Adaptive Grazing and Relationship to Soil Health

Allen R Williams, Ph.D.
Grass Fed Insights, LLC
Three Principles

- Principle of Compounding
- Principle of Diversity
- Principle of Disruption
Conventional Grazing
Adaptive Grazing
Adaptive or Flex Grazing

- Allows Practitioner to address multiple goals and objectives.
- Not a routine or rigid system
- Adapt to changing conditions
Principles of Adaptive Grazing

- Goal Oriented
- Stock Density vs. Stocking Rate
- Management and flexibility are key
- Frequent Movement & Frequent Rest
- Plant Root System Recovery
- Highly reliant on temporary fencing technology
- Compounding & Cascading Effects
Regenerative Grazing Research Shows:

- Ecological function and profitability increase with increasing number of paddocks.
- Short periods of grazing with adequate recovery gave the greatest profit and ecological function.
- Adjusting grazing management with changing conditions increases ecological function and profitability.
- Fixed management protocols reduced benefits.
- Profitability decreases if recovery is too short or too long.
- Stocking rates can be increased without damaging ecological function as number of paddocks is increased.

Teague et al. 2015. Journal of Environmental Management
What Does It Look Like?

- 250,000
- 100,000
- 500,000
- 1,000,000
Simulate Nature
Mimic Nature: Biomimicry/Ecomimicry
Nurtures Ecological Memory
Soil Carbon Cowboy Series

- Soil Carbon Cowboys - 12 minutes; [https://vimeo.com/80518559](https://vimeo.com/80518559)
- One Hundred Thousand Beating Hearts - 15 minutes: [https://vimeo.com/170413226](https://vimeo.com/170413226)
- A Fence and an Owner - 9 1/2 minutes: [https://vimeo.com/201215707](https://vimeo.com/201215707)
- During The Drought - 12 minutes: [https://vimeo.com/200109813](https://vimeo.com/200109813)
- Luckiest Places on Earth - 25 minutes: [https://vimeo.com/181861077](https://vimeo.com/181861077)
- Soil Carbon Curious - 6 minutes: [https://vimeo.com/130721684](https://vimeo.com/130721684)
- Next…..”Givers and Takers”
Additional Resources

- www.pastureproject.org
  - Grass Fed Beef Decision Calculator
  - PowerPoint Presentations
  - “How –To Video” series
  - Webinars

- “Before You Have A Cow”
  - www.joyce-farms.com
Case Studies
Mississippi Farm

Case Study
Condition at Purchase
Starting Point
Soil OM – 1.3% to 1.6%
Water Infiltration Rates – < ½ in/hr
Plant Brix – 2%
Major forage species – 3-4
Stocking Rate – 1 AU/6 acres
Implemented Strategy

- Bale Grazing 1\textsuperscript{st} winter.
- High Stock Density/Short Duration Grazing.
- Long rest periods.
- Strategic use of microbial quorum sensing.
Grazing Weeds
Year 2 Grazing Season
Year 3 Grazing Season
Year 4 Grazing Season
Progress

- Soil OM – 5.2% to 5.6%
- Forage species – 43, including natives.
- Plant Brix – Avg 15 – 22%
- Water infiltration – 10+ in/hr
- Stocking Rate – 1 AU/1.5 acres.
- FREE ACRES!!!
- Significant increase in earthworms, soil level insects, pollinators, and wildlife.
Multi-Paddock Construction for Multiple Daily Moves
Allen’s Fencing Rig
Keeping Cattle Out Of Ponds
Stockpiled Prairie
Moving Cows to Fresh Stockpile
Who Is The Employee?
South Carolina
Pompey’s Rest Farm

Soil Destroyer to Soil Builder

Dec. 2016 National GLCI Conference

New Soil Carbon Cowboys film

– Givers & Takers
Initial Pasture Condition
After One Year of Adaptive Grazing
Abundant Grass....
Kansas

**Neighboring farms comparison**

- **Farm 1**: Corn/soybean rotation for 25+ years.
  - No cover crops
  - No-till last 10 years
  - Center pivot irrigation
  - Grazes cornstalks every other year – set-stock
  - High synthetic use
  - TLMB = 730 ng/g
Farm 2

