Holistic management and systems thinking in organic agriculture

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Becky Weed 13 Mile Farm
Holistic management

• Made famous by Alan Savory
• Holistic management describes a **systems thinking** approach to managing resources
• Focuses grazing management on
  • Water cycle
  • Carbon cycle
  • Energy flow
  • Community dynamics (ecosystems)
Systems thinking (theory)

- System is interrelated and interdependent parts
- Complex arrangement of elements
- Changes can affect parts or whole system
- Systems ecology focuses on interactions and transactions within and between biological and ecological systems.
Systems thinking

• Complex interactions
• Complex decision making
• Dynamic
• No prescriptive cure
Agricultural systems are complex systems
Internal regulation (Preemptive)

- N and C cycling
- Water conservation and storage
- Soil conservation
- Weed and seed bank suppression
- Insect pest and disease cycle disruption
- Habitat provision for beneficial insects

Agroecosystem 1: High reliance on internal regulation

Disturbance

Agroecosystem 2: High reliance on external regulation

External regulation (Reactive)

- Fertilizers
- Irrigation water
- Imported pollinators
- Herbicides
- Insecticides

Ecological, agricultural, and social outcomes

Peterson et al 2017, Agricultural systems
Understand the ecology of the system

• An example of cropping systems from Havre (Northern Ag Research Center)
Cover crop trade-offs: evaluating soil moisture, weed suppression, and soil microbial communities

Montana Ag Experiment Stations
Virtual field day 2020

Tim Seipel, Maryse Bourgault, Darrin Boss, Mary Ellyn DuPre, Tindall Overson, David Weaver, and Fabian Menalled
Project Design

• Began in 2012

• Wheat – cover crop rotation
  • With different mixtures of cover crops
  • Different phenologies and diversity of mixtures
• We also compared the outcomes under warmer and drier conditions
Cover crop mixtures

- We assessed a 5-species (early phenology) and 7 species mixture (mid season phenology)

<table>
<thead>
<tr>
<th>Cover crop species</th>
<th>2018</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>early</td>
<td>mid</td>
</tr>
<tr>
<td>Otana Oat (Avena sativa)</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Purple Top Turnip (Brassica rapa)</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Frontier Chickpea (Cicer arietinum)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Sheyenne Soybean (Glycine max)</td>
<td>-</td>
<td>X</td>
</tr>
<tr>
<td>Indian Head Lentil (Lens culinaris)</td>
<td>-</td>
<td>X</td>
</tr>
<tr>
<td>Arvika Pea (Pisum sativum)</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Ground Hog Radish (Raphanus raphanistrum)</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Golden German Millet (Setaria italica)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Grazex III Sorghum x sudan grass (Sorghum x drummondii)</td>
<td>-</td>
<td>X</td>
</tr>
<tr>
<td>Hairy Vetch (Vicia villosa)</td>
<td>X</td>
<td>-</td>
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</tbody>
</table>
Biomass and relative abundance of cover crops

All crop species

Mean cover crop biomass (lb/acre)

<table>
<thead>
<tr>
<th></th>
<th>Ambient</th>
<th>Warmer/drier</th>
</tr>
</thead>
<tbody>
<tr>
<td>E</td>
<td>450</td>
<td>350</td>
</tr>
<tr>
<td>M</td>
<td>350</td>
<td>250</td>
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</table>

Radish

Mean radish biomass (lb/acre)

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>Warmer/drier</th>
</tr>
</thead>
<tbody>
<tr>
<td>E</td>
<td>350</td>
<td>250</td>
</tr>
<tr>
<td>M</td>
<td>90</td>
<td>100</td>
</tr>
</tbody>
</table>
Shift to more mustard biomass in warmer and drier conditions
Soil moisture

Charts show the soil moisture levels over time for different groups and mixes, indicating variations in moisture content through the months.
Wheat yield

Mean wheat grain yield (bsh/ha)

- F
- E
- M

- A
- Warmer/drier
Weed biomass best suppressed in early season cover crop

- Cover crops
- Winter wheat
In early season cover crop more beneficial fungi species and more pathogens in fallow.
In summary

• There are trade-offs when using cover crops
  • More soil moisture usage and lower wheat yields
  • But better weed suppression
  • More beneficial fungi and fewer fungal pathogens

Requires complex systems thinking
Becky’s thoughts
Acknowledgements

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