2nd lecture: Physiology

Ripening index: harvesting, quality and fruit changes

Properties of fresh produce after harvesting

The product is still alive and breathing (produce CO_2)

Sugar + Oxygen → Water + Energy and Heat

What is the best quality for harvesting?

Features or properties that give a product value as food

Growers	Buyers	Consumers
Good appearance		
High yield		
Resistance to diseases		
Easy to harvest		
Resistance to wounding		

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High yield	Long postharvest life	
Resistance to diseases	Fruit firmness	
Easy to harvest		
Resistance to wounding		

What is the best quality for harvesting?

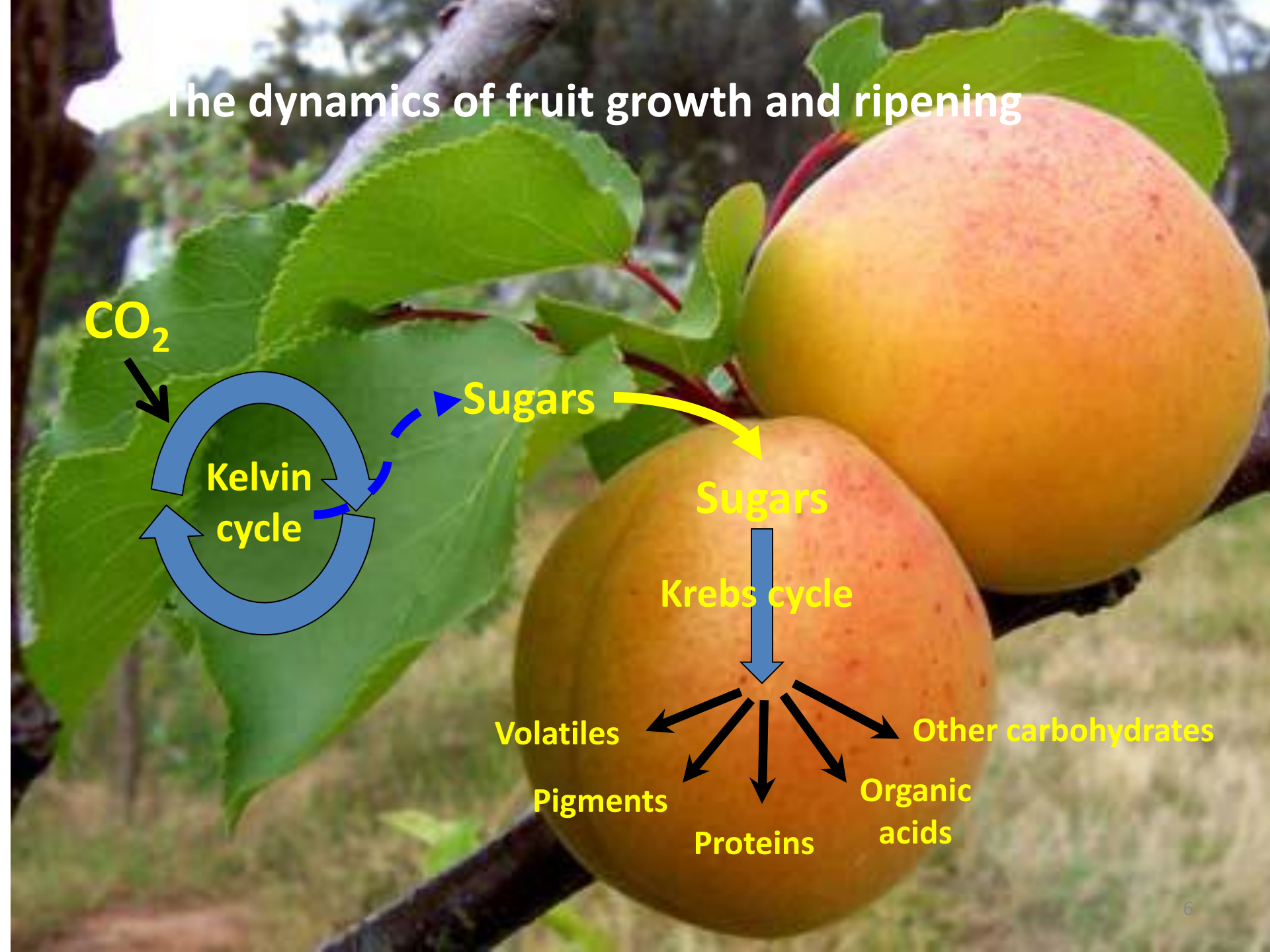
Features or properties that give a product value as food

Growers	Buyers	Consumers
Good appearance	Good appearance	Good appearance
High yield	Long postharvest life	Fruit firmness
Resistance to diseases	Fruit firmness	Taste and aroma
Easy to harvest		Nutritional values
Resistance to wounding		Resistance to stresses

Picking at the right ripening conditions is the key for quality produce

Maturation indexes = harvesting indexes

The dynamics of fruit growth and ripening



International Ripening indexes

Are the wide range of physical and chemical characteristics of the produce, that allow to harvest and treat large volumes of the product in a non destructive way.

Practical applications of maturation indexes

1. **Government/marketing regulation that includes the minimum and maximum state of product maturation**

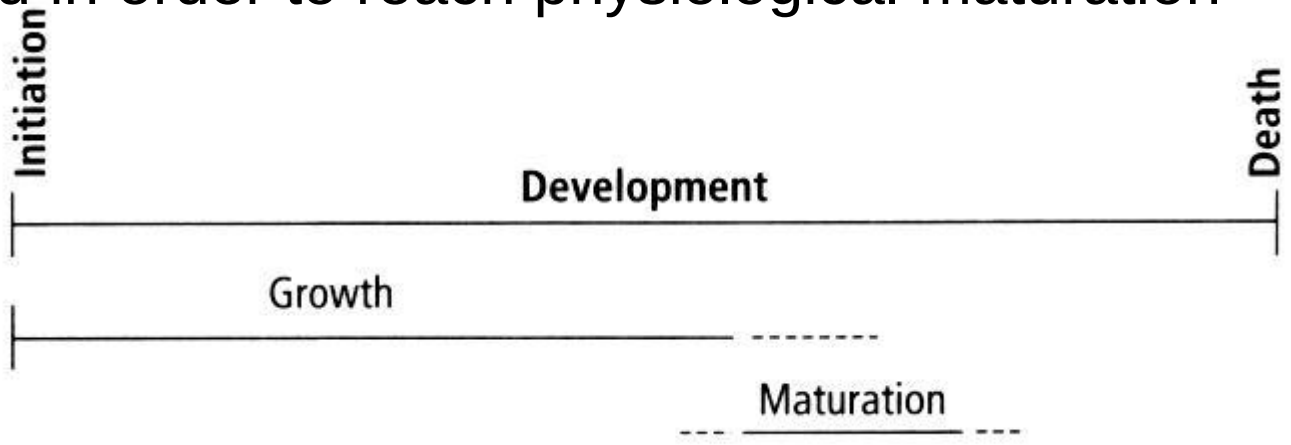
2. **Marketing strategy to achieve premium prices throughout the growing season and marketing for quality produce.**

3. **The use of manpower to start and finish harvesting at the right time, with the right equipment, at optimal costs.**

Definitions

Development of the produce: Include all the biological processes from the initiation (fruit set after flowering) to product senescence

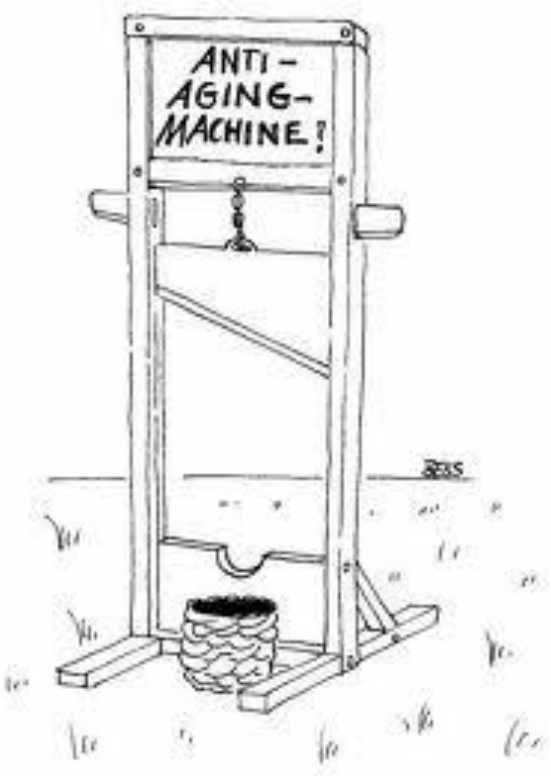
Maturation: A unique stage in the development of the product, where all the characteristics of the product were achieved in order to reach physiological maturation