- Corn/soybean rotation until 2004.
- Conventional till & high synthetic use.
- Transitioned into eastern gamagrass, alfalfa, birdsfoot trefoil, chicory, clovers, several other plant species from latent seed bank.
- Started grazing in 2006.
- TLMB in 2014 = 3590 ng/g
- Significant **mycorrhizal fungi** population.
- Soil pits in 2014, 15, 16 – Change in root depth and AMF tremendous. Soil C and OM significantly better at depth.
- Went from 4-6 inches topsoil in 2004 to 42 inches topsoil in 2016. Most significant changes in last three years since ramping up AMP grazing.
Alabama
South Central par of state
Black Belt Prairie
5300 acres
Organic Grains and cattle
Started Adaptive Grazing less than 2 years ago.
Started cover crops & No-Till 2 years ago.
Starting Point
Rolled Cover Crop – 10K+ Biomass
Soybeans drilled into 9 seed CC after roll down. Beans emerging through mat. Rolled 5/1/17. Picture taken 5/21/17
50 Bushel/Ac Organic Wheat
Tennessee
Long Term No-Till on Left. Planted 2 weeks earlier. No Cover crop.
What They Did

Cover Crop – 8 Seed Mix – Cereal Rye, Winter Oats, Triticale, Winter Pea, Hairy Vetch, Crimson Clover, Daikon Radish, Canola

Rolled down Early May. Planted into 20K+ standing biomass.

C:N ratio > 30:1.

Planted using a Roller and JD Air Seeder.

Lost all fear of biomass. If we can get it on the ground we can plant.

Less than 5.5 inches rain from planting until August. 55+ days with 90-98 temp.

Cover Crop Field yield 215 bu/ac. No-Till yield 160 bu/ac.
Green Acres Research Farm: Cincinnati, Ohio

Chad Bitler, M.S.
Agriculture Resource Coordinator (ARC)
Email – cbitler@green-acres.org
Direct – (513) 898-3159
Green Acres Research Farm: Cincinnati, Ohio

55 Days after planting
- 8500 lbs/ac DM
- No fertilizer
- Steers gained >3.0 lbs/day.
- 4500 lbs/ac DM 2\textsuperscript{nd} Grazing.

Chad Bitler, M.S.
Agriculture Resource Coordinator (ARC)
Email – cbitler@green-acres.org
Direct – (513) 898-3159
18 species warm season cocktail mix.

SOM increased 3.6% to 4.4% in the 120 day grazing period – A gain of 0.8%

Added 20,000 gallons/ac water holding capacity.

Over 100 acres that is 2 million gallons.

Soil N increased 58 lbs/ac.

Soil mineral value increased $105/ac.

Soil microbial activity increased 44%.

Earthworms increased to >130,000/ac.
2016 Forage and Grassland Council Presentation.

Turned ground adjacent to an abandoned sand quarry into productive soil with cattle.

20+ years ago ground averaged 37 bushels of corn/acre, with side dressing.

Corn Yields now in the 170’s with no fertilization. Non-GMO Corn.

Picture shows soil taken about 10 yards apart. The one sample has been mob grazed for about 20 years. The other sample is from the other side of the fence.

Runs 600 head of grass fed beef and about 100 sheep.

Host about 15 tours a year. Just hosted a delegation from the Ukraine.
North Dakota
Farm Comparisons

Farm 1:

- Organic operation that is very diverse in its cropping system.
- The operator grows spring wheat, barley, oats, corn, sunflowers, peas, soybeans, dry edible beans and alfalfa.
- Natural, organic fertilizers are used.
- **No livestock or covers** integrated.
Farm 2:
– No-till, low diversity. Operator plants only flax and spring wheat in rotation
– Anhydrous ammonia is used.
– Crop yields are average for the area.
– **No livestock or covers.**
Farm 3:

- No-till, medium diversity, high synthetic use.
- Grows corn, barley, sunflowers, spring wheat and soybeans.
- It has not been tilled for nearly twenty years.
- Yields are high but to get those yields high rates of synthetics are used.
- Fertilizers, fungicides, pesticides and amendments are all used.
- No livestock or covers.
Farm 4:

- No-Till since 1993.
- Grow corn, spring wheat, barley, oats, peas, cereal rye, winter triticale, and hairy vetch as our cash crops.
- All fields have a complex cover crop each year. Either before the cash crop, along with the cash crop or after the cash crop.
- No synthetic fertilizer since 2007. Do not use any purchased fertilizers, compost tea, or other soil amendments.
- Small amount of compost which is used on gardens.
- Livestock fully integrated onto cropland. Beef cow/calf pairs, stockers, grass finishers, sheep, pork, laying hens and bees, all are integrated throughout the ranch.
# Haney Test Results - 2016

