# Crop Quality: An Overview of What We Know and Don't Know

## Midwest Winter Production Conference; Jefferson City, MO; 2/11/19


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THE OHIO STATE UNIVERSITY
COLLEGE OF FOOD, AGRICULTURAL, AND ENVIRONMENTAL SCIENCES

- consumers
- growers
- distributors
- retailers
- processors (food companies)
- food scientists, technologists
- chefs, food service stewards
- health care providers
- scientists, educators
- organizations

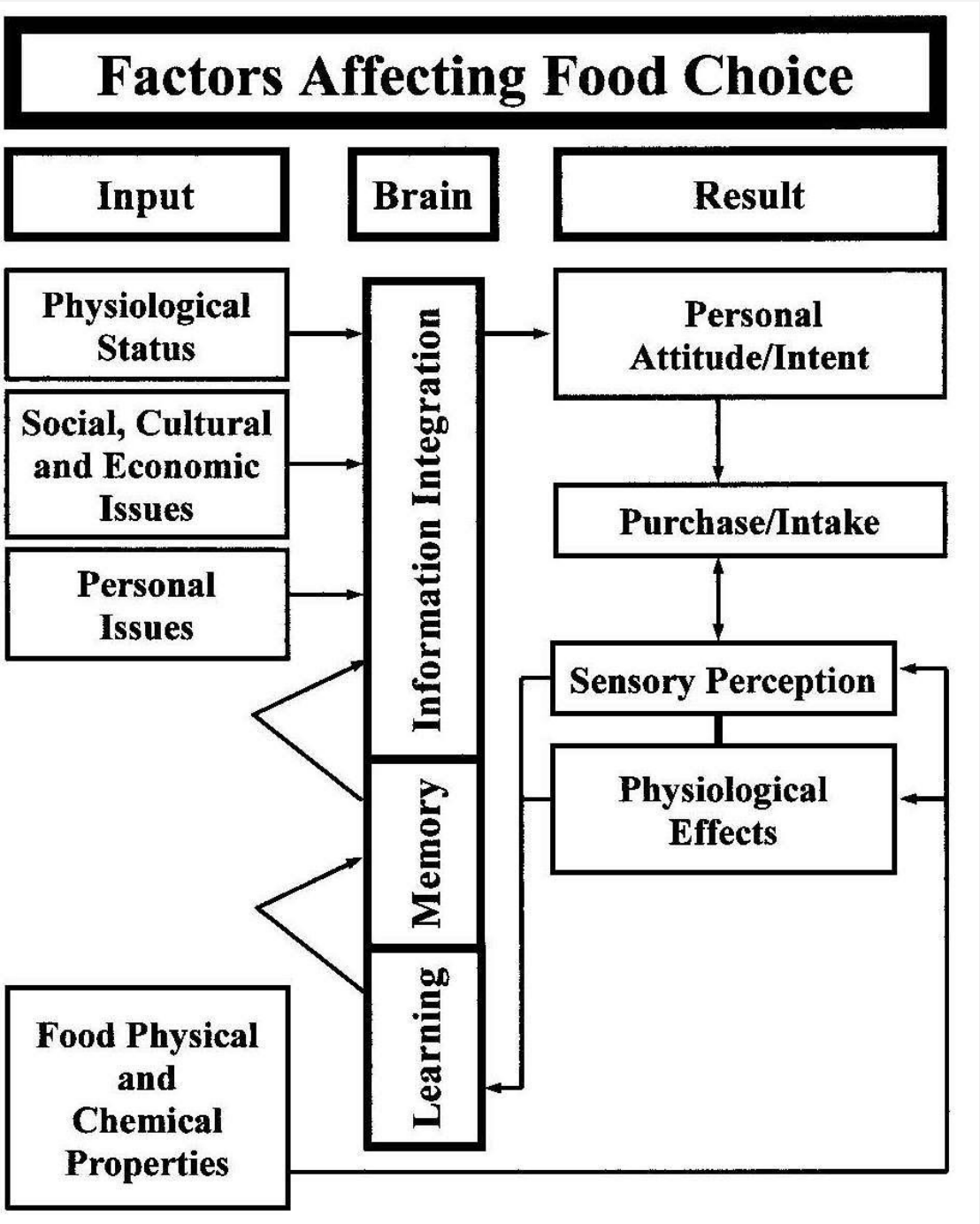
**Crop Quality:** everyone has an opinion

# Crop Quality

- subjective
- defined by each buyer, whose perspective may change.

# Crop Quality

- requires ongoing study to keep up with buyers' perspectives




Scheerens, J.C. 2001. Phytochemicals and the consumer: Factors affecting fruit and vegetable consumption and the potential for increasing small fruit in the diet. HortTechnol 11:547-556.

**quality =**

**loss or gain of repeat sales**

- study conducted in 2002 by Slippery Rock University (NW PA)
- 120 consumers, 20 farmers
- quality issues related to fresh fruit and vegetable consumption and production

**Fruit and vegetable quality perspectives from producers and consumers at a local university in western Pennsylvania**
**Borsari, B. Acta Hort 604:69-74.**

| (1-5) | Consumers | Producers |
|---|---|---|
| Seasonality | 1.98 | 4.96 |
| Taste | 4.45 | 5 |
| Freshness | 4.43 | 4.68 |
| Salubrity | 4.2 | 4.83 |
| Price | 3.71 | 4.25 |
| Ethics | 2.1 | 4.32 |
| Locally grown | 1.99 | 4.76 |
| Organic | 2.26 | 3.92 |
| Shelf-life | 2.5 | 4.1 |
| Agronomic practices | 1.23 | 3.79 |
| Average | 2.87 | 4.46 |

# Preferences of Americans

- taste and cost drove consumer food decisions
- nutrition ranked 3rd and was linked to other demographic factors, such as age (↑), gender (women), and ethnic group but not income

| Attribute | Food choice consideration (1-5) |
|---|---|
| Taste | 4.7 |
| Cost | 4.1 |
| Nutrition | 3.9 |
| Convenience | 3.8 |
| Weight control | 3.4 |

Glanz, et al. 1998. Why Americans eat what they do: Taste, nutrition, cost, convenience, and weight control concerns as influences on food consumption. Journal of the American Dietetic Association 98 (10):1118-1126.

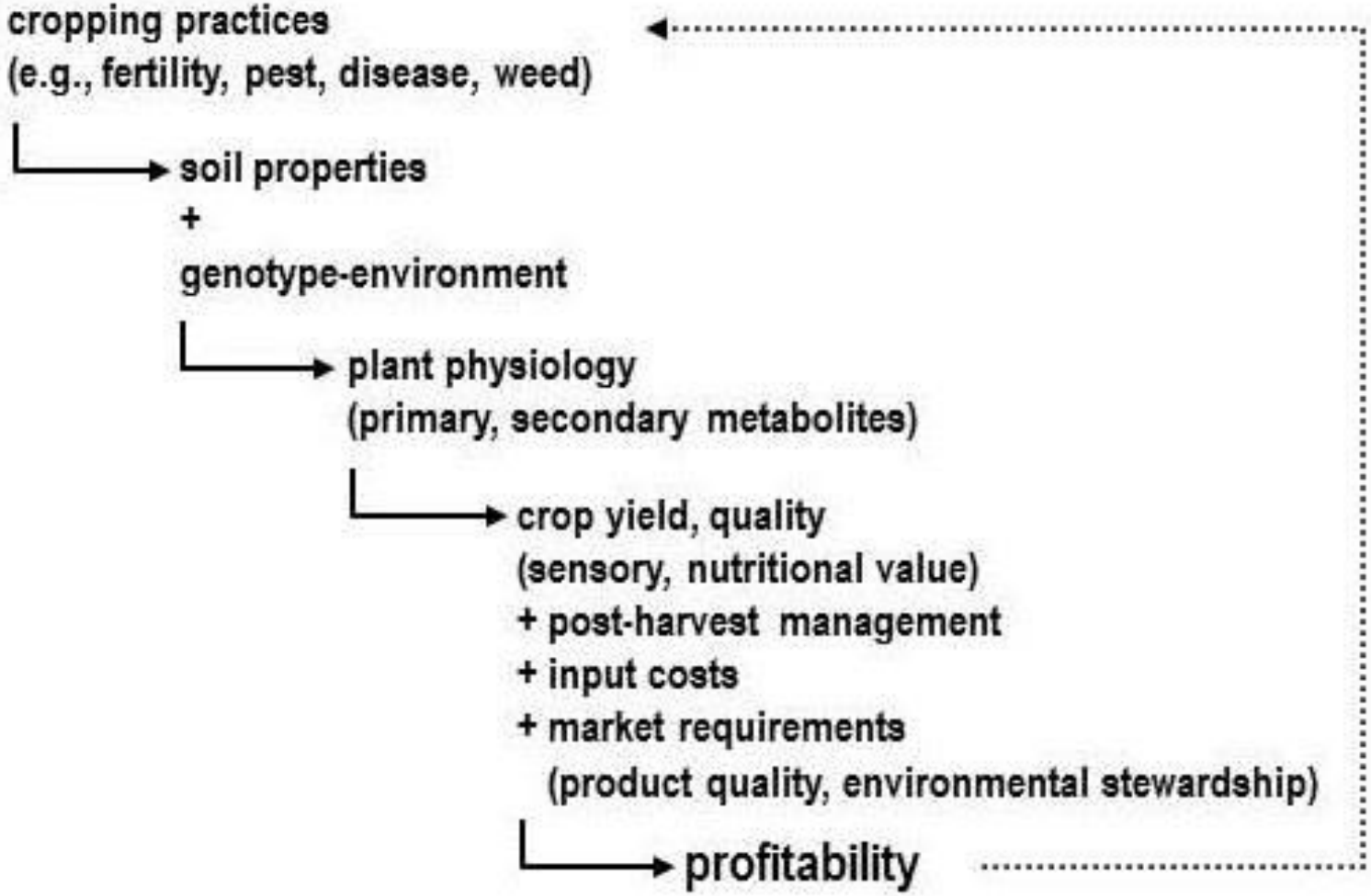
# Crop Quality

- **ESSENTIAL for direct marketers to manage at the highest level; often THE reason buyers would want their product**

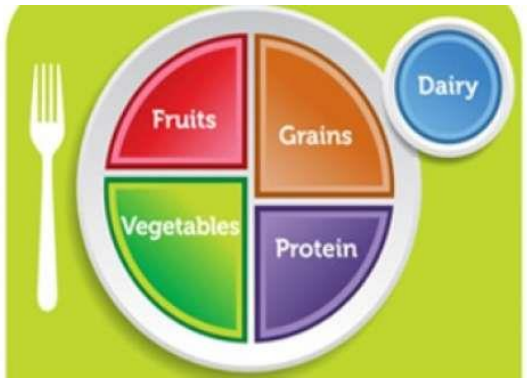
# Crop Quality

- explains much about the difference between total and marketable yield and, therefore, profit potential

Diagrammatic representation of the functional flow from cropping practices to profitability, via the ability of vegetable growers to meet the food quality-related expectations of their market within an agroecological context.



