Grazing Cropland and Grassland

Justin Morris and Dean Thomas
June 24th and 27th, 2019
Detroit Lakes and Marshall, MN
Advantages Grazing Cropland

• Livestock manure as primary source of nutrients for crop production cycling nutrients from crops through animals and back to land*

• Biological acceleration, improving soil health at faster rate
  ▪ Add biology
  ▪ Incorporation of organic matter

• Additional source of income

• Increased nutrient cycling (C/N ratio impacts)
Advantages Grazing Cropland

• Increase mycorrhizal fungi abundance
• More rapid building of soil aggregates
• Improved infiltration
• Minimize import of feedstuffs to farm*
Advantages Grazing Cropland

• Potential increase in diversity of insects to help reduce pest species

• Livestock serve as a sink for agricultural byproducts*

King’s Agriseeds
Disadvantages Grazing Cropland

- Lack of knowledge/familiarity about:
  - Livestock management/herd health
  - Equipment/infrastructure needed; how to use
- Increased time/level of management to prepare operation, move fence, livestock, water, etc.
- Lack of grazing infrastructure: no fences, fences in poor condition, no water nearby
Disadvantages Grazing Cropland

- Potential hassle working out lease agreement with livestock owner
- Potential risk of livestock not being moved frequently enough causing compaction
- Liability if livestock cause accident on public roads
Impacts of Grazing Cover Crops on Soil Health

• Pasture Project studied 3 years of cover crop and livestock integration on 8 farms in MN and IA

• Livestock grazed diverse, cover crop mixes (at least two brassicas, two legumes, two grasses)
Impacts of Grazing Cover Crops on Soil Health

Compared to control (no covers/no grazing):

- **Fertility** → slight increases for P, K, Ca, Mg, S, B, Cu, Mn
- **Chemistry** → no change for pH, OM, CEC
- **Carbon** → increases for Total Organic Carbon, Inorganic C, Total C
- **Biology** → increases for TLMB (Total Living Microbial Biomass), TBB (Total Bacteria), G+ bacteria, Actinobacteria, Rhizobial bacteria, G- bacteria, total fungi, AMF, Saprophytic fungi, Protozoa
Impacts of Grazing Cover Crops on Soil Health

No Winter Cover Crop

- Plant diversity
- Pre-harvest: cash crop
- Post-harvest: cover crop
- Soil retention
- Soil microbial activity
- No cover crop costs
- Reduced soil health
- No forage revenue

Ungrazed Winter Cover Crop

- Pre-harvest: cash crop
- Post-harvest: cover crop
- Soil retention
- Soil microbial activity
- Cover crop costs
- Improved soil health
- No forage revenue

Grazed Winter Cover Crop Using Adaptive Management

- Pre-harvest: cash crop
- Post-harvest: cover crop
- Soil retention
- Soil microbial activity
- Cover crop costs
- Improved soil health
- Forage revenue
Impacts of Grazing Cover Crops on Soil Health

- Research in Georgia grazing cereal rye, pearl millet cover crops under conventional tillage and no-till
- Compared to ungrazed control:
  - Bulk density $\rightarrow$ slight negative effect
  - Aggregate stability $\rightarrow$ no effect
  - Water infiltration $\rightarrow$ reduced when soil water content was high
  - Soil penetration resistance $\rightarrow$ greater in conventional tillage; no effect in no-till
- Conclusion: grazing cover crops did not cause substantial physical damage to soil
Impacts of Grazing Cropland on Soil Health

- Research in Iowa grazing corn stalks in winter in a corn-soybean rotation
- Compared to ungrazed control:
  - Bulk density → no effect
  - Penetration resistance → greater in top 4 inches for areas grazed when temperatures were above 32 deg.
  - Soybean establishment → no effect
  - Soybean yield → minimal reduction
- Conclusion: utilizing corn stover as an inexpensive feed source is a viable option; posing minimal reductions to soybean yield
Impacts of Grazing Cropland on Soil Health

- 16-year study in Nebraska grazing corn residue in fall or spring
- Compared to ungrazed control:
  - Bulk density → no effect
  - Aggregate stability → no effect
  - Particulate organic matter → no effect
  - Soil organic C → no effect
  - Penetration resistance → negative effect
  - Yield response → no effect on corn or soybean yield
- Conclusion: long-term corn residue grazing had little to no effect on soil properties and did not affect crop yields
### Impacts of Grazing Cover Crops on Soil Health