<table>
<thead>
<tr>
<th>Management</th>
<th>N (lbs/ac)</th>
<th>P (lbs/ac)</th>
<th>K (lbs/ac)</th>
<th>WEOC (PPM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organic, CT Farm 1</td>
<td>7</td>
<td>156</td>
<td>95</td>
<td>233</td>
</tr>
<tr>
<td>NT, LD Farm 2</td>
<td>27</td>
<td>244</td>
<td>136</td>
<td>239</td>
</tr>
<tr>
<td>NT, MD, HS Farm 3</td>
<td>37</td>
<td>217</td>
<td>199</td>
<td>262</td>
</tr>
<tr>
<td>NT, HD, NS, Lvst Farm 4</td>
<td>281</td>
<td>1006</td>
<td>1749</td>
<td>1095</td>
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</tbody>
</table>

CT = Conventional Tillage, NT = No-Till, LD = Low Diversity, MD = Moderate Diversity, HS = High Synthetics, NS = No Synthetics, Lvst = Livestock.
Las Damas Ranch
Mexico
Neighbor’s Pasture

Las Damas Ranch
Las Damas Ranch
Background

Typical 11 inch rainfall region.
   - Last 4 years – 10”, 9”, 8”, 5” inches.

5 years ago – monoculture of toboagras
   - Now = More than 4 dozen species…..

Run 1 cow/calf per 40 acres.

FREE ACRES!!!
Luis Robles Ranch – Chihuahua, Mexico

Robles Ranch

Neighbor’s Ranch
Caterras Cattle Co. – Chihuahua, Mexico
Australia
Adaptive Grazing

Set Stock Grazing

Long-chain, non-labile, stable carbon

20 Inches

Short-Chain, unstable, Labile carbon
Comparisons

Set-Stock:

- Decades of combining conventional cropping with set-stock grazing.
- Used a range of chemical fertilizers and herbicides.
- Accelerated soil C loss at depth.
- Biodiversity loss.
- Significant mineral loss.
- Increase in metabolic diseases.
Comparisons

Adaptive Grazing:

– No fertilizer in last 30 years.
– Levels of total and available plant minerals have improved significantly.
– **Solubilization** of mineral fraction by microbes.
  – Energized by increase in liquid carbon.
– **Stable**, long-chain, humic substances formed via plant-microbe sequestration pathway.
  – Cannot disappear in a drought.
**Data**

- **68.2 tons more C** sequestered per acre from 1990 – 2010 vs. Set-stock.

- **78%** of new carbon was Stable, Non-labile.

- **Mineral increases:**
  - Mineral value increase: **$208/ac/yr**

- **Carrying capacity** doubled.

- **High N & P applications** inhibit formation of plant-microbe bridge.
BENEFITS
Does Grazing Strategy & Methodology Matter?
Soil Carbon Data

Three types of farms/ranches sampled:

- 2014 – 2015

- Farm/ranch Type Descriptions:
  - AHSD/AMP Grazing for minimum of 5 years
  - High Level Conventional Grazing Management
    - CG – Slow Rotation - 10+ years minimum
  - Low Level Conventional grazing management
    - CG – Continuous - 10+ years
  - All same soil types
Soil Carbon Data

- Soil pits dug in random locations at each farm. Same topography.
- Each pit 3 feet deep and 3 feet square.
- Collected soil samples within every 6 inch section.
- Noted root growth and structure.
- Noted soil life, texture, aggregation.
Soil Carbon Data – Total Soil Carbon

<table>
<thead>
<tr>
<th>Horizon</th>
<th>AHSD</th>
<th>CG - Rotation</th>
<th>CG – Cont.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4.67</td>
<td>1.64</td>
<td>1.36</td>
</tr>
<tr>
<td>2</td>
<td>4.00</td>
<td>1.88</td>
<td>1.37</td>
</tr>
<tr>
<td>3</td>
<td>2.95</td>
<td>1.03</td>
<td>0.40</td>
</tr>
<tr>
<td>4</td>
<td>2.04</td>
<td>1.02</td>
<td>0.54</td>
</tr>
<tr>
<td>5</td>
<td>1.71</td>
<td>0.38</td>
<td>0.40</td>
</tr>
<tr>
<td>6</td>
<td>1.42</td>
<td>0.41</td>
<td>0.34</td>
</tr>
</tbody>
</table>
## Soil Carbon Data – Soil Organic Matter

