Crop-livestock integration in conservation agriculture systems
Martin Entz, colleagues and students
Resilience of grain-based CA systems challenged…
How are CA farmers coping with weather?

No-till in Manitoba’s wet Interlake region
Alfalfa (lucerne) mimics native prairie plants

Weaver, 1919

Perennial phases cure many problems of grain-based crop production

Weaver, 1919
Agronomic benefits of perennial hay phases in grain-based cropping systems
Figure 3. Multiple indicators of cropping system performance.

http://www.plosone.org/article/info:doi/10.1371/journal.pone.0047149
<table>
<thead>
<tr>
<th>Feeding regime</th>
<th>Omega 6:3 ratio</th>
<th>β-carotene μg/g</th>
<th>Vitamin E μg/g</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grass-fed</td>
<td>1.53</td>
<td>0.45</td>
<td>2.1 to 7.7</td>
</tr>
<tr>
<td>Grain-fed</td>
<td>7.65</td>
<td>0.06</td>
<td>0.7 to 2.9</td>
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</tbody>
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Shift from grains to forage for ruminant production - human and environmental health benefits profound
Animals in confinement or pasture?
Rothamsted Broadbalk plots: Since 1843

No nutrients added

Farmyard manure
Rotation: Maize-spring oat-red clover-autumn oat

Adapted from Norton et al. 1995 Australian J. Exp. Agric 35:893-902. Glen Innes, NSW, Australia
Impact of manure management on total millet yield (Mg/ha) over 3 years (Powell et al.)

- 7.1 Mg cattle manure DM/ha (2 nights)
- 3.2 Mg sheep manure DM/ha (2 nights)

Bar charts showing the yield difference between barn manure and corral manure over 3 years.
Soil C sequestration (Mg ha\(^{-1}\) yr\(^{-1}\)) (0-5 yr):

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate (Mg ha(^{-1}) yr(^{-1}))</th>
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<tbody>
<tr>
<td>Hayed</td>
<td>0.30</td>
</tr>
<tr>
<td>Unharvested</td>
<td>0.65</td>
</tr>
<tr>
<td>Grazed</td>
<td>1.40</td>
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</tbody>
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Summary and future opportunities

What we know…
- Grain forage systems superior
  - Yield
  - Weeds
  - Energy
- Resilient to climate variation
- Grazing vs confinement improves
  - Nutrient cycling
  - Soil C accumulation
  - Human health benefits from animal products

Future systems…
- Winter grazing
  - The rumen as portable soil
- Perennial grains dual purpose crop
- Novel perennial systems with trees
- Role of livestock in small holder CA
Processing C rich food when soil biology stopped
Can we grow perennial plants for grain?
Dr. Doug Cattani

University of Manitoba selected “Kernza”

- Grain production (July)
- Grazing (Sept)
- Undersown to legumes for N supply
New crop-livestock integration approaches

Animals must work!
C fertilization
Small-holder CA maize monoculture
Add legume to CA maize
RICE-FISH-HORT-LIVESTOCK BASED INTEGRATED FARMING SYSTEM MODEL FOR RAINFOED LOW LAND

Provide sustainability in production & economic employment & nutritional security to the farmers

COMPONENTS
- Rice, Fish
- Ornamental Fish
- Prawn
- Hort. Crops
- Vegetables
- Pulses & Oil seeds
- Agro forestry
- Poultry
- Duckery
- Goatry
- Rabbitry

RESOURCES FLOW MODEL IN INTEGRATED FARMING SYSTEM
Example 4. Integrated Farming System - India
Adaptive cycle (Holling)
Thank you

Google: *Natural Systems Agriculture*
C fertilization 二氧化碳施肥
Organic no-till wheat
“Crop – livestock specialization is an ecologically disfunctional design for food production. Ann Clark
Organic, no forages

Organic with 50% forages

www.umanitoba.ca/afs/plant_science/glenlea/glenlea.html
Perennial forages offer ...

1. Permanent soil cover
2. Crop rotation diversity
   1. Subsoil