Organic Growing

Michael Bomford
Kentucky State University
GOLD New Potatoes $1.50 pound Scott County from our farm

Fayette Co. $1.50 Heirloom Tomatoes 100% Chemical Free
Certified Organic Producers, 2006
• 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)
Certification:
Who can use the word “organic”?

- >$5,000 annually?
  - *Must* certify.

- <$5,000 annually?
  - *May* certify
  - must follow standards
  - subject to audits (NOP pays)

- **Misuse of “organic”**
  - $10,000 fine

As of 10/21/02

USDA ORGANIC
Organic Certification Requirements

1. Management plan, approved by certifier
   – Required:
     • Boundaries, buffer zones separate organic from conventional
     • Organic seed, transplants
     • Maintain/improve soil fertility, organic matter
     • Rotation
   – Prohibited:
     • Synthetic fertilizers and pesticides
     • Genetically modified organisms
     • Sewage sludge
     • Burning (some exceptions)

2. Record keeping
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.”
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Site specific conditions

- not a cookbook
- plans reflect unique characteristics of each operation
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**Cultural practices** *(how you grow)*

- crop timing
- crop selection
- resistance
- interplanting
- spacing
- orientation
- etc...
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Biological practices (use your friends)
- release biocontrols
- develop beneficial habitat
- livestock grazing
- rhizobial inoculation
- etc...
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- till
- weed
- mow
- flame
- fence
- etc...
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Ecological Balance
- achievement of steady state by ecosystem
- dynamic equilibrium between organisms and environment
- reduced outbreaks / extinctions (symptoms of imbalance)
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Biodiversity

Diversity of living organisms

Consider scale:
- range from cellular to biome
- applies to genes, species, ecosystems
Organic Seed and Transplants

• Expect 20% price premium
• Organic transplants difficult to find…
  – Potential market!
• No wetting agents or synthetic fertilizer in potting mix
• Organic fertilizers available
  – Bone meal, blood meal, soy meal, fish meal, compost etc.
The organic farmer feeds the soil and the soil feeds the plant.

-Jerome Belanger
Good earth

- Soft, crumbly
- Warms quickly
- Drains well
- Holds moisture
- Little clodding / hardpan / crusting / erosion
- Little fertilizer need
- Rich, earthy smell
- High quality crops
Living Soil?

- **Water**: 25%
- **Minerals**: 45%
- **Air**: 25%

**Organic matter**: 1-5%

- **Arthropods**: 15%
- **Earthworms**: 15%
- **Bacteria**: 26%
- **Fungi**: 42%
- **Protozoa**: 2%
- **Earthworms**: 15%
- **Arthropods**: 15%
- **Bacteria**: 26%
- **Fungi**: 42%

**Stabilized organic matter (humus)**: 33% - 50%
- Fresh residue: <10%
- Decomposing organic matter (active fraction): 33% - 50%
Soil Minerals

- Insoluble components:
  - Aluminum, Silicon, Iron oxide
- Most minerals needed by plants are “locked” in molecules
- Small proportion available to plants through:
  - weathering
  - acids produced by roots and microbes
  - chelating substances

Form multiple bonds to a single metal ion (eg. heme):
## Plant Nutrients

<table>
<thead>
<tr>
<th>Non-mineral</th>
<th>Macronutrients</th>
<th>Micronutrients</th>
</tr>
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<tbody>
<tr>
<td>Carbon (C from CO₂)</td>
<td>Nitrogen (N from N₂ via N fixation)</td>
<td>Boron (B)</td>
</tr>
<tr>
<td>Hydrogen (H from H₂O)</td>
<td>Phosphorus (P)</td>
<td>Copper (Cu)</td>
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<td>Magnesium (Mg)</td>
<td>Molybdenum (Mo)</td>
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<td>Zinc (Zn)</td>
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<td></td>
<td></td>
<td>Chlorine (Cl)</td>
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<td></td>
<td></td>
<td>Cobalt (Co)</td>
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<td></td>
<td></td>
<td>Nickel (Ni)</td>
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Absorbed by roots with soil solution.
## CB HOPKNS CaFe

"Mighty good, Nice Coffee"

Closed Mon -- Cu Zn!

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Earthworms

- Create tunnels for water infiltration / root penetration
- Process soil and organic matter through gut, making nutrients available to plants
- Mix soil
- Like surface residue
- Killed by cultivation
  - Cut up
  - Tunnels destroyed
- Killed by some pesticides

1,000 lbs/acre
Arthropods
(Insects, mites, spiders, centipedes etc.)