<table>
<thead>
<tr>
<th>Horizon</th>
<th>AHSD</th>
<th>CG - Rotation</th>
<th>CG – Cont.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4.26</td>
<td>3.28</td>
<td>2.72</td>
</tr>
<tr>
<td>2</td>
<td>3.22</td>
<td>3.76</td>
<td>2.74</td>
</tr>
<tr>
<td>3</td>
<td>3.10</td>
<td>2.06</td>
<td>0.80</td>
</tr>
<tr>
<td>4</td>
<td>2.98</td>
<td>2.04</td>
<td>1.08</td>
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<tr>
<td>5</td>
<td>2.80</td>
<td>0.76</td>
<td>0.80</td>
</tr>
<tr>
<td>6</td>
<td>1.98</td>
<td>0.82</td>
<td>0.68</td>
</tr>
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</table>
# Soil Carbon Data – Carbon Assessment Per Acre

<table>
<thead>
<tr>
<th>Farm Descrip</th>
<th>Carbon (kg/sq meter)</th>
<th>Carbon (Ton/ac)</th>
<th>Carbon (Ton CO2 Equiv)</th>
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</thead>
<tbody>
<tr>
<td>AHSD</td>
<td>12.69</td>
<td>51.41</td>
<td>188.13</td>
</tr>
<tr>
<td>CG – Rotation</td>
<td>7.09</td>
<td>28.71</td>
<td>105.07</td>
</tr>
<tr>
<td>CG – Cont.</td>
<td>5.47</td>
<td>22.16</td>
<td>81.09</td>
</tr>
</tbody>
</table>
Can Make Rapid Improvements in Soil Organic Matter and Total Soil Carbon
Improvement in Soil Organic Matter Using AMP Grazing

Source: Grass Fed Insights, LLC
Rebuilds Soil Microbial Biomass and Restores Microbial Balance
Building Microbial Biomass (ng/g of Soil)
New Soil Health Analytics

Quorum Labs, Eldorado, IL

- Complete Soil Bio-Profile
  - Active & Inactive fractions of soil microbes
  - Non-Sporulated & Sporulated
  - Individual microbial species specification & identification
  - Metagenomics, Proteogenomics, PCR, GC capabilities

- Haney Test
- Plant Tissue analysis
- Pathology
- Water Quality
- Affluent Testing
Scenario One – Reasonably Healthy Soil

Genus (16 Groups Present)

Acidobacteria a little low.

Species – 16000 Species Present
Scenario Two – Poor Soil

Genus (2 Groups Only)

Species – 1480 Species Present
Scenario Three – Average Soil

Genus (12 Groups Only)

Species – 6755 Species Present
Protect Soil Temperatures
FLIR – Air Temp 96°
1. At 70 °F, 100% of Soil moisture is used for growth.
2. At 100 °F, 85% of Soil moisture is lost and 15% is used for growth.
3. At 115 °F, microbes begin to breakdown, and
4. At 140 °F they die.
Even Manure Distribution

One paddock of 3–pasture rotation

One paddock of 24–pasture rotation
## Manure Distribution

<table>
<thead>
<tr>
<th>Rotation Frequency</th>
<th>Years to Get 1 Pile/sq. yard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous</td>
<td>27</td>
</tr>
<tr>
<td>14 day</td>
<td>8</td>
</tr>
<tr>
<td>4 day</td>
<td>4 – 5</td>
</tr>
<tr>
<td>2 day</td>
<td>2</td>
</tr>
<tr>
<td>1 time a day</td>
<td>1</td>
</tr>
</tbody>
</table>
Indicators of Improved Soil Health
Insects/Arthropods
Pollinator Insects
Earthworms
Dung Beetles
**Dung Beetles**

I  Tunnelers

II  Dwellers

III  Rollers or Tumblers

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**Figure 1.** Cross section through dung pat depicting three nesting types:

**Tunnelers I** - *Phanaeus vindex* tunnel with single, soil-coated brood ball in single chamber; B. *Onthophagus* species tunnel with multiple brood masses; C. *Copris minutus* multiple brood balls; D. beetle excavating new tunnel (note subsurface soil is pushed through the dung pat crust)

**Dwellers II** - *Aphodius pseudolividus* eggs are laid singly or in groups inside dung pat; B. *Aphodius erraticus* bury dung under pat with eggs laid beside brood masses.