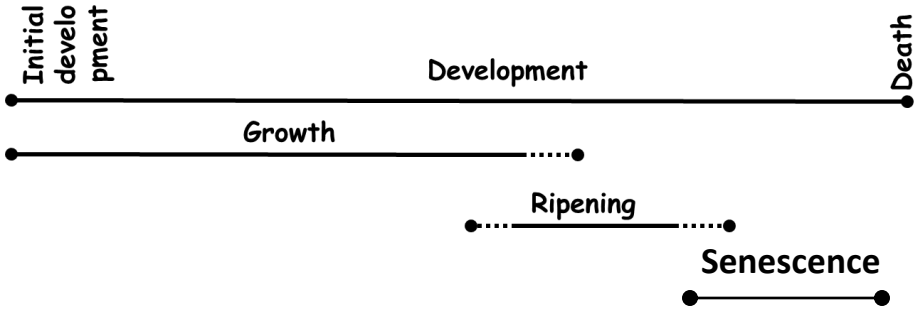


Other definitions

Ripening: A concept that describes the last stage of fruit development in which significant changes in color, texture, taste and aroma were achieved.

Senescence or aging: A concept that describes the condition that is conducive to cell, tissue and organs death. In fruits it is the stage after ripening



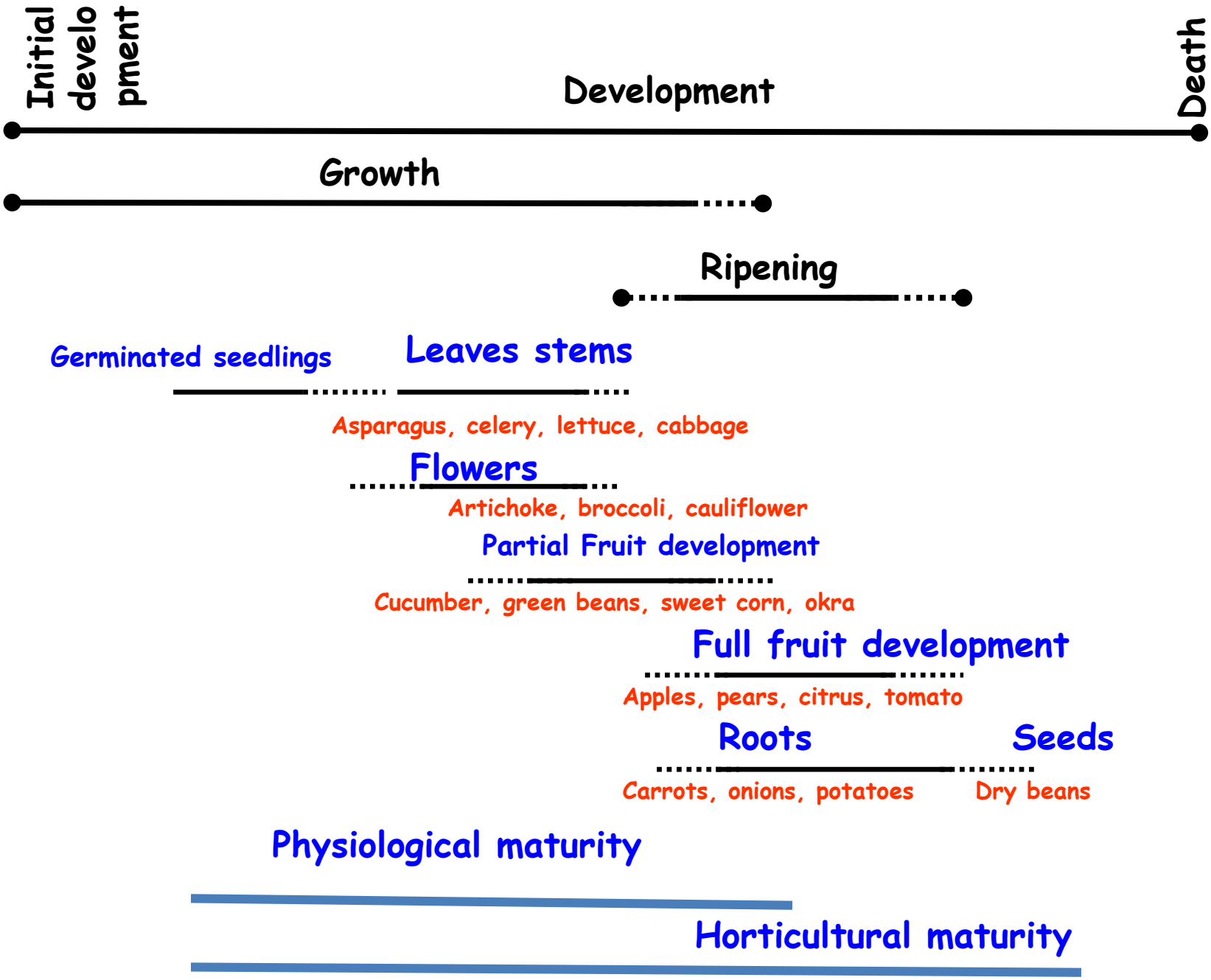


Other definitions

Physiological maturity	Horticultural ripening
The degree of development of the fruit and vegetable that enable physiological changes after it is harvested, leading to ripe fruit	
Indicates the end of the development phase	
Maximum growth and maturation occurred	
Mainly used for fruits	
Allows normal ripening after picking	
Quality has reached the minimum quality eating	

Other definitions

Physiological maturity	Horticultural maturity/ripening
The degree of development of the fruit and vegetable that enable physiological changes even after it is harvested (ripe fruit)	The degree of development of the vegetable and fruit containing the characteristics necessary for consumption by the consumer
Indicates the end of the development phase	Specifies a desired change to enable marketing
Maximum growth and maturation occurred	Maximum growth, maturation and ripening occur
Mainly for fruits	It is true mainly for vegetables
Allows normal ripening after picking	Will continue to ripen after picking
Quality has reached the minimum quality eating	


Initial development
Development
Death
Growth
Ripening
Germinated seedlings
Leaves stems
Asparagus, celery, lettuce, cabbage
Flowers
Artichoke, broccoli, cauliflower
Partial Fruit development
Cucumber, green beans, sweet corn, okra
Full fruit development
Apples, pears, citrus, tomato
Roots
Seeds
Carrots, onions, potatoes
Dry beans
Physiological maturity
Horticultural maturity

Mature fruit (Physiological maturity)

Mature fruit – is a fruit which has completed its natural growth and development and is ready for harvest

Mature but not ripe banana

Ripe fruit (Horticultural ripening/maturity)

Ripe fruit - is a stage at which a fruit is attaining the final desired state for consumption

Ripe banana

Horticultural ripening/maturity

Optimal maturity does not coincide with optimal eating quality

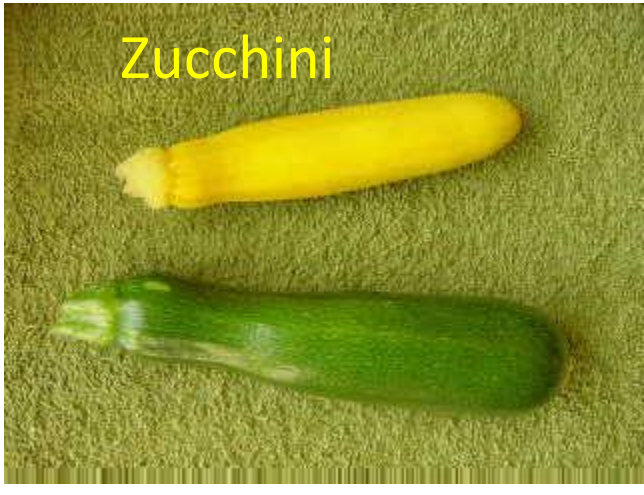
Fruits such as banana and avocado are picked when mature (physiological maturity) but not ripe (horticultural ripening)

Eating quality is a stage after ripening process when the fruit become edible

Horticultural maturity/ripening

Horticultural maturity depends on the desired use of the product.

