Organic agriculture and diversity

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• U.S. organic food sales have grown between 17 and 21% each year since 1997 (total U.S. food sales over this time have grown in the range of 2-4% a year)

• Organic food sales represent approximately 2% of U.S. food sales.
  – (Organic Trade Association’s 2004 Manufacturer Survey)
Organic Production Standards

Organic agriculture is “a production system that is managed in accordance with the Act and regulations in this part to respond to site-specific conditions by integrating cultural, biological, and mechanical practices that foster cycling of resources, promote ecological balance, and conserve biodiversity.”
Organic agriculture

• Stems from diversity
• Depends on diversity
• Promotes diversity

Can it survive success?
(is homogenization the price of growth?)
# Roots of organic agriculture

<table>
<thead>
<tr>
<th>Pioneer</th>
<th>Cultural influences</th>
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<tbody>
<tr>
<td>Rudolf Steiner</td>
<td>Agrarian peasants leading medieval lifestyles</td>
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<td>Forward-thinking urban intellectuals</td>
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<td>Mysticism, Science, Art, Philosophy</td>
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<td>Albert Howard</td>
<td>Peasant farmers of China and India</td>
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<td>(<em>Farmers for Forty Centuries</em>)</td>
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<td>British agricultural scientists</td>
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Rudolf Steiner (1861-1925)

- Austrian occult philosopher, theologian, educator, architect, dramatist, artist
- Diverse influences
  - agrarian peasants living medieval lifestyles
  - most forward thinking intellectuals of the era
- Eight lectures combined into *The Birth of a New Agriculture* (1924)
“For I have always had the opinion… that [the peasants’] alleged stupidity or foolishness is wisdom before God, that is to say, before the Spirit. I have always considered what the peasants and farmers thought about their things far wiser than what the scientists were thinking…. I have always been glad when I could listen to such things, for I have always found them extremely wise, while, as to science in its practical effects and conduct I have found it very stupid. This is what we at Dornach are striving for, and this will make our science wise will make it wise precisely through the so-called ‘peasant stupidity.’ We shall take pains at Dornach to carry a little of this peasant stupidity into our science, then this stupidity will become Wisdom before God.”

--Rudolf Steiner
Steiner: Principles of Biodynamics

• Broad perspective
  – Plants influenced by “the depths of the earth to the heights of the heavens.”

• Reading nature
  – careful observation

• Cosmic rhythms
  – prepare ground, sow, cultivate & harvest according to cycles of sun, moon, planets, & stars
Steiner: Principles of Biodynamics

• Plants tied to soil
  – build humus through composting

• New view of nutrition
  – vital plants make vital people; goal is quality, not just quantity

• Medicine for the earth
  – biodynamic preparations applied to compost, plants & soil
    – organize chaotic elements
    – draw life force from cosmos
Steiner: Principles of Biodynamics

• Self-contained farm
  – recycling of waste
  – balance of plants & animals

• Value farmer knowledge
  – agricultural economics absurd
  – association of producers and consumers for mutual benefit / producer security
  – beginning of CSA concept
Albert Howard (1873-1947)

• British agricultural scientist.
• 25 years in India.
• Critical of reductionist agricultural science and specialization
• Blamed fall of past civilizations on unsustainable agriculture
• Wrote *An Agricultural Testament* (1940)
Howard on Chinese agriculture

- “The small-holdings of China, for example, are still maintaining a steady output and there is no loss of fertility after forty centuries of management.”
- Tiny farms.
- Lots of people and animals.
- Lots of labor.
- Food crops, not cash crops.
Howard’s view of Chinese agriculture

- Balance between livestock and crops
- Use animal *and* human wastes (contrary to Rudolph Steiner)
- Lots of legumes
- Little cultivation
Howard on Natural Ecosystems

- Mixtures are the rule. Plants with animals. Mixed crops.
- Cycle of steady decomposition, renewal
- Mineral cycle.
- Biological balance. Live and let live. No poisons, vaccines, etc.
- Large, growing farms
- Monocultures
- Mechanized.
  - Machines consume resources, but do not contribute urine and dung for soil fertility
- Synthetic fertilizer dominates
- Increasing crop disease
- More processed and preserved foods
  - Questioned nutritional value
- Success judged by profit
- Too much food
  - People forced off farms into cities.

