Farmer to Consumer: The Nutritional Quality of Organically and Locally Grown Foods

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Outline

• Introduction - Our national eating disorder!
• Brief & selected history of organics
• Nutritional quality of organically & locally produced foods
  ▪ pesticides
  ▪ vitamins, minerals, phytochemicals
  ▪ human preferences
• Resources
  ▪ government
  ▪ advocacy groups
Michael Pollan’s “Omnivore’s Dilemma”

• Our national eating disorder
• Natural history of four meals
  ▪ industrial
  ▪ organic or alternative
  ▪ local, home grown
  ▪ gathered & hunted
• Subsidization of corn
  ▪ meat production
  ▪ high fructose corn syrup
Prevalence of Overweight and Obesity in the United States, 1999-2004
Ogden et al., J. Amer. Medical Assoc. 295:1549, 2006

2 of 3 adults are overweight or obese (BMI of 25 or higher)

Obese U.S. Adults (Age 20 yrs and older with BMI≥30)
Prevalence of Overweight and Obesity in the United States, 1999-2004
Ogden et al., J. Amer. Medical Assoc. 295:1549, 2006

Overweight Children & Adolescents
(BMI for age at 95th percentile)

<table>
<thead>
<tr>
<th>Age</th>
<th>1999-00</th>
<th>2003-04</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-5 yrs</td>
<td>26%</td>
<td></td>
</tr>
<tr>
<td>6-11 yrs</td>
<td></td>
<td>37%</td>
</tr>
<tr>
<td>12-19 yrs</td>
<td></td>
<td>34%</td>
</tr>
</tbody>
</table>

Risk of overweight & overweight (85th percentile)
Disease and Disadvantage in the United States and in England
Banks et al., *J. Amer. Medical Assoc.* 295:2037, 2006
Obesity in adolescents

• “Dieting” increased binge eating, decreased breakfast consumption & physical activity, and was associated with increased BMI among teens
  Neumark-Sztainer et al., *JADA*, March 2007 (Univ. Minnesota)

• Higher BMIs in girls 3-5 years old resulted in earlier onset of puberty
  Lee et al., *Pediatrics*, March 2007 (Univ. Michigan)

• Bariatric surgery (mostly gastric bypass) tripled among 12 to 19 year olds from 2000-2003
  Tsai et al., *Arch. Pediatric & Adolescent Med.*, March 2007 (Univ. Medicine & Dentistry of New Jersey)
Omnivore’s Dilemma

- What should we eat? Is it healthy or harmful?
- confronts every omnivore, of which humans are the most conflicted
- physiological adaptations (i.e. dentition & digestion) to eating a varied diet of vegetation and meat
- characteristics of omnivores:
  - recognition & memory
  - availability & opportunity
  - pleasure & revulsion
New books on food choices

2006

Dr. Marion Nestle
Professor Nutrition, Food Studies & Public Health, New York Univ.
http://www.foodpolitics.com

Brian Halweil
Senior Researcher, Worldwatch Institute
http://www.worldwatch.org

2004

Nina Planck
Food writer, director of farmer’s markets
http://www.ninaplanck.com
Food issues impact everyone

- land ownership
- family farm
- farm workers
- farm profitability
- resources
- environmental quality
- globalization/localization
- pesticide risks
- affordability
- food attitudes
Definitions of food quality vary

• producers
• processors/handlers
• marketers
• dieticians/nutritionists
• chefs & cooks
• consumers
• scientists
Definition of food quality

• The standards of excellence of a product that distinguishes it as superior

• Composite of attributes
  ▪ productivity
  ▪ ripeness/freshness
  ▪ storage/processing capacity
  ▪ attractiveness, smell & flavor
  ▪ nutritious
  ▪ disease prevention
  ▪ safety
Brief and Selected History of Organics
Rachel Carson’s legacy

• exposed the risks of synthetic pesticides
• inspired establishment of the Environmental Protection Agency (1970)
• pesticide safety evaluations
• National Academy of Sciences study, *Pesticides in the Diets of Infants and Children* (1994)
• Food Quality Protection Act of 1996
• USDA’s pesticide use & residue monitoring system

Scientist & author
1907-1964
National Organic Program

“Organic food is produced by farmers who emphasize the use of renewable resources and the conservation of soil and water to enhance environmental quality for future generations.”

