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
Principle of Compounding

- Never singular effects or impact
- Never Neutral – Always either positive or negative
- Everything we do creates a series of compounding & cascading events
- Also creates epigenetic effects
**Principle of Diversity**

- Want highly diverse and complex pastures and annual mixes – not monocultures.
- Grasses, Legumes, Forbs
- Primary nutrients, PLUS secondary & tertiary compounds.
- Creates series of positive compounding effects and benefits.
Principle of Disruption

Nature has tremendous resilience and responds well to challenges.
Planned, purposeful disruptions.
Creates host of positive compounding effects.
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
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
Mob Grazing High Carbon Biennials
Moving Cattle
Carbon!
Stocking rate and stock density with continuous grazing

Ten head on ten acres
Stocking rate = 1 hd/acre
With continuous grazing:
stock density = stocking rate
Both are still 1200 lb/acre
Pasture subdivision and stock density

With pasture subdivision stocking rate may not change but stock density does!

Stock density is 10 hd/2.5 acres or 4800 lb/acre
Pasture subdivision and stock density

Each level of subdivision results in higher stock density

Stock density is now 12,000 lb/acre
Pasture subdivision and stock density

Stock density is now 24,000 lb/acre

You’ve got it, right?
Soil Carbon Cowboy Series

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

https://www.no-tillfarmer.com/topics/65
Pertinent Article

https://www.no-tillfarmer.com/articles/6809-evaluating-herbicide-carryover-on-cover-crops-deu
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
Case Studies
# Texas Study – Grazing Comparison

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Heavy Continuous</th>
<th>Light Continuous</th>
<th>Adaptive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil Organic Matter</td>
<td>3.1</td>
<td>4.4</td>
<td>4.86</td>
</tr>
<tr>
<td>Fertility CEC</td>
<td>24.6</td>
<td>23.7</td>
<td>27.4</td>
</tr>
<tr>
<td>Water Holding (Ga/ac)</td>
<td>55,700</td>
<td>79,059</td>
<td>87,324</td>
</tr>
</tbody>
</table>

Source: Dr. Richard Teague, TX Agri-Life Extension
Research Summary

- Less bare ground
- More forage production
- Better plant species diversity
- Better fungi to bacteria ratio
- Higher soil OM
- Better CEC
- Increased water holding capacity
Mississippi Farm

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

- Bale Grazing 1st winter.
- High Stock Density/Short Duration Grazing.
- Long rest periods.
- Strategic use of microbial quorum sensing.
Year 1 Grazing Season
Grazing Weeds
Year 2 Grazing Season
Year 3 Grazing Season
Year 4 Grazing Season
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
Livestock pipeline installation.
Quick Couplers.
Easy and Simple.
Making a watering block

Geotextile pad with aggregate topping

Temporary fence line

Cattle in this paddock

Electric bungee gates

Set posts at 30 – 80 foot depending on herd size
Stockpiled Prairie
Moving Cows to Fresh Stockpile
Livestock Impact
How Easy is it to Move Cattle?

Let’s follow Brad Dennis through a move of 700 head in 15 minutes....
Have pigtail posts and polywire reel ready to go on ATV
Pigtail post rack ready to pull and put in the ground.
Fence reel holder and post racks ready to build and pick up temporary fences.
Drive the perimeter of the new paddock to mark out the boundary with ATV tire tracks. Put down new post with power drill and a mallet.
Hook the polywire onto post and drive the length of the new fence, putting down pigtails at points if it's not a straight line. Attach the reel over on the other side. Brad just lets the reel hang down.
Cattle Lined Up and Ready to Move
Reeling in Polywire
https://www.youtube.com/watch?v=79hvT_pVQ28
https://www.youtube.com/watch?v=M2lPSpyo-MI
https://youtu.be/M2lPSpyo-MI
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....
10 Inches Rain – Hurricane Joquin – Oct. 2016 - SC
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 gammagrass, 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.
Stoney Creek Farm
Grant, Dawn & Karlie Breitkreutz

*Cow-Calf Producer – Rotational Grazing
*Cover Crops for fertility, grazing, forage
Sadly, this has become more common during the spring in our area.
Single-Species Cover
- 1 out of 3 was a success
- 2 out of 3 were a BIG failure for multiple reasons.
  - Lack of moisture
  - Financial- Rented ground, incorrect seed, herbicide residuals & ineffective
- In a dry year, the more species planted, the more likely some- thing will germinate & grow.
Cover crop mix following wheat harvest.