BUY FRESH
BUY LOCAL




+

AICR'S
FOODS THAT FIGHT CANCER™

# farm success

EDEN FOODS

**Garbanzo Beans, Organic**

12/15 oz

# Nutrition Facts

| | |
|---|---|
| Serving Size | 1/2 cup (130g) |
| Servings Per Container | About 3.5 |

**Amount Per Serving**

| | |
|---|---|
| **Calories 130** | Calories from fat 10 |
| | **% Daily Value*** |
| **Total Fat** 1g | **2%** |
| Saturated Fat 0g | **0%** |
| Trans Fat 0g | |
| **Cholesterol** 0mg | |
| **Sodium** 30mg | **1%** |
| **Potassium** 250mg | **7%** |
| **Total Carbohydrate** 23g | **8%** |
| Dietary Fiber 5g | **20%** |
| Sugars <1g | |
| **Protein** 7g | **14%** |

| | |
|---|---|
| Calcium 6% • | Iron 8% |
| Thiamin (B1) 4% • | Riboflavin (B2) 4% |
| Niacin (B3) 2% • | Folate (B9) 25% |
| Phosphorus 10% • | Magnesium 10% |
| Zinc 8% | |

*Percent Daily Values are based on a 2,000 calorie diet.

Not a significant source of Vitamin A & C.

| | | | | |
|---|---|---|---|---|
| Starch[v] | | | X | |
| Sugars[v or t] | | | X | X |
| Dietary fiber[s and t] | X | X | X | X |
| Organic acids[q] | | | | X |
| Sesquiterpene lactones[q] | X | | | |
| Crude protein content[o] | | | X | |
| Nitrates[o] | X | X | X | X |
| Oxalate[t orq] | X | X | | |
| Minerals[o] | X | X | X | X |
| Carotenes[q] | X | X | | X |
| Vitamin A[q] | X | X | | X |
| Vitamin E[q] | | X | | X |
| Vitamin K[q] | X | X | | |
| Thiamin[v orq] | | | X | |
| Riboflavin[v orq] | | X | X | |
| Niacin[v orq] | | | X | X |
| Vitamin $B_6$[q] | | | X | X |
| Pantothenic acid[n] | | X | X | X |
| Folate[q] | X | X | | |
| Vitamin C[v orq] | X | X | X | X |
| Total antioxidant capacity[m] | X | X | X | X |
| Total phenolic compounds[v] | X | X | X | X |
| Specific phenolic compounds[q] | X | | X | |
| Glyoalkaloids[q] | | | X | X |

# Nutritional parameters based on 13 recognized by USDA as important.

**Lettuce, spinach, tomato, potato as target crops.**

[z]By gravimetric determination.
[y]By visual inspection and rating.
[x]By color reflectance values.
[w]By Instron analysis or with a Hunter force gauge.
[v]By colorimetry.
[u]By refractometry.
[t]By gas chromatorgraphy.
[s]By enzyme degradation.
[r]By titration against base of standardized concentration.
[q]By high performance liquid chromatography.
[p]By gas chromatography-mass spectrometry.
[o]Analyzed by Service Testing and Analytical Research (STAR) Lab, OARDC.
[n]By enzyme-linked immunosorbent assay.
[m]By the ABTS and FRAP methods of Rice -Evans et al. (1996) and Benzie and Strain (1996), respectively.

# Components of Nutritional Value

1. Mineral Nutrients
2. Total Crude Protein
3. Carbohydrates
4. Other – "phytonutrients"
   (numerous roles in human health)

# Components of Nutritional Value

1. Mineral Nutrients
2. Total Crude Protein

In most crops, can be measured by commercial labs familiar to growers (tissue, soil analysis).

# Components of Nutritional Value

## 3. Carbohydrates

Possibly the least important to health-conscious consumers but very important in other contexts. Sugars can be measured with refractometers and test strips.

# Components of Nutritional Value

4. Other – "phytonutrients" (e.g., antioxidants, vitamins)

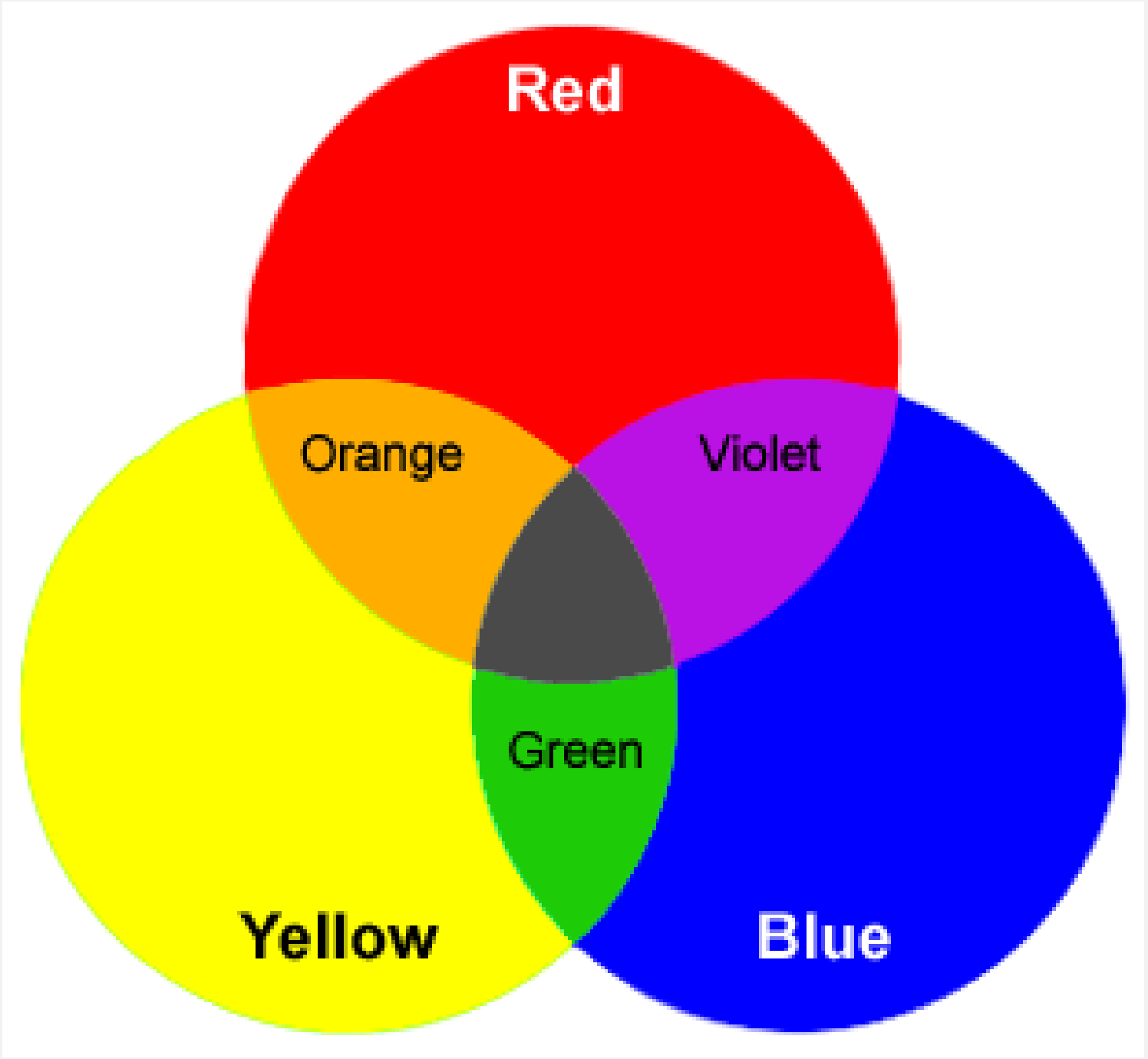
- sustain
- enrich, fortify
- protect

all levels of organization, sub-cellular to organ system

# Components of Quality*

- physical
- biological
- chemical
- sensory
- other

*can overlap


Red
Orange
Violet
Green
Yellow
Blue

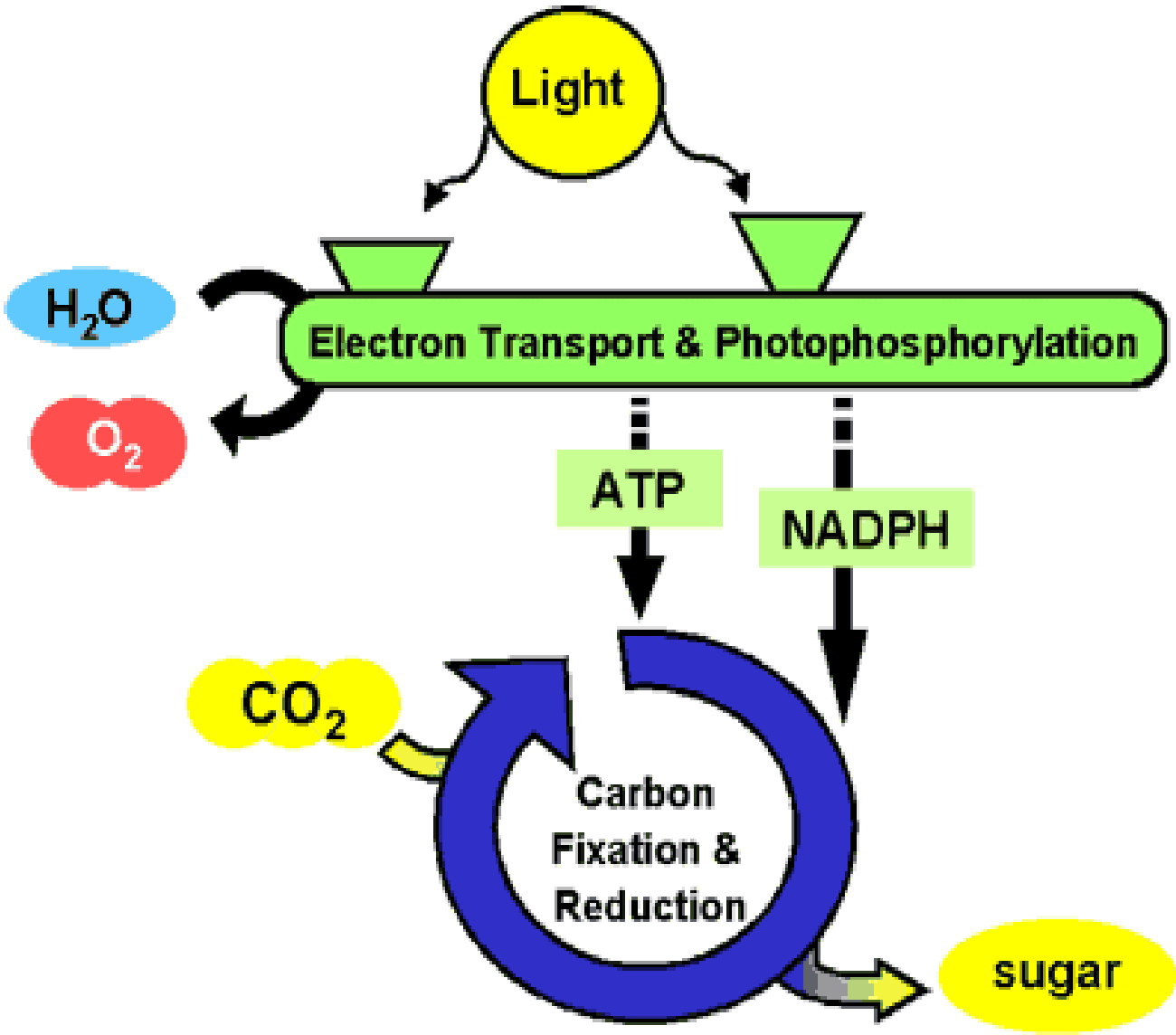
NOT AT ALL VERY

- easily managed during production
- easily or cheaply assessed during production
- objective
- new
- related to most peoples' health
- related to crop and soil status

