# Crop Yield and Farming Systems Affect the Nutritional Value of Plant Foods

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# Bad and Good News about the Nutritional Value of Plant Foods

- "Dilution effects" in high-yield crops reduce many nutrient concentrations
- Conventional farming systems may reduce phytochemical concentrations
- How consumers can increase nutrient and phytochemical intakes now

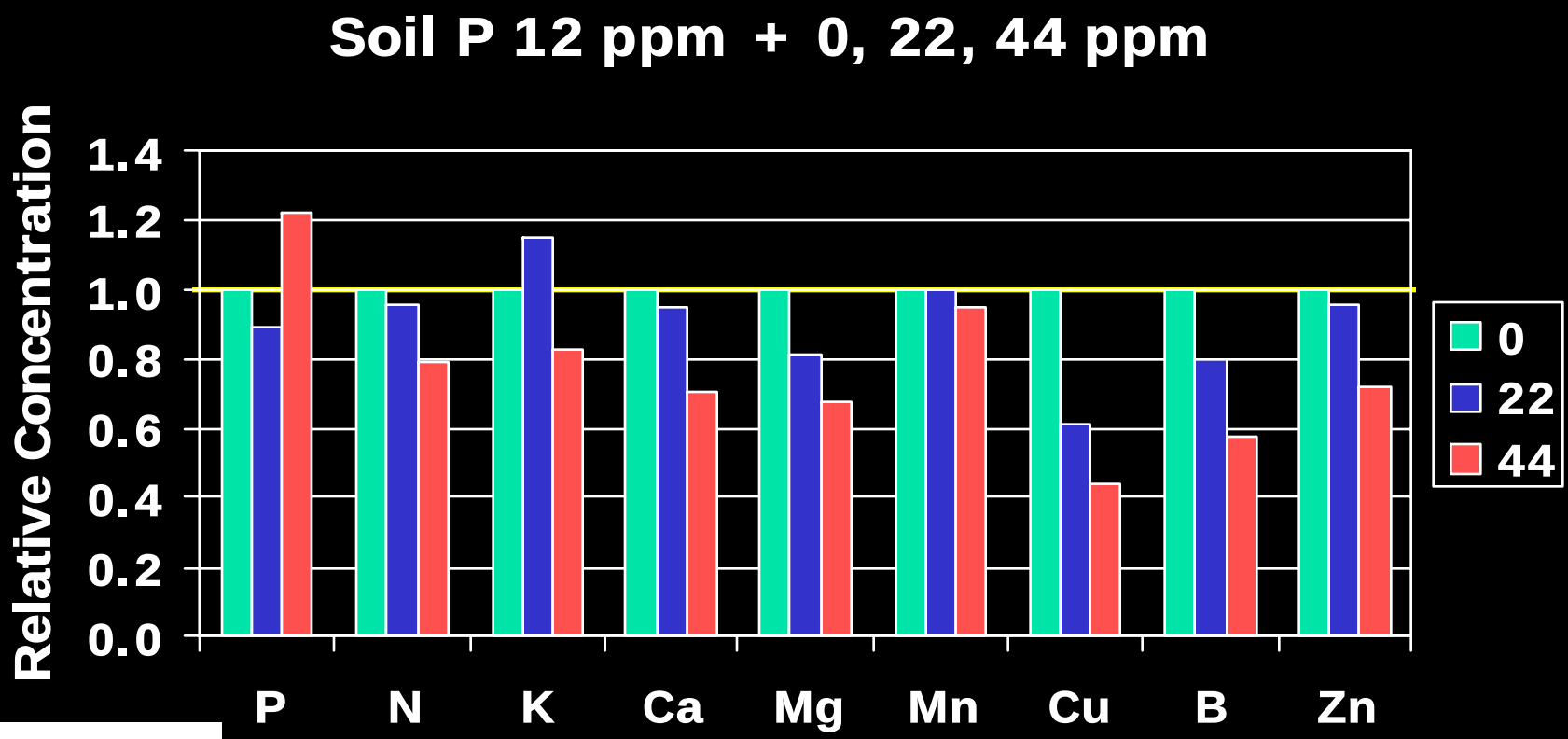
# Evidence for Dilution Effects

- Inverse relations between crop yield and nutrient concentrations (1940s on)
  - "The dilution effect," well known to experts
- Apparent declines in mineral, vitamin and protein concentrations in historical food composition data (1997 on)
- Inverse relations between yield and nutrient concentrations in side-by-side plantings of new and old varieties (2000 on)
  - "Genetic dilution effect"

# 1. Inverse relations between crop yield & mineral concentrations

- "The Dilution Effect in Plant Nutrition Studies"
  Wesley M. Jarrell & R.B. Beverly
  *Advances in Agronomy* 1981; 34:197–224
  - 28 pages, 101 references, 1940s and later
  - Cited 177 times since 1981
- Yields increased by fertilization & irrigation: *Environmental* dilution effects