<table>
<thead>
<tr>
<th>Mix</th>
<th>Variety/Crop</th>
<th>Germ Origin Test Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>25%</td>
<td>Rymin Winter Rye</td>
<td>85% SD 07/15</td>
</tr>
<tr>
<td>25%</td>
<td>Fridge Winter Tnt</td>
<td>95% KS 05/15</td>
</tr>
<tr>
<td>19%</td>
<td>Tillage Max Dover Oat/Radish</td>
<td>90% CA/NZ 04/15</td>
</tr>
<tr>
<td>12%</td>
<td>VNS Winter Pea</td>
<td>70/13% MT 02/15</td>
</tr>
<tr>
<td>6%</td>
<td>VNS Hairy Vetch</td>
<td>85% AUS 05/15</td>
</tr>
<tr>
<td>6%</td>
<td>Medium Red Clover w/ Nitro</td>
<td>85/55% OR 07/15</td>
</tr>
<tr>
<td>5%</td>
<td>Winfred Brassica</td>
<td>96% OR 07/14</td>
</tr>
<tr>
<td>2%</td>
<td>Tillage Radish</td>
<td>90% OR 05/15</td>
</tr>
</tbody>
</table>

96.775% Purity, 0.19% Crop, 3.03% Inert, 0.01% Weeds

Noxious Weeds: None
Lot 5042 Wt 50 lb
Prairie Creek Seed, Inc., 21995 Fillmore Rd.,
Cascade, IA 52033 877-754-4019
September 16, 2015, after wheat harvested & straw baled.
October 30, 2015, same field.
Ungrazed cover crop
We were challenged to adapt a standard corn planter to no-till our corn crop.
Corn planter set up for no-till.
We adapted our no-till drill to interseed cover crop into corn.
Freshly seeded cover into standing corn and surviving cover from fall.
September 11th, chopping corn silage.
Approved cover crop seeded in corn crop on DNR-owned land as part of the cooperative farming agreement. Picture taken November 8th.
Study field root pit October 7th
Live roots
3 ½ feet in soil
March 2016
Soil from our field.

Soil from a tilled field.
Increased Soil Aggregation
Wheat field cover cost: $37.25/acre
Wheat field feed cost: $.70/cow/day
Weight gained: 130-150# over 43 days

Corn field:
Flown-on seed cost: $66.52/acre
Inter-seeding cost: $26.45/acre
Study Field cover cost: $37/acre
Cover crop feed cost: $.46/lb. of gain
Weight gained: 3.4 lbs/day bred heifers
2.4 lbs/day calves

Dollars & “Sense”
Wheat “Sense”

<table>
<thead>
<tr>
<th>Expense</th>
<th>Return</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seeding/acre</td>
<td>Cow Feed/acre</td>
</tr>
<tr>
<td>Seed</td>
<td>Straw/acre</td>
</tr>
<tr>
<td>Total</td>
<td>Total</td>
</tr>
</tbody>
</table>

Seeding/acre $20
Seed $38
Total $58

Cow Feed/acre $110
Straw/acre $35
Total $145

Net Gain=$87

Delayed Gains/Savings for Following Crop Year

- Purchased Fertilizer $39/ac
- Purchased Herbicide $11-$20/ac
- Purchased Seed $53/ac

Total $103/acre

Total Net Gain=$190/acre
One of the best rewards for our efforts!

CLEAN WATER!!!
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

- 120+ head Piney Woods cows
- Overstocked & Overgrazed
- Basically monoculture pastures
- Feeding 150 days annually
- Very poor soil health parameters
- Limited birds, pollinators, wildlife
After Two Years

- More than 2 dozen additional plant species
- Added 400 more head of cattle
- Forage biomass has more than tripled
- Significantly more earthworms, insects, pollinators, birds, wildlife
- Expanded opportunities…….
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
80 Bushel/Ac Organic Wheat
### Legumes

<table>
<thead>
<tr>
<th>Name</th>
<th>Rate (lbs)</th>
<th>Cost/seed</th>
<th>Cost/acre</th>
<th>Cost/yr</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sunn HempxNES 86.3</td>
<td>12</td>
<td>$1.25</td>
<td>$12.60</td>
<td></td>
<td>$3.80</td>
</tr>
<tr>
<td>Conventional &amp; Crop Resc</td>
<td>62</td>
<td>$0.00</td>
<td>$0.00</td>
<td></td>
<td>$12.00</td>
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<tr>
<td>Black Cowpea 88</td>
<td>35</td>
<td>$4.00</td>
<td>$4.25</td>
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<td>$4.25</td>
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</table>

