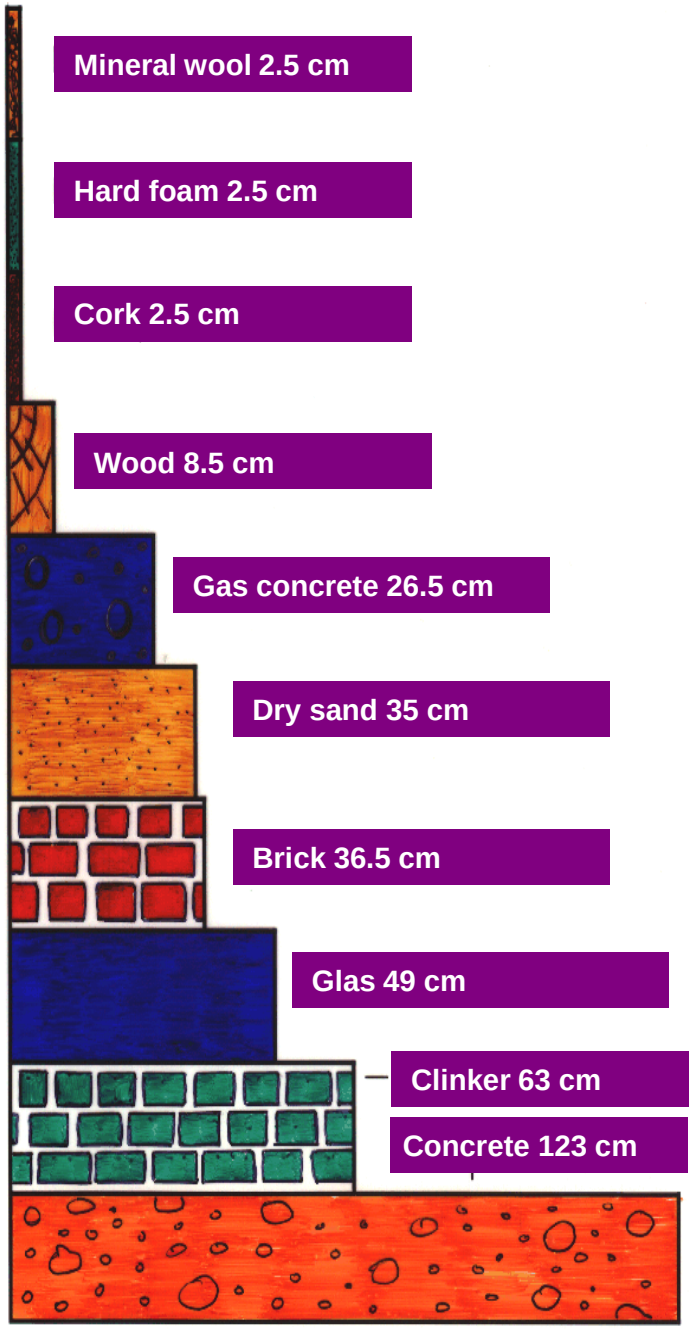
TOLSMA Open Space Ventilation & Cooling Using Ambient Air



Sensor/box placement for optimum control by Tolsma Open Space System



- Outside temperature
- Relative humidity
- Duct temperature
- Room temperature
- Product temperature
- CO_2 sensor



Insulation

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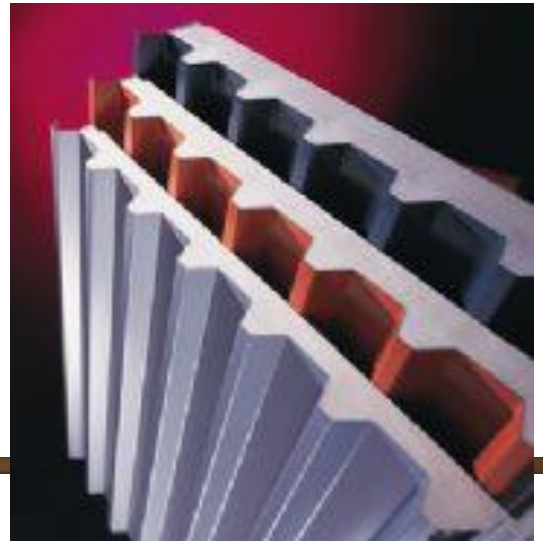
- Keep heat, cold and moisture outside and avoid condensation
- Insulation Material
- Coolroom panel
- Spray foam



