Farm Systems, Farm Practices and Resilience:

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Why do Beneficial Practices Not Get Adopted?
Why do Beneficial Practices Not Get Adopted?

- We know a lot of recommended practices enhance resilience.
- Diversity -- Conservation Tillage--Incorporation of Perennials--Use of Cover Crops.
- These practices all improve resilience and adaptability.
- Adoption by producers is more limited.

<table>
<thead>
<tr>
<th>State</th>
<th>Grassland to Corn/Soy</th>
<th>Corn/Soy to Grassland</th>
<th>Grassland Net Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>North Dakota</td>
<td>129 (320)</td>
<td>40 (100)</td>
<td>89 (220)</td>
</tr>
<tr>
<td>South Dakota</td>
<td>256 (632)</td>
<td>73 (181)</td>
<td>182 (451)</td>
</tr>
<tr>
<td>Minnesota</td>
<td>92 (228)</td>
<td>13 (31)</td>
<td>80 (196)</td>
</tr>
<tr>
<td>Iowa</td>
<td>195 (481)</td>
<td>42 (104)</td>
<td>152 (376)</td>
</tr>
<tr>
<td>Nebraska</td>
<td>125 (309)</td>
<td>100 (247)</td>
<td>25 (62)</td>
</tr>
<tr>
<td>Sum</td>
<td>797 (1969)</td>
<td>268 (663)</td>
<td>528 (1306)</td>
</tr>
</tbody>
</table>

Adapted from Wright and Wimberly 2013 PLOS 110:4134-4141.
Integrating Crops and Livestock

• Strong potential to add resiliency to farms
• Incorporation of livestock can enhance other attributes for adaptation.
• Can occur at different scales
  • Farm
  • Regional
  • Between regions

• Review current state of agriculture.
• Focus on advantages of integrated systems
• Discuss some reasons why ICL may not be adopted.
• Suggest some remedies to help with adoption
Technology Innovations

• Machinery size - Precision ag - GMO
• Similar trends in the livestock sector especially pork and dairy.
  • CAFOs
Today’s agriculture

O’Donoghue et al 2011
Today’s Agriculture

- Current estimates have the farm numbers at roughly 2.05 million (ERS, 2019)
Today’s Agriculture

- About 120,000 farms in the US produce 75% of US farm output (Sumner 2014)
Implications of Structural Change in US Agriculture

- Diversity
- Decoupling

Figure 4
As farms have become more specialized, the number of commodities produced per farm has decreased

Commodities per farm

<table>
<thead>
<tr>
<th>Year</th>
<th>1900</th>
<th>1930</th>
<th>1945</th>
<th>1970</th>
<th>2002</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

Note: The average number of commodities per farm is a simple average of the number of farms producing different commodities (corn, sorghum, wheat, oats, barley, rice, soybeans, peanuts, alfalfa, cotton, tobacco, sugar beets, potatoes, cattle, pigs, sheep, and chickens) divided by the total number of farms.

Diversity
Diversity

Crop Species Diversity and Dominant Crops in North Dakota

Effective No. of Crop Species
- 1: 2 (low diversity)
- 2: 3
- 3: 5
- 4: 8
- 5: 10
- 6: 12
- >12 (high diversity)

Data Source: USDA Census of Agriculture National Atlas of USA
Livestock Concentration
Today’s Agriculture
Integrating Livestock into farming systems

• Alternatives to the current system have to address many concerns and issues relevant to producers and society.

• Integrated Crop-Livestock Farms
  • Can address the three legs of sustainability.
  • But there are trade-offs.

Hendrickson et al. 2008
Soil Physical Properties

• Northern Great Plains—Near surface soil properties were not adversely impacted by the inclusion of livestock (Liebig et al. 2011).

• Australia—concerns with compaction in upper 10 cm of soil. Little economic impact to farmer (Bell et al. 2011)
There are trade-offs with livestock production and greenhouse gas emissions.

Integrated systems may provide an opportunity to recouple C-N cycles.
  - Straw and manure
  - Reduce excess N

Data from Brazil suggested that N$_2$O emissions from Integrated crop-livestock systems that used no-till were closer to native savannah than other agricultural systems (Sato et al. 2017).

Adding trees or shrubs into these systems may reduce greenhouse gas emissions (de Carvalho et al. 2017, Monjardino et al. 2011, da Pontes et al. 2013).
Production Concerns

• Generally incorporating livestock into cropping systems has little impact on subsequent crop yield.

• Tracy and Zhang (2008) found an increase in corn yields under an integrated crop-livestock system.