• Organic food is produced without most conventional pesticides & fertilizers made with synthetic ingredients, sewage sludge, bioengineering, or ionizing radiation.
• Organic meat, poultry, eggs & dairy products come from animals given no antibiotics or growth hormones, and have some access to “free-range.”
• To be labeled "organic," a Government-approved certifier inspects the farm or food processor, handler or restaurant to meet USDA organic standards.
• To receive the organic seal, packaged products must contain at least 95% organic ingredients.
• Applies to domestic & imported food products.
Organic food sales in U.S.

Why consumers buy organic?

Organic Trade Assoc., 2005

Whole Foods Market, 2006
Organic-Conventional Food Comparisons
Pesticides residues in produce

Pussemier et al. 2006. Chemical safety of conventionally & organically produced foodstuffs. Food Control 17, 14-21
Pesticides in conventional produce

Dirty dozen
- Peaches 100
- Apples 89
- Bell peppers 86
- Celery 85
- Nectarines 84
- Strawberries 82
- Cherries 75
- Pears 65
- Grapes, imported 65
- Spinach 60
- Lettuce 59
- Potatoes 58

Cleanest dozen
- Onions 1
- Avocado 1
- Sweet corn, frozen 2
- Pineapples 7
- Mangoes 9
- Asparagus 11
- Sweet peas, frozen 11
- Kiwifruit 14
- Bananas 16
- Cabbage 17
- Broccoli 18
- Papaya 21

Environmental Working Group
http://www.foodnews.org/index.php
Dietary intervention study in Seattle

- 23 children (3-11 yrs old)
- all ate conventional diets before study
- intervention sequence:
  - 4 days on CON diet
  - 5 days on ORG diet
  - 7 days on CON diet
- collected daily urine samples
- measured Malathion metabolite

Does Organic Production Enhance Phytochemical Content of Fruit and Vegetables?
Zhao et al., *HortTechnology* 16:449, 2006

“The evidence overall seems in favor of enhancement of phytochemical content in organically grown produce, but there has been little systematic study of the factors that may contribute to increased phytochemical content in organic crops. It remains to be seen whether consistent differences will be found, and the extent to which biotic and abiotic stresses, and ... soil biology contribute to those differences. Problems associated with most studies tend to weaken the validity of comparisons.”
Phytochemicals (phytonutrients)

Non-essential, yet beneficial, plant-derived compounds that can protect humans against diseases

- **cyanidin** (berries)
- **quercetin** (fruits, veggies, tea)
- **epicatechin** (tea)
- **resveratrol** (wine)

- **lycopene** (tomato)
Peaches and pears grown in Italy

- 3-year study
- organic & conventional
- peaches (‘Regina bianca’) & pears (‘Bartlett’)
- analyzed fresh, immediately after harvest
- no information on location of fields & replication

Other vitamins & phytochemicals

\( \alpha \)-Tocopherol (vitamin E)

- Higher in conventional peaches & organic pears

Polyphenols

- Higher in both organic peaches & pears
Kiwifruit grown in California

• mature ‘Hayward’ kiwifruit vines
• grown in Sacramento Valley
• stored for 4 months at 0°C (32°F)
• only one field of CON & one field of ORG separated by a mile

Minerals in kiwifruits

All higher in organic kiwifruit
Tomatoes grown in France

- 3 tomato varieties (Félicia, Izabella, Paola)
- grown in plastic tunnels
- harvested 2x per week for 6 weeks when red
- stored at 4°C (39°F)
- prepared tomato purees from frozen powder by brief heating & hypobaric
- 20 non-smoking 21-39 year old females for diet supplementation
- 100 g tomato puree per day for 3 weeks followed by 3 week washout period

Tomato puree

Vitamin C & polyphenols higher in organic puree

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>CON (mg/100g FW)</th>
<th>ORG (mg/100g FW)</th>
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<tbody>
<tr>
<td>Lycopene</td>
<td>NS</td>
<td>15</td>
</tr>
<tr>
<td>beta-Carotene</td>
<td>NS</td>
<td>2</td>
</tr>
<tr>
<td>Vitamin C</td>
<td></td>
<td>40</td>
</tr>
<tr>
<td>Polyphenols</td>
<td>10</td>
<td>20</td>
</tr>
</tbody>
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NS: Not Significant
Diet supplementation with tomato puree

**β-Carotene**
- CON
- ORG

**Vitamin C**
- CON
- ORG

Plasma concentration (nmol/L)

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<tr>
<th></th>
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<th>Supplement</th>
<th>Washout</th>
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<td>CON</td>
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Intervention diet study in Denmark

