GRAZING COVER CROPS TO EXTEND THE GRAZING SEASON
Benefits of Grazing Cover Crops

Cover crop value increases
• Farmer gets immediate economic returns
• Farmer pays more attention cover crops mgmnt
• Cover crops grown bigger

Soil improvement
• Manure and urine feed soil and crops
• Trampling organic matter into soil
• Saliva may have beneficial impact

Reduce costs of livestock feeding
• Cover crops can meet forage needs in critical periods
• Costs of grazing forage < half of fed forage
• You remove

We found that using no-tillage, and Management Intensive Grazing greatly improved ability to graze cover crops
Nutrient Management Benefits of Grazing vs Haying

Data from Wilson Land & Cattle
130 acre crop/pasture land

Nutrient removal in grass hay
1 T grass hay
45 lbs N
12 lbs P$_2$O$_5$
50 lbs K$_2$O

Total 130 A @ 3 T/A = 390 T
17,550 lbs N
4,680 lbs P$_2$O$_5$
19,500 lbs K$_2$O
1625 lbs S

Nutrient removal in animals
10 cows (@1150 lbs)
2 freezer beef (@ 1000 lbs)
6 steers/bulls (@900 lbs)
10 bred heifers (@900 lbs)
5 calves (@450 lbs)
20 calves (@500 lbs)
60 sheep/goats (@70 lbs)
(2.8% N, 0.72% P, 0.2% K, 0.15% S)

Total 44,350 lbs
1242 lbs (N 7%)
731 lbs P$_2$O$_5$ (16%)
106 lbs K$_2$O (0.5%)
67 lbs S (4%)
Benefits of No-Till for Grazing Covers

- Reduced cost of establishment of cover crops and main crops
- Ability to establish (cover) crops quickly
- Cover crops produce more above- and below ground biomass
- Lower seeding rate needed for small-seeded crops due to more precise seed placement
- Soil erosion control
- Increased surface soil organic matter
- Better surface soil aggregation
- Continuous macropores in subsoil
- Lower susceptibility to compaction
- Greater infiltration
- Lower water evaporation losses
- More earthworms
- More beneficial microbes
Management-Intensive Grazing (MIG) is an integral component of the puzzle

- Short duration grazing events (grazing days or hours)
- High stock density (as high as 1,000,000 lbs liveweight/A)
- Long rest periods (20 - 80 days)
- Only part of standing biomass is consumed, a lot is left for soil improvement and regrowth
- Rotational grazing yields are 9-68% higher than continuous grazing yields

* Nelson, C.J. (Ed.) 2012 Conservation outcomes from pastureland and hayland practices: Assessment, recommendations, and knowledge. Allen Press, Lawrence, Kansas
Benefits of Management-Intensive Grazing

1. Short grazing period limits compaction
2. Long rest period stimulates strong roots
3. Long rest period allows soil life to heal compaction
4. New pasture regrowth is not grazed prematurely
5. Height of grazing (4-8”) optimal for regrowth
6. About 50% of standing biomass is left to feed soil and act as solar panel for regrowth
7. Manure spread more uniformly
8. Vegetation is grazed more uniformly
Needs for MIG: A Grazing Plan Including Fencing and Water Supply to all Paddocks
Manure Piles are Centers of Biological Activity so by Improving Their Distribution Soil Health is Improved
Grazing Cover Crops to Complement Cool-Season Perennials

Winter Slump

Summer Slump

Jan  Feb  Mar  Apr  May  Jun  Jul  Aug  Sep  Oct  Nov  Dec
Summer Slump
Winter Slump
Maximizing Grazing by Integration with annual and perennial ‘cover’ crops

- **Cool season** annuals
- **Warm season** perennials and annuals
- One-grazing cool season annuals
- One-grazing warm-season annuals
- Stockpiled forages (e.g. tall fescue, brassicas, corn)

Seasonality and planting strategies are key for optimizing grazing opportunities.
Some Results from Three Pennsylvania Case Studies Showing how Grazing and No-Till can be integrated Successfully
Farm 1 - Wilsons

