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# The storage of Fruit & Vegetables

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## Objective





# Objective

$$\text{Storage} < \frac{\text{Produce Consumed}}{\text{Produce Grown}}$$



# The enemies

- Senescence → Respiration
- Rotting → Fungal Decay
- Shriveling → Water Loss



# Senescence



Also showing Bitter Pit

# Rotting



# Rotting

Growing practice

Spray programs

Harvest hygiene & weather

Fruit handling damage

Fungicide dip before storage

CO<sub>2</sub> in storage atmosphere



# Shrivel





# Shrivel

## Water loss

Noticeable after 2-3%

Loss in quality & value

Longer storage..greater loss

Cooler design, Store insulation

Conditions at harvest



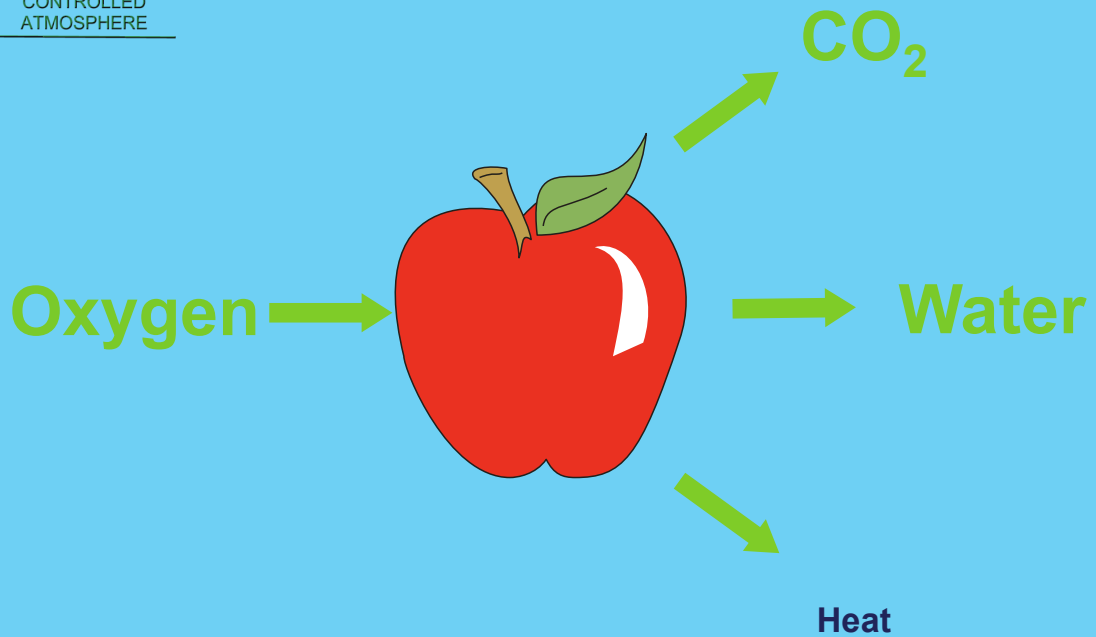
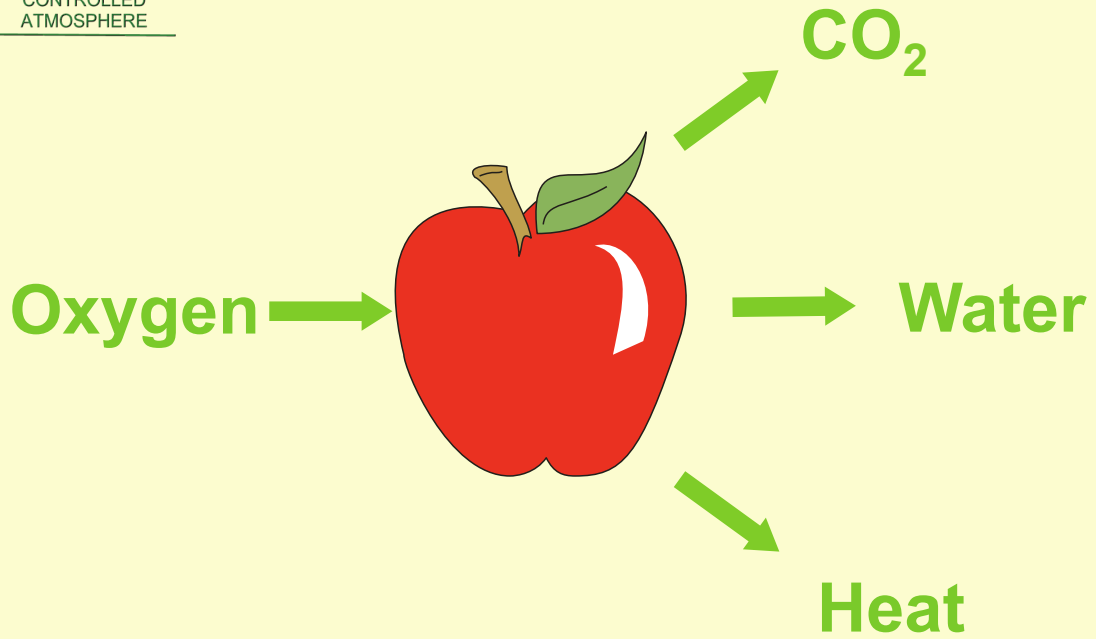
# Respiration