<table>
<thead>
<tr>
<th>Farm</th>
<th>N (lbs/ac)</th>
<th>P (lbs/ac)</th>
<th>K (lbs/ac)</th>
<th>WEOC* (ppm)</th>
<th>OM (%)</th>
<th>INFL (in/hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>156</td>
<td>95</td>
<td>233</td>
<td>1.7</td>
<td>0.5</td>
</tr>
<tr>
<td>2</td>
<td>27</td>
<td>244</td>
<td>136</td>
<td>239</td>
<td>1.7</td>
<td>0.7</td>
</tr>
<tr>
<td>3</td>
<td>37</td>
<td>217</td>
<td>199</td>
<td>262</td>
<td>1.5</td>
<td>0.45</td>
</tr>
<tr>
<td>4</td>
<td>281</td>
<td>1006</td>
<td>1749</td>
<td>1095</td>
<td>6.9</td>
<td>30.0+</td>
</tr>
</tbody>
</table>

Farm 1: Diverse cash grain, tillage, cover crops, no synthetics, no livestock  
Farm 2: Minimum tillage, two crops, mod. synthetics, no livestock  
Farm 3: Med. diversity, no-till, high synthetics, no livestock  
Farm 4: High diversity, no-till, cover crops, 1 herbicide, livestock

*Water Extractable Organic Carbon*
Impacts of Grazing Cover Crops on Permanent Grassland in Rotation

- Greater plant recovery
- Greater forage production
- Maintains and/or improves plant diversity → sufficient time that plants can reseed themselves
- Greater root biomass
- Greater drought tolerance
- Improved plant nutrient density from roots accessing previously unexplored depths of soil profile
Something to Ruminate About

• What are some advantages for grazing cover crops?
• What are some disadvantages for grazing cover crops? How can they be overcome?
What are Some Advantages from Grazing Grasslands for Soil Health?

• High quantity & quality forage for livestock from perennials

• Allows enough leaf area to:
  ▪ Protect soil from raindrop impact
  ▪ ↓ Evaporation
  ▪ ↑ Infiltration
  ▪ Hasten plant recovery

• Post-grazing recovery to maintain plant vigor, desired plant composition

• Controls grazing pressure in time, space
What are Some Advantages from Grazing Grasslands for Soil Health?

- ↓ Need for mechanical harvest
- Greater gain per acre
- Biological acceleration, improving soil health at faster rate
  - Add biology
  - Incorporation of organic matter
- ↑ Nutrient cycling (C:N ratio)
- Ensures livestock eat variety of plants for improved animal health
Impacts of Grazing Grasslands for Soil Health

- 9-year ranch-scale study compared heavy continuous, light continuous, multi-paddock, and no grazing on vegetation and soil properties
- Bare ground highest under heavy continuous grazing
- Aggregate stability lowest under heavy continuous grazing
- Dominant grasses
  - Multi-paddock/No grazing: tall grasses
  - Light/Heavy continuous: short grasses
Impacts of Grazing Grasslands for Soil Health

- Soil penetration resistance lowest under multi-paddock grazing, no grazing
- No difference in bulk density, infiltration rate
- Sediment loss highest with heavy continuous grazing
- OM and CEC highest with multi-paddock grazing, no grazing
- Fungal/bacteria ratio highest with multi-paddock grazing indicating higher:
  - Water-holding capacity
  - Nutrient availability/retention
Impacts of Grazing Grasslands for Soil Health

• 3 Mississippi farms
  ▪ All same soil types

• Farm 1: Adaptive High Stock Density grazing management for 5 years

• Farm 2: Continuous grazing; slow rotation for 50+ years

• Farm 3: Continuous grazing; 30+ years; no rotation
Impacts of Grazing Grasslands for Soil Health