Vision Control Climate Computer

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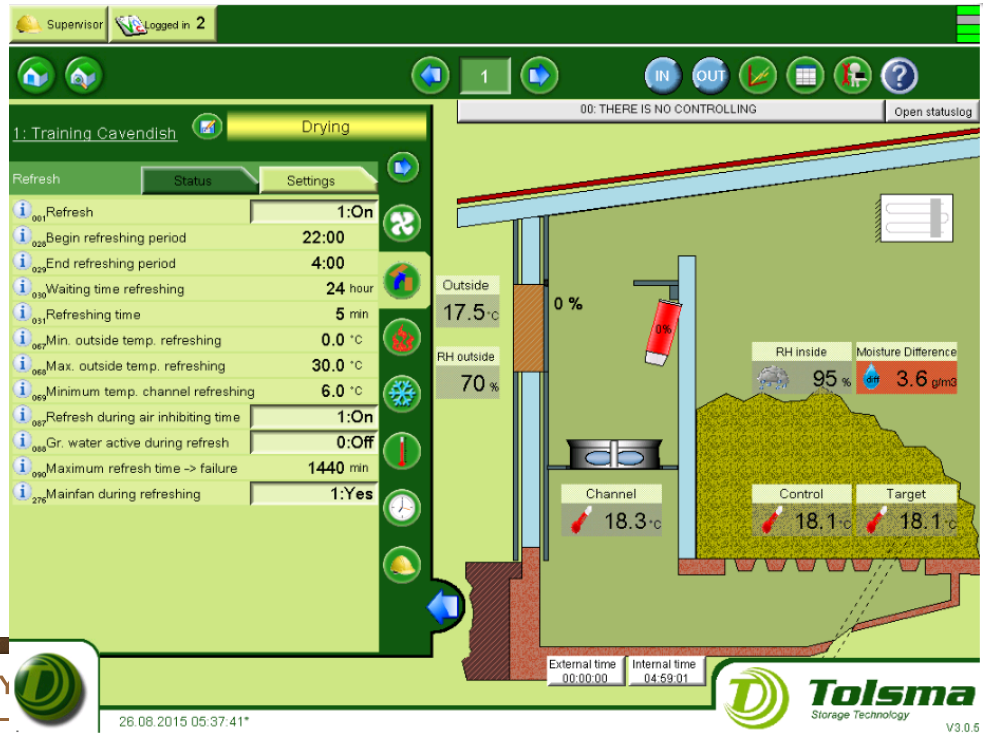
Designed for your high value crop

- Optimal control of temperature, relative humidity and CO_2 inside by managing the climate.
- Automatic control of ventilation, cooling & heating.
- Reduce physiological age.
- Low storage losses.
- Maximum energy saving.



Stages of (seed) potato storage:

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- **Skin setting and drying**
  - 10 to 14 days at temperature range between 15°C and 20 °C.
  - Running time 24/7, flat out.
- **Cooling the product**
  - Bring product at right temperature between around 3 °C depending upon variety.
  - Running time 10 hours/day, slowly decreasing 0.3 °C.
- **Maintain product at right temperature**
  - Running time: 2.5 hours/day.

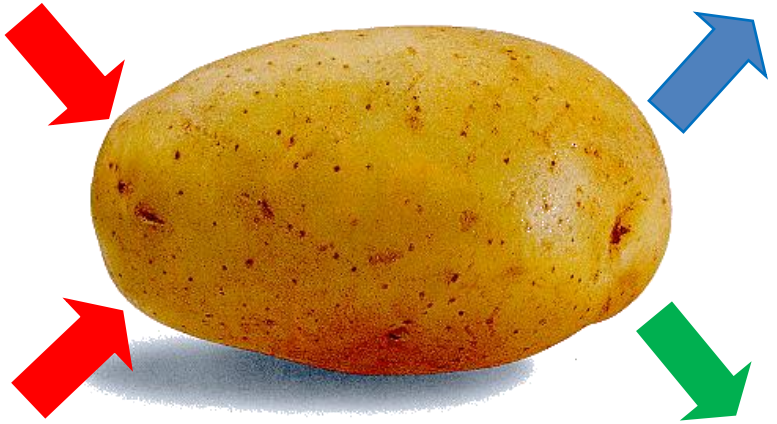
For 6 months storage period average 1,200-1,300 running hours

Why drying & skinsetting in storage ?