# Dilution Effect of Phosphorus in Red Raspberry Plants



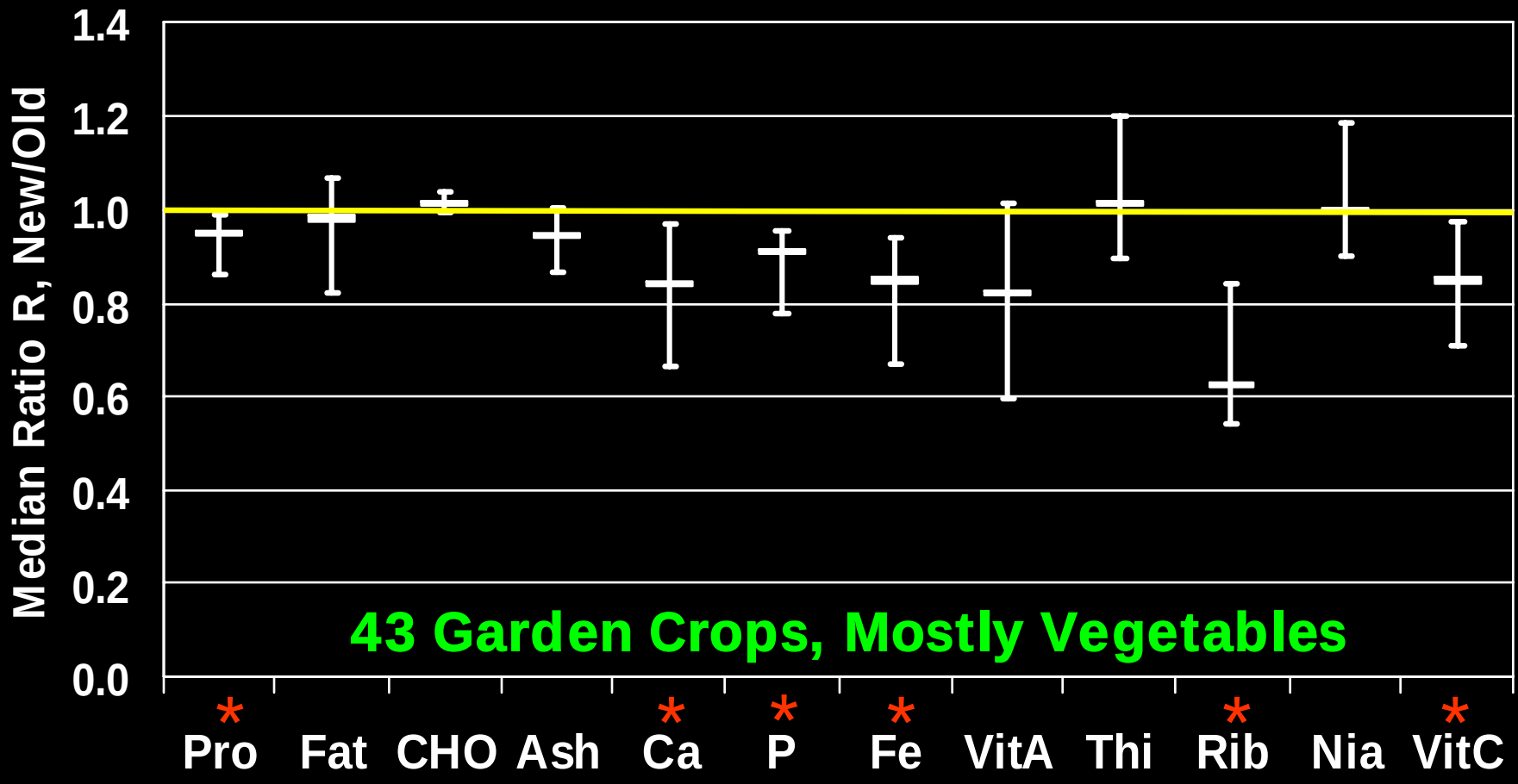

Yields (DW)
1 : 1.4 : 2.2

Hughes, Chaplin & Martin, *HortScience,* 1979; 14:521

# 2. 50-yr declines in historical food composition data

- Mayer 1997, UK data
  - 20 vegetables, 20 fruits
- Davis, Epp & Riordan 2004, US data