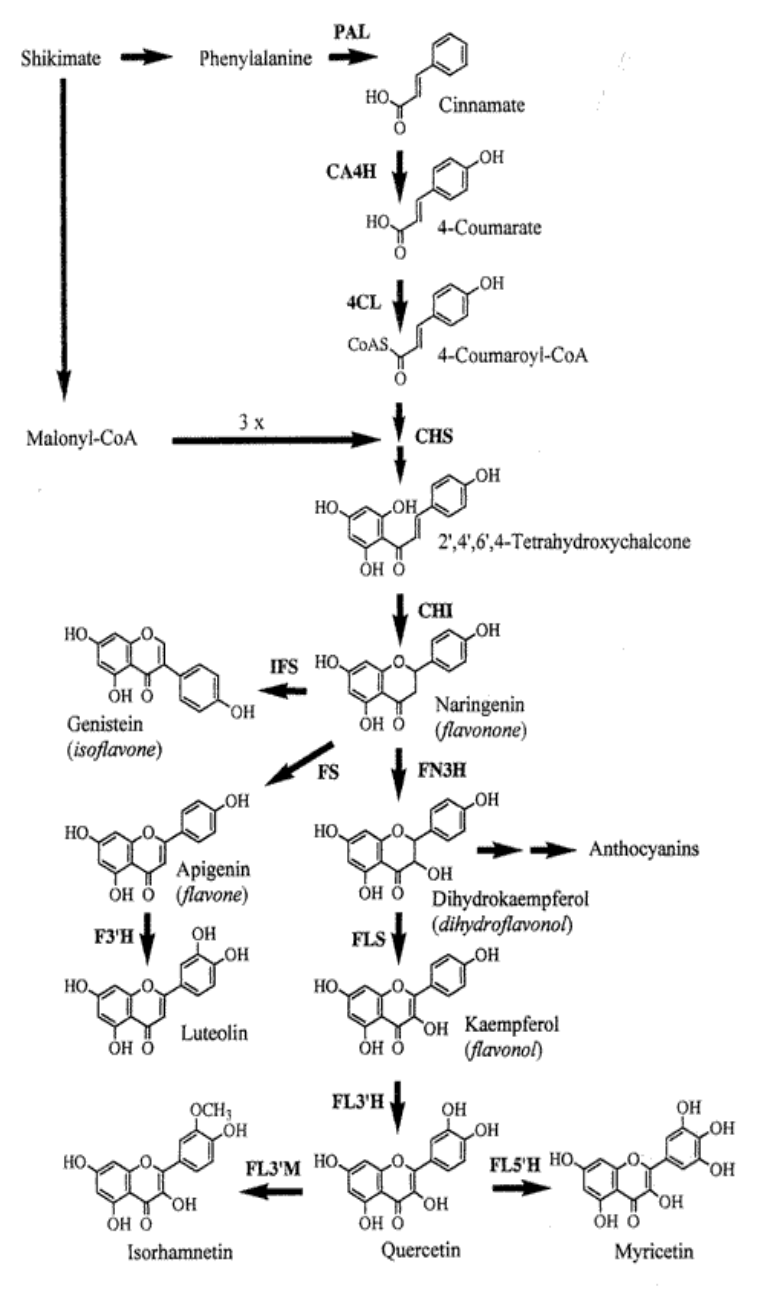
# Crop Quality

- will never be greater than at the point immediately before harvest

image courtesy USDA-ARS




**Primary metabolism provides energy, supports life.**




# Products of plant primary metabolism are raw material for secondary metabolism upon which human nutrition relies.

# Crop Quality

- lost at every point harvest through delivery

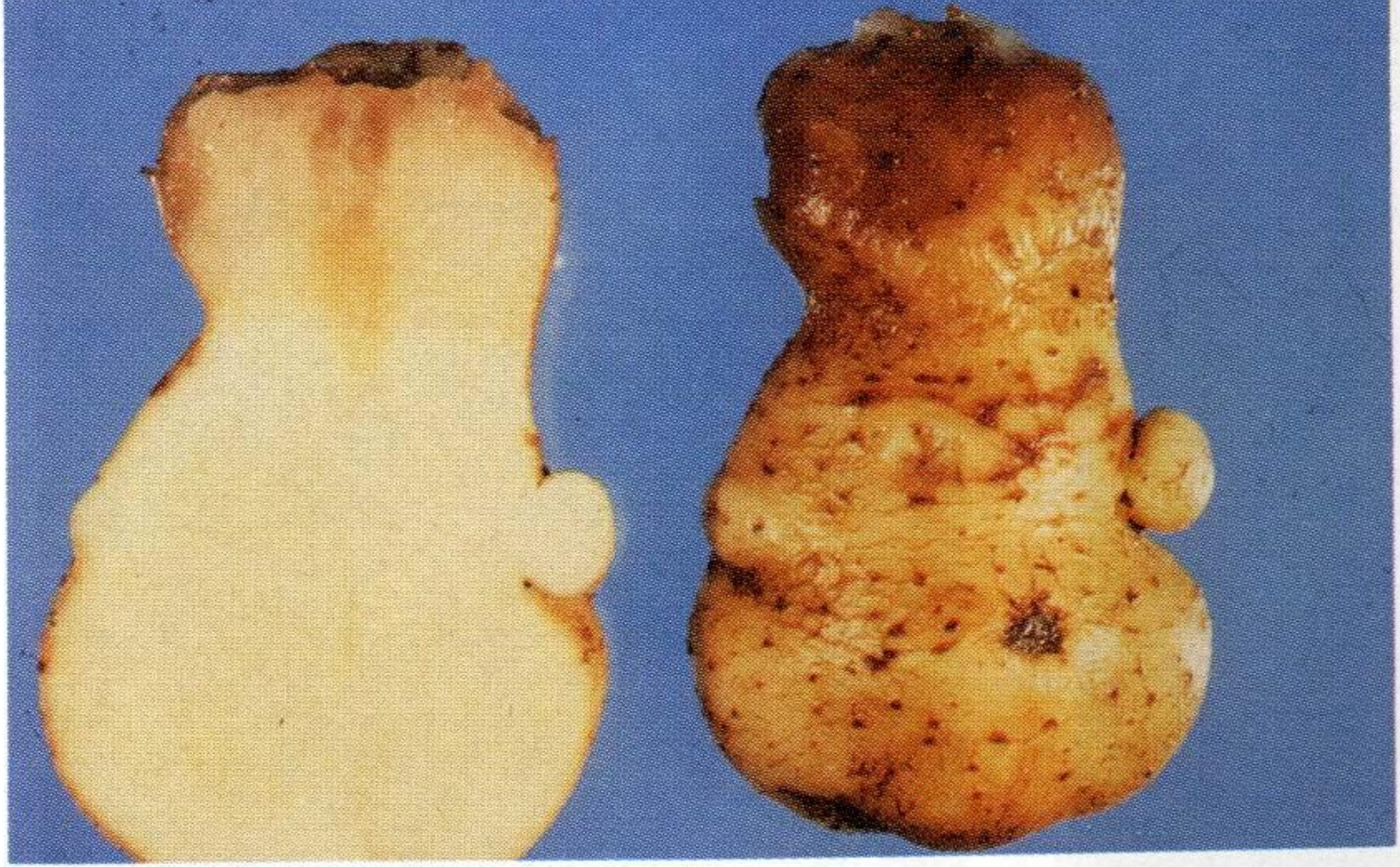
# Crop Quality

- components and buyer criteria can be measured or assessed


with assistance from Shearer’s Foods

# Tuber Secondary Growth

**Internal Brown Spot** small necrotic regions in pith where tissue died during tuber development. Ca deficiency most often suspected. Compare to **Internal Heat Necrosis** (small necrotic specks of dead tissue in medulla)



**8.** Translucent end affecting the stem end of a tuber. This disorder is usually associated with second growth and pointed stem end. (Courtesy R. C. Rowe)

# MAJOR CARROT TYPES

| | IMPERATOR | NANTES | HALF-LONG | FINGER |
|---|---|---|---|---|
| Example rieties: | Spartan Bonus<br>Spartan Fancy<br>Tendersweet<br>Trophy<br>King Imperator | Nantes Coreless<br>Scarlet Nantes<br>Spartan Premium<br>Sparton Classic | Danvers Half-Long<br>Danvers 126<br>Red Cored Chantenay<br>Royal Chantenay | Short 'n Sweet<br>Goldinhart<br>Gold Nugget<br>Minipak<br>Tiny Sweet<br>Little Finger |

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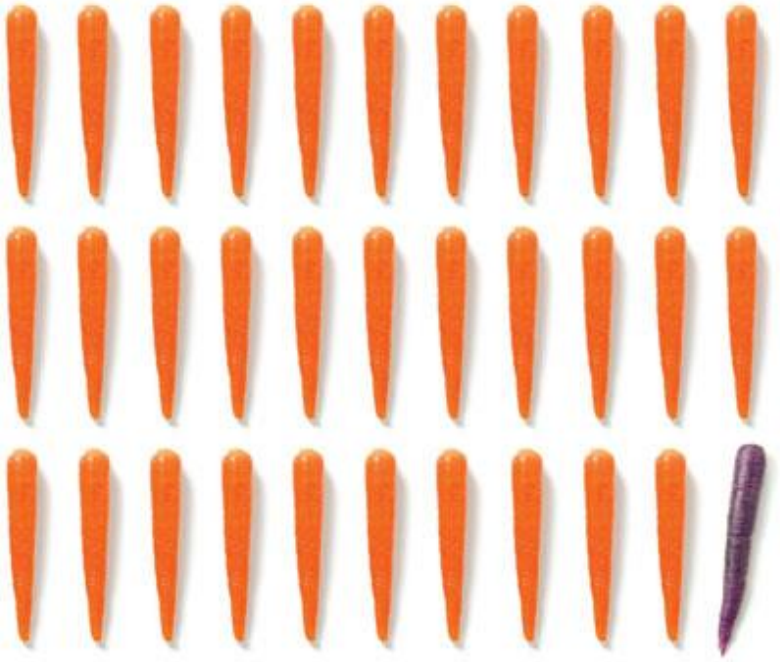
the global specialist



# A LITTLE DIFFERENT. **A LOT BETTER.**

Vegetable seed companies are often difficult to tell apart, but we take pride in our difference. Members of the Nunhems USA Carrot Crop Team think about carrots all day, every day. Our goal? To put the Nunhems global breeding program and network of carrot information exchange to use in your fields, and to make your operation more profitable.