Horticultural maturity defined as the stage of development at which a plant or plant parts possesses the attributes for use by consumers for a particular purpose



Horticultural maturity in relation to developmental stages of plants

- Sprouts (beans sprouts, cereals sprouts)
- Stems (asparagus, celery)
- Leaves (lettuce, cabbage)
- Inflorescence (broccoli, cauliflower, zucchini flowers)
- Partially developed fruit (cucumber, green bean)

Horticultural maturity in relation to developmental stages of plants

- Fully developed fruit (apples, citrus, tomatoes)
- Roots (carrots, radish)
- Tubers (potatoes, yam)
- Seeds (dry beans, cereal seeds, nuts)

Horticultural maturity: Edible sprouts

Horticultural maturity: Stems of celery and asparagus

Horticultural maturity: Leaves of cabbage and lettuce

Horticultural maturity: Zucchini flowers

broccoli,

cauliflower

Horticultural maturity: inflorescence

Beans

Zucchini

Cucumbers

Horticultural maturity: Partially developed fruit

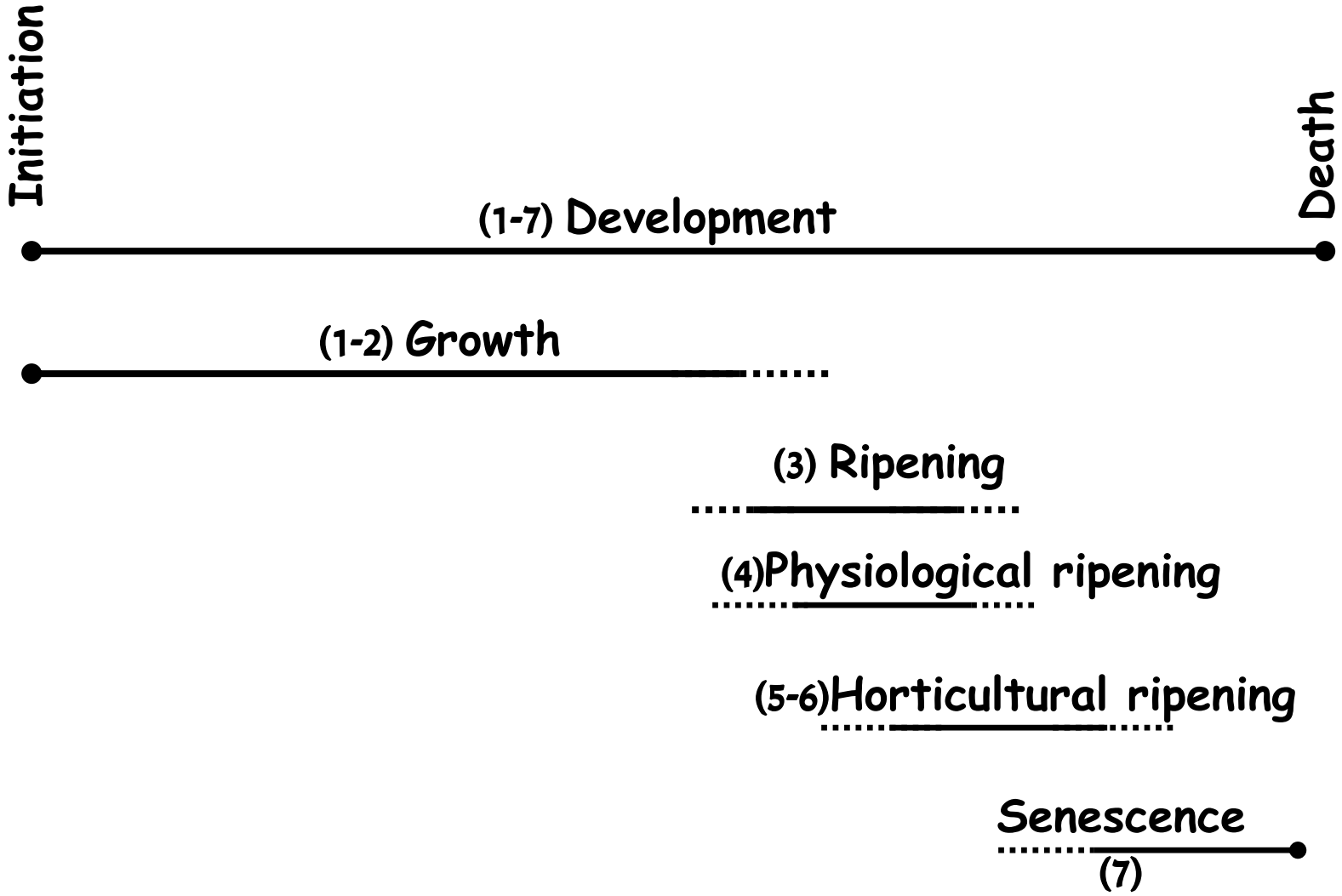
Horticultural maturity: Fully developed fruit + ripe fruit

An apple

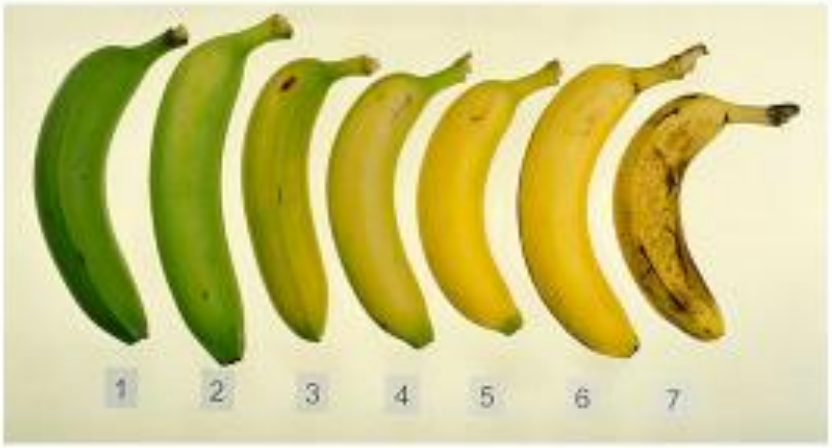
Avocado

Horticultural maturity: Fully developed fruit

Changes during fruit maturation (growth and development)



Changes during maturation (growth and development)



Initiation

Death

(1-7) Development

(1-2) Growth

(3) Ripening

(4)Physiological ripening

(5-6)Horticultural ripening

Senescence (7)

So what are the tools for proper harvest?

Index for harvesting and ripening

Index	Example
Days from flowering	Apple, pear
Development of stem tissue	Melons, apples
Texture over the fruit peel	Melon netting, cuticle development in grapes
Size	Most of the fresh produce
Shape	Banana, mango, broccoli head
Firmness	Lettuce, cabbage, Brussels sprout
Crispiness	Appel, pear
Outside color	Most of all the fruits and vegetables
Internal color	Mango and other fruits and vegetables
Starch	Apples
Sugar	Grapes, apples
Sugar: acid relation	Citrus, melons, pomegranate
Oil	Avocado
Stringency	Persimmon, dates