- organically & conventionally produced diets
- 22 day cross-over diets with 3 week washout period
- 6 males & 10 females, 21-35 yrs old, with average BMI=23.4 kg/m²
- non-smokers, non-pregnant & non-lactating women

Organic milk in Europe


http://www.qlif.org/
Farm system–food quality study criteria

Vertically oriented (farm-to-consumer), food quality extensive
- matched soil, microclimate & crop variety
- multiple paired fields or on-farm replication
- mimic distribution system for storage, processing, transportation & marketing
- mimic consumer handling & preparation
Collaborators

John Reganold, PhD
Regents Professor of Soil Science, WSU

Neal Davies, PhD
Associate Professor of Pharmaceutical Science, WSU

Carolyn Ross, PhD
Assistant Professor of Food Science, WSU
Sustainability of three apple production systems
JP Reganold, JD Glover, PK Andrews & HR Hinman

- Crop quality
- Soil quality
- Farm profitability
- Environmental risks of agrochemicals
- Energy efficiency

Apple orchard productivity and fruit quality under organic, conventional, and integrated management
GM Peck, PK Andrews, JP Reganold & JK Fellman
*HortScience* 41:99, 2006
Apple study

• Yakima Valley, Washington
• On-farm, replicated
  ▪ Organic
  ▪ Conventional
  ▪ Integrated
• Soil & topography identical
• Varieties
  ▪ Golden Delicious
  ▪ Gala
• Farmer/scientist managed
Fruit firmness

Antioxidant activity

Quercetin (flavonoid)

Skin 4X concentration of flesh

P < 0.05

Total quercetin (mg/100g FW)

Harvest

3-month CA

Unpublished
“Researchers at Minnesota's Mayo Clinic report that quercetin, … found most abundantly in apples, may provide a new method for preventing or treating prostate cancer.” *Carcinogenesis* 22:409, 2001

“Researchers at the University of Hawaii found that increased consumption of quercetin was associated with a reduced risk of lung cancer.” *J. Natl. Cancer Inst.* 92:154, 2000

http://www.usapple.org/educators/research/index.cfm
Consumer taste panels

*P < 0.05

2003 storage/shelf-life

Strawberry study

• Monterey & Santa Cruz Counties, California

• Paired ORG/CON farm fields
  ▪ 5 pairs in 2004
  ▪ 8 pairs in 2005

• Soil & topography matched for each pair

• Varieties
  ▪ Diamante
  ▪ San Juan
  ▪ Lanai
Antioxidant activity

Trolox equivalents (μmol/g FW)

CON  ORG

Unpublished
Ascorbic acid (vitamin C)

![Graph showing concentration of Ascorbic acid (vitamin C) in CON and ORG samples. The graph displays higher concentration in the ORG sample compared to the CON sample.](image)

Unpublished
Phytochemicals

![Bar charts showing concentrations of phenolics, flavonoids, and anthocyanins with CON and ORG categories.](image)

Unpublished
Polyphenolics

Unpublished

Ellagic acid

CON

ORG

Glycoside

Aglycone

Naringin/Naringenin

CON

ORG

Unpublished
• chiral (R and S enantiomers) flavanone
• citrus, tomato, cherry, apple
• anti-oxidant, -cancer, -mutagenic properties
• glycoside and aglycone forms of enantiomers have different bioavailabilities and bioactivities
Consumer taste panels

Unpublished
Compared to conventional produce

- Organic produce usually has less pesticide residues
- Organic produce usually has higher:
  - vitamin contents
  - phytonutrient contents
  - antioxidant activity
- Organic produce usually has similar mineral contents
- Organic produce usually has lower protein contents
- Organic produce is often preferred by consumers
- No study has directly shown that organic food prevents human diseases
  - bioavailability & bioactivity of food constituents is still lacking
Locally grown produce

- Those who eat locally grown produce are likely to eat more fruits & veggies
- Home gardening, community gardens & farmers markets promote physical activity & tend to favor sustainable methods
- “Food miles” increase food costs & pollution
- “Farm-to-school” activities link students to farming
- Nutritional competencies - part of the school curriculum

California middle school program
http://www.eatfit.net/
Resources from Government Agencies and Advocacy Groups
Steps to a Healthier You

One size doesn’t fit all. MyPyramid Plan offers you a personal eating plan with the foods and amounts that are right for you. Click on the MyPyramid Plan box to get started.

MyPyramid Tracker offers a detailed assessment of your food intake and physical activity level. Click on the Tracker box for an in-depth look at your food and physical activity choices.