Howard on Western agriculture
Howard’s Prescription

• Follow example of nature and persistent civilizations
• Compost! (Indore Process)
• Systems approach to agricultural research
• Premium prices for sustainably produced food
Organic Agriculture Depends on Diversity
Measuring diversity
Measuring diversity
(a.k.a. Taking the fun out of ‘Old Macdonald’)

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Cow</td>
<td>1</td>
</tr>
<tr>
<td>Chicken</td>
<td>1</td>
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<tr>
<td>Goat</td>
<td>1</td>
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<td>Horse</td>
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<tr>
<td>Cat</td>
<td>1</td>
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<tr>
<td>Mule</td>
<td>1</td>
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<tr>
<td>Llama</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>6</td>
</tr>
<tr>
<td>Richness</td>
<td>6</td>
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<tr>
<td>Diversity</td>
<td>2.15</td>
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$H = \sum_{i=1}^{s} (p_i)(\log_2 p_i)$

$H = \text{Shannon-Weiner Index}$

$s = \text{number of species}$

$p_i = \text{proportion of individuals in area belonging to species } i$
Diversity

• More diverse habitats have lower pest populations
  – Resource concentration hypothesis
    • Easier for pests to find uniform habitat
    • Easier for pests to stay in uniform habitat
  – Natural enemies hypothesis
    • Predators / parasitoids more common in diverse habitat
  – Trap crop hypothesis
    • Alternate hosts draw pest away from main crop
Diversity reduces specialist pests

Population density of herbivorous arthropod species (plant eaters) in polyculture compared to monoculture

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<thead>
<tr>
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<th>Lower</th>
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<tr>
<td>Monophagous (250)</td>
<td>8%</td>
<td>59%</td>
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<tr>
<td>Polyphagous (67)</td>
<td>40%</td>
<td>28%</td>
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</table>

Andow, 1991
Diversity favors natural enemies

Population density of natural enemy species in polyculture compared to monoculture

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<tr>
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<tr>
<td>Predators (90)</td>
<td>43%</td>
<td>12%</td>
</tr>
<tr>
<td>Parasitoids (40)</td>
<td>75%</td>
<td>3%</td>
</tr>
</tbody>
</table>

Andow, 1991
Diversity reduces plant disease

More diverse habitats have less disease damage

- Yunnan province, China: mixed varieties of rice reduce rice blast levels and allow farmers to stop fungicide use (Nature, 2000)
- Disease epidemics dampened
Diverse systems are more productive.
Small farms are more productive

Production per unit area

- Ethiopia
- Nigeria
- Tanzania
- Uganda
- Sudan
- Syria
- Mexico
- Peru
- Barbados
- Bangladesh
- India
- Myanmar
- Nepal
- S. Korea
- Thailand
Modified from Belfrage et al. 2005. The Effects of Farm Size and Organic Farming on Diversity of Birds, Pollinators, and Plants in a Swedish Landscape. *Ambio* 34: 582-588
99 studies testing effects of organic agriculture on diversity

Organic Niche Marketing
Diversifying Consumer Base

- 1998-2001: Several studies characterize consumers of organic food as white, wealthy, and highly-educated
- Income and ethnicity are no longer significant factors
  - More than half have income < $50,000
  - African-Americans, Asian-Americans and Hispanics purchase more organic produce than Caucasians
  - Buyers clustered in two age groups: 18-29 and 40-49
- Parents of infants often buy organic food

-Dimitri and Oberholtzer 2006.
Can organic ideals survive the supermarket?

• Elimination of farmer-customer relationships
• Preference for
  – large farms
  – high volume
  – fewer suppliers
  – centralized distribution
  – consistency not diversity
• Lower prices to farmer
What is best for diversity?

- A small organic market that remains pure?
- A large organic market where growth demands compromise?
- Is there a middle way?
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