1 mg/kg/hr CO<sub>2</sub> =      11kJ/tonne/hr  
   2.6 Kcal/tonne/hr  
   10.4 Btu/ton/hr  
   3.05 watts/tonne



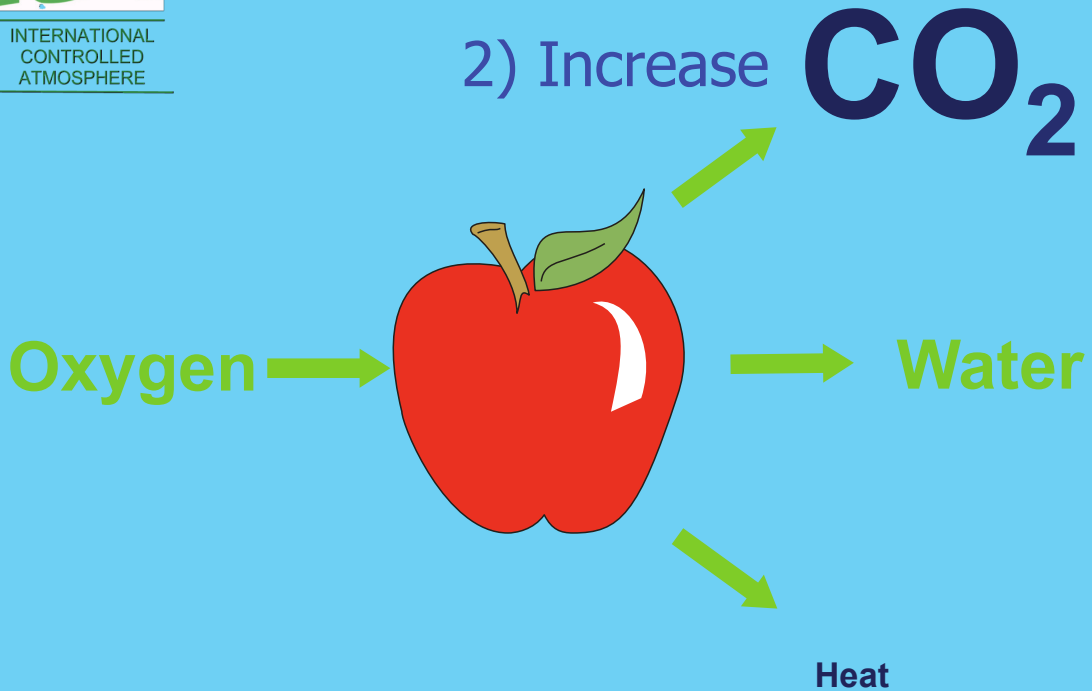
# Respiration



1) Reduce temperature



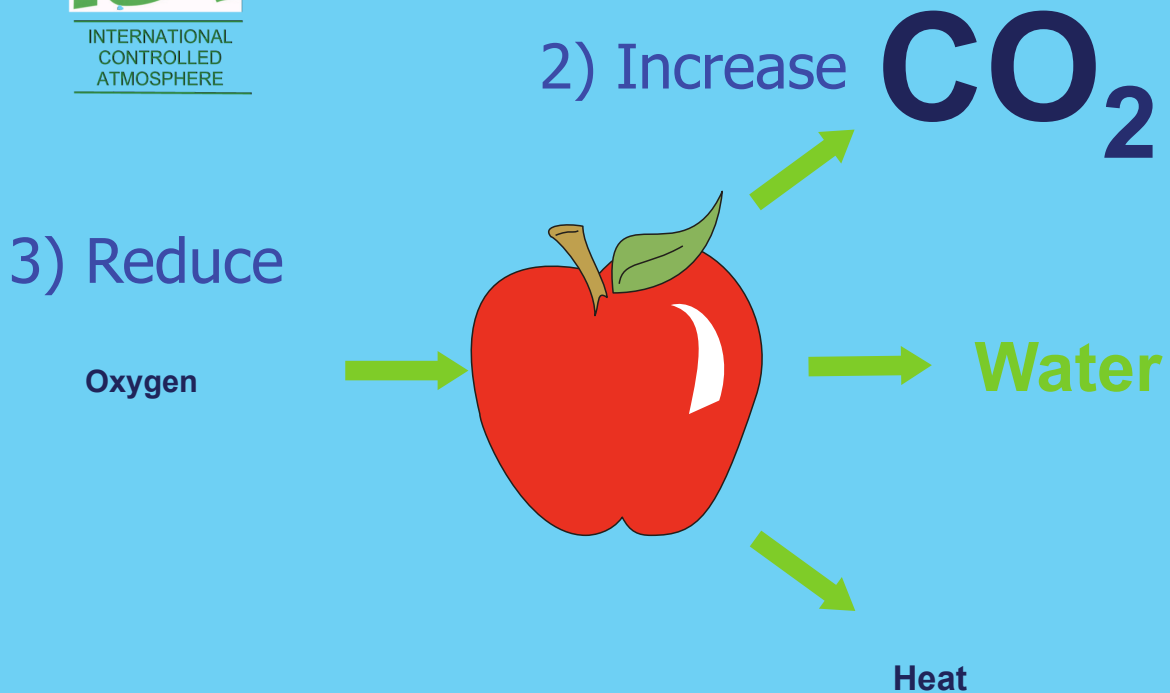
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1) Reduce temperature