### Grasses

<table>
<thead>
<tr>
<th>Name</th>
<th>Rate (lbs)</th>
<th>Cost/seed</th>
<th>Cost/acre</th>
<th>Cost/yr</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearl Millet - Triticum 3127</td>
<td>19</td>
<td>$1.10</td>
<td>$11.00</td>
<td></td>
<td>$3.30</td>
</tr>
<tr>
<td>Foxtail Sorghum - DW 400</td>
<td>8</td>
<td>$1.80</td>
<td>$14.40</td>
<td></td>
<td>$1.80</td>
</tr>
<tr>
<td>Erecta Dwarf 31RT 38</td>
<td>25</td>
<td>$1.25</td>
<td>$12.50</td>
<td></td>
<td>$3.00</td>
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</table>

### Brassicas

<table>
<thead>
<tr>
<th>Name</th>
<th>Rate (lbs)</th>
<th>Cost/seed</th>
<th>Cost/acre</th>
<th>Cost/yr</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>African Cabbage - W 464</td>
<td>10</td>
<td>$2.70</td>
<td>$27.00</td>
<td></td>
<td>$2.70</td>
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<tr>
<td>Colorado Potato Forage - 87</td>
<td>10</td>
<td>$1.00</td>
<td>$10.00</td>
<td></td>
<td>$1.00</td>
</tr>
</tbody>
</table>

### Broadleaves

<table>
<thead>
<tr>
<th>Name</th>
<th>Rate (lbs)</th>
<th>Cost/seed</th>
<th>Cost/acre</th>
<th>Cost/yr</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sunflower Black Oilseed -</td>
<td>12</td>
<td>$0.10</td>
<td>$1.20</td>
<td></td>
<td>$0.10</td>
</tr>
</tbody>
</table>

### Summary

- **Pounds/Acre:** 365.50
- **Seeds/Acre:** 954,500.00
- **Species:** 9.00
- **Total Pounds:** 1,825.00

**Total Cost:** $2,100.11

### Growing Period

- **Start:** 05/31/2017
- **End:** 11/22/2017
- **Duration:** 175 days

### Region

- **Zip Code:** 32212
- **Phone:** 9e
- **Frost Free:** 02/05 - 12/21
Results

- Added 400 more cows.
- Eliminated fertilizer.
- Reduced hay feeding from 150+ days to under 30 days.
- Significantly more diversity, earthworms, pollinators, bird species, wildlife.
- Water infiltration rates increased more than 400%.
Tennessee
Coffee County, TN

Planted into rolled down cover crop

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**.
OHIO
Green Acres Research Farm: Cincinnati, Ohio

Chad Bitler, M.S.
Agriculture Resource Coordinator (ARC)
Email - cbitler@green-acres.org
Direct - (513) 898-3159
55 Days after planting - 8500 lbs/ac DM
- No fertilizer
- Steers gained >3.0 lbs/day.
- 4500 lbs/ac DM
2nd Grazing.

Chad Bitler, M.S.
Agriculture Resource Coordinator (ARC)
Email - cbitler@green-acres.org
Direct - (513) 898-3159
Green Acres - Results

- 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.
George Lake - Pennsylvania

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>
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<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>
</tr>
</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
Las Damas Ranch
Background & Results

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

Started with a monoculture of tobosagrass
  – Now = More than 4 dozen species…..

Run 1 cow/calf per 40 acres.

FREE ACRES!!!