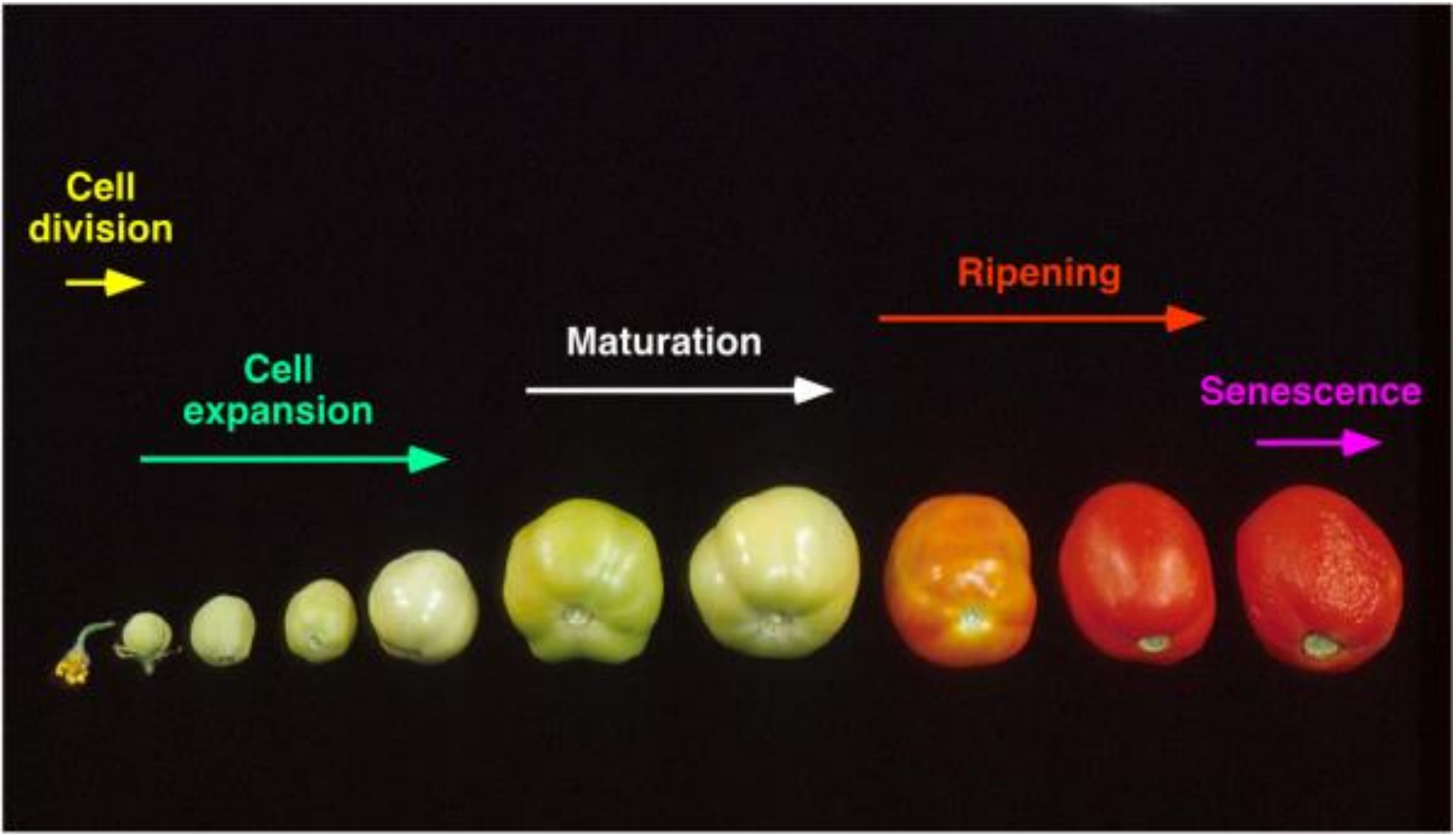

A&D
ELECTRONIC BALANCE
FX-4000
POISON
SODIUM HYDROXIDE
(0.10+/-0.005)M
CORROSIVE
Rowe Scientific
PHONE: (08) 9302 1911
PHENOLPHTHALEIN
INDICATOR
PYREX

Different ripening indexing

Related to physiological age

- Several days from planting/planting to ripening(vegetables)
- Days from fruit set (apples)
- Calculation of heat/cold units with chronological changes according to weather fluctuations (pears)

Depends on environmental/seasonal impacts



Stages of tomato fruit development

Depends on environmental/seasonal impacts

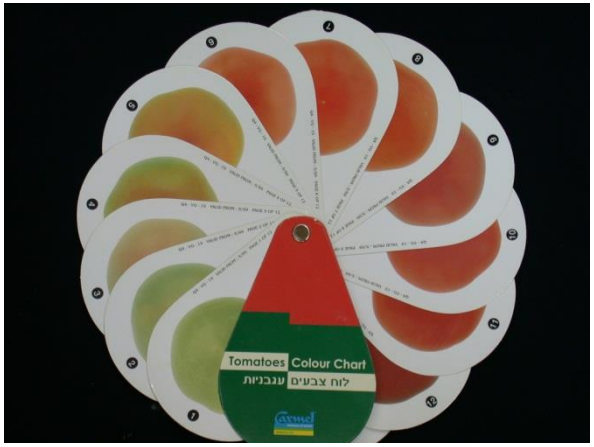
Ripening Indexing

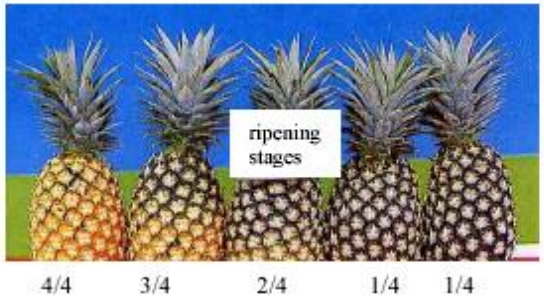
Physical factors

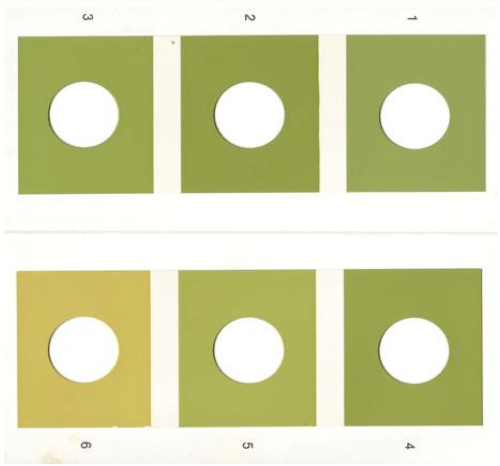
1. External color
2. Internal color

Fits to many fruits and vegetables.

Minolta
CR-400 **Chroma Meter**







Colorimeter | Konica Minolta

The CR-400 hand held Chroma meter is a color measuring instrument that can be used on a variety of surfaces in many types of applications. The Chroma Meter is calibrated by measuring a calibration color plate 30 times at intervals of 10 seconds.