To sign-up for our carrot newsletter, please contact your local sales specialist or Nunhems Customer Service at **(800) 733-9505.**

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www.nunhemsusa.com

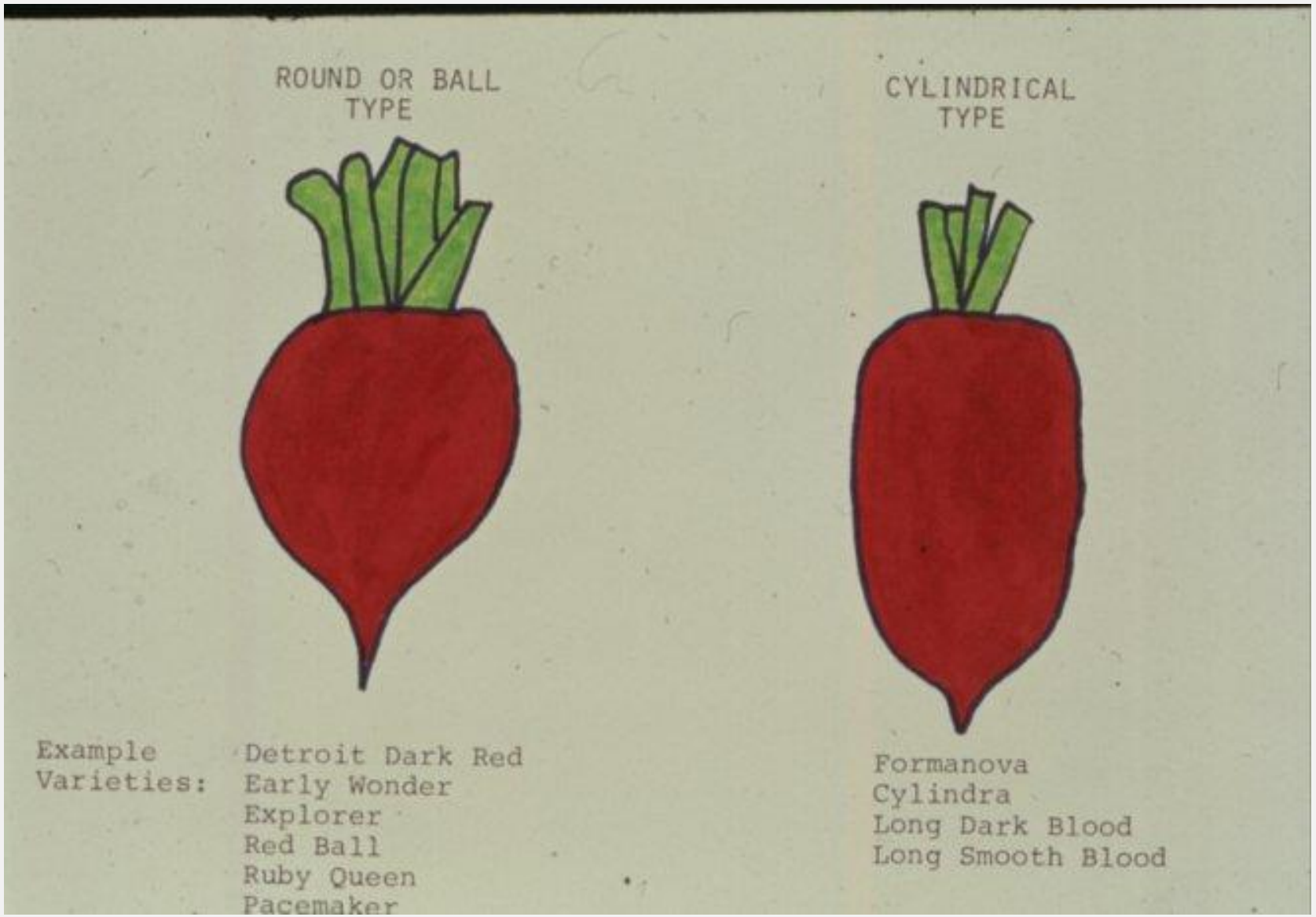

30-1

Genes: *P1, P2* purple root (anthocyanin),
*Y , Y2, Y3* yellow xylem, xanthophyll (lutein*)*
*L, A* lycopene synthesis
*O, Or* orange xylem, carotene

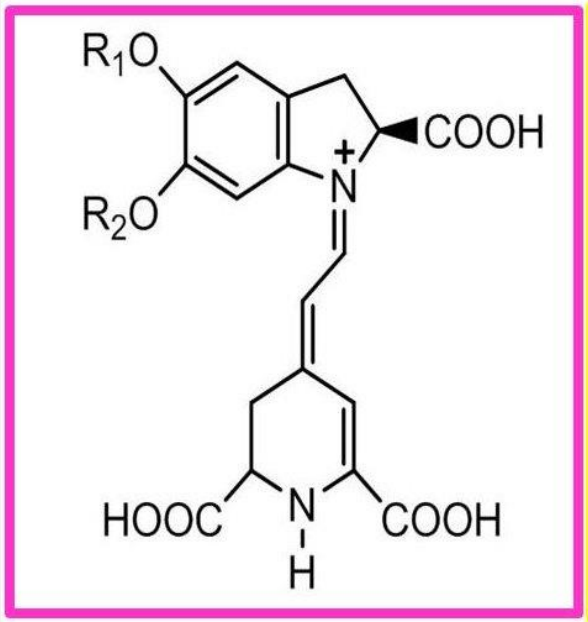
courtesy
C.F Quiros,
UC-Davis

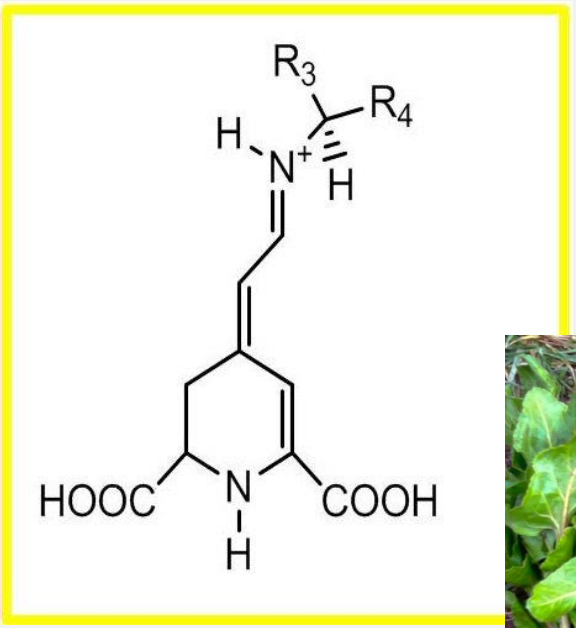
# Note harvest index

**Beets - an annual crop, grown for roots or tops as greens**




**Various beet shapes**




**Duke Univ campus farm**

**http://sfnottingham.blogspot.com/2011/01/colour-of-beetroot.html**

**http://mchale.chem.wsu.edu/?s=betalains**

# farmer-friendly tools for measuring fruit and vegetable crop quality

| Major Plant Pigment | Prominent Color(s) |
| --- | --- |
| 1. Anthocyanins, other flavonoids | blue, purple, red, yellow, white |
| 2. Betalains | red-violet, yellow-orange |
| 3. Carotenoids | pink, orange, red, yellow |
| 4. Chlorophylls | green |

A B C D

A: carotenes (α, β)
B: carotenes + anthocyanins
C: lycopene
D: xanthophylls

* after Simon, P.W. 1997. Plant pigments for color and nutrition. Hortsci 32(1):12-13.

http://horticulture.wisc.edu/faculty-and-staff-2/faculty-and-staff/


**Colorimeter:** sensitive, standardized measure and expression of color, but not grower-friendly

# Royal Horticultural Society Colour Charts Edition V. Version 2 (measured with spectrophotometer)

**Colours in sRGB, CIE L*a*b* (CIELab) and CIE LCh system**
**Illumination: D65, Observer: 10°, specular component: SCE**

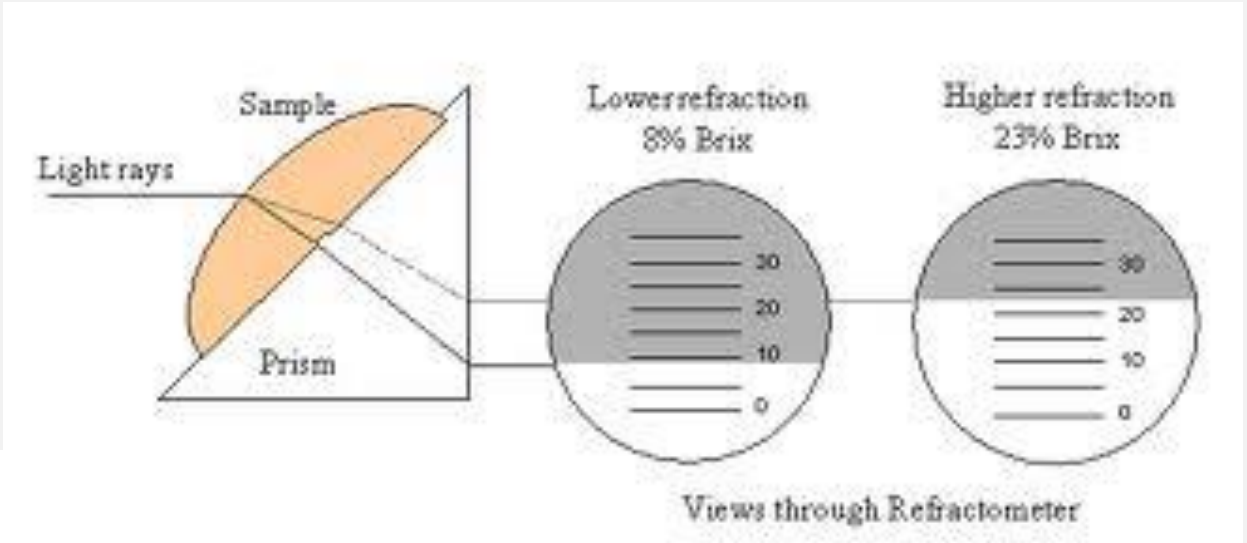
**yellow-red**
**purple-blue**
**turquoise-green**
**brown-grey**