Harvesting causes damage to your seed potatoes:

- Skin peeling
- Cuts
- Bruising
- Mother tubers
- Moisture

Good storage reduces:



Reducing the risk and spread of diseases and defects in store

Black dot

Black Scurf and Stem Canker

Blackheart

Brown rot

Bruise and damage

Common Scab

Dormancy and physiological age of seed

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- Dormancy is the physiological state where sprout growth doesn’t take place
- Physiological age is the development stage of seed potatoes, which is continuously changing due to growth and storage circumstances
- The physiological age is influencing the potential yield

Physiological age

- Tuber size
- Growing conditions
  - Climate, moisture, temperature, soil conditions
- Storage period
  - Cooling rate (slow – fast)
  - Storage temperature (respiration rate)
  - Temperature fluctuations
  - CO_2 levels
  - RH levels

Physiological age

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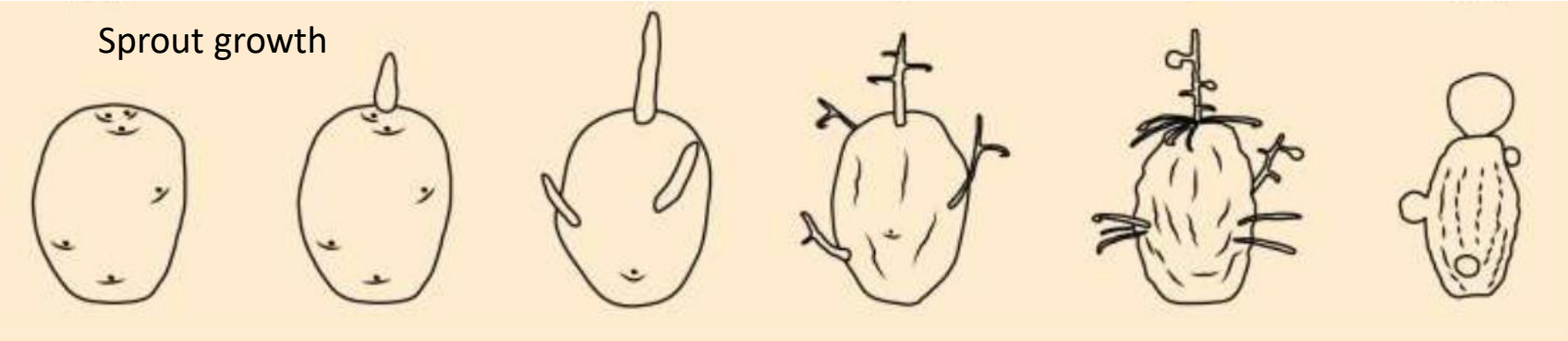
Young ……Old

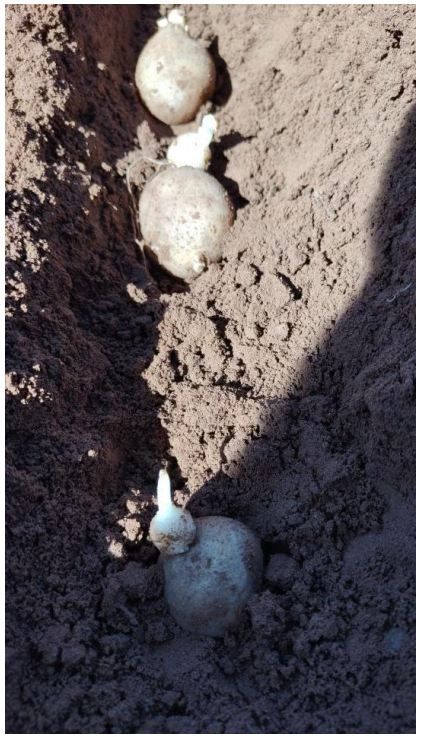


Potential yield

zero	low	quite high	high	low	very low

Controlling the physiological age in storage

- Temperature and grams of water
- Temperature fluctuations
- O_2:CO_2 , Max. level of CO_2 = 3,000-5,000 PPM
- Chemicals (example: Desprouting)
- Risk of diseases in store
- Warming before planting