Ripening Indexing

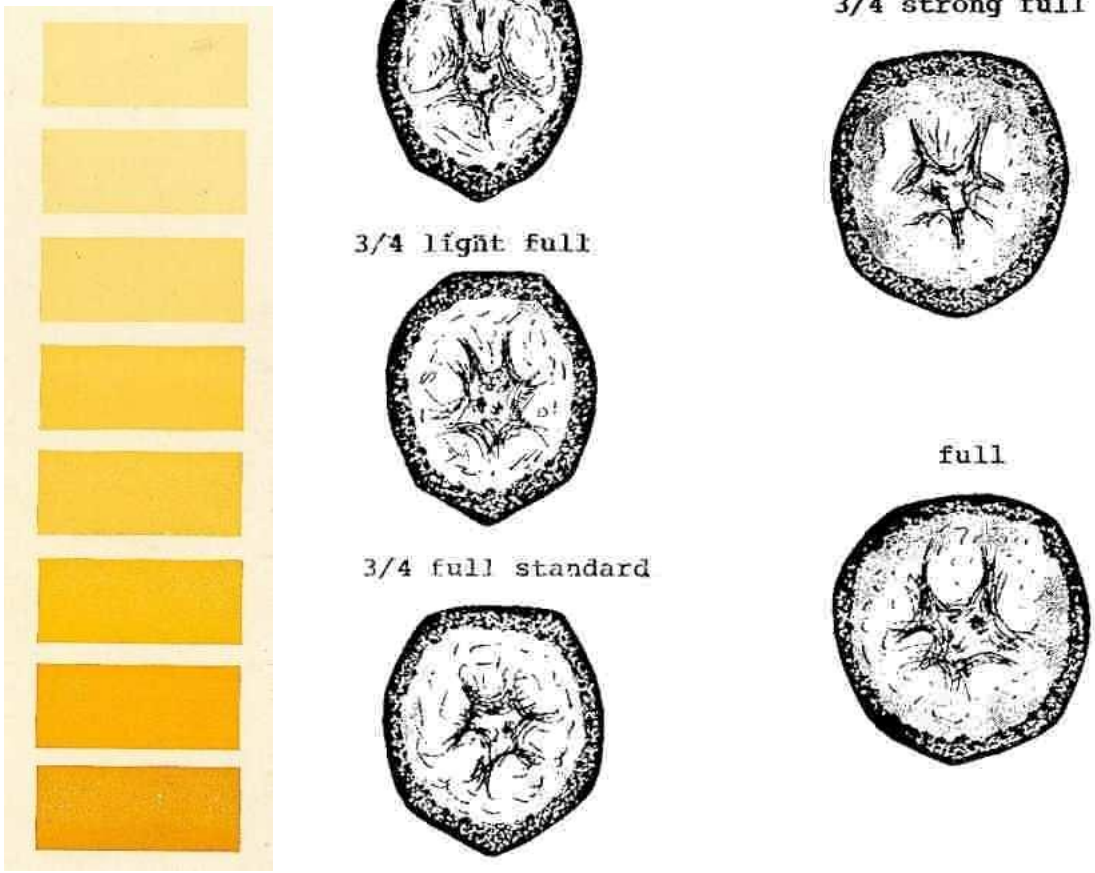
Physical factors

Size – Not necessarily a good ripening index because it is affected by many factors, but is effective for collecting peas, beans, carrots, potatoes

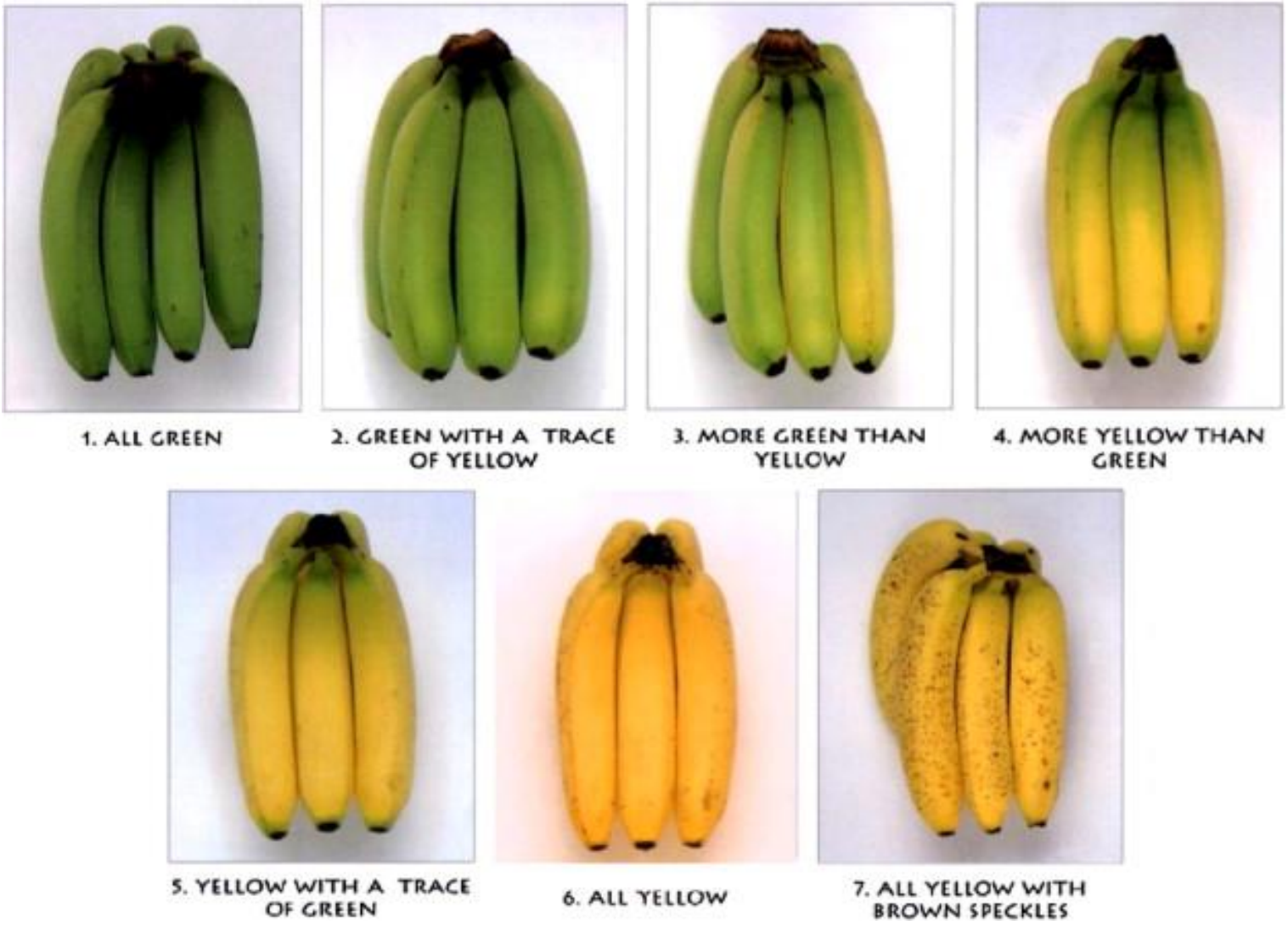
Ripening indexing

Physical factors, Shape

Number of products harvested when they reach a specific shape

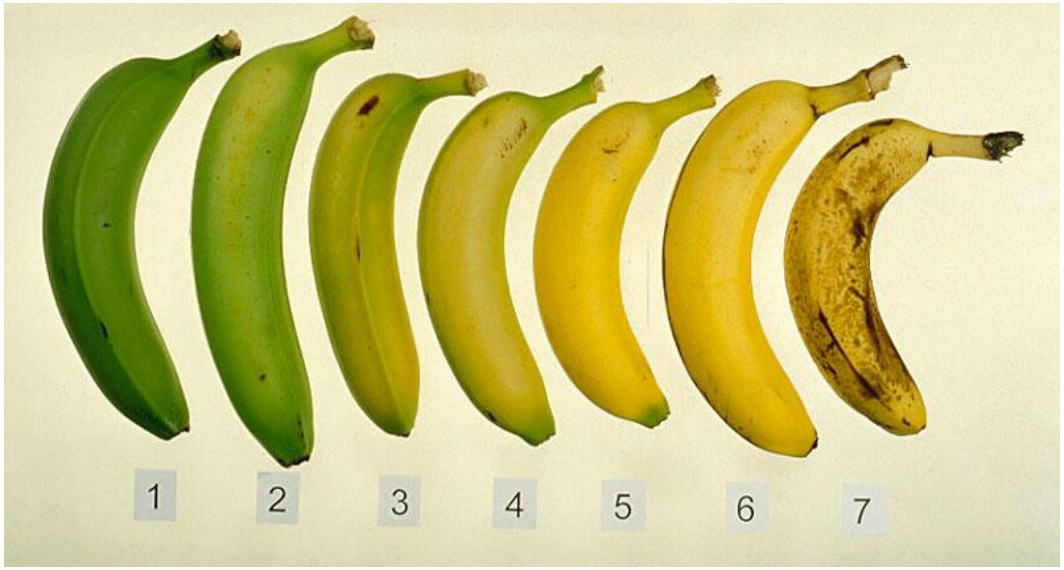


The adequate maturity index for banana is the degree of fullness of the fingers, which is indicated by the disappearance of angularity in a cross section.



Colorimetric indicator for classification of bananas during ripening

Changes during maturation (growth and development)



Initiation

Death

(1-7) Development

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Senescence

(7)

Ripening index- Sugar content-

Total Solid Solids detected in the vineyard (brix percentage indicate sugar)

Level of TSS in different cultivars between 14 to 16% TSS

Staining the starch content in granny Smith apples, USA
Dark color indicate higher amount of starch

0 =

¼ of the area within the coreline white, remainder blue, all of

1 =

½ area within coreline white, cortex blue.