Wilson Land & Cattle Co, Tionesta, Forest County, Pennsylvania, started in 2009
1600 feet above sea level, Average annual temperature 47 F, Average precipitation 43”

- 220 acre farm – all owned except for 10 acres
- 130 acres cropland and pasture
- 100% no-till

- 102 black angus beef cows
- 160 dorset sheep
- 12 goats

- Farm entirely perimeter fenced
- 30 permanent paddocks
- Electric mobile interior fencing
- Started intensive rotational grazing in 2011
- Moves cows typically 4-6 times a day
- 70+ different plant species for grazing
Farm 2 - Brubakers

Double B Farms, McAlisterville, Juniata County, PA
650 feet above sea level, Average annual temperature 51F, Average annual precipitation 40”

- Enterprises:
  - farm store
  - broiler production
  - grain production
  - grass-fed limosine
  - embryo sales

- 400 acres – 180 acres owned
  - 90 acres fenced paddocks (22 total)
    - w. perennial pasture
  - 90 acres perimeter fenced
    - 35 acres cropland (corn, soyb., spelt, hay)
    - Graze cover crops and crop residues
    - 55 acres pasture
    - Typically move animals 1 time a day

- 50 breeding cows + calves = approx 90
- 100% no-till since 1996
Farm 3 – Weavers
Eli Weaver, Leola, Lancaster County, PA
400 feet above sea level, Average annual temperature 53 F, Average annual precipitation 43”

- Enterprises:
  - dairy farm
  - Seed business
  - Nutrition business

- 30 milk cows, 12 replacement stock (calves, heifers, dry cows)
- 45 acres
Overview of Farms - Weaver

- One part of farm is fenced for grazing:
  - 7 acres alfalfa/grass, or orchardgrass/perennial ryegrass/meadowfescue/red+white clover
  - 3 acres cool and warm season annuals
  - 15 acres can be used for grazing or harvesting

- The other part of the farm is set up for harvesting:
  - 20 acres (two 10 acre blocks that are rotated) – very intensive double and triple cropping for silage. E.g. triticale/annual ryegrass-sorghumsudan-oat/radish/y.sweet+red+white clover.

  - The cows are typically grazed at night only and moved once every day, given 1/3rd of an acre at a time
Meeting Grazing Needs with Cool Season Annuals

Single or multiple-grazing cool season annuals
### Grazing No-Till Cool Season Annuals

<table>
<thead>
<tr>
<th></th>
<th>Rye/vetch mix</th>
<th>Rye/vetch/clover mix</th>
<th>Rye/ryegrass vetch/clover mix</th>
<th>Annual ryegrass / triticale mix</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lbs DM/A</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Date</td>
<td>7/17/15</td>
<td>6/1/16</td>
<td>4/21, 6/12/17</td>
<td>4/17, 5/4, 5/26/17</td>
</tr>
<tr>
<td>Location</td>
<td>Tionesta</td>
<td>Tionesta</td>
<td>Tionesta</td>
<td>Leola</td>
</tr>
<tr>
<td>Pre-</td>
<td>3618</td>
<td>6051</td>
<td>Varied</td>
<td>Varied</td>
</tr>
<tr>
<td>Post-</td>
<td>2818</td>
<td>2398</td>
<td>2614**</td>
<td>3470*</td>
</tr>
<tr>
<td>Grazed (%)</td>
<td>800</td>
<td>3653</td>
<td>2150**</td>
<td>4216*</td>
</tr>
<tr>
<td>Grazed (%)</td>
<td>23%</td>
<td>60%</td>
<td>55%</td>
<td>45%</td>
</tr>
</tbody>
</table>

* Sum of three grazings
** Sum of two grazings

Grazed yields ~ **0.4-2.1 T/A**
Meeting Grazing Needs with Warm Season Annuals
Grazed Several Times