• Three Mississippi farms
• Farm 1: Adaptive High Stock Density grazing management for 5 years
• Farm 2: Continuous grazing; slow rotation for 50+ years
• Farm 3: Continuous grazing; 30+ years; no rotation
• All same soil types
<table>
<thead>
<tr>
<th>Soil Depth</th>
<th>AHSD Grazing</th>
<th>Continuous Grazing Slow Rotation</th>
<th>Continuous Grazing No Rotation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 6”</td>
<td>4.67</td>
<td>1.64</td>
<td>1.36</td>
</tr>
<tr>
<td>6 – 12”</td>
<td>4.00</td>
<td>1.88</td>
<td>1.37</td>
</tr>
<tr>
<td>12 – 18”</td>
<td>2.95</td>
<td>1.03</td>
<td>0.40</td>
</tr>
<tr>
<td>18 – 24”</td>
<td>2.04</td>
<td>1.02</td>
<td>0.54</td>
</tr>
<tr>
<td>24 – 30”</td>
<td>1.71</td>
<td>0.38</td>
<td>0.40</td>
</tr>
<tr>
<td>30 – 36”</td>
<td>1.42</td>
<td>0.41</td>
<td>0.34</td>
</tr>
</tbody>
</table>

AHSD: Adaptive High Stock Density
Source: Allen Williams, 2016
Impacts of Grazing Grasslands for Soil Health – Soil Organic Matter (kg/m²)

<table>
<thead>
<tr>
<th>Soil Depth</th>
<th>AHSD Grazing</th>
<th>Continuous Grazing Slow Rotation</th>
<th>Continuous Grazing No Rotation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 6”</td>
<td>4.26</td>
<td>3.28</td>
<td>2.72</td>
</tr>
<tr>
<td>6 – 12”</td>
<td>3.22</td>
<td>3.76</td>
<td>2.74</td>
</tr>
<tr>
<td>12 – 18”</td>
<td>3.10</td>
<td>2.06</td>
<td>0.80</td>
</tr>
<tr>
<td>18 – 24”</td>
<td>2.98</td>
<td>2.04</td>
<td>1.08</td>
</tr>
<tr>
<td>24 – 30”</td>
<td>2.80</td>
<td>0.76</td>
<td>0.80</td>
</tr>
<tr>
<td>30 – 36”</td>
<td>1.98</td>
<td>0.82</td>
<td>0.68</td>
</tr>
</tbody>
</table>
Barnes soil – Eastern South Dakota
Deuel County, SD
Barnes soil

Infiltration Rate

Continuous season-long
Rotational Grazing
Hyde County
Glenham soil

Infiltration Rate

Rotation Continuous Cropland

Elapsed mins

5
29
120

Rotation Continuous Cropland
Impacts of Grazing Grasslands for Soil Health

<table>
<thead>
<tr>
<th>% Leaf Removed</th>
<th>% Root Growth Stopped</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>20</td>
<td>0</td>
</tr>
<tr>
<td>30</td>
<td>0</td>
</tr>
<tr>
<td>40</td>
<td>0</td>
</tr>
<tr>
<td>50</td>
<td>2 to 4</td>
</tr>
<tr>
<td>60</td>
<td>50</td>
</tr>
<tr>
<td>70</td>
<td>78</td>
</tr>
<tr>
<td>80</td>
<td>100</td>
</tr>
<tr>
<td>90</td>
<td>100</td>
</tr>
</tbody>
</table>
When You Overgraze the Shoot
You Overgraze the Root!

Tall Fescue
Rotational

Tall Fescue
Continuous

Tall Fescue
Continuous

Orchardgrass
Rotational

Orchardgrass
Rotational

Fescue/Bluegrass
Rotational
Well-managed Species A
Well-managed Species B
Well-managed Species B
Recently Grazed Species B
Overgrazed Species B
Overgrazed Species A
Effect on Carbon Cycle with Livestock

CO₂

Plants

Respiration

Rumen microorganisms

Livestock

Photochemical oxidation

CH₄

Manure

Soil organic matter

NRCS | SHD | Grazing Cropland and Grassland | v2.1
Effect of Grazing on Nitrogen Cycle

The diagram illustrates the nitrogen cycle, showing the processes of losses and gains. Key processes include:

- **Removal by Crop** (N$_2$)
- **Feeding Farm Animals**
- **Artificial Fixation**
- **Nitrogen Fixation** (Legumes)
- **Fertilizer**
- **Erosion**
- **Denitrification**
- **Ammonification** (NH$_3$)
- **Nitrate** (NO$_3^-$)
- **Ammonium** (NH$_4^+$)

These processes are interconnected, showing the dynamic nature of nitrogen management in grazing systems.
Effect of Graze Period on Animal Performance

Source: University of Missouri Forage Systems Research Center
Forage Quality Declines as Livestock Graze Closer to the Soil

Higher Forage Quality
CP: 14%  
TDN: 63.5%  
RFV: 149.1

50% by Weight

Lower Forage Quality
CP: 7.2%  
TDN: 56.3%  
RFV: 97.9
Knowledge Check

On perennial cool-season grasses, what percentage of leaf area can be removed without significantly affecting root growth?