2 =

All area within coreline white, cortex blue.

3 =

All are within coreline white, ¼ of the cortex area white,

4 =

All area within coreline white, ½ area of cortex white, remainder blue.

5 =

All area within coreline white, ¾ of cortex area white.

6 =

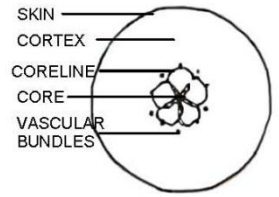
All surface white.

Values of 2.5 and higher are considered matured fruits

The Chart should be used as follows:

1. Use the descriptive terms to determine the numerical value of each sample apple.
2. Compare the sample to the pictures to make sure you are interpreting the chart correctly.
3. Samples difficult to categorize will be assigned the higher value.
4. Each apple is assigned a whole number not a decimal (1.0, 2.0, 3.0, not 1.2, 2.4, 2.7).
5. The 2.5 standard is a mathematical average of the samples (the sum of all scores divided by thirty).

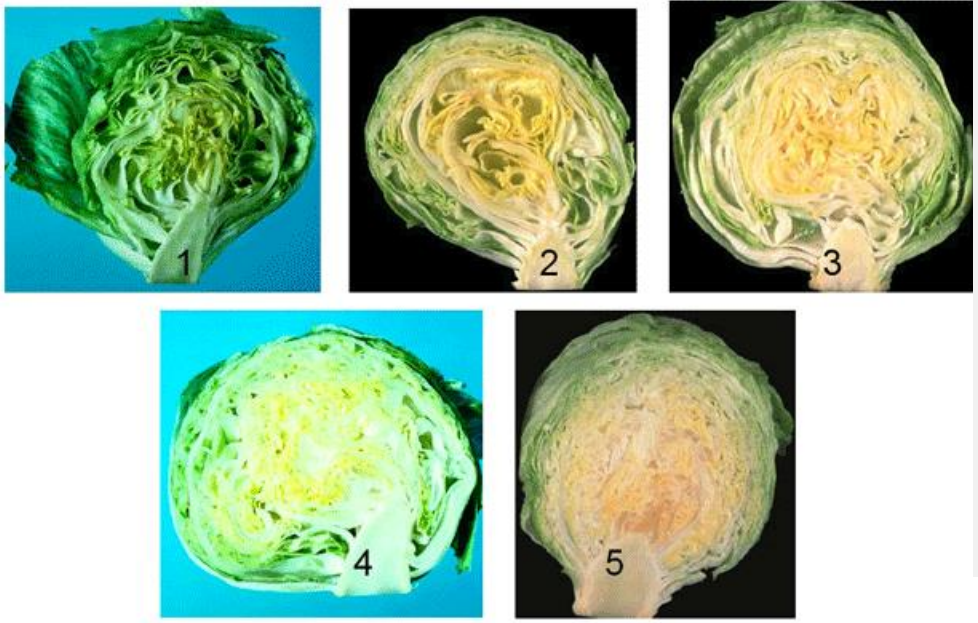
CROSS SECTION OF AN APPLE



Ripening indexes

Physical factors

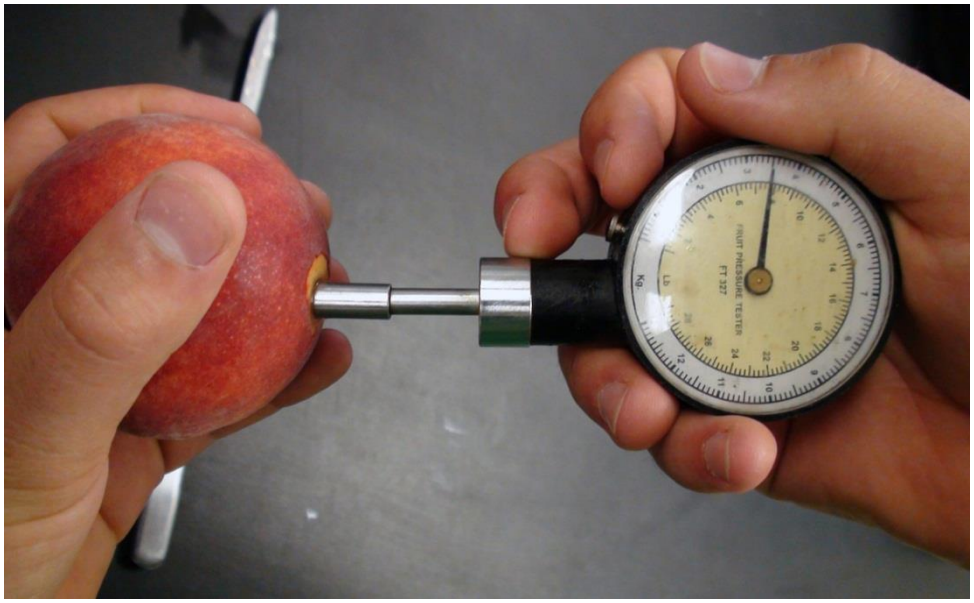
Density – heads of lettuce, cabbage, Chinese cabbage are harvested on the basis of head firmness (CA, USA)



Ripening Indexes

Physical factors –

Texture/firmness- deciduous fruits (apple, pear, peach)

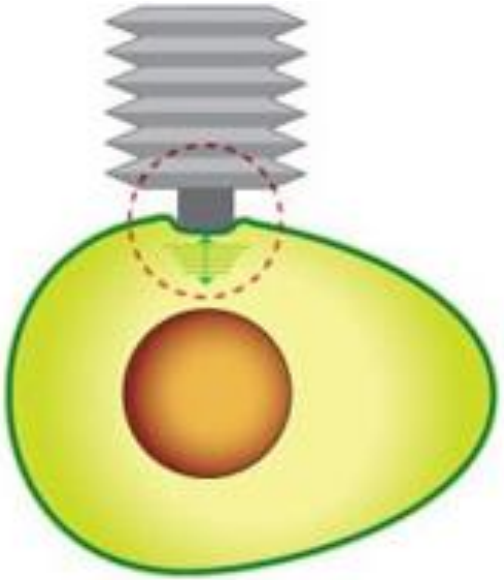


Penetrometer

Ripening indexes

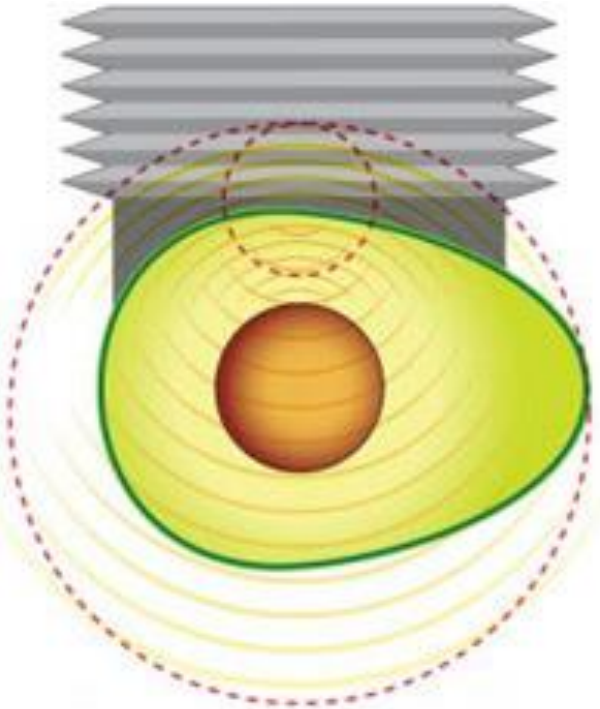
Physical factors

Texture/firmness - avocado fruits (ripeness)
Acoustic method - Firmalon (no-destruction)