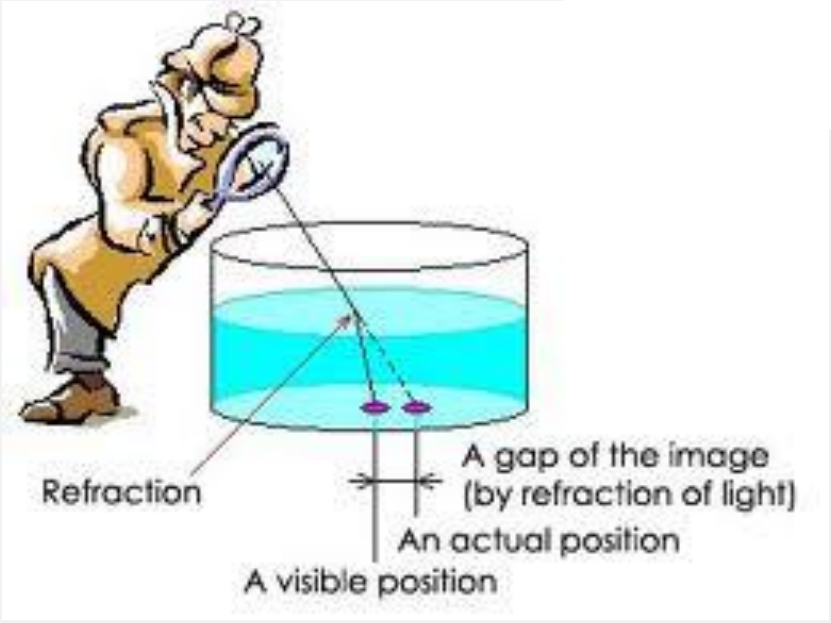

**http://azaleas.org/index.pl/azcolorsystems.html**

**color solid | munsell | rhs | ucl | hcc | ridgway || related pages**

# lowes.com

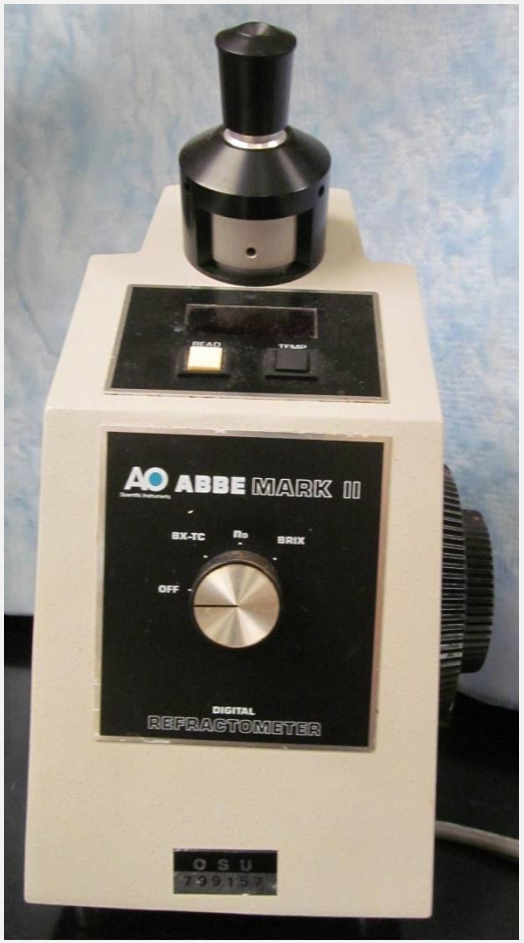
# Refractive Index




Academics.skidmore.edu
Primetab.com
Grapestompers.com






| | | | |
|---|---|---|---|
| **Portable?** | yes | yes | no |
| **Cost?** | $10s | $100s | $1000s |
| **Light Source?** | overhead | internal | internal |
| **Farm Use** | common | less common | rare |

http://u.osu.edu/vegprolab/research-areas/product-quality/resources/publications/


HYG-1650-12

## Using °Brix as an Indicator of Vegetable Quality

### An Overview of the Practice

**Matthew D. Kleinhenz** and **Natalie R. Bumgarner**
Department of Horticulture and Crop Science
The Ohio State University, Ohio Agricultural Research and Development Center

**Introduction**

Many variables are used to assess fruit and vegetable quality. Some quality metrics such as size, shape, and color are relatively obvious and tend to influence "eye appeal." Others, such as flavor, texture, aroma, and nutrient content, however, are more subjective. They may also reported in values of °Brix. °Brix values are important because they can be measured objectively and they relate to a subjective criterion that buyers and eaters use to assess vegetable quality—flavor or sweetness. When obtained and applied correctly, °Brix values can aid in variety selection, harvest scheduling, and other aspects


HYG-1651-12

## Using °Brix as an Indicator of Vegetable Quality

### Linking Measured Values to Crop Management

**Matthew D. Kleinhenz** and **Natalie R. Bumgarner**
Department of Horticulture and Crop Science
The Ohio State University, Ohio Agricultural Research and Development Center

Crop quality is important to fruit and vegetable growers, buyers, and handlers. °Brix readings indicate soluble solids content. Since soluble solids represent a product's potential sweetness (an aspect of quality), °Brix readings can interest many throughout the value chain. Three steps

growers, buyers, and handlers may be the "bank" of numbers they develop in their own operation over time through consistent, conscientious measurement. Nevertheless, in this fact sheet, we present three sets of reference °Brix values.


HYG-1652-12

## Using °Brix as an Indicator of Vegetable Quality

### A Summary of the Measurement Method

**Natalie R. Bumgarner** and **Matthew D. Kleinhenz**
Department of Horticulture and Crop Science
The Ohio State University, Ohio Agricultural Research and Development Center

Farmers, as well as produce managers and handlers need straightforward, reliable, proven, and inexpensive criteria, tools, and techniques to gauge the potential quality of their fresh fruits and vegetables. The level of soluble solids in a fruit or vegetable is often used as an indicator of the sugars present in it. Soluble solids levels are usually reported in values of °Brix. °Brix values can be measured easily and reliably in the field, shop, or shed using a relatively inexpensive piece of equipment able to

sheets provide specific instructions for the taking of °Brix readings in five vegetable crops and guidance in making the best use of the values obtained.

**Equipment, Material, and Sample Considerations**

Soluble solids (°Brix) values are obtained using refractometers. These instruments measure the degree to which light is bent as it passes through a sample (i.e., the refractive index). Refractometers vary in design.


HYG-1653-12

## Using °Brix as an Indicator of Vegetable Quality

### Instructions for Measuring °Brix in Cucumber, Leafy Greens, Sweet Corn, Tomato, and Watermelon

**Natalie R. Bumgarner** and **Matthew D. Kleinhenz**
Department of Horticulture and Crop Science
The Ohio State University

Crop quality is important to everyone in the vegetable value chain, including growers, buyers, managers, handlers, processors, restaurateurs, and consumers. Various measures are used to assess and describe different aspects of quality but few may be as popular and important as soluble solids or °Brix. As described in other fact sheets in this series, °Brix has the attention of many throughout

# °Brix

## Accepted by Nearly Everyone

- important
- used for many years
- objective (method, underlying principles)

# °Brix

## Accepted by Nearly Everyone

- easily, inexpensively, and reliably measured
- fluctuates with genetics, growing conditions, timing

# °Brix
## Debated by Many

- relation to …
  … taste, nutritional value
  … crop and soil status

# °Brix
## Debated by Many

- ease of management during soil-based production, especially outdoor, and of consistently achieving target values in multiple crops

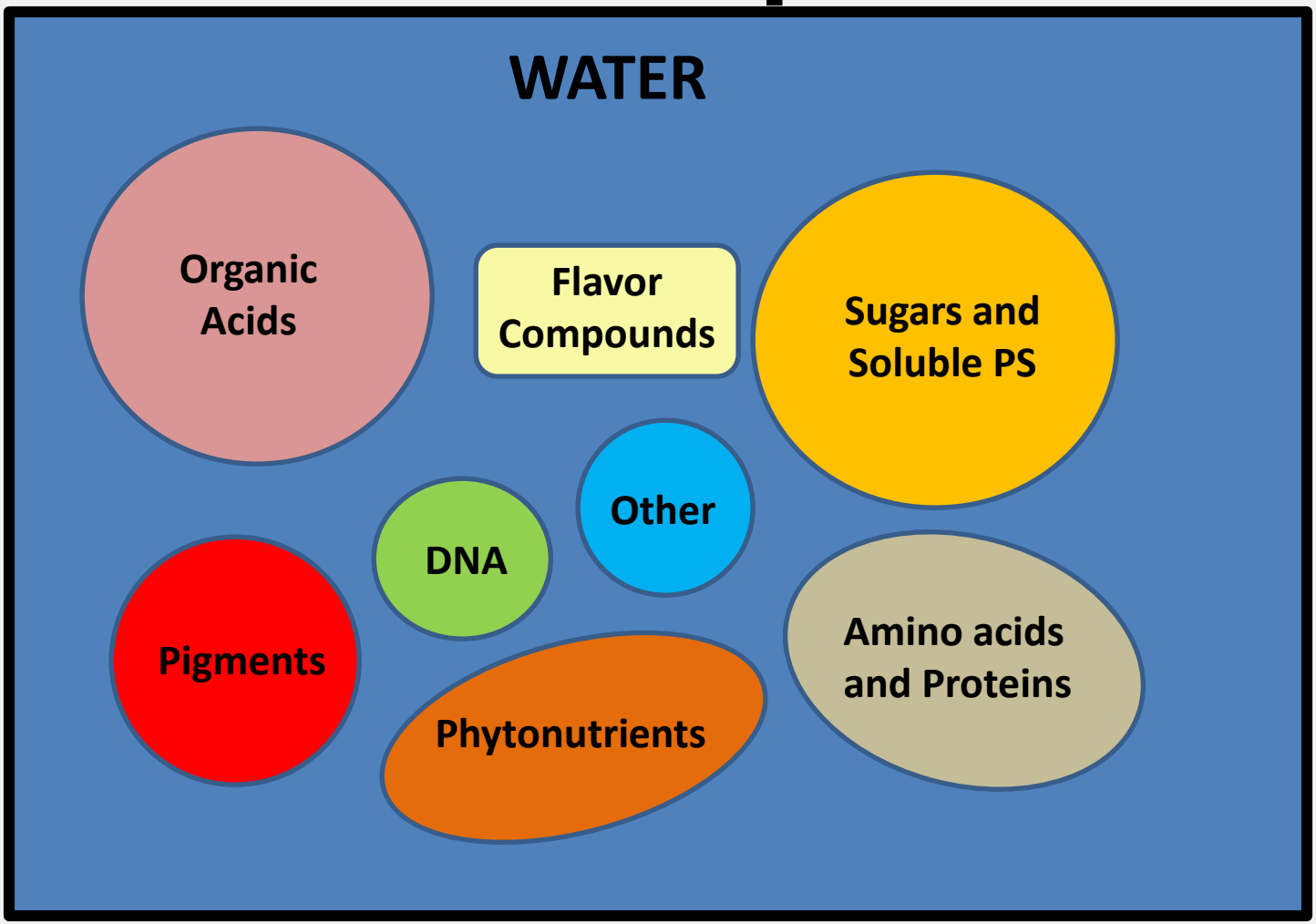
# °Brix
## Debated by Many

- the ‘correctness’ of certain published Brix values describing crop quality and health (bad-excellent)

# °Brix
## Understood by Few

- the importance of a measurement protocol consistent with key facts and of following the protocol strictly

# plant cells contain many parts and compounds



## General

| | |
|---|---|
| 172.0 grams | water |
| 1.6 grams | Protein |
| 0.4 grams | Lipids |
| 7.1 grams | carbohydrates |
| 2.2 grams | fiber |
| 33 calories | |

## Minerals

| | |
|---|---|
| 18 mg | Ca |
| .49 mg | Fe |
| 20 mg | Mg |
| 44 mg | P |
| 431 mg | K |
| 9 mg | Na |
| 0.31 mg | Zn |

