


Slide 1

**Soil Quality and Sustainability:  
Why Bother?**

Ecofarm Day, Cornwall ON  
(via webconference)  
Andy Hammermeister  
Manager, Organic Agriculture Centre of Canada



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Slide 2

**Why Do We Need Agriculture?**

- Air pollution (GHG, pesticides, dust, smoke)
- Source of 70% of water pollution in U.S.
  - 40-50% of U.S. fresh water can't swim in or drink
  - Pesticides in almost all fresh water sampled
- 70% of U.S. corn & soybean feeding livestock
- Water & land use conflicts
- Heavily subsidized (unlike other industries)
- Only 9.3% of Cdn disposable income for food
- >85% of food is imported



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Slide 3

**Why do we need agriculture?**

- Food, fibre, fuel, pharmaceuticals
- Managed landscape
- Agritourism
- Social and cultural diversity
- Distribution of population



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Slide 4

**The Next Green Revolution**

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- First Green Revolution – Increase Yield
  - Inputs: Fertilizers, Pesticides, Irrigation
  - Crop breeding: Yield, Lodging & Disease Resistance
- What is the Next Green Revolution
  - Biotechnology or nanotechnology?
  - Selecting for efficient crop roots
  - Waste recycling



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Slide 5

**Principles of Organic**  
National Standard of Canada - ICS 67.040

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- Protect the environment, minimize soil degradation and erosion, decrease pollution, optimize biological productivity and promote a sound state of health.
- Maintain long-term soil fertility by optimizing conditions for biological activity within the soil.
- Maintain biological diversity within the system.
- Recycle materials and resources to the greatest extent possible within the enterprise.
- Provide attentive care that promotes the health and meets the behavioural needs of livestock.
- Prepare organic products, emphasizing careful processing, and handling methods in order to maintain the organic integrity and vital qualities of the products at all stages of production.
- Rely on renewable resources in locally organized agricultural systems.



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Slide 6


**Principles of Organic Agriculture**

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[www.ifoam.org/about\\_ifoam/principles/](http://www.ifoam.org/about_ifoam/principles/)

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- Agriculture is one of humankind's most basic activities because all people need to nourish themselves daily. History, culture and community values are embedded in agriculture. The Principles apply to agriculture in the broadest sense, including the way people tend **soils**, water, plants and animals in order to produce, prepare and distribute food and other goods. They concern the way people interact with living landscapes, relate to one another and shape the legacy of future generations.



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Slide 7

**Principle of Health**

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[www.ifoam.org/about\\_ifoam/principles/](http://www.ifoam.org/about_ifoam/principles/)

*Organic Agriculture should sustain and enhance the health of soil, plant, animal, human and planet as one and indivisible.*



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Slide 8

**Principle of Ecology**

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[www.ifoam.org/about\\_ifoam/principles/](http://www.ifoam.org/about_ifoam/principles/)

*Organic Agriculture should be based on living ecological systems and cycles, work with them, emulate them and help sustain them.*



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Slide 9


**Principle of Fairness**

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[www.ifoam.org/about\\_ifoam/principles/](http://www.ifoam.org/about_ifoam/principles/)

*Organic Agriculture should build on relationships that ensure fairness with regard to the common environment and life opportunities*

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Slide 10

**Principle of Care**  
[www.ifoam.org/about\\_ifoam/principles/](http://www.ifoam.org/about_ifoam/principles/)

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Organic Agriculture should be managed in a precautionary and responsible manner to **protect the health and well-being of current and future generations** and the **environment**.



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Slide 11

**Organic principles lead to what end?**

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- Nutritious food
- Sustainable yield
- Input reduction, contamination avoidance/minimization
- Nourishment and well-being
  
- Ecological balance
- Protect and benefit the common environment
- Environmental resources should be held in trust for future generations
- Accountability for real environmental and social costs
- Conservation of resources
  
- Healthy people
- Healthy animals
- Healthy environment (ecologically sound)



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Slide 12


**Sustainability**

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**Reducing environmental impact**

**Vs.**

**Improving the environment**



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Slide 13

### What is Soil Quality?

- Soil Quality
  - The characteristics of the soil
    - Physical
    - Chemical
    - Biological
- Soil Capability (for agriculture)
  - Suitability of the quality characteristics to serve a purpose
- Soil Health



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Slide 14

### Soil Health, Survey of Farmers Methods - UBC

- What indicators of soil health do farmers normally use?