Suface Pressure
Low Technology

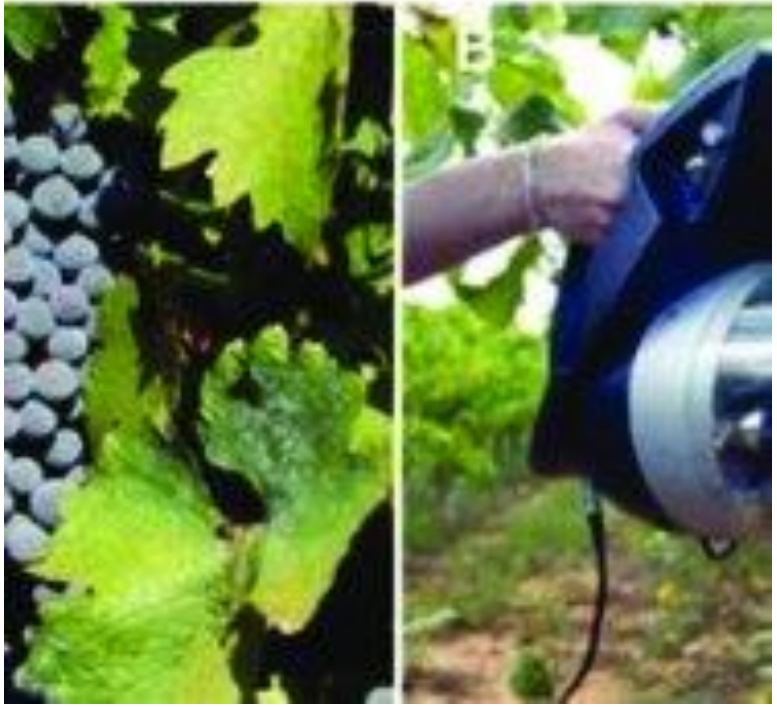
versus



Acoustic Firmness Sorting
High Technology

Multiplex- uses florescence technology with multiple excitation to measure polyphenols and chlorophyll

It provides accurate and complete information on the physiological state of the crop, allowing real-time and non-destructive measurements of chlorophyll and polyphenols contents in leaves and fruits.



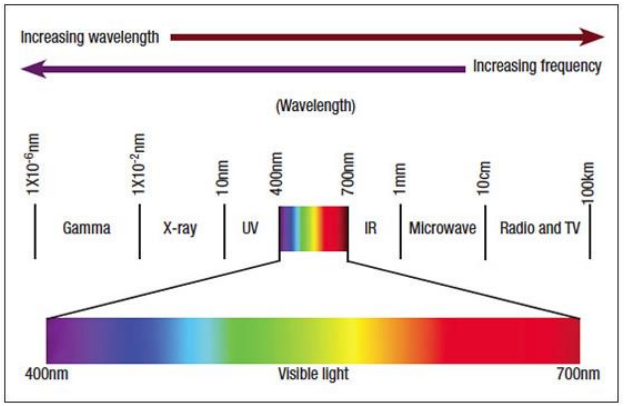
Multiplex assesses the chlorophyll and polyphenols indices by making use of two attributes of plant fluorescence: the effect of fluorescence re-absorption by chlorophyll and screening effect of polyphenols. The sensor is an optical head which contains:

Optical sources: (UV, blue, green and red)
Detectors (blue-green or yellow, red and far-red (NIR))

Anthocyanins are the most diverse group of plant pigments and derived from secondary metabolites of phenylpropanoids that contribute to the red-colored appearance of mango skinand caann .

Improving the Red Color and Fruit Quality of 'Kent' Mango Fruit by Pruning and Preharvest Spraying of Prohydro-jasmon or Abscisic Acid

Ripening index, Delta A



Internal factors

Concentration of chlorophyll

Delta absorbance (ΔA) meter

A not destructive method based on NIR

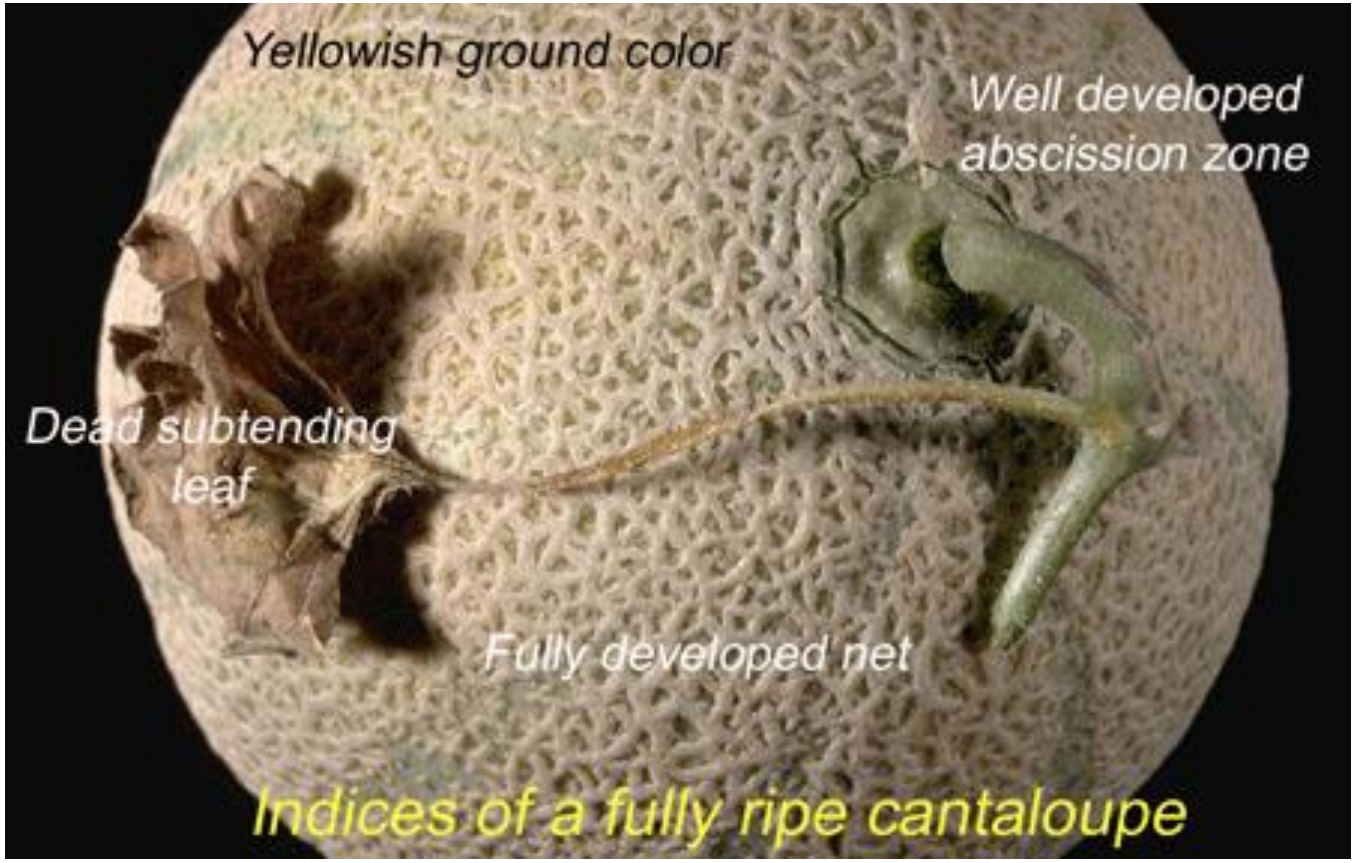
Ripening Index

Morphological Changes

1. Development of detachable stem tissue and dead subtending leaf (Melon - Cantaloupe)
2. Development of external peel netting (Melon - Cantaloupe)
3. Development of a waxy surface (grapes, Melon Honey dew, prunes)
4. Internal changes in the fruit (development of jelly tissue in to seed tomato)
5. Structure of the stem (Asparagus)


