No-till organic

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What we do to the soil, we do to ourselves – Wendell Berry

Soil in river flowing to the ocean

Problems associated with tillage in dryland farming

Soil erosion

Soil salinity

Organic agriculture produces healthy soils

Long-term DOK study at FIBL, Switzerland
Year 23.

CO2/(mg Soil C)

1.66a

1.16 bc

Conventional

Organic

Organic Conventional

Year 23.

Welsh et al. (2008)

Mycorrhiza spores – the "seeds"

Glenlea annual rotation

(ground manure-wheat-flax-oat)
Soil carbon sequestration in organic farming systems

Comparable to no-tillage!

Comparing organic with no-till in Montana
Perry Miller et al. 2008 (Agronomy Journal)

<table>
<thead>
<tr>
<th>Crop rotation</th>
<th>Nitrates (top 2')</th>
<th>N (min)</th>
<th>Net return ($/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No-till Pea-wheat-canola-wheat</td>
<td>140</td>
<td>79</td>
<td>125</td>
</tr>
<tr>
<td>Organic Pea (gm)-wheat-lentil-barley</td>
<td>82</td>
<td>97</td>
<td>101</td>
</tr>
</tbody>
</table>

Nitrate (top 2')
N (min)
Net return ($/ha)

Crop rotation

No-till farming in Honduras, October, 2008

No-till farming without a technical use agreement is possible!

Organic farming blamed for soil erosion

Must be an organic farmer

Soil erosion from conventionally managed land

– Red River Valley, Manitoba
Survey shows that organic farmers use less tillage than many conventional farms (Clancy et al. 1992 – North Dakota)

No-Till Organic
• Early technologies
• New technology
  • Rollers
  • Air-seeders
• New plant species
• Livestock integration

Early scientists recognized the value of not tilling prairie soil

Effect of tillage regime on wheat yields (bu/acre) in 1892-1896

Soil conserving technologies of the 1930's

Crop residue management

Paul Unger (1994)
Crisp residue management
Water conservation and management

- Trapping (capturing) water
- Keeping it in soil
- Using it efficiently

25-30% of precipitation as snow

Effect of wheat stubble height on snow and water capture
Black and Siddoway (1977) North Dakota

- Alternating strips of 5 m tall and short stubble increased water storage by 30%
- Maintain tall strips of stubble

Snow-trapping in SW Siberia - 2000

Surface residue increases crop WUE by reducing soil evaporation
Year to year variation much greater than tillage system
In dry years, reduced tillage really pays off

So, how do we replace this?

Mowers part of plan

Carman, MB

Blade rollers

Direct-seeding with discers
2006 – First year

Oat/pea mixture
Rolled with tractor tires

2007 – Bigger field experiment

Compared rolling with standard green manure tillage

Green manure erosion risk high

N uptake into wheat following pea/oat green manure

Blade roller in Manitoba - 2007

Roller kills plants once flowering occurs
1100 lb/acre of small grain residues are needed to protect soils during critical wind erosion periods. The residue must be anchored to avoid being blown away.

― From Crop residue management (1994)
Rolling different legume species
- Fababean
- Chickling vetch
- Lentil
- Hairy vetch

N losses from no-till?
Iris Vaisman, MSc project
Let's talk about hairy vetch

Wagger et al. (1989)
Hairy vetch/cereal intercrops for green manure or forage/green manure combinations

Spring wheat seeded into hairy vetch/oat intercrop, 2008

Hairy vetch/barley intercrop – rolled several times (Aug to Oct.)

Indeterminate growth habit
Hairy vetch/barley intercrop – Barley silage, regrowth green manure

Drought year

Hairy vetch
-Seeded in May
-Rolled 3X

Photo: October 2008
Oxbow, Saskatchewan

Hairy vetch for organic vegetable production
(Onions)

In tomato, hairy vetch green manure increased expression of genes for:
-Delayed leaf loss
-Disease resistance
USDA, Beltsville

Evaluation of novel legumes continues...

How much mulch required to suppress weeds?
1 to 3”
About 1” mulch present

Lack of disturbance reduces small-seeded annual weeds

Direct-seeding Preseeding spring tillage

Shrliffe, Schoofs and Entz (2000)

Lack of disturbance reduces small-seeded annual weeds

Direct-seeding Preseeding spring tillage

Ominski and Entz (1999)

Can tillage be completely eliminated?
or
When do I till again?

Lower available P levels reduces competitiveness of weeds like Redroot pigweed
Steps to reduce weed pressure

Allelopathic crops like fall rye will suppress weeds

Seed crop
Cover crop
http://www.newfarm.org/features/0903/inst_rye.shtml

But, perennial weeds may require special attention, including tillage

Fall rye mulch systems in organic production

Perennial legume

Two year alfalfa hay stand reduced Canada thistle root biomass by 70%

Ominsiki 1999
Control quackgrass with 7 pigs/ha for 30 days

Biological tillage

Well folks, time to wrap up for now...

No-till organic

- machines
- plants
- animals
- flexibility

Canadian Wheat Board
Manitoba Government (ARDI)
Agriculture and AgriFood Canada
Organic Agriculture Centre of Canada
Farmer co-operators
Organic Connections
Include an understory crop in the rotation

Benefits of Medic systems

Metabolic quotient ($q_{\text{CO}_2}$)
Amount of energy required to maintain microbial biomass

<table>
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<th>Treatment</th>
<th>$q_{\text{CO}_2}$ (mg CO$<em>2$ C g$^{-1}$ C$</em>{mic}$.h$^{-1}$)</th>
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<tbody>
<tr>
<td>Conventional Mineral fert.</td>
<td>0.00a</td>
</tr>
<tr>
<td>Conventional FYM</td>
<td>1.40 b</td>
</tr>
<tr>
<td>Bio-organic</td>
<td>1.40 bc</td>
</tr>
<tr>
<td>Biodynamic</td>
<td>1.40 c</td>
</tr>
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</table>

Flessbach et al. (2007) Ag Ecosys Environ. 118:273-284

30 lb/acre N after 5 years