- Primary decomposers
- Predators
- Scavengers
- Herbivores
- Fungivores
- Algal eaters
- Diggers

100 lbs/ac
Microbes
(Bacteria, fungi, actinomycetes, protozoa, nematodes)

- 70% of soil life, by mass
- Release nutrients from soil
- Change nutrients to plant-available forms
- Increase nutrient uptake of roots (mycorrhizae)
- Decompose organic matter
- Sweet, earthy small (actinomycetes)
- Fix nitrogen from air (bacteria, algae)
- Plant diseases
- Biological controls

4,500 lbs/ac
Organic matter = Food for soil life
Conditions that favor soil life

• Nutrient source = organic matter
• pH > 5.5
• Aeration
  – Need $O_2$ for respiration
  – Some micronutrients become too available (toxic) without $O_2$
  – Allows soil to warm quickly
• Not too wet, not too dry
  – Water carries nutrients (soil solution)
  – Wilting point $\approx$ 50% of soil water used
Soil pH and Availability

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<th>pH RANGE</th>
<th>Availability</th>
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<tr>
<td>4-5</td>
<td>Fungi</td>
</tr>
<tr>
<td>5-6</td>
<td>Bacteria/Actinomycetes</td>
</tr>
<tr>
<td>6-7</td>
<td>Nitrogen</td>
</tr>
<tr>
<td>7-8</td>
<td>Calcium/Magnesium</td>
</tr>
<tr>
<td>8-9</td>
<td>Phosphorus</td>
</tr>
<tr>
<td>9</td>
<td>Potassium</td>
</tr>
<tr>
<td></td>
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<tr>
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Nutrients in Soil
(Approximate proportions for P, K & Mg)

Total Reserves 100%

Exchangeable Nutrients 5%
Available Nutrients 0.1%
Crop Needs 1%

Soil Test
Weathering & microbial breakdown
Weathering & microbial breakdown

Living Soil Goal: Keep pipeline open by feeding microbes

Conventional Goal: Replenish supply of available nutrients (hydroponics)
Aggregation

- Promoted by soil life; promotes soil life
- Improves structure of clayey and sandy soils
  - Reduced crusting
  - Increased air and water infiltration
  - Reduced compaction

MICROBIAL AND FUNGAL BYPRODUCTS GLUE THE PARTICLES TOGETHER

DISPERSED STATE AGGREGATED STATE

Well-Aggregated Crusted
## Aggregation

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<th>Reduces aggregation</th>
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<td>Mulches, cover crops</td>
<td>Bare soil</td>
</tr>
<tr>
<td>Grasses, perennials</td>
<td>Annuals</td>
</tr>
<tr>
<td>No-till, low-till, and conservation till systems</td>
<td>Cultivation (especially when too wet or too dry)</td>
</tr>
<tr>
<td>OM addition</td>
<td>Excess fertilization (salt build-up; OM breakdown)</td>
</tr>
</tbody>
</table>
Soil Quality Data from Cedar Meadow Farm
(Lancaster County, PA)

Carbon and sugars (%)

% Extractable carbon
% Microbial biomass C
% Extractable sugars
Aggregate stability

Years without cultivation

Aggregate stability (%)
Soil Fertility: Cover Cropping

- Rye/vetch mix adds ~135 lb N/ac
- Slow release
- Organic matter
- Erosion control

WVU organic research project

- Winter rye & vetch cover crop
- Cover crop + compost @10t/ac
Soil Fertility: Animal Waste
Soil Fertility: Animal Waste

- Raw manure pre-harvest interval:
  - > 90 days if edible portion does not contact soil
  - > 120 days if edible portion contacts soil
Soil Fertility: Compost

- No pre-harvest interval
- Strict requirements for manure-based compost
  - 131-170°F for 15 days in windrows
  - C/N = 25-40
Why Mulch?

• Weed management
• Moisture retention
• Add O.M.

What Mulch?

• Organic
  – wood chips, shredded bark, chopped leaves, straw, grass clippings, compost, sawdust, pine needles, paper

• Inorganic
  – gravel, stone, black plastic, landscape fabric
Organic Mulch

- 4”-6” to completely discourage weeds
- mulch next to stems invites slugs, rodents
- slows warming in spring
- adds O.M.

Plastic Mulch

- Warms soil, radiates heat at night
- Protects fruit from rotting
- Conserves moisture
- Non-renewable, non-biodegradable
- Organic standards require complete removal each year
Pest Management: Solarization and Biofumigation
White mold (Sclerotinia sclerotiorum)
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