Warm season perennials and annuals
## Summer Annuals - Repeat Grazing

<table>
<thead>
<tr>
<th></th>
<th>Japanese millet</th>
<th>Pearl millet (w. rape)</th>
<th>Sudangrass</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lbs DM/A</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Date</strong></td>
<td>7/17/15</td>
<td>7/23/15</td>
<td>7/15/16</td>
</tr>
<tr>
<td>9/5/15</td>
<td>8/8/16</td>
<td>8/4/16</td>
<td>8/31/16</td>
</tr>
<tr>
<td><strong>Location</strong></td>
<td>Tionesta</td>
<td>McAlisterville</td>
<td>Leola</td>
</tr>
<tr>
<td><strong>Pre-</strong></td>
<td>6786</td>
<td>3996</td>
<td>3131</td>
</tr>
<tr>
<td>4442</td>
<td>3657</td>
<td>3247</td>
<td>3872</td>
</tr>
<tr>
<td><strong>Post-</strong></td>
<td>3259</td>
<td>2944</td>
<td>2003</td>
</tr>
<tr>
<td>2409</td>
<td>1285</td>
<td>1582</td>
<td>1576</td>
</tr>
<tr>
<td><strong>Grazed</strong></td>
<td>3527</td>
<td>1053</td>
<td>1128</td>
</tr>
<tr>
<td>2033</td>
<td>2372</td>
<td>1867</td>
<td>2296</td>
</tr>
<tr>
<td><strong>Grazed (%)</strong></td>
<td>51%</td>
<td>26%</td>
<td>36%</td>
</tr>
<tr>
<td>46%</td>
<td>64%</td>
<td>57%</td>
<td>59%</td>
</tr>
</tbody>
</table>

Grazed yields ~ **2.8 – 3.2 T/A**
Pearl Millet pre and post grazing
Japanese Millet and Rape/Pearl millet mixture
Sorghum Sudan Grass Pre and Post Grazing
Meeting Grazing Needs with Summer Annuals

Grazed Once

One-grazing warm-season annuals
### Summer Annuals - One Grazing

<table>
<thead>
<tr>
<th></th>
<th>Corn/cucurbit s/sunflower mix</th>
<th>Millet mix*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lbs DM/A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Date</td>
<td>8/26/16</td>
<td>9/13/17</td>
</tr>
<tr>
<td>Location</td>
<td>Tionesta</td>
<td></td>
</tr>
<tr>
<td>Pre-</td>
<td>11,173*</td>
<td>7238</td>
</tr>
<tr>
<td>Post-</td>
<td>4469**</td>
<td>2617</td>
</tr>
<tr>
<td>Grazed</td>
<td>6704**</td>
<td>4621</td>
</tr>
<tr>
<td>Grazed (%)</td>
<td>60%**</td>
<td>64%</td>
</tr>
</tbody>
</table>

* Cucurbits = 26%, Corn/Sunflower = 74%
** Not measured

### Grazed Yield ~ 2.3-3.4 T/A

* 2017 summer annual millet mixture was:
  7 # Japanese millet
  5 # Sorghum sudangrass
  3 # Forage sorghum
  4 # Grain sorghum
  2 # Annual ryegrass
  .5 # Teff
  4 # Sunflower
  1 # Mungbean
  2 # Cowpea
  1 # White clover
  1 # Red clover
Versatility of mixtures

Mixture in better drained part of field

Same Mixture in poorly drained part of field

7 # Japanese millet
5 # Sorghum sudangrass
3 # Forage sorghum
4 # Grain sorghum
2 # Annual ryegrass

5 # Teff
4 # Sunflower
1 # Mungbean
2 # Cowpea
1 # White clover
1 # Red clover
## Annualized yields of different forage rotations

<table>
<thead>
<tr>
<th></th>
<th># Grazings</th>
<th>Grazed yield (T DM/A)</th>
<th>Soil food and regrowth aboveground (T DM/A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winter annual mix</td>
<td>1</td>
<td>1.8</td>
<td>1.2 (40%)</td>
</tr>
<tr>
<td>Summer annual mix</td>
<td>2-3</td>
<td>2.8-3.2</td>
<td>2.8-3.2 (50%)</td>
</tr>
<tr>
<td>Summer annual mix</td>
<td>1</td>
<td>3.4</td>
<td>2.2 (40%)</td>
</tr>
<tr>
<td>Annual Yield of Winter/Summer Annual Rotation</td>
<td>2-4</td>
<td>4.8-5.2</td>
<td>3.4-4.2 (40-50%)</td>
</tr>
<tr>
<td>Switchgrass/ Big Bluestem/ Indiangrass</td>
<td>2</td>
<td>4.7</td>
<td>1.0-1.1 (32%)</td>
</tr>
</tbody>
</table>
# Soil Health Evaluations 2016