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Slide 15

<ul style="list-style-type: none"><li>– Biological Indicators:<ul style="list-style-type: none"><li>• earthworms</li><li>• <u>soil smell</u></li><li>• rate of residue breakdown</li><li>• soil respiration, microbial biomass</li><li>• plant or animal pathogens</li></ul></li><li>– Chemical Indicators:<ul style="list-style-type: none"><li>• organic matter</li><li>• pH</li><li>• nitrogen availability</li><li>• other nutrient availability</li></ul></li></ul>	<ul style="list-style-type: none"><li>– Physical Indicators:<ul style="list-style-type: none"><li>• texture, bulk density</li><li>• <u>structure, aggregate</u> stability, surface crust</li><li>• topsoil depth, rooting depth</li><li>• soil temp. &amp; colour</li><li>• aeration, moisture content, infiltration rate, water holding</li><li>• erosion</li></ul></li><li>– Non-soil Indicators:<ul style="list-style-type: none"><li>• water quality</li><li>• plant &amp; animal health</li><li>• weed species</li></ul></li></ul>
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Slide 16

### Why choose to farm organically?

- **Why respondents choose to farm organically**
  - Land stewardship and ecological sustainability.
  - Chemical avoidance for family & farm worker health.
  - Chemical avoidance for environmental health.
  - Organic represents good farming practices—like the results.
  - Ecological principles: view farm as ecological system.
- **How respondents began farming organically**
  - 51% of respondents transitioned from conventional
  - 49% began farming as organic farmers.

• Survey published by: *Organic Farming Research*



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Slide 17

### Soil and the Canadian Standard

(Paraphrased from: National Standard of Canada - ICS 67.040)

- The main objective of the soil fertility and crop nutrient management program shall be to
- Maintain fertility and biological activity by
  - a. crop rotations, plough-down, legumes, catch crops or deep-rooting plants;
  - b. incorporating plant and animal matter
- Maintain or improve soil organic matter content, crop nutrients, and soil fertility without contamination of crops, soil or water...
- Tillage and cultivation practices that:
  - maintain or improve soil physical, chemical & biological condition
  - minimize damage to the structure and tilth of soil,
  - that minimize soil erosion.



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### Soil and the Standard cont.

(Paraphrased from: National Standard of Canada - ICS 67.040)

- Minimize risks from neighbouring areas
  - E.g. spray drift
- Soil erosion shall be controlled by good management practices ....
- The use of posts or wood treated with materials is prohibited unless indicated as permitted



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Slide 19

### Factors affecting yield & quality of potatoes

(Kunkel et al. 1972 (from Tisdale et al. 1985))

**Can't be 'controlled'**

- Day length
- Frost-free period
- Air temp., wind, humidity
- Light intensity
- Soil temperature



**Grower -- 'controlled'**

- Moisture
- Insects
- Diseases
- Days grown
- Fertilizers
- Seed quality
- Seed piece size
- Number of plants
- Timely operations
- Variety
- Compaction

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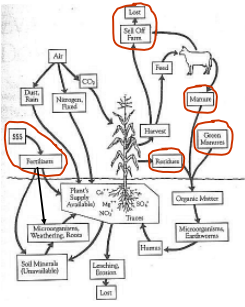
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Slide 20

### Nutrients in the Agroecosystem

Figure from: Zimmer, G.F. 2000. The biological farmer. Acres U.S.A



**Cultivation speeds up decomposition rates and increases nutrient losses. Fertilizers reduce dependence on soil nutrients and alter the soil microbiology.**

**Balancing the loss of nutrients is the key to managing fertility. Tools include: good residue management, cover cropping, forages, and green manures**

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Slide 21

### Importance of Adequate Nutrition

- Crop yield
- Crop quality
- Storage properties
- Time to maturity
- Plant structure
- Disease and insect resistance
- Competitiveness
- Rooting


