Managing Upland Grazing to Restore Soil Health and Farm Livelihoods

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Wimberley, Texas
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**Carbon rich soil:**

Benefits the entire ecosystem

**Healthy Ecosystems result in:**

- Improved water infiltration and retention;
- Increased biodiversity of soil microbes, plants, insects, wildlife;
- Reduced soil erosion & reduced NET GHG emissions; and
- Contributing to improved livestock and farmer well-being.
90% of Soil function is mediated by microbes

Microbes depend on plants

So how we manage plants is critical
Biggest limiting factor in Rangeland
Water in the Soil
What good infiltration looks like....
The Four Ecosystem Processes

1. **Energy flow** - Maximize the flow of solar energy through plants and soil.

2. **Water cycle** - Maximize capture and cycling of water through plants and soil. Reduce export and import.

3. **Mineral cycle** - Maximize cycling of nutrients through plants and soil.

4. **Community dynamics** - High ecosystem biodiversity with more complex mixtures and combinations of desirable plant species leads to increased stability and productivity.
To improve Soil Health

Improve soil microbe population by:

- Keeping the 4 ecosystem processes functioning
- Improving plant cover
- Perennial plants rather than annuals
- Manage for most productive plants
- Leave adequate plant residue
- Minimizing bare ground
- Manage for green leaves for as many days each year as possible
Landscape impact of continuous grazing

Edwards Plateau Ranch 3-D View w/ GPS Locations

1. 39% area used
2. 41% GPS points on 9% area
3. SR: 21 ac/cow
4. Effective SR: 9 ac/cow
Light continuous grazing
- patch selection
- no recovery
Many graziers use Adaptive Multi-Paddock grazing successfully

Most conservation winners use MP grazing

- Overgrazing has little to do with number of animals.
- But with the amount of time plants are exposed to animals.
Adaptive Multi-Paddock Grazing

- Ranch road
- Existing fence
- Electric fence
- Water point
North America - Semi-Arid Rangeland

Continuous grazing

H₂O → CO₂

AMP grazing

H₂O → CO₂
Causal Mechanisms

AMP grazing with
  • Short graze
  • Good recovery

Light continuous grazing
  • patch selection
  • no recovery

Energy Flow
Water Cycle
Mineral Cycle
Community Dynamics
Importance of Microbes and Fungi

- Improve soil structure
- Produce and cycle nutrients plants need
- Access and transport nutrients to plants
- Promote efficient photosynthesis
- Extend root volume and depth
- Produce exudates to enhance soil C
- Increase water and nutrient retention
- Increase drought resistance
- Fend off pests and pathogens
- Plant growth increases with increasing fungal to bacterial ratio

Lehman et al. 2015; Montgomery & Biklé 2015
Dung beetles in the Ecosystem

Tunnelers  Dwellers  Rollers

Estimated value ± $2 Billion per year
Earthworms in the ecosystem

Anecic burrow entrances called "middens" are surrounded with a mound of cast material (worm poop) and crowned with fragmented leaf parts.

Epigeic
- Litter dweller, feeder
- No burrows
- Pigmented skin
- Small size

Endogeic
- Soil feeder
- Mineral soil dweller (0-50 cm)
- No skin pigmentation
- Creates a network of horizontal, branching burrows
- Small to medium-sized

Aneic
- Fresh litter feeder
- Soil dweller
- Pigmented skin
- Digs deep, vertical, unbranching burrows
- Large size

Anecic burrows may reach depths up to two meters!

Three major ecological groups of earthworms have been identified based on the feeding and burrowing behaviors of the different species.
High density AMP grazing

- 200 cows drop 25 tons of dung a week
- Increase infiltration ~ 130%
Low density continuous grazing

High density AMP grazing
Restoration using Planned grazing

Noble Foundation, Coffey Ranch

Degraded rangeland
18 paddocks + water point
Managed to IMPROVE plant species
Restoration using Planned grazing

Noble Foundation, Coffey Ranch
Charles Griffith, Hugh Aljoe, Russell Stevens
Managing for Desired Outcomes

- Flexible stocking to match forage availability and animal numbers
- Spread grazing over whole ranch
- Defoliate moderately in growing season
- Use short grazing periods
- Adequate recovery before regrazing
- Graze again before forage too mature
- Adaptively change with changing conditions
Influence of multi-paddock grazing on soil and vegetation
Influence of multi-paddock grazing on soil and vegetation

Neighbouring ranches in each county:

- Usual case Continuous graze @ heavy SR (± 10 ac/AU)
- Best case Continuous graze @ light SR (± 20 ac/AU)
- Planned HM graze @ heavy SR (± 10 ac/AU)

Grazing treatment at least 10 years
Continuous grazing at high SR
Multi-paddock grazing at high SR
Bare Ground

P = 0.0006

Heavy Continuous

Heavy Multi-camp

Light Continuous
Tall Grasses

![Bar chart showing biomass (kg ha\(^{-1}\)) for different management practices.]