## Russ Wilson Soil Health Scores

<table>
<thead>
<tr>
<th>Field ID</th>
<th>F5</th>
<th>P3C</th>
<th>P3A</th>
</tr>
</thead>
<tbody>
<tr>
<td>DATE</td>
<td>5/4/16</td>
<td>5/4/16</td>
<td>5/4/16</td>
</tr>
<tr>
<td>Cover crop</td>
<td>Heavily compacted soil with grey/red mottling in surface horizon but bright yellow colored material below. Crimson, alsike, sweet yellow and some white clover</td>
<td>Cover crop mix of hairy vetch, alsike clover, red clover, sweet yellow clover, annual ryegrass</td>
<td>Indigenous perennial warm season mix (13 species)</td>
</tr>
<tr>
<td>Surface cover</td>
<td>7</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Soil Structure</td>
<td>4</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>Organic matter</td>
<td>5</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Soil erosion</td>
<td>8</td>
<td>8</td>
<td>8.5</td>
</tr>
<tr>
<td>Soil compaction</td>
<td>4</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>Water infiltration</td>
<td>2</td>
<td>7.5</td>
<td>8</td>
</tr>
<tr>
<td>Soil diversity</td>
<td>5</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Plant and root growth</td>
<td>5</td>
<td>6</td>
<td>8</td>
</tr>
</tbody>
</table>
Immediately after grazing
09.13.2017

After 2 months of rest
09.13.2017

Compacted surface

Healed surface
Soil life is the basis for healing compacted surface
Time (sec) to infiltrate 1 or 2 inches of water (single-ring infiltration test, Spring 2016)

- **Indigenous 13-species perennial warm season mix**
- **Annual cool season vetch/clovers/ryegrass mix**
- **Compacted soil with clover mixture**
- **Compacted soil w. perennial ryegrass in corn**
- **Perennial warm season mix**
2020-2021 project to study grazing of cover crops in more depth

- Two scenarios for grazed cover crops
  1. Small grain - double crop soybean vs grazed cover crop mixtures
  2. Corn silage – grazed vs un-grazed cover crop

South-Central PA
Preliminary Results New Cover Crop Grazing Project – After Small-Grain Harvest

Average of Infiltration (cm/hour)

CC: Ungrazed Cover crop    LG: Cover crop grazed a month ago    RG: Recently grazed cover crop    Soy: Soybean
Preliminary Results New Cover Crop Grazing Project – After Small-Grain Harvest

Average of Wet Aggregate Stability%

- CC: 75.02471656
- LG: 91.26237798
- RG: 76.88134135
- Soy: 93.73278724
Preliminary Results New Cover Crop Grazing Project – After Small-Grain Harvest

Average of bulk density:

- CC: 1.173523642
- LG: 1.107781954
- RG: 1.201111766
- Soy: 1.193022981
Conclusion

- Grazing is a cost effective way of feeding ruminant livestock
- No-till winter and summer annuals can be combined with cool and warm season perennials to meet summer and winter grazing needs
- If combined with intensive rotational grazing soil improves
- High production possible (5 T grazed DM/A/yr + 4 T left in field)
- This can help grass-fed beef and milk production increase in the U.S.
Reading resources

- Extending the grazing season with plant diversity
  https://extension.psu.edu/extending-the-grazing-season-with-plant-diversity
- No-till annuals to beat the summer slump on a dairy farm
  https://extension.psu.edu/no-till-annuals-to-beat-the-summer-slump-on-a-dairy-farm
- Integrating grazing and no-till systems on a grain farm
  https://extension.psu.edu/integrating-grazing-in-no-till-systems-on-a-grain-farm

- You-Tube videos on the same topics
  - https://extension.psu.edu/beating-the-summer-slump-on-dairy-farms-with-no-till-annuals
  - https://www.youtube.com/watch?v=sqdZ8ydVXcM