Neighbor ranch runs 1 cow/calf per 200 acres.
Since 2006 cattle sales have increased 2.5 times.
Hay expenses reduced by one half.
Net profits are 4 times greater.
Pounds of calf produced per hectare has increased 3.7 times.
Caterras Cattle Co. – Chihuahua, Mexico
Australia
Adaptive Grazing

Set Stock Grazing

Long-chain, non-labile, stable carbon

Short-Chain, unstable, Labile carbon

20 Inches
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.
Dickinson Research Station - NDSU
Mineral N vs. Organic Matter

Y = 8.844 + 0.877
R^2 = 0.351
NET RETURN

$\$/AC

<table>
<thead>
<tr>
<th>YR 1</th>
<th>YR 2</th>
<th>YR 3</th>
<th>YR 4</th>
<th>YR 5</th>
</tr>
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<tbody>
<tr>
<td>45</td>
<td>65</td>
<td>53</td>
<td>98</td>
<td>48</td>
</tr>
</tbody>
</table>

CTRL (P=0.15)

ROT
Control Wheat

Rotation Wheat
North Carolina
Planting Into Rolled Down Cover Crops Following Grazing
7 WAP NO POST Herbicide
No Post Soybeans-86.5bu/ac
Plenty of Earthworms!

Soil Aggregate
Planting Corn into Roll Down
Dryland Corn

• **Yield Results:**
  • Average Yield 214 bu/ac

• **NC 1st Place 2016 Dryland Corn Yield-318bu**
  – Not factored into overall avg yield of 214 bu/ac

• **Direct Cost Per Bushel - $1.25/bu**

• **County Average-120 bu/ac**
Seeding Options
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>
</tr>
<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>
</tbody>
</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>
</tr>
</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

Acidobacteria a little low.

Genus (16 Groups Present)
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><strong>1 time a day</strong></td>
<td><strong>1</strong></td>
</tr>
</tbody>
</table>
Cattle Manure Fertilizer Value is:

In Units of nitrogen (N), Phosphorus (P), and Potassium (K):

84N – 54P – 189K per year or **0.23N-0.15P-0.52K** per cow/day

So, How long does it take to fertilize a pasture using AMP Grazing?

100 cows x’s 1,000 lbs/hd x’s 1 day grazing/1 acre = 23N-15P-52K/ac

3 Days Grazing/Acre = 69N-45P-156K/ac
Indicators of Improved Soil Health
Pollinator
Insects
Costa Rica
150 Plants & Animals
24 Hours - Forest

Cape Town, South Africa
100 Plants & Animals
24 Hours - Grassland

Iowa Corn Field
8 Plants & Animals
24 Hours
Earthworms
Dung Beetles
Dung Beetles

I Tunnelers

II Dwellers

III Rollers or Tumblers

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

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

Dwellers II A. Aphodius pseudolivides 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 A. Canthon pilularis adult carrying 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 \( \vartheta \) and females \( \varphi \).
Photographs by Max Fassnacht.

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

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

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

Aphodius pseudorubriscus
Size: 1/8 3/16"

Aphodius melanopus
Size: 3/8 3/16"

Onthophagus scutellatus \( \vartheta \)
Size: 3/8 3/16"

Onthophagus texanus \( \varphi \)
Size: 3/8 3/16"

Onthophagus nescore \( \vartheta \)
Size: 3/8 3/16"

Onthophagus nescore \( \varphi \)
Size: 3/8 3/16"

Onthophagus texanus \( \varphi \)
Size: 1/4-3/8"

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

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

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

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

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

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

Canthion philarus
Size: 1/2-5/8"

Canthion philarus
Size: 1/2-5/8"

Dichotomius carolinus
Size: 3/4 – 1 1/8"

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

Aphodius atricostus: A-fö-di-us atr-ik-tüs
Aphodius erraticus: A-fö-di-us er-räkt-i-üs
Aphodius anthracinus: A-fö-di-us an-thræk-nüs
Aphodius pseudorubriscus: A-fö-di-us pü-ströo-brüs-icus
Aphodius melanopus: A-fö-di-us mel-ä-nop-us
Copturus nubiferus: Ko-pöö-nü-bäf-ä-rüs
Copturus nemurus: Ko-pöö-nü-mä-nöö-rüs
Dichotomius carolinus: Dik-o-trööm-us kar-o-li-nüs
Gnorimus blackburni: G-noö-rëms bläck-bürn-i
Onthophagus gazella: On-thö-fä-gäz-ä-lä
Onthophagus hecate: On-thö-fä-he-kät-ä
Onthophagus pseudovivus: On-thö-fä-pöö-sü-vüs-viv-us
Onthophagus taurus: On-thö-fä-tä-rüs
Phanaeus vindex: Fän-në-us vin-deks (Rainbow beetle)
Increased Soil Aggregation
Enlarged Soil Aggregates

Glomalin and hyphae

Dr. Kris Nichols, Microbiologist, ARS, Mandan, ND
The Aggregate: Lungs of the soil
Illinois Grazing Trial