Answer: 50%
Grazing System Objectives

- Grazing is a tool that can....
  - Improve the resource
  - Degrade the resource

- Grazing System Objective:
  - Provide adequate nutrition
  - Protect and feed soil: feed above/below-ground herd
  - Work within manager’s labor; social constraints

- Fast track to soil health ➔ look to nature for common patterns; mimic them as closely as possible
Natural Disturbances Stimulating Major Ecological Change

- Tornados
- Hurricanes
- Earthquakes
- Volcanos
- Lightning strikes
- Wildfires
- Large herd of herbivores on migration
Dimensions of Disturbance

Three dimensions of disturbance:
- Frequency
- Duration
- Intensity

Natural disturbance patterns that stimulate major ecological change are acute, not chronic:
- Low frequency
- Short duration
- High intensity
Grazing Management Controls

- When/how often livestock graze a field/paddock → Frequency
- When livestock leave → Duration
- Amount of forage removed → Intensity
- Weight of herd/flock in field/paddock → Intensity
- Field/paddock size → Intensity

Livestock must be controlled through grazing management to achieve greatest benefits

Stock Density
Grazing Management for Soil Health

- Provide sufficient quantity and quality of forage
- Ensure animals eat a variety of plants and decrease impacts on desirable plants
- Leave enough leaf area to facilitate interception and infiltration of precipitation; maintain sufficient photosynthetic capacity for rapid plant recovery
- Sufficient post-grazing recovery to maintain plant vigor and desired plant composition
- Control grazing pressure in time and space to facilitate previous four principles
Adaptive Grazing Management

Mimics natural, acute disturbance patterns under changing environmental conditions; uses feedback from the system to adapt management to fit ecosystem

- **Frequency**: low $\Rightarrow$ plants grazed few times per year for total plant recovery of desirable plants
- **Duration**: short $\Rightarrow$ few days to daily to few hours* to prevent re-grazing of desirable plants; facilitate higher stock densities
- **Intensity (forage removed)**: low to moderate $\Rightarrow$ for total soil cover and plant regrowth; facilitate higher stock densities
- **Intensity (stock density)**: moderate to high $\Rightarrow$ for best trampling effect, nutrient distribution, plant diversity, forage quality

*Depending on forage growth rate, resource concerns, time constraints, and objectives
Grazing Systems and Stock Density

- **Rotational System:** less than 4,000 lbs/ac
- **Management-intensive Grazing (MiG):** 4,000 – 50,000 lbs/ac
- **High Stock Density (HSD):** 50,000 – 250,000 lbs/ac
- **Ultra-High Stock Density (UHSD):** greater than 250,000 lbs/ac
- **Adaptive Grazing:** 4,000 – 250,000+ lbs/ac
Adaptive Grazing Management

- Low frequency
- Short duration
- Variable intensity

Soil Health Principles

- Minimize (chronic) disturbance
- Maximize soil cover
- Maximize biodiversity
- Maximize living roots
Continuous Grazing

**Chronic disturbance resulting in poor soil health**

- **Frequency**: high → same plants grazed every 7 – 9 days
- **Duration**: long → livestock access plants long enough to severely graze regrowth multiple times
- **Intensity (forage removed)**: moderate to high → all plants grazed down very short or plants grazed very short with ungrazed/unpalatable plants in same field/paddock
- **Intensity (stock density)**: low

Requires little to no management skill
Growth Potential with Sufficient Recovery
Management Strategies

- Proper utilization
- Adequate recovery
- Change season of use from year to year
- Move to year-round grazing as much as feasible
Leaves – The Facts of Growth

- Roots uptake and send water, minerals, and micronutrients to leaves.
- Roots DO NOT transport carbohydrates to the leaves.
- Leaves use carbohydrates to respire.
- 5-10% of new leaf growth is from residual sheath & crown carbohydrate reserves.
- 90-95% of new leaf growth comes from carbohydrates resulting from current photosynthesis.
Bottom Line

It takes leaves to make leaves!
Haying

Another disturbance resulting in poor soil health
Effect of Haying on Aggregate Stability
Mellette County, SD

![Graph showing Aggregate Stability (%) with data points for Hayfield and Native Range.](image)
Effect of Continuous Haying on Water Infiltration Rate
Mellette County, SD

Rotational Grazing

Hayland

Range

Hayland

Inches/hr

27

0.59
Knowledge Check

What are the three major characteristics of Adaptive Grazing?