Control physiological age – improve yield

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The same seed, only stored different:

2017 Terry Buckley seed potato store

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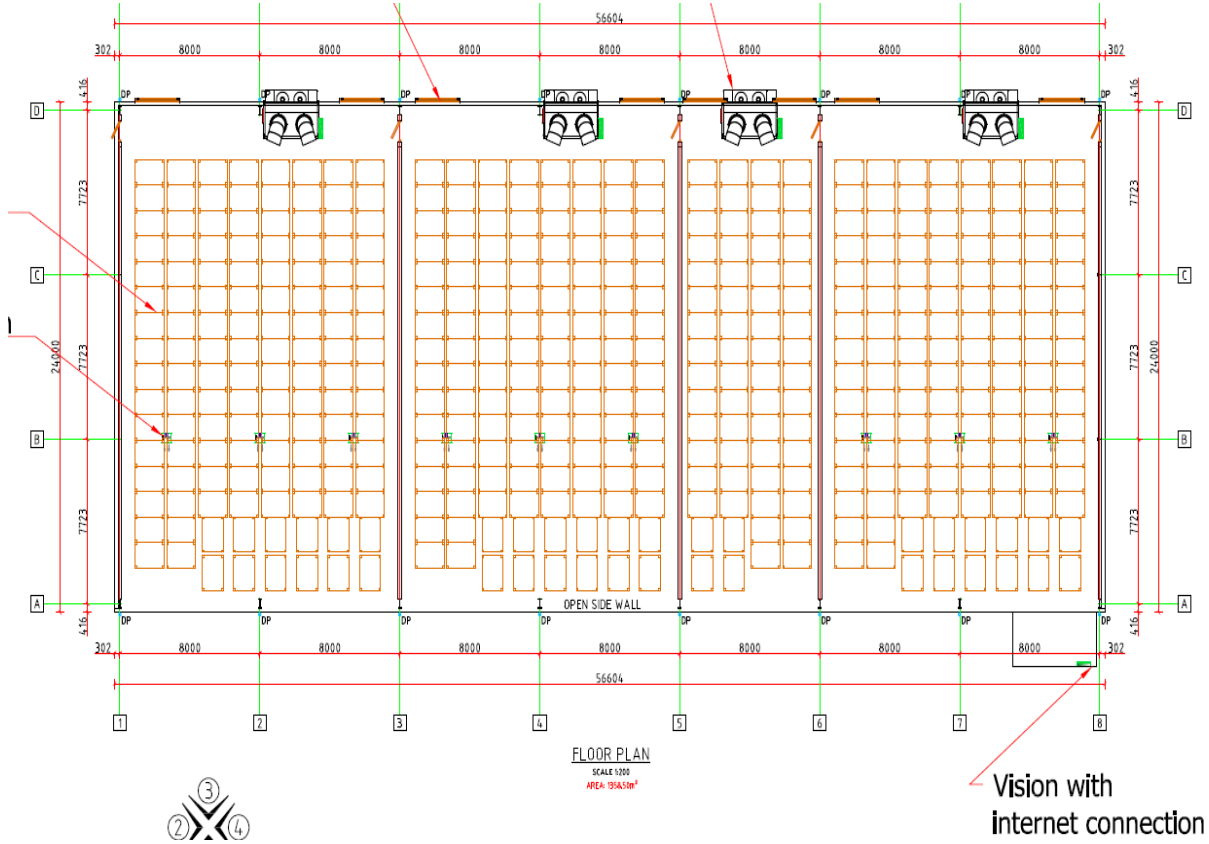

Control of optimal physiological age resulted in a yield increase of approx. 10% per year

Recommendations for optimum storage results:

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Specific system designed for your high value seed crop;

- Airflow by Open Space Ventilation System is minimum 50 m^3 to 60 m^3 per m^3 potatoes at 50Pascal.
- Air Speed is between 4 and 6 meter/sec.
- Temperature for seed potatoes around 3^oC (depending on variety).
- Product temperature variation of max. 1^oC all over the compartment.
- Humidity level between 85% to 95%.
- CO_2 -level, maximum between 3,000 and 5,000 ppm.