2 inches rain night before

6 inches rain in two days.
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
Diversity/Complexity

Monoculture

Diversity/Complexity

Drawing by Lynda Wallis, freelanceillustrations.com. Used with permission.
Where Do Majority of Soil Microbes Live & Function?
Microbe “Home” - Soil microbes live and function in root zone
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>
</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>

**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
- Grasses
- Forbs
Warm Season Annuals
Cool 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 (Narrow & 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
Winter Bale Grazing
Winter Forage Management
Bale Grazing in Nova Scotia
Winter Stockpile Grazing
## Value of Winter Stockpile

<table>
<thead>
<tr>
<th>Variable</th>
<th>Suggested Value</th>
<th>Sample Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>TDN</td>
<td>&gt;60</td>
<td>65</td>
</tr>
<tr>
<td>NFD_d</td>
<td>60-70</td>
<td>62</td>
</tr>
<tr>
<td>NE_L</td>
<td>0.65 – 0.70</td>
<td>0.68</td>
</tr>
<tr>
<td>RFQ</td>
<td>140-170</td>
<td>179</td>
</tr>
</tbody>
</table>
Millet: 9% CP 50% TDN
Sorghum/Sudan: 12% CP 72% TDN
Hairy Vetch: 18% CP 70% TDN
Radish: 14% CP 70% TDN
Future of Agriculture

More Stacked Enterprises

- Multispecies livestock
- Beekeeping, beneficial insect raising
- Integration of higher value crops
  - Specialty grains
  - Fruits and nuts
  - Vegetable and herbs
- Recreational & entertainment
- On Farm restaurants, cooking & canning schools, etc....
Mixed fruit & nut orchards - interspersed

Multispecies Livestock

Specialty Grains, organic crops, specialty crops

Hunting, fishing, recreational, agri-tourism, clinics

The “New” Farm
Equipment
Equipment
Variety of Ways to Get Job Done
Allen’s Fencing Rig
Fencing In Mississippi
Getting Serious in the Sandhills
Creative Corrals
Temporary (and Edible) Corral
What is AHSD Grazing?

• Adaptive High Stock Density (AHSD) Grazing is defined as:
  – A uniquely flexible grazing system designed to facilitate maximum flexibility in land use and forage utilization, while optimizing animal performance and soil health goals.

• Also known as Adaptive Multi-Paddock (AMP) Grazing.
• AHSD grazing relies on the basic tenets of keen observation and fencing portability.
• Stock densities and animal movement frequency can be altered throughout the annual grazing cycle in order to adjust to changes in climate, forage dry matter (DM) production, animal performance and soil health objectives.
Key Benefits

• Increased forage dry matter production on a seasonal and annual basis.
• Enhanced animal performance.
• Significant improvements in soil health, including:
  • Increased water infiltration rates and soil water retention.
  • Increased soil aggregation, improved soil tilth, and reduction in soil compaction.
  • Reduced erosion and runoff.
  • Increased soil microbial population and microbial balance.
Key Benefits, Con’t.

• Greater plant diversity through “tapping” of latent seed bank.
• Increased atmospheric nitrogen fixation through plant legumes and N-fixing soil bacteria - nodulating and non-nodulating.
• Reduced reliance on inorganic fertilizers.
• Incremental increases in soil organic matter and CEC.
Key Benefits, Con’t.

• Natural soil pH buffering capacity.
• Incremental increases in livestock carrying capacity.
• Greater plant species and wildlife species diversity.
• Improvement in earthworm, soil level arthropods, and pollinator insect populations.
Research Results & Lit. Cited
Available in Full Slide Deck
AHSD Methodology

• Involves first determining goals and objectives of your grazing program and then designing and implementing an annual grazing strategy that allows goals and objectives to be optimally achieved.

• The primary purpose of AHSD grazing is to utilize variable high stock densities throughout a grazing season to effectively realize accomplishment of key benefits.
• Stock densities will vary depending on soil and forage conditions, management constraints, and goals.

• Practitioners should strive to achieve stock densities of at least 250,000 pounds per acre at least once annually. Target Poorest Areas.