  - 43 garden crops, mostly vegetables
- White & Broadley 2005, UK & US data
  - 26 veg., 38 fruits (UK), 18-50 US foods

# Davis, Epp & Riordan
# USDA Data, 1950 to 1999




*J Am Coll Nutr,* 2004; 23:669

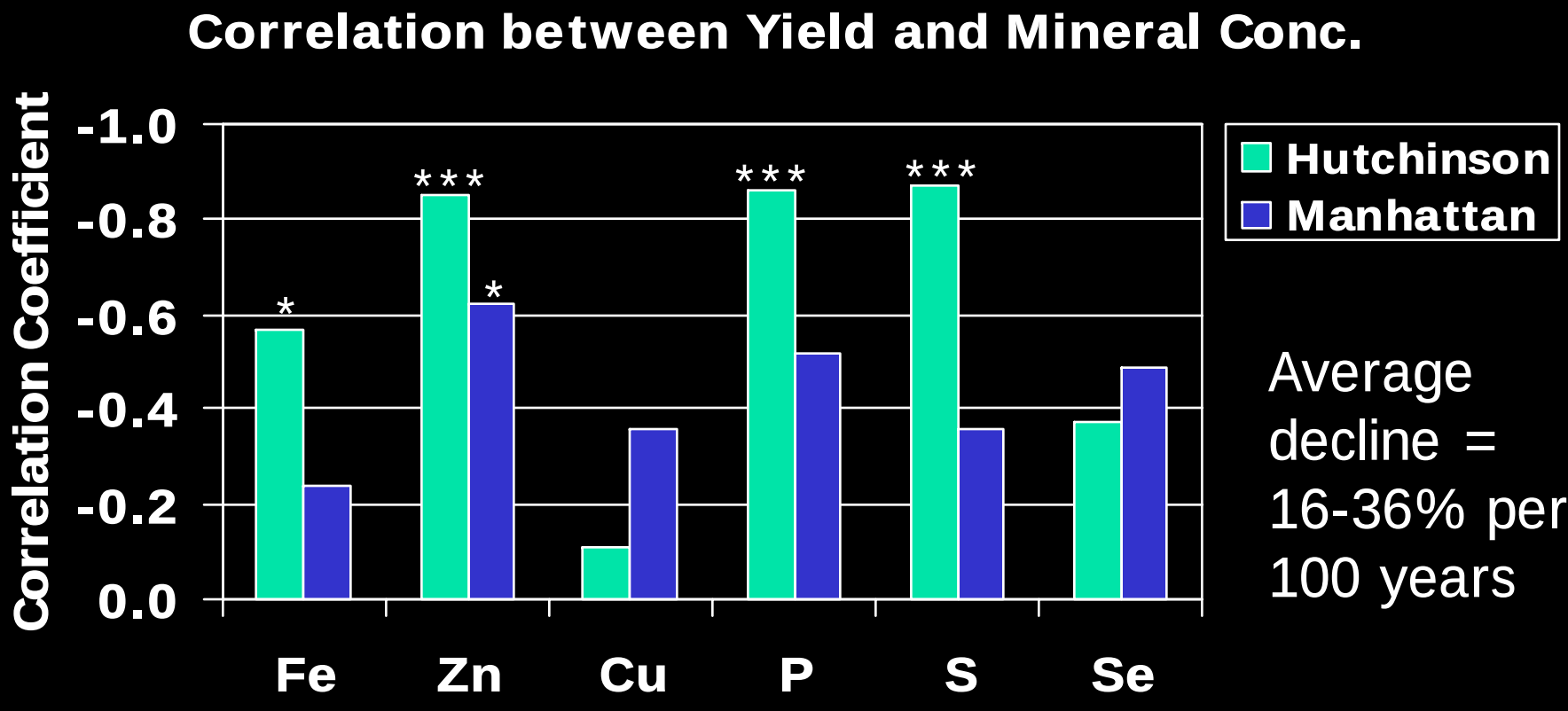
# 3. Side-by-side comparison of old and new plant varieties