- **Heavy Continuous**
- **Heavy Multi-camp** with annotation 'a'
- **Light Continuous** with annotation 'b'

**P = 0.003**
**Mid Grasses**

![Bar chart showing biomass (kg ha$^{-1}$) for different management practices: Heavy Continuous, Heavy Multi-camp, and Light Continuous. The P-value is 0.188.](chart)

**Legend:**
- Heavy Continuous
- Heavy Multi-camp
- Light Continuous

**Groups and Significance:**
- Group b
- Group ab
- Group a

**Significance Levels:**
- P = 0.188
Annual Forbs

![Annual Forbs graph](image)

- **Biomass (kg ha\(^{-1}\))**
- **Heavy Continuous**: a
- **Heavy Rotation**: b
- **Light Continuous**: b

\[ P = 0.014 \]
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Grazing Management</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Heavy continuous</td>
</tr>
<tr>
<td>Total bacteria (gm⁻²)</td>
<td>82a</td>
</tr>
<tr>
<td>Total fungi (gm⁻²)</td>
<td>97b</td>
</tr>
<tr>
<td>Fungi to Bacteria</td>
<td>1.2b</td>
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</table>
# Soil Carbon, Nutrients and Water

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Heavy Continuous</th>
<th>Light Continuous</th>
<th>Multi-paddock</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil Organic Matter</td>
<td>3.1b</td>
<td>4.4b</td>
<td>4.86a</td>
</tr>
<tr>
<td>Fertility CEC</td>
<td>24.6b</td>
<td>23.7b</td>
<td>27.4a</td>
</tr>
<tr>
<td>Water holding (Gal/ac)</td>
<td>55,700</td>
<td>79,059</td>
<td>87,324</td>
</tr>
</tbody>
</table>
Clear Creek watershed, north Texas

Legend
- Stream Gage
- Clear Creek
- Ranch
- CCW

Land use
- Agriculture
- Water
- Residential
- Bare field
- Forest
- Rangeland

Legend
- Danglemayr
- Pittman
- Mitchell
- Leo
### Riesel Experimental ranch, Texas - net returns

<table>
<thead>
<tr>
<th>Category</th>
<th>Conservation ranch ($)</th>
<th>Traditional ranch ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labor</td>
<td>2,058</td>
<td>3,972</td>
</tr>
<tr>
<td>Feed</td>
<td>6,586</td>
<td>12,780</td>
</tr>
<tr>
<td>Vet.</td>
<td>480</td>
<td>596</td>
</tr>
<tr>
<td>Misc.</td>
<td>463</td>
<td>16</td>
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<tr>
<td>Sampling</td>
<td>516</td>
<td>0</td>
</tr>
<tr>
<td>Capital</td>
<td>3,022</td>
<td>0</td>
</tr>
<tr>
<td>Cattle purchases</td>
<td>6,500</td>
<td>13,000</td>
</tr>
<tr>
<td>Mach./fuel</td>
<td>3,382</td>
<td>6,549</td>
</tr>
<tr>
<td>Seed</td>
<td>5,182</td>
<td>2,106</td>
</tr>
<tr>
<td>Fertilizer</td>
<td>4,879</td>
<td>9,386</td>
</tr>
<tr>
<td>Chemical</td>
<td>745</td>
<td>670</td>
</tr>
<tr>
<td><strong>Total costs</strong></td>
<td><strong>33,812</strong></td>
<td><strong>49,075</strong></td>
</tr>
<tr>
<td><strong>Revenue</strong></td>
<td><strong>34,983</strong></td>
<td><strong>48,995</strong></td>
</tr>
<tr>
<td><strong>Avg. net profit</strong></td>
<td><strong>1,170</strong></td>
<td><strong>(-80)</strong></td>
</tr>
</tbody>
</table>
Soil microbial communities are fundamentally important to plant productivity

The 4 principles to optimizing microbe benefits are:

1. Maintenance of year-round living cover, via perennial pastures on grazed land and/or multi-species cover crop on farmed land.

Almost every living thing in and on the soil depends on green plants for its existence.

The more green plants, the more life.
2. **Provide support for the microbial bridge, to enhance the flow of carbon from plants to soil.**

   This requires reducing inputs of high analysis nitrogen and phosphorus fertilizers that inhibit the complex biochemical signalling between plant roots and microbes.

3. **Promote plant and microbial diversity.**

   The greater the diversity of plants the more checks and balances for pests and diseases and

   The broader the range of microhabitats for the soil organisms involved in nutrient acquisition, nutrient cycling and soil building.
4. The land responds positively to the presence of animals provided management is appropriate.

High intensity, short duration livestock grazing with adequate recovery on perennial pastures is the fastest and most economical way to improve soils.

It adds manure and urine to soils, and increases root exudation and stimulates the number and activity of associative nitrogen-fixing bacteria in the root zone.

This stimulates positive response to defoliation and provides extra nitrogen required by the plant for the production of new growth.
What we have learnt from ranchers......1

- It takes a minimum of 10 paddocks just to stop overgrazing

- Ranchers with 8 or fewer paddocks are not rotationally grazing, but rotationally overgrazing

- To support decent animal performance takes 14-16 paddocks

- The most rapid range improvement takes 30 paddocks

- The biggest decrease in workload and greatest improvement has been with > 50 paddocks

Dave Pratt, Ranch Management Consultants, rancher survey
What we have learnt from ranchers

- The fastest, cheapest way to create more paddocks is combining herds
- 1 herd reduces workload a lot; checking 4 herds of 200 animals takes much longer than 1 herd of 800
- Productivity per acre is improved without decreasing individual animal performance
- Carrying capacity and total productivity are greatly increased at low cost
- Long recovery periods are critical
- Do not move to the adjacent paddock but to the paddock that has recovered the most

Dave Pratt, Ranch Management Consultants, rancher survey
Importance for Ecosystem Function?

Adaptive Multi-Paddock grazing can:

- Build SOC levels and soil microbial function
- Enhance water infiltration and retention
- Build soil fertility
- Control erosion more effectively
- Enhance watershed hydrological function
- Improve economic returns while improving the resource base
- Enhances wildlife and biodiversity
- Result in grazed soils being a net greenhouse gas sink
Successful multi-paddocks managers use:

- Flexible stocking to match forage availability and animal numbers
- Spread grazing over whole ranch
  - Moderate grazing during growing season
  - Short graze periods
  - Allow recovery before regrazing
  - Graze again before forage too mature
- Use multiple livestock species
Thank you