**Rollers III** - *Canthon pilularius* adult carving out dung into a ball; B. ball rolled a distance away from pat and buried shallowly.
Figure 3. Picture Guide to Dung Beetles Associated with NC Pastures
Males are indicated by the symbol ♂ and females ♀
Photographs by Matt Bertone

Aphodius distinctus  
Size: 1/8-3/16"  

Aphodius erraticus  
Size: 1/4-3/8"  

Aphodius fimetarbus  
Size: 1/4-3/8"

Aphodius pseudocymnus  
Size: 1/8-3/16"  

Georgopus blackburni  
Size: 3/8-3/4"  

Onthophagus gazella (♂)  
Size: 3/8-1/2"

Onthophagus gazella (♀)  
Size: 3/8-1/2"  

Onthophagus gazella (♂)  
Size: 3/8-1/2"  

Onthophagus taurus (♀)  
Size: 1/4-3/8"  

Onthophagus taurus (♂)  
Size: 1/4-3/8"  

Onthophagus taurus (♀)  
Size: 1/4-3/8"  

Phanaeus vindex (♀)  
Size: 3/8-7/8"  

Phanaeus vindex (♂)  
Size: 3/8-7/8"  

Phanaeus vindex (♀)  
Size: 3/8-7/8"  

Canthon pilularis  
Size: 1/2-5/8"  

Heteronogus carolinus  
Size: 3/4 – 1¼"

Pronunciation guide: There are no common names of these beetles. To make their names easier to understand, a pronunciation guide is provided.

Aphodius distinctus: A-fə-di-us dist-ink-tus
Aphodius erraticus: A-fə-di-us er-uh-tik-us
Aphodius fimetarbus: A-fə-di-us fin-ə-tar-bus
Aphodius graminis: A-fə-di-us gra-mi-nis
Aphodius pseudocymnus: A-fə-di-us sue-do-kuhm-nus
Georgopus blackburni: Ge-oh-gopus blak-burn-ee
Onthophagus gazella: On-thə-fə-gəs gas-el-ə
Onthophagus hector: On-thə-fə-gəs hek-tər
Onthophagus taurus: On-thə-fə-gəs too-rəs
Phanaeus vindex: Fan-ay-us vin-dex (Rambow beetle)
Increased Soil Aggregation
Illinois Grazing Trial

6 inches rain in two days.

2 inches rain night before
Diversity Is Key
Penn State Trial

Compared 2-seed perennial mix vs. 5-seed mix

- 2-seed – Orchardgrass & white clover
- 5-seed – Orchardgrass, white clover, fescue, alfalfa, chicory
- 9 year trial
- Grazed treatment & control equally
- Advantages for 5-seed mix
  - 31% more forage DM production
  - SOC down to 39 inches
    - 1.8 tons/ha in 5-seed
    - 0.5 tons/ha in 2-seed
Where Do Majority of Soil Microbes Live & Function?
Approximately 2/3 Of Your OM Increase Will Come From Roots!
Decrease drought impacts

<table>
<thead>
<tr>
<th>% Leaf Volume Removed</th>
<th>% Root Growth Stoppage</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>2-4%</td>
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<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>

Range Condition

- Excellent
- Good
- Poor

Courtesy: R. Teague, TAMU
Desired Mix

Principle of Three

- Grasses
- Legumes
- Forbs

- Strive for minimum of three grasses, three legumes, and three forbs in mix, whether perennial or annual.
Perennial Pastures

Legumes

Forbs

Grasses
Warm Season Annuals
Why Complexity & Diversity?

- Compounding & Cascading Effects
  - Always occur – Positive or negative?
  - Secondary & Tertiary compounds
    - Dr. Fred Provenza & Others
  - Diversity in microbial species
  - Diversity in macroorganisms
  - Exponential rather than linear

“No effect or impact is singular”
Perennial Mix

- Bromegrass, Orchardgrass, MeadowFescue, Tall Fescue, Bluegrass, Reeds Canary, Timothy, Natives, ….

- White Clover, Red Clover, Trefoil, Hairy vetch, Milk vetch, lespedezas, Sweet Clover, Tick Clover, Alfalfa, Sainfoin, ….

- Chicory, Plantains (Narrrrow & Broadleaf), Yarrow, Sheep’s parsley, Burette, Dandelion, Docks, ….
Principle of Disruption
Flexibility is Key

- Do NOT do things the same way every time!
- AMP/AHSD is NOT a system.
  - Alter stocking densities
  - Do not move through rotations in same pattern
  - Alter grazing heights
  - Alter rest periods
  - Alter species order
  - Alter time of season/year