## Sugars

| | |
|---|---|
| 2.3 g | glu |
| 2.5 g | fru |
| 4.8 g | suc |

## 18 types of amino acids

46 mg Leu-

49 mg Lys-

33 mg Val-

33 mg Isoleucine

## Vitamins

| | |
|---|---|
| 24.9 mg | Vit C |
| 67 µg | Thiamin |
| 23 µg | Riboflavin |
| 1.1 mg | Niacin |
| 109 µg | Pantothenic Acid |
| 146 µg | Vit B6 |
| 27 µg | Folic Acid |
| 12.2 mg | Choline |
| 200 µg | Betaine |
| 76 µg | Vit A |
| 817 µg | Beta carotene |
| 184 µg | Alpha carotene |
| 224 µg | Lutein + zeaxanthin |
| 4.7 mg | Lycopene |
| 980 µg | Vit E |
| 14.4 µg | Vitamin K |

USDA Nutritional Databse for Standard Reference Release 28
Full Report (All Nutrients) 11529, Tomatoes, red, rip, raw, year round average
Report Date: December 31, 2015
Data based on 1 large whole (3'dia.) 182 g tomato

# Abundance by Weight of Major Constituents of Raw Tomato Fruit Relative to each Unit of Sucrose

| water | carbs | fructose + glucose | proteins + lipids + fiber | minerals + major amino acids + vitamins |
|---|---|---|---|---|
| 36 | 1.48 | 1.0 | 0.87 | 0.16 |

# From Fruit Composition to °Brix

- all of the components of a tissue (leaf, fruit, etc) are NOT included in sap used to measure °Brix … some locked in ‘dry matter’

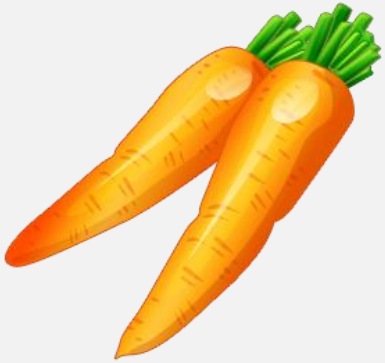
# From Fruit Composition to °Brix

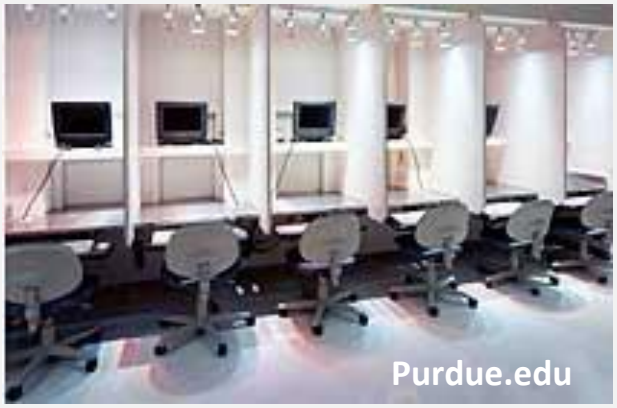
- the relative abundance of molecules in sap (a solution) affects its refractive index (°Brix)

# From °Brix to Quality

- because of what °Brix measures and does not measure, it is best as a first-cut assessment of potential sweetness

# Relationship between °Brix and perceived sweetness of table carrots






**Correlation between °Brix and perceived sweetness = 0.38**

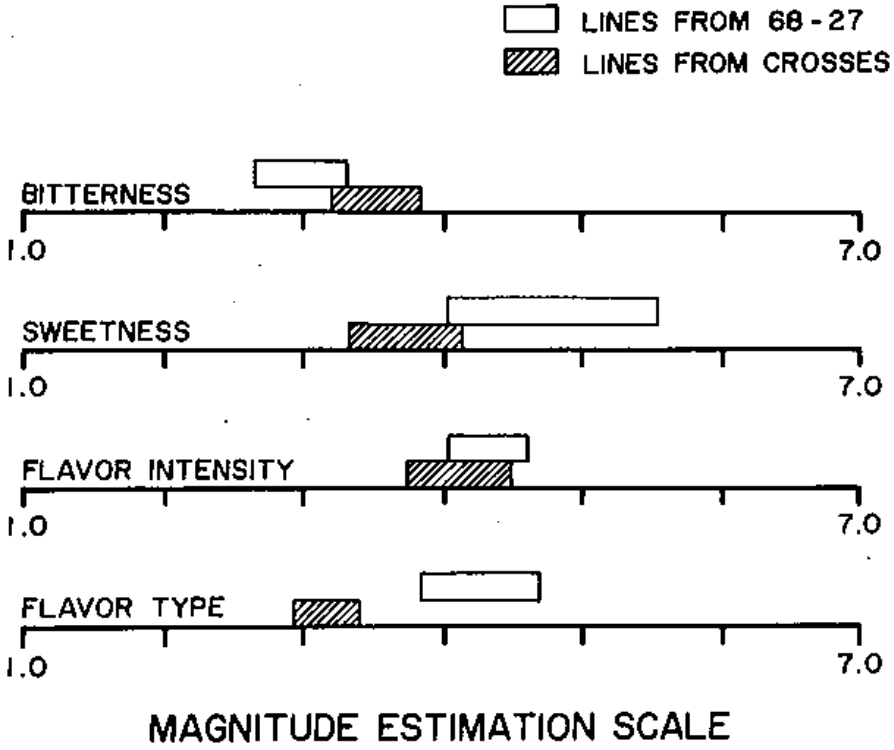



Fig. 1. Quantitative descriptive analysis profiles of mean judge scores from taste evaluations I and II arranged according to the genetic sources from which breeding lines were derived (see Table 1 for endpoint descriptions).

**Scheerens and Hosfield, 1976, J. Amer. Soc. Hort . Sci.**

# THANK-YOU and GOOD LUCK!


# QUESTIONS?

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## Dept. of Horticulture and Crop Science
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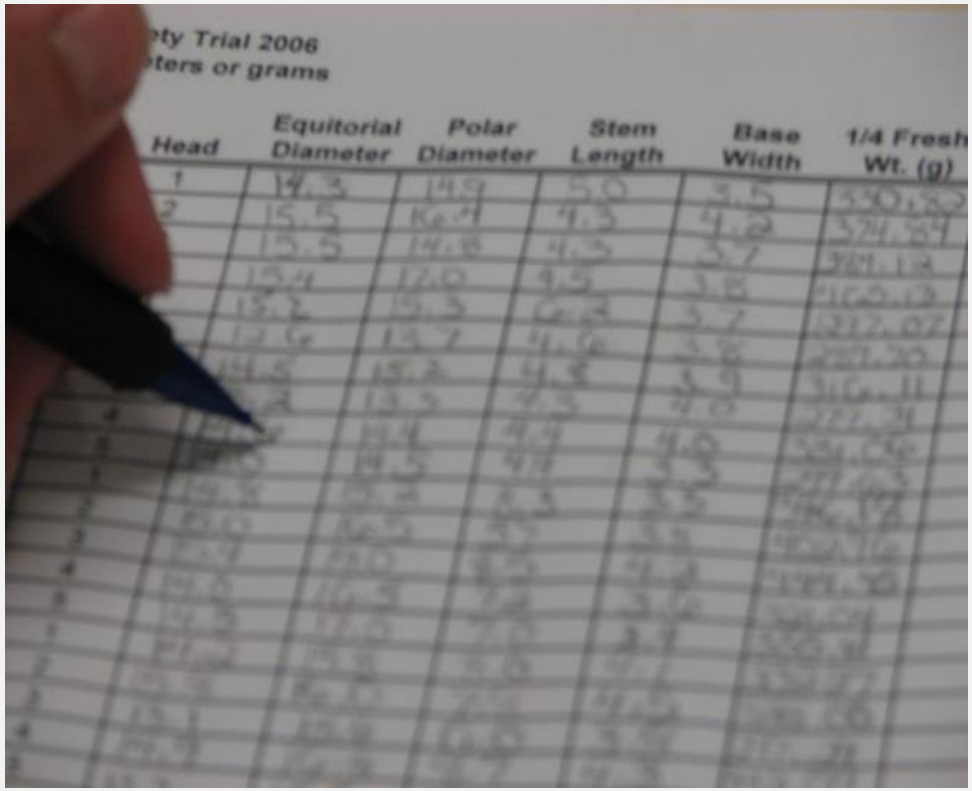
perspectives on or definitions of quality

Differ with person, place, crop, time, and other factors.

## Facts Important to Growers and all others in the Vegetable Value Chain

**Product weight and other physical, chemical, biological and chemical properties that affect buyer acceptance change continuously … changes and their rates differ among commodities and varieties.**

- customer base
- prices and receipts
- bank account




**Quality has many individual components; they are grouped into various categories.**

# Five Major Stages of Commercial Vegetable Production

1. Before Planting
2. Planting
3. Planting-Harvest
4. Harvest
5. After Harvest

# Factors contributing to Postharvest Loss

- Temperature
- Damage
- Ethylene
- Nutrition
- Water relations
- Diseases
- Continued growth

# Bridging gaps in understanding and practice takes resources, work, and communication.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# Measuring and Using Brix Values on Vegetable Farms

- equip growers
- Brix measured on 24 crops on 11 farms and at OARDC (July-November 2011)

| Crop | °Brix average | °Brix range | # obs | # Farms |
|---|---|---|---|---|
| Beet | 7.8 | 2.8 - 13.6 | 36 | 4 |
| Bean | 6.9 | 2.9 - 15.7 | 56 | 3 |
| Swiss Chard | 4.6 | 2.6 - 6.5 | 14 | 2 |
| Cucumber | 3.3 | 2.2 - 5.4 | 59 | 4 |
| Squash | 4.3 | 3.5 - 5.3 | 42 | 4 |
| Sweet corn | 16.2 | 9.5 - 26.5 | 65 | 2 |
| Ch. Tomato | 7.5 | 4.5 - 11.7 | 99 | 5 |
| Tomato | 4.7 | 2.3 - 8.2 | 440 | 10 |
| Turnip | 6.0 | 4.5 - 6.9 | 19 | 3 |
| Watermelon | 10.8 | 9.0 - 12.8 | 65 | 4 |
| Zucchini | 4.0 | 2.4 - 6.0 | 70 | 5 |