- A very powerful method
  - Eliminates all uncertainties inherent in comparisons of historical data
    - No potential confounding by variations in soil, environment, sampling, or analytical methods
  - Applies to single foods
  - Unlimited choice of foods and nutrients
  - Allows testing of proposed remedies for dilution effects

# Three Side-By-Side Comparisons

- Farnham, Grusak & Wang, 2000
  - Broccoli—27 commercial hybrids
  - Ca & Mg;  2 crop years in South Carolina
- Garvin, Welch & Finley, 2002 & 2006
  - Wheat—14 commercial cultivars, 1873 to 1995
  - Fe, Zn, Cu, Se, P & S;  2 locations in Kansas
- Scott, Edwards, Bell, *et al.,* 2006
  - Maize— 45 commercial cultivars, 1920 to 2001
  - Protein, starch, oil & 3 amino acids;  Iowa & CA

# Garvin, Welch, & Finely
# 14 Wheats, 1873 to 1995




Average decline = 16-36% per 100 years

* $P < 0.05$

*** $P < 0.001$

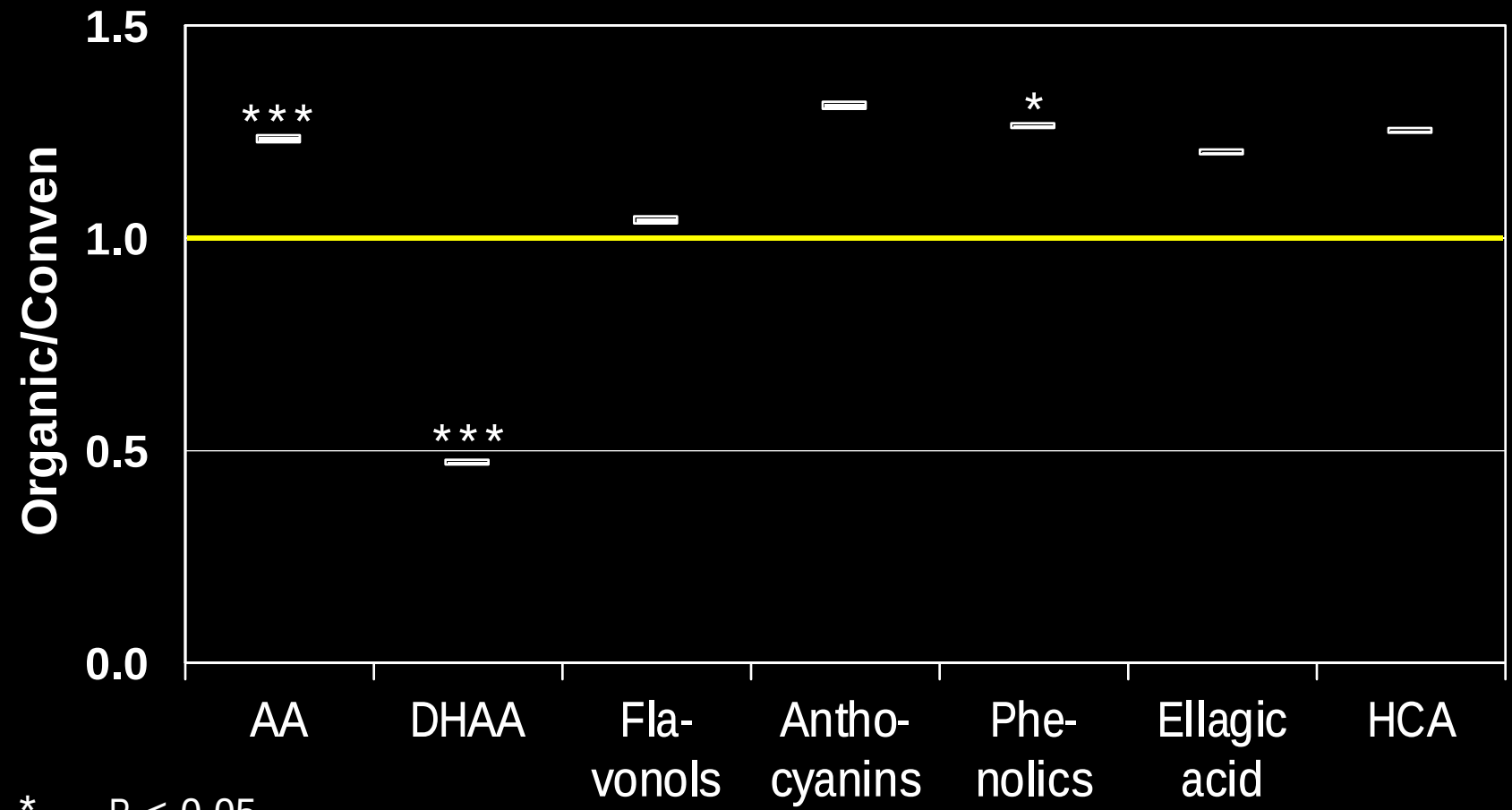
Poster, ASA/CSSA/SSSA meeting, 2002

*J Sci Food Agric*, 2006; 86:2213

# Emerging Evidence of Benefits of Organic Production Methods

- Average increases in phytochemicals ~30%
  - Antioxidants and secondary plant metabolites
- Probable enhanced disease prevention
  - CHD, cancer, diabetes, aging, Alzheimer's disease
- "Elevating Antioxidant Levels in Food Through Organic Farming and Food Processing" Charles Benbrook, The Organic Center, 2005 www.organic-center.org
  - Seven key studies
  - 81 pages + 136-page bibliography with abstracts