Use the advice "Inside MyPyramid" to help you:

- Make smart choices from every food group.
- Find your balance between food and physical activity.
- Get the most nutrition out of your calories.
- Stay within your daily calorie needs.

MyPyramid food patterns are designed for the general public ages 2 and over. They are not therapeutic diets for specific health conditions, or for pregnancy or lactation. Those with a chronic health condition should consult with a health care provider to find a dietary plan that is right for them.

http://mypyramid.gov/
MyPyramid

- Make half your grains whole
- Vary your veggies - dark green to orange
- Eat a variety of fruits
- Make most of your oils from fish, nuts & vegetable oils
- Get calcium-rich dairy foods
- Choose low-fat or lean meats & poultry; eat more fish, beans, nuts & seeds
- Get 30 minutes of moderate to vigorous physical activity every day

Personalized planning that includes:
Food intake – physical activity = energy balance
http://www.cfsan.fda.gov/list.html
Welcome to **We Can!**

**We Can!** or "Ways to Enhance Children’s Activity & Nutrition" is a national program designed for families and communities to help children achieve a healthy weight. The program focuses on three important behaviors: **improved** food choices, **increased** physical activity and **reduced** screen time. **Read** more about the program.

**We Can!** provides families and communities just like yours with helpful resources including practical tips that you can start using today. **Learn** how your family can start **living** more healthfully today.

A variety of organizations have joined the **We Can!** community and are making a difference in the lives of families across the country. So far, more than 145 communities have joined **We Can! Discover** more about **We Can!** sites.

Centers for Disease Control & Prevention

Eat a Variety of Fruits & Vegetables Every Day

How Many Fruits & Vegetables Do You Need?

Every body is different. Enter your age, sex and level of physical activity to find the amount that's right for you.

Age: [Select]
Sex: [Select]
Physical Activity: Choose the level that you do above and beyond the light activity of everyday life:

Show Me

Fruit and Vegetable of the Month

Mix up your daily choices with this month's featured fruit or vegetable. View Calendar

Recipes

Find great meals and create your own cookbook in our Recipes.

Tips

Learn some easy ways to fill your day with fruits and vegetables.

http://www.fruitsandveggiesmatter.gov/
Robert Wood Johnson Foundation

Childhood Obesity

Helping halt the rise in childhood obesity by promoting healthy eating and physical activity in schools and communities throughout the nation.

Active Living by Design: Increasing Physical Activity Through Community Design

Bike, Walk and Wheel: A Way of Life in Columbia—One of 25 community partnerships that change environments in ways that help kids and families be more physically active.

Recent Features

Foundation Commits $500 Million to Reverse Childhood Obesity

About 25 million kids and teens in the United States are overweight or obese. Unless we take action now to reverse this alarming trend, we’re in danger of raising the first generation of American children who will live sicker and die younger than their parents’ generation.

http://www.rwjf.org/portfolios/interestarea.jsp?iaid=138
Local Harvest

http://www.localharvest.org/
Lunch Lessons

LUNCH LESSONS
Changing the Way We Feed Our Children

Join me on my mission to change the way our children are eating. Together, we'll tackle outdated district spending policies, commodity-based food service organizations, political platforms with no mention of school food or child health — and ultimately the USDA — to ensure that kids everywhere have wholesome, nutritious, delicious food at school.

Sign up for "Ann Alerts" or take the "School Food Challenge" to uncover new ideas, strategies, tips and recipes. Your passion and commitment will help us make a difference for future generations. Keep on fighting the good fight.

Chef Ann
Renegade Lunch Lady

http://www.lunchlessons.org/
Consumer Reports on organic food

- **Buy organic as often as possible**
  - *Dirty Dozen* fruits & veggies
  - meat, poultry, eggs, dairy
  - baby food
- **Buy organic if price is no object**
  - *Clean Dozen* fruits & veggies
  - breads, pasta, cereals
  - oils
  - snack & packaged foods
- **Don’t bother buying organic**
  - seafood
  - cosmetics

- Chemical health risks of conventionally produced foods: pesticides, growth hormones, antibiotics, toxins (e.g. heavy metals)
- Products labeled *Natural, Free Range, No Spray* are not certified organic
Acknowledgements

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• Organic Farming Research Foundation

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  ▪ Carolina Torres
  ▪ Peggy Collier

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  ▪ Marc Evans
  ▪ Herb Hinman
  ▪ John Fellman
  ▪ Rich Alldredge
Imagine the ideal food system and how together we can make it happen.