# For Fresh Raw Produce Only
# Comparison Chart for Brix Readings - Vegetables

| CROP | Poor | Average | Good | Excellent |
|---|---|---|---|---|
| Asparagus | 2 | 8 | 11 | 15+ |
| Beets | 6 | 8 | 10 | 14+ |
| Bell Peppers | 4 | 6 | 8 | 12+ |
| Broccoli | 6 | 8 | 10 | 12+ |
| Cabbage | 6 | 8 | 10 | 12+ |
| Carrots | 4 | 6 | 12 | 18+ |
| Cantaloupe | 8 | 12 | 14 | 16+ |
| Cauliflower | 4 | 6 | 8 | 10+ |
| Celery | 4 | 6 | 10 | 12+ |
| Cow Peas | 4 | 6 | 10 | 12+ |
| Cucumbers | 4 | 6 | 8 | 12+ |
| Escarole | 4 | 6 | 8 | 10+ |
| Field Peas | 8 | 10 | 12 | 14+ |
| Green Beans | 4 | 6 | 8 | 10+ |
| Honeydew | 8 | 10 | 12 | 14+ |
| Hot Peppers | 4 | 6 | 8 | 10+ |

| CROP | Poor | Average | Good | Excellent |
|---|---|---|---|---|
| Kohlrabi | 6 | 8 | 10 | 12+ |
| Lettuce | 4 | 6 | 8 | 10+ |
| Onions (regular varieties) | 6 | 8 | 10 | 16+ |
| Onions (green) | 6 | 12 | 16 | 20+ |
| Potatoes | 4 | 6 | 8 | 12+ |
| Rutabagas | 4 | 6 | 10 | 12+ |
| Spinach | 4 | 6 | 8 | 12+ |
| Squash | 6 | 8 | 12 | 16+ |
| Sweet Corn | 6 | 8 | 18 | 24+ |
| Sweet Potato | 6 | 8 | 10 | 14+ |
| Tomatoes | 4 | 6 | 8 | 12+ |
| Tomatoes (cherry) | 10 | 14 | 16 | 22+ |
| Turnips | 4 | 6 | 8 | 10+ |
| Watermelon | 8 | 12 | 14 | 16+ |

Extracted from The Pelly Chart courtesy of Beda Biologics, Kitchener, Ontario (519-895-2798)

# The Reams Composite Chart - Vegetables

| CROP | Poor | Avg | Good | Excellent | Disease Free |
|---|---|---|---|---|---|
| Asparagus | 2 | 4 | 6 | 12 | () |
| Beets | 6 | 8 | 10 | 12 | () |
| Broccoli | 6 | 8 | 10 | 12 | () |
| Cabbage | 6 | 8 | 10 | 12 | () |
| Cantaloupe | 8 | 12 | 14 | 16 | (16) |
| Carrots | 4 | 6 | 12 | 18 | () |
| Cauliflower | 4 | 6 | 8 | 12 | () |
| Celery | 4 | 6 | 10 | 12 | (16) |
| Corn, Sweet | 6 | 10 | 18 | 24 | (24) |
| Cucumber | | | | | (13) |
| Eggplant | | | | | (12) |
| Escarole | 4 | 6 | 8 | 12 | () |
| Garlic | | | | | () |
| Green Beans | 4 | 6 | 8 | 14 | (14) |
| Honeydew | 8 | 10 | 12 | 14 | (16) |

| CROP | Poor | Avg | Good | Excellent | Disease Free |
|---|---|---|---|---|---|
| Lettuce | 4 | 6 | 8 | 12 | (12) |
| Onions | 4 | 6 | 8 | 13 | (13) |
| Pea, Blackeye | 4 | 6 | 10 | 12 | () |
| Pea, English | 8 | 10 | 12 | 14 | (14) |
| Pepper, Hot | 4 | 6 | 8 | 12 | (12) |
| Potato, Irish | 3 | | | 13 | (13) |
| Potato, Sweet | 6 | 8 | 10 | 14 | () |
| Pumpkin | | | | (15) | () |
| Romaine | 4 | 6 | 8 | 12 | () |
| Rutabaga | 4 | 6 | 10 | 12 | () |
| Squash | 6 | 8 | 12 | 14 | (15) |
| Tomato | 4 | 6 | 8 | 12 | (18) |
| Turnips | 4 | 6 | 8 | 12 | () |
| Watermelon | 8 | 12 | 14 | 16 | () |

Extracted from the Reams Composite Chart courtesy of Pike Agri-Lab Supplies Inc., Strong, ME (207-684-5131)

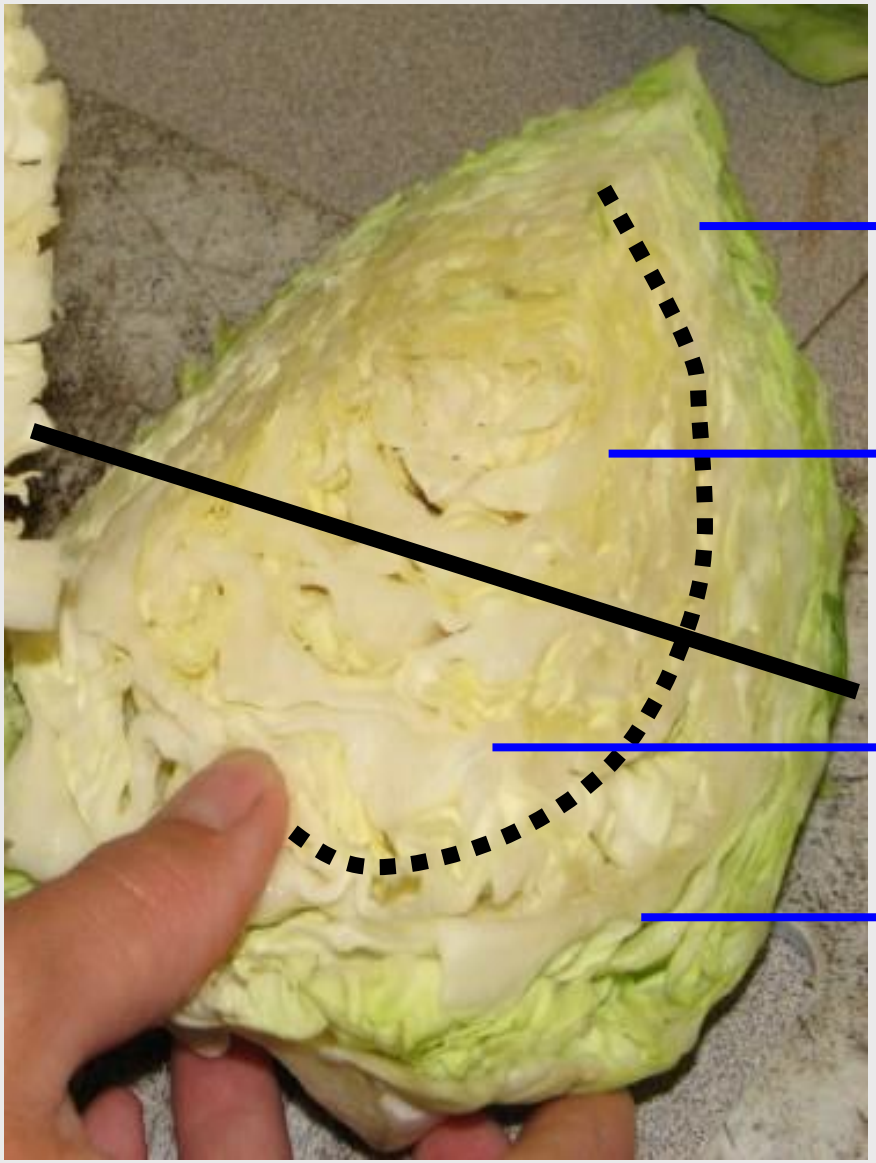
# Aspects of Management that Affect Brix (within one crop)

- variety
- irrigation
- fertility
- post-harvest
- population

# Aspects of Crop Environment or Sample that Affect Brix (within one crop)

- plant part
- age (maturity, position)
- time of day
- temperature-light

# Brix Samples



top-outer

top-inner

bottom-inner

bottom-outer

# Conclusions

- within-head variation in Brix unimportant in manufacturing but key in sampling, analysis

| | low | high |
|---|---|---|
| Kaitlin | 6.7 a | 7.1 ab |
| Krautman | 5.3 b | 6.0 c |
| Megaton | 5.9 ab | 7.3 a |
| SG 3378 | 6.7 a | 7.1 ab |
| SuperKraut | 6.4 a | 6.3 bc |
| TransAm | 6.7 a | 7.0 ab |
| XBC 2329 | 6.6 a | 7.3 a |
| 17-698 | 5.9 ab | 6.3 bc |
| Pr > F | 0.0085 | 0.0029 |
| LSD | 0.87 | 0.79 |

**Variety Effects on Brix at Two Populations**

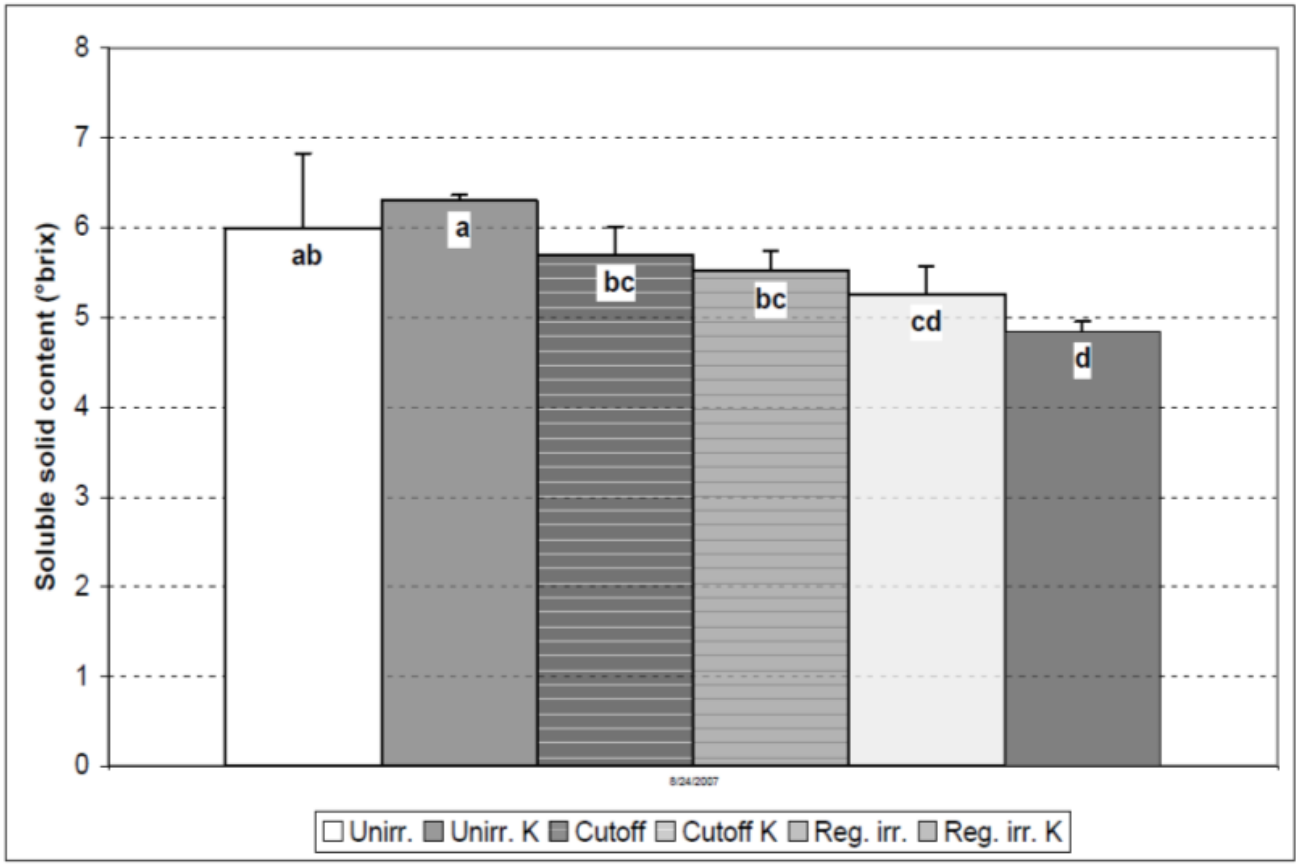



Fig. 3. Effect of irrigation and potassium rate on soluble solids content of tomato. Columns bearing the same letter are not significantly different. Vertical bars represent the significant differences at p=0.05 (*n*=4).