1) Low frequency
2) Short duration
3) Variable intensity
Benefits of Adaptive Grazing

Continuous Grazing
- resting 0%
- grazing 100%

Typical Rotational Grazing
- resting 75%
- grazing 25%

Adaptive Grazing
- resting 95%
- grazing 5%

Increasing livestock density per acre

Increasing microbial and mycorrhizal activity

Source: Pasture Project
Characteristics of Adaptive Grazing

- **Continuous Grazing**: no moves, no rest
- **Typical Rotational Grazing**: move 1x/week, some rest period for paddocks
- **Adaptive Grazing**: move 1x/day (or more), according to observations, needs, goals, and objectives; very paddock size; long rest period for paddocks

Source: Pasture Project
Management Strategies for Grazing Cover Crops

Continuous Grazing

Chronic Disturbance
- High frequency
- Low intensity
- Long duration
Management Strategies for Grazing Cover Crops and Grasslands

Adaptive Grazing Management

Compared to non-subdivided field:
• More days grazing
• More days for plant recovery
• Greater forage re-growth
• Greater stock density, manure/urine concentration, hoof impact
• Better animal performance
Management Strategies for Grazing Cover Crops and Grasslands

Secondary Containment Fence
Next Paddock Fence

Portable 1-strand Polywire

Above-ground Mobile Pipe
Management Strategies for Grazing Cover Crops and Grasslands

1         2         3
Management Strategies for Grazing Cover Crops and Grasslands
Management Strategies for Grazing Cover Crops and Grasslands

Non-frozen Ground:
- 2x Graze: move back fence; water every 3 days
- 1x Graze: no back fence; move water every 3 – 5 days

Frozen Ground:
- No back fence; no need to move water
Management Strategies for Grazing Cover Crops and Grasslands
Other Soil Health Improvement Strategies

Bale Grazing

Saskatchewan Agriculture

Saskatchewan Agriculture
Portable Fencing Equipment

Powerflex Fence

Gallagher

Novel Ways, Ltd.
More to Rumenate On

How does continuous haying affect soil health?

- Reduction in aggregate stability
- Reduction in soil carbon
Water: Portable Water Troughs

Rubbermaid

K-Line North America

Judge Jessop
Cover Crop Selection

• Mixtures typically provide considerably higher production and quality versus single species plantings

• Warm-season mixes: typically somewhat lower in protein, but usually higher in production

• Cool-season mixes: typically higher in protein and usually lower in production
Cover Crop Selection

- Usually limit rape to no more than 20% of mix if grazing will occur, and brassicas overall to no more than 70% (potential toxicity issues)
- Mixes with grasses dominant or co-dominant are typically best for cattle
Herbicide Residual Considerations

• Herbicides used on cash crop may prevent crop residues or cover crops from being used as livestock forage

• Most herbicide labels state which cover crop species can be planted given a specified time period between herbicide application on cash crop and cover crop planting

• Several online sources for comparing planting/grazing restrictions of specific herbicides for specific cash crops

• Follow the label
Methods to Avoid Bloat

- Do not introduce hungry animals into a field
- Introduce animals slowly or restrict access over 7 – 10 day period
- Provide dry matter (hay, millet hulls, dry pasture, or crop stalks) when grazing cover crop
- Cover crop species should be at least 25% grasses; no more than 70 – 80% brassicas
- Strip graze if possible for best utilization of cover crop; causes animal to utilize entire plant instead of leafy portion of brassica plant first and bulb later
- Use bloat blocks wherever practical
Knowledge Check

Where is the highest quality forage on a plant?

a) Lower leaves  
b) Middle leaves  
c) Upper leaves  
d) Forage quality is the same throughout

Answer: (c)
Grazing in the 21st century will require.....

- Minimize (chronic) disturbance
- Maximize soil cover
- Maximize biodiversity
- Maximize living roots
This information is provided as a public service and constitutes no endorsement by the United States Department of Agriculture or the Natural Resources Conservation Service of any service, supply, or equipment listed. While an effort has been made to provide a complete and accurate listing of services, supplies, and equipment, omissions or other errors may occur and, therefore, other available sources of information should be consulted. The USDA is an equal opportunity provider and employer.