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1) Reduce temperature



## Limitations

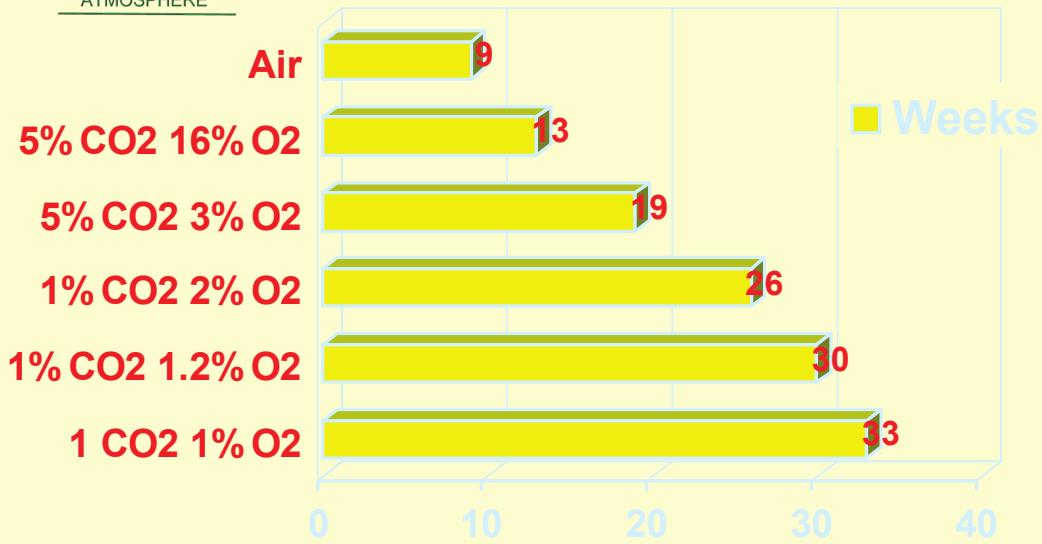
- Temperature too low.....breakdown or freezing
- Oxygen too low.....anaerobic... tissue death
- CO2 too high.....product damage