**Reducing soil moisture and altering K rates increased tomato Brix.**

**Helyes, L., J. Dimeny, A. Bocs, G. Schober, and Z. Pek. 2009. The effect of water and potassium supplement on yield and lycopene content of processing tomato. Acta Hort. 823:103-108.**

# Sample (plant part) affects Brix.*

## High tunnel and float-bed hydroponic lettuce sampled in October (OARDC 2012)

| Treatment | Fresh wt. (grams/head) | Immature leaf °Brix | Mature leaf °Brix |
|---|---|---|---|
| Solution 1 | 138 | 3.8 | 2.4 |
| Solution 2 | 115 | 5.8 | 4.2 |

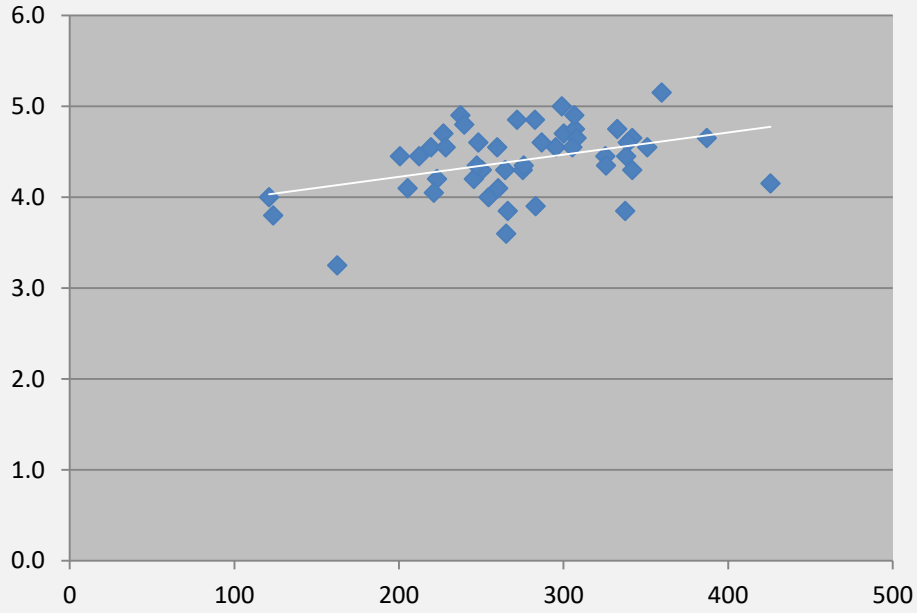
* Data also show that nutrient solution and lettuce head size may also affect Brix.

# Maturity and harvest practices affect Brix.

**Table 1—Comparison of the analysis of Laura tomatoes ripened on and off the vine under the same environmental conditions. The results show the mean and the confidence interval.**

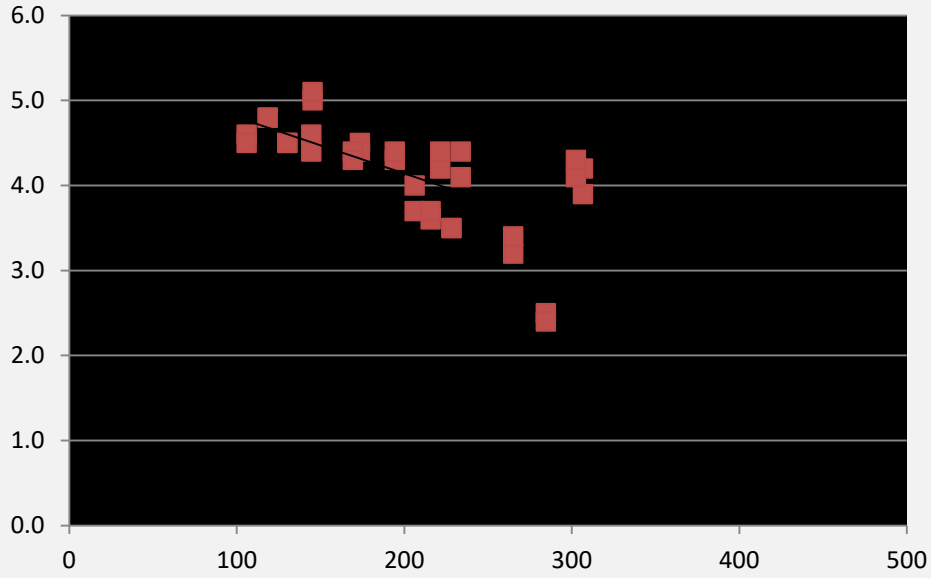
| Analysis | On | Off | Difference, % | |
|---|---|---|---|---|
| Lycopene, mg/100 g | 6.63 (0.9) | 5.00 (0.6) | 32.51 | * |
| β-carotene, mg/100 g | 0.18 (0.01) | 0.13 (0.01) | 32.66 | ** |
| Soluble solids, EBrix | 5.50 (0.01) | 5.00 (0.01) | 10.00 | ** |
| Total solids, % | 5.88 (0.09) | 5.46 (0.05) | 7.61 | ** |
| Ascorbic acid, mg/100 g | 20.17 (0.40) | 20.09 (0.37) | 0.42 | |

Arias, R., T.C. Lee, D. Specca, and H. Janes. 2000. Quality comparison of hydroponic tomatoes (Lycopersicon esculentum) ripened on and off the vine J. Food Sci. 65:545-548.




# Fruit fresh weight and Brix (OARDC studies 2011)

# tomato




# zucchini


**Sucrose levels fluctuate with time of day, so Brix readings will, too.**

## Daily Schedule

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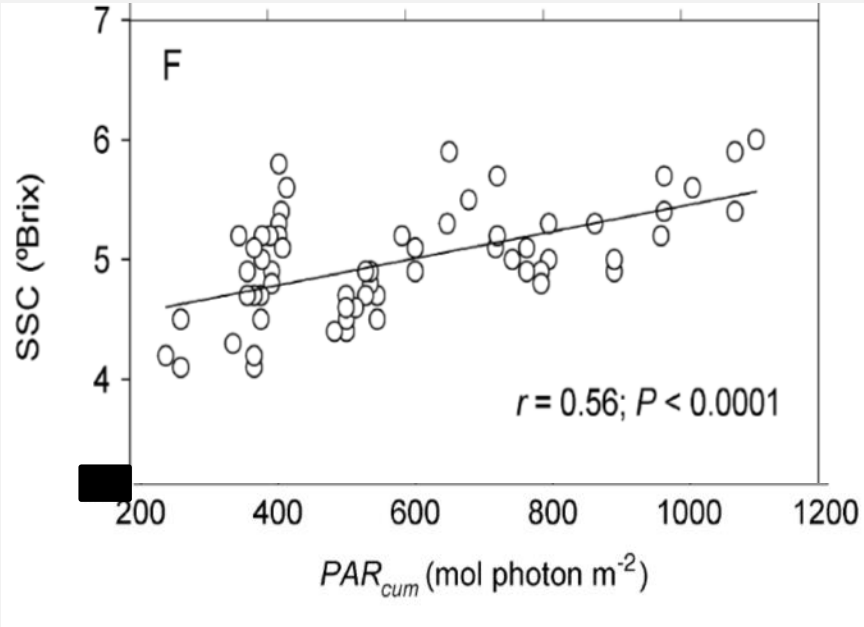
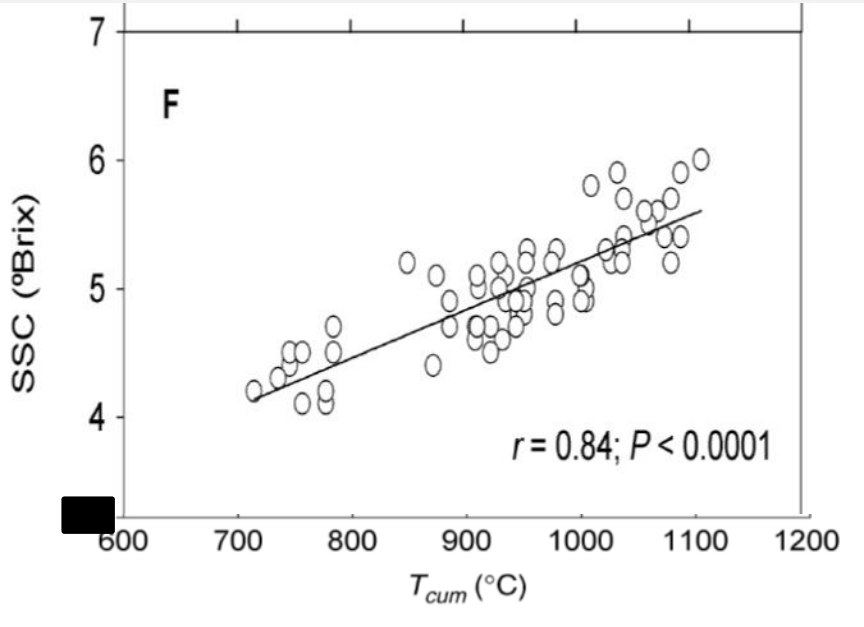
# Greenhouse tomato growers tend to know that higher light and temperature levels can increase tomato Brix values.




light

temperature

# So, when looking to manipulate Brix, …

# Sampling to Measure Brix

## Vegetables:

- below-ground
  - rhizome, root, stolon, tuber
- near surface
  - hypocotyl
- above-ground
  - stem, petiole, leaf;
  - flower, fruit, seed, pod

# Sampling to Measure Brix and Using Readings

Consider …

- plant part
- age (maturity, position on plant)
- condition of plant part
- (recent) growing conditions
- time of day

# Sampling to Measure Brix and Using Readings

- correct techniques and tools
- know the plant, plant part
- long-term approach to using readings … keep records
- know what Brix measures

# AICR's Foods That Fight Cancer™

http://www.aicr.org/foods-that-fight-cancer/

Scientific Report of the 2015 Dietary Guidelines Advisory Cmte

## Appendix E-3.2: Food Group Contributions to Nutrients in USDA Food Patterns and Current Nutrient Intakes

http://www.health.gov/dietaryguidelines/2015-scientific-report/15-appendix-E3/e3-2.asp


KIMTECH

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# Research Conclusions

1. Clear potential to alter crop properties associated with nutrition and health outcomes following consumption.

# Research Conclusions

2. Secondary metabolites are amenable to on-farm manipulation and, perhaps, most worthy of attention in enhancing human health.

# Research Conclusions

3. Enhancing secondary metabolite production currently can result in penalties, especially to growers.

# As we work toward creating a higher quality, more nutritious supply of fresh food …

# Operational Principle

1. Set baseline and target levels carefully, using a wide range of input and with growers and consumers in mind.

# Operational Principle

2. Coordinate education on what "nutritionally enhanced" truly means in practical, clear, and substantiated terms.