A
B
C
D

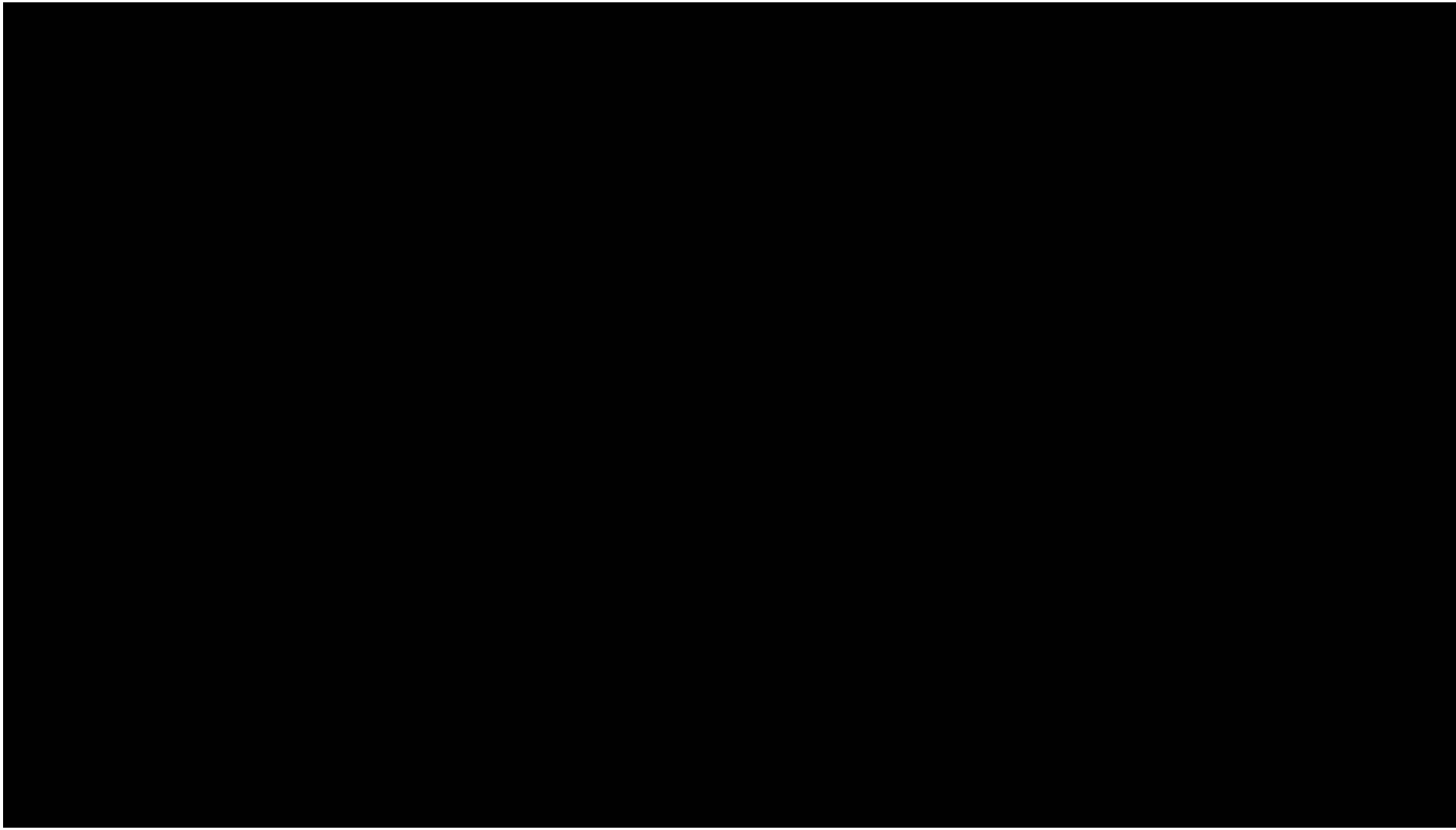
Morphological Ripening indices



Ripening index

Chemical composition

1. Change in starch (turning starch into sugar) (apple, pear).
2. Total soluble solids/sugar (apple, pear, deciduous, grapes).
3. The relation sugar/acid ratio (citrus, pomegranate, kiwi).
4. The juice content (citrus).
5. Dry material (avocado).
6. Oil content (avocado).
7. Astringents (persimmon).
8. Production of ethylene (apple, pear – long storage)



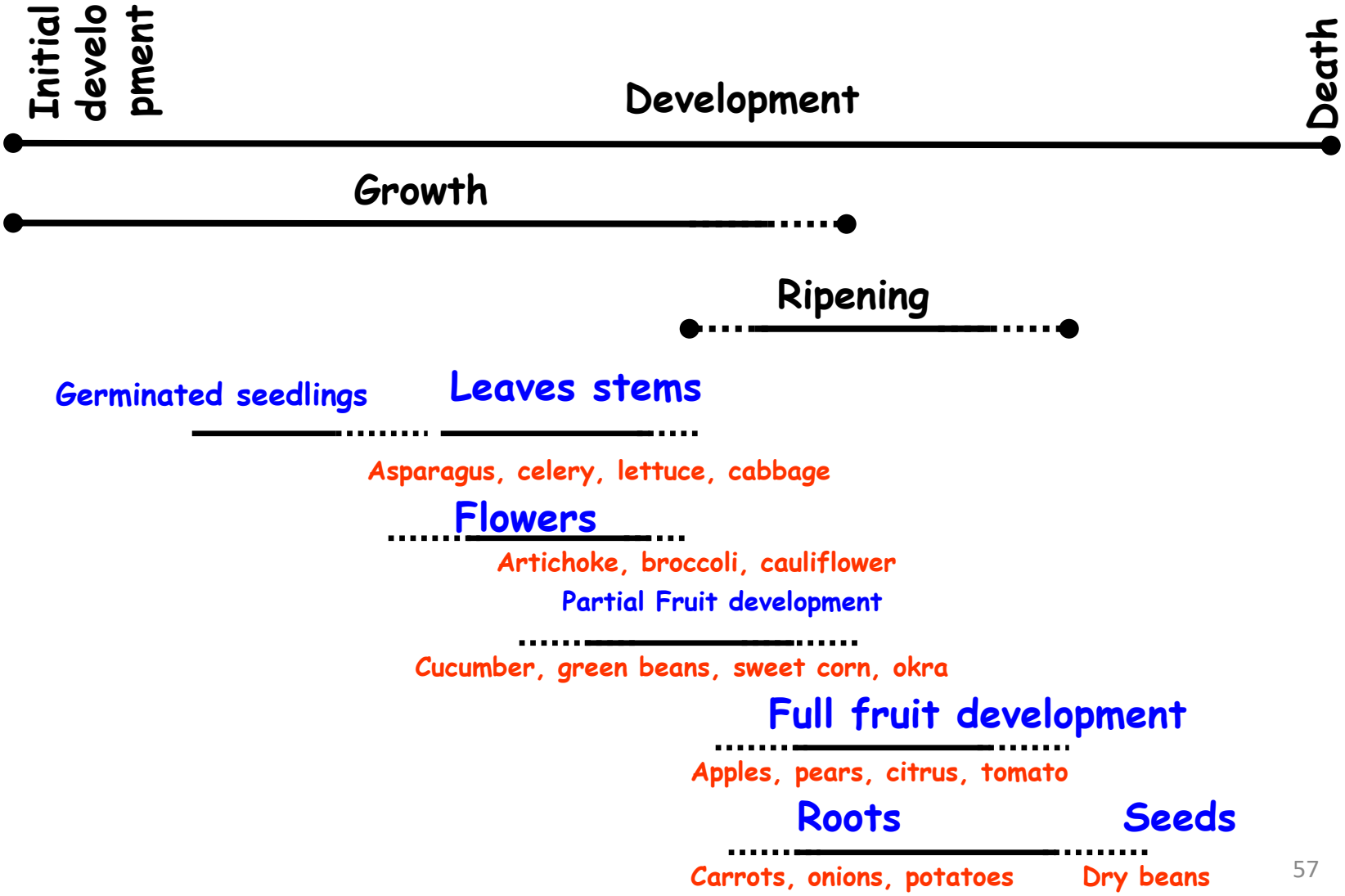
Summary of Different ripening indexes

Apple harvesting characteristics

- Days from full flowering
- Heat/cold units from fruit set
- Days after picking to the beginning of ethylene
- Firmness of texture
- Level of TSS content
- Concentration of starch (iodine test)
- Internal concentration of ethylene
- Change in firmness and starch content

(Streif)

Summary of fruit development and ripening indexes



Summary:

It is very important to use several maturation metrics indexes

Simple to implement
Objective versus subjective
Related to quality
Related to shelf life
Evaluate changes with ripening
Allow for prediction of ripening
Do not change from year to year
Cheap not destructive