Nigel

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Q & A

Resources

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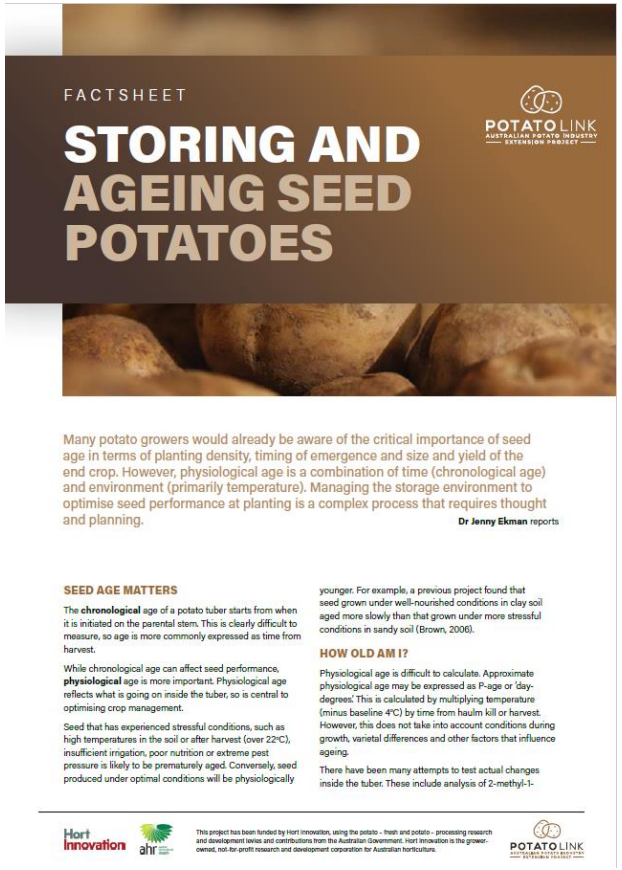
PotatoLink Fact sheet



FACTSHEET

STORING AND AGEING SEED POTATOES

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Many potato growers would already be aware of the critical importance of seed age in terms of planting density, timing of emergence and size and yield of the end crop. However, physiological age is a combination of time (chronological age) and environment (primarily temperature). Managing the storage environment to optimise seed performance at planting is a complex process that requires thought and planning.

Dr Jenny Ekman reports

SEED AGE MATTERS

The **chronological** age of a potato tuber starts from when it is initiated on the parental stem. This is clearly difficult to measure, so age is more commonly expressed as time from harvest.

While chronological age can affect seed performance, **physiological** age is more important. Physiological age reflects what is going on inside the tuber, so is central to optimising crop management.

Seed that has experienced stressful conditions, such as high temperatures in the soil or after harvest (over 22ºC), insufficient irrigation, poor nutrition or extreme pest pressure is likely to be prematurely aged. Conversely, seed produced under optimal conditions will be physiologically younger. For example, a previous project found that seed grown under well-nourished conditions in clay soil aged more slowly than that grown under more stressful conditions in sandy soil (Brown, 2006).

HOW OLD AM I?

Physiological age is difficult to calculate. Approximate physiological age may be expressed as P-age or 'day-degrees'. This is calculated by multiplying temperature (minus baseline 4ºC) by time from haulm kill or harvest. However, this does not take into account conditions during growth, varietal differences and other factors that influence ageing.

There have been many attempts to test actual changes inside the tuber. These include analysis of 2-methyl-1-

Hort Innovation ahr

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POTATO LINK

Best management practice guide