# Antioxidants in 3 Organic Vs. 4 Conventional Strawberries

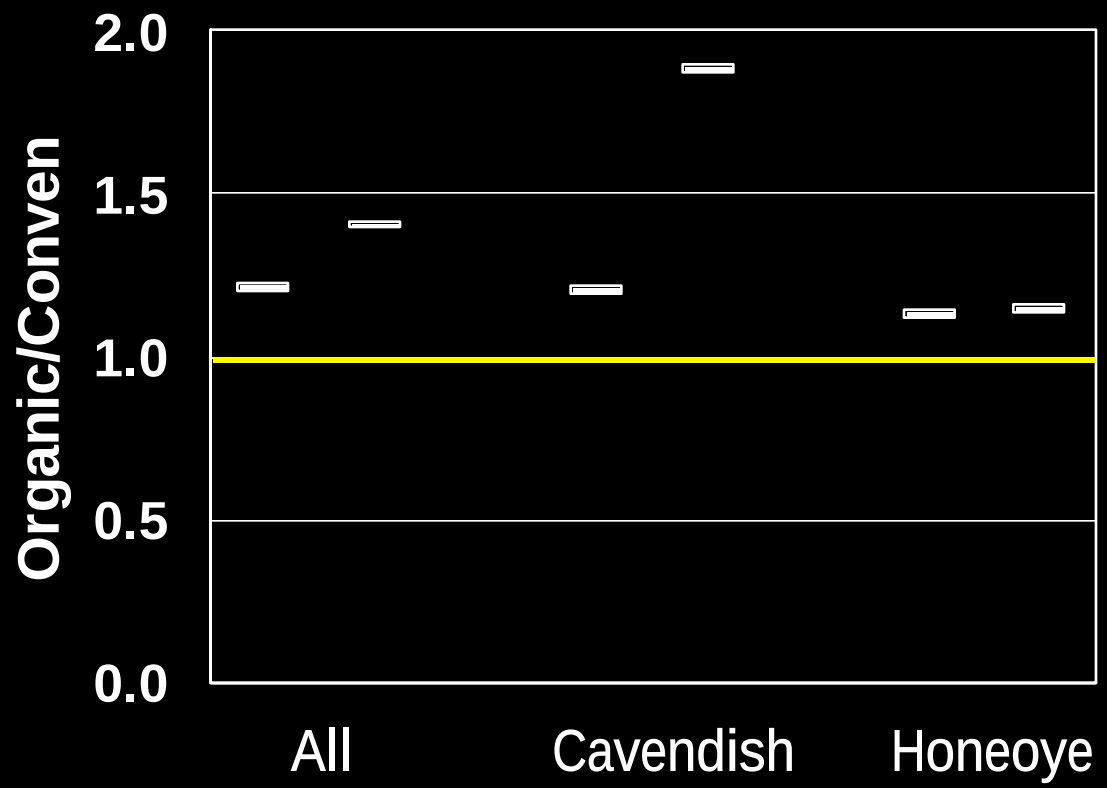



* P < 0.05

*** P < 0.001

*J Agric Food Chem* 2006; 54:1248

# Activity Against Cancer Cells by 0.5% Strawberry Extract




Colon Breast
HT29 MCF-7

P < 0.05 to 0.001

*J Agric Food Chem* 2006; 54:1248

# What to Do About Dilution Effects on Nutrients

- Eat more fruits, vegetables and whole grains
  - Current crops, especially vegetables, are still our richest source of nutrients and phytochemicals
- Eat less sugars, added fats and refined grains
  - These man-made “foods” have lost much more than the losses of dilution effects
- Reevaluate single-minded focus on yield
  - Research methods to reduce dilution effects
  - Breeding, heirloom varieties, organic methods?

# What to Do About Phytochemicals

- Consider organic fruits and vegetables
  - Hope for lower costs, increasing evidence
- Emphasize fruits and vegetables high in phytochemicals, conventional or not
  - Intense colors can be a useful guide
  - Emphasize fresh or frozen over dried, cooked or canned
- Eat whole grains, nuts and beans

# Crop Yield and Farming Systems Effects on Nutrition

- Evidence for dilution effects of yield
  - Environmental dilution effects long known
  - Declines in historical food composition data
  - Genetic dilution effects recently discovered
- Conventional farming probably reduces phytochemical concentrations
- Eat more whole foods & less added sugars, added fats, and white flour & rice

# E-mail and Coming Article

- d.r.davis@mail.utexas.edu
- “Declining Fruit and Vegetable Nutrient Composition—What Is the Evidence?” Submitted to *HortScience*