Figure 7: Soybean yield after grazed (light gray bars) or ungrazed (white bars) cover crops. Dark gray bars are steer liveweight gain per area (kg ha\(^{-1}\)) on mixed black oat (Avena strigosum Schreb) and Italian ryegrass (Lolium multiflorum L.) grazed cover crops managed with moderate-grazing intensity (20 cm sward height). Liveweight gains were transformed into equivalent soybean productivity (Mg ha\(^{-1}\)) by relative soybean and beef cattle market prices from each year (Martins et al., 2015).
Economics

- Diversification should lead to greater resiliency in our systems but is there and economic cost?
- Northern Great Plains case study suggests that more diverse can be more profitable (Archer et al. 2018).
- In Iowa, Poffenbarger et al (2017) found returns to be similar among 4 different farming systems including those with and without livestock BUT labor increased with diversity and livestock integration.

<table>
<thead>
<tr>
<th></th>
<th>SG-FALL</th>
<th>Cont SW</th>
<th>SG-WW-Sun</th>
<th>5 –year Rotation</th>
<th>Dynamic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross Returns</td>
<td>369</td>
<td>627</td>
<td>696</td>
<td>723</td>
<td>723</td>
</tr>
<tr>
<td>Costs</td>
<td>264</td>
<td>429</td>
<td>451</td>
<td>412</td>
<td>418</td>
</tr>
<tr>
<td>Net returns</td>
<td>106</td>
<td>198</td>
<td>245</td>
<td><strong>310</strong></td>
<td><strong>304</strong></td>
</tr>
</tbody>
</table>

Archer et al 2018
Analyzing trade-offs using the BARN

Inside the livestock region
- Grass-fed animals (green) or concentrate-fed (orange)
- Hedges, bocage
- Partnership between local actors
- Agro-food industries
- Local recycling of nutrients (manure, …)
- Nutrient flows (manure, …)

Environment and climate
- Water quality
- C sequestration
- GHG emissions
- Biodiversity

Markets
- Food products
- Monetary added-value
- Quality labels for animal products
- Crops

Inputs
- Concentrate-feed
- Nitrogen, pesticides, energy

Social and cultural features
- Landscape aesthetic
- Reglementary rules and law
- Gastonomic heritage

Labour and employment
- Livestock keepers, farm employees
- Indirect employees (tourism, agri-food chains, …)
Comparison of 2 regions in France

• Top figure is Brittany—a French region with high livestock density and the bottom figure is the Massif central that has more grassland based beef production (Ryschawy et al. 2018).

• Inclusion of livestock can, if targeted correctly, enhance aspects of resiliency. However, no system is perfect as illustrated by comparing both regions.
Quick summary

1. The structure of agriculture has changed.
   a) Especially in the center of the USA, farms are larger and less diverse.
   b) This change in structure MAY impact resilience and the ability of the system to adapt to change.

2. Integrating crops and livestock is a potential avenue for enhancing resilience and adaptability.
   a) While there are potential issues with greenhouse gas production, research from Brazil and the US suggests, from the soil standpoint, integrated systems may reduce greenhouse gas emissions compared to conventional agricultural systems.
   b) Including livestock into cropping systems does not reduce crop yields substantially.
   c) Profitability from integrated systems is similar to cash cropping systems.
SO why don’t we see more integrated systems?

- There is not any easily accessible data on number or percent of farms with both crop and livestock operations.
- Anecdotally, it appears more and more farms are decoupled.
- How do we address this issue?
As farmers age, there is less interest in working with livestock.

91% of Iowa farmers surveyed identified the greater labor requirement as an impediment to including livestock (Arbuckle et al. 2009).
How to switch the Narrative

Focus on younger producers
More production
Less Capital
Cropland prices

Hard to have the capital to expand when younger
Cropland Prices

- Increased cropland prices will require more productivity per unit area.
- Integrating crops and livestock may provide this productivity.
Focus on Multi-Generational Farms

- Multi-generational farms with kids under 18 may be more diverse (Valliant et al. 2017).
  - Sometimes the diversity is just to get kids through college.
  - Sometimes, it’s to bring a child back to the farm.
Summary

- Current farming practices have resulted in farms becoming larger and more specialized
  - This structure may result in less resilient and adaptable systems.

- Increasing diversity may enhance resiliency.

- Including livestock in operations can provide economic and biological resiliency in farming systems.

- Integrated systems are:
  - More productive
  - Enhanced soil quality
  - Economically similar to cash grain farms.

- Why NOT more?
  - Older Farmers—Less Labor

- Focus on Millennials
  - Younger farmers more amenable to increased labor demands
  - Potentially capital poor
  - Ways to be incorporated back into the farming operation.
Thank You for Listening
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