• Many current AHSD grazers have effectively used stock densities exceeding 500,000 lbs. /acre, followed by long rest periods, to rapidly build soil organic matter (OM), increase soil water infiltration rates, tap into the latent seed bank, and apply “natural” fertilizer in the form of animal manure and urine.
• The key to successful implementation of such high stock densities is to allow the livestock to consume no more than 40-50% of total available forage DM before moving forward into a fresh grazing paddock.

• Temporary grazing paddocks can be constructed (using electrified polywire and tread-in posts) that contain the appropriate amount of forage dry matter needed to support the stock density desired.
Stock Density Calculations

• If you have 3000 lbs per acre of available forage DM and want to utilize 50% and leave 50% trample:

• $3000 \times 50\% = 1500 \text{ lbs}$ DM available for 24 hour period.
Stock Density Calculations

- Assume 100 head of 1200 lb lactating beef cows.
- Assume 3.5% DM consumption needed daily.
- $1200 \times 3.5\% = 42$ lbs forage DM/hd/day.
- $100 \times 42 = 4200$ lbs DM needed daily for herd.
Stock Density Calculations

- If you have 1500 lbs DM available per acre and need 4200 lbs DM daily, then average paddock size:

- $\frac{4200}{1500} = 2.8$ acres needed per day.
- Stock density = $1200 \times 100 = 120,000$ lbs
- $\frac{120,000}{2.8} = 42,857$ lbs/acre.
# Stock Density Calculations

<table>
<thead>
<tr>
<th>No. Moves Per Day</th>
<th>Stock Density Per Acre (lbs/ac)</th>
<th>Paddock Size (acres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>42,857</td>
<td>2.8</td>
</tr>
<tr>
<td>2</td>
<td>85,714</td>
<td>1.4</td>
</tr>
<tr>
<td>3</td>
<td>128,571</td>
<td>0.93</td>
</tr>
<tr>
<td>4</td>
<td>171,428</td>
<td>0.7</td>
</tr>
<tr>
<td>5</td>
<td>214,285</td>
<td>0.56</td>
</tr>
<tr>
<td>10</td>
<td>428,570</td>
<td>0.28</td>
</tr>
</tbody>
</table>
Ecosystem Multi-functionality

EMF is heavily linked to above and below ground biodiversity

Mediated by climate

Our impact on the land (soil, plants, etc.) can significantly influence climate impact
Why Grazing for Grassland Birds?

Grassland birds are the most rapidly declining group of species in North America.

71% of grassland bird species are declining.
Grasslands Need Disturbance
Frequent Disturbance is Essential

Grasslands east of the 34th Meridian becomes too tall and dense for grassland-adapted wildlife without disturbances that set-back plant succession.
Historic Grassland Disturbances
Modern Tools, Same Purpose
Grassland Management Options

Mechanical disturbance requires time, fossil fuels and equipment

It is expensive and only briefly effective
Grazing Sculpts Grassland Habitat

✓ Fire maintains grassland, but does not reduce vegetative height and density.

✓ Grazing sculpts cover to be more usable by wildlife.
Grazing is an Efficient Grassland Management Tool

✓ Requires little fuel, equipment, labor

✓ Gradually removes & structures cover

✓ Normally pays for itself
Grazing is not grazing is not grazing

Not all grazing benefits wildlife

Grassland that has been seriously degraded by grazing has actually been degraded by chronic OVERgrazing.
Post-Grazing Bird Response

Years Since Grazing

- Bobwhite
- Pr.Chicken
PBG/AMP Creates Habitat Across the Continuum

Burned Patch

- 2nd & 3rd years
- 4th & 5th ‘Idle’ years

- Heavy
- Moderate
- Light

- Horned Lark
- Grasshopper Sparrow
- Upland Sandpiper
- Henslow’s Sparrow
- Northern Bobwhite
- Greater Prairie-Chicken

- Bare
- Short
- Medium
- Tall
- Shrubby
What does this look like on the ground?

Previous Year Burn
Nesting Cover

Current Year Burn
Brood Cover
Nesting and Brooding Cover

Brooding Cover

Nesting Cover
**BIRD-FRIENDLY GRAZING**

New paddock with over 36 documented species

Pasture after adaptive grazing with cover remaining for birds

Images courtesy of Dr. Allen Williams
Moving from grazed to ungrazed pasture – note the difference in forage height

Pasture allowed to mature prior to next grazing provides cover for birds

Images courtesy of Dr. Allen Williams
Grazing Improves Grassland Bird Habitat

Bird-Friendly Grazing

Courtesy of Laura Paine