“The optimum storage condition for each product, cultivar and production area is potentially different”





# Apple Storage Life

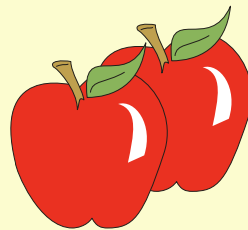


Cox's life from harvest



## Ambient

N<sub>2</sub> = 79%  
O<sub>2</sub> = 21%  
CO<sub>2</sub> = .035%



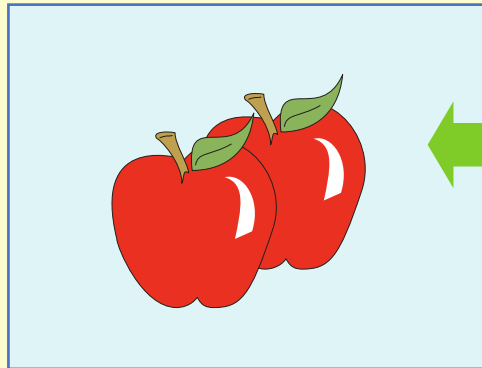
T = +25°C

*Life = 2 weeks*



# Chill Store

$N_2 = 79\%$   
 $O_2 = 21\%$   
 $CO_2 = .5\%$

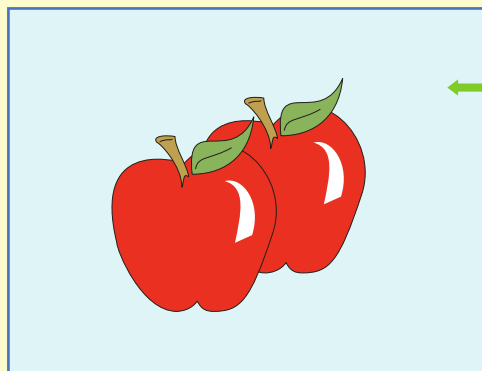


$T = +1^\circ C$

*Life = 10 weeks*

# Controlled Ventilation Store

$N_2 = 97\%$   
 $O_2 = 3\%$   
 $CO_2 = .5\%$

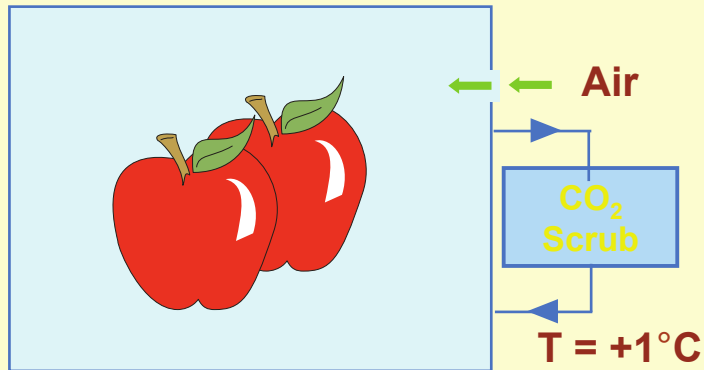


$T = +1^\circ C$

*Life = 18 weeks*

# C.A. Store

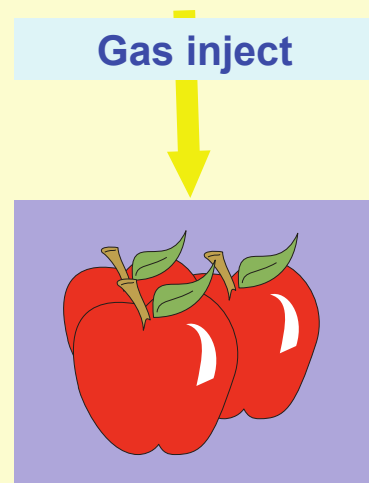
$N_2 = 97\%$   
 $O_2 = 2\%$   
 $CO_2 = 1\%$



*Life = 40 weeks*

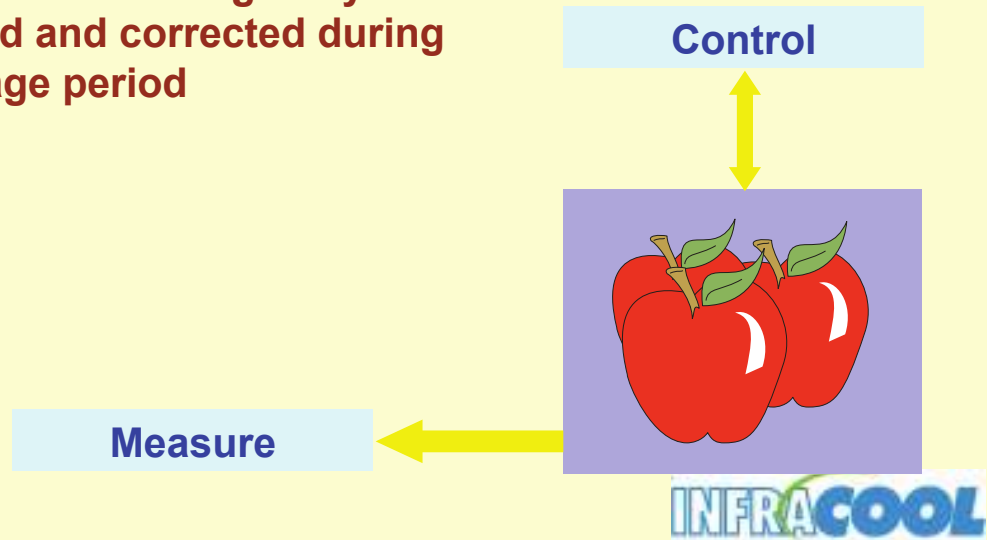
# Modified Atmosphere

**A storage atmosphere that is different from ambient air which is created at the beginning of the storage period and is expected to be maintained without further measurement or active control**



## Controlled Atmosphere

**A storage atmosphere containing lower O<sub>2</sub> and / or higher CO<sub>2</sub> than ambient air that is regularly measured and corrected during the storage period**



## Fruit & vegetables commonly stored in CA

- Apple & Pear
- Banana
- Kiwi
- Strawberry (MA)
- Blueberry
- Redcurrant
- Avocado
- Plum
- Cherry
- White Cabbage
- Onion
- Chinese leaf
- Asparagus

In general, CA has very little benefit for Citrus fruits



# Controlled Atmosphere Storage

- To extend marketing season
- Transportation
- Research
- (Packaging MA)



# Controlled Atmosphere

## Benefits

- Longer storage life
- Improved product quality at point of sale
- Less chemical input

## Results

- Extended marketing season
- Better prices
- Greater volume
- More distant markets





# History

- BC Egyptians store in limestone crypts
- 1918 Kidd & West in Cambridge UK
- 1929 1st commercial store in UK
- 1938 Smock in Cornell NY USA
- 1965 Low Oxygen storage (2%) apples
- 1970,s Cabbage, Bananas, Onions
- 1978 Ultra low apple storage (1.2%)