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1x fertilized    2x not fertilized

Note: 1x is conventional seeding rate of wheat

**Results to date (Plot scale):**

- Highest seed rate (2x) has higher wheat yield, lower weed biomass
- Fertilized plots had higher weed biomass, lighter kernel weight, lower wheat biomass and yield

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Slide 23


### Soil Organic Matter

- Key indicator of soil quality (ability of soil to produce crops)
- Source of nutrients via decomposition



- **Forms of OM**
  1. Living biomass
  2. Recognizable dead plant tissues – readily decomposed
  3. Nonhumic material – low resistance (0-10 yrs to degrade)
  4. Humic material
    - Fulvic acid – least stable (10 – 50 yrs to degrade)
    - Humic acid – relatively stable (centuries to degrade)
    - Humin - (complexed with clays) very stable

Humus



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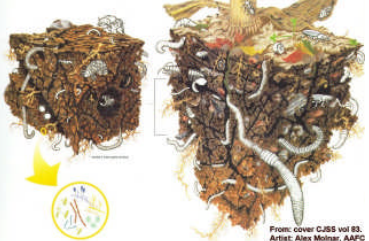
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Slide 24



From: cover C.J.S.S. vol 83. Artist: Alex Molnar, AAFC

The soil biological community can weigh from **1100 to 14000 kg/ha**; a similar weight as 2 to 28 yearling steers!

Over 1 billion microbes in 1 tsp of a fertile soil

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Slide 25

**Soil Ecology cont.**

- **The kinds of soil organisms and their population depends on:**
  - organic matter (kinds, quality, quantity, location)
  - environment (temperature, moisture)
  - soil characteristics (texture, bulk density, porosity, pH, chemical properties)
  - frequency and intensity of disturbance



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Slide 26

**Soil Ecology cont.**

- **Microorganisms:**
  - Decompose organic matter → nutrients available to plants
  - Contribute to good soil structure
  - Release plant growth promoting substances
  - Attack plant pathogens
- **Organic transition – microbial community needs time to recover and adjust to new management**



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Slide 27

**Perennial forages:**



- feed livestock
- build soil OM, fertility, biology
- compete with weeds
- break disease & insect cycles



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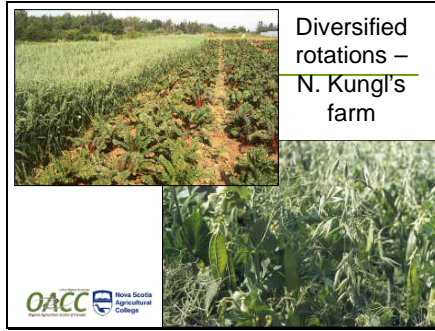
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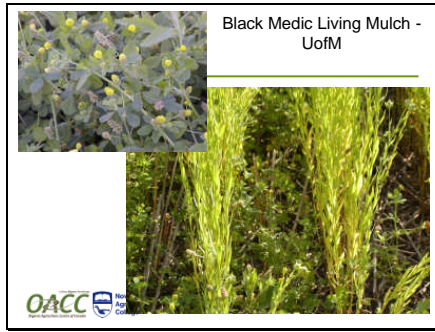
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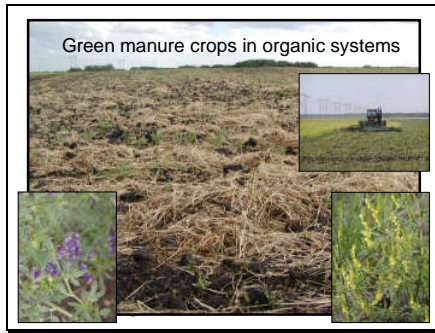
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Slide 30



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Slide 31

### Soil Fertility Challenges in Organic

- Sustainable nitrogen (N) and phosphorus (P)
- Value of forage legumes and livestock
- Variability of organic amendments
- Soil ecology & inoculants
- Soil fertility in transition
- Composts and manures
- Micronutrients
- Soil testing
- Others?



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Slide 32

### Green manure crops in organic systems



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Slide 33

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