AMP Grazing Research Proposal

Can Adaptive Multi-Paddock (AMP) grazing contribute to sequestering carbon in soils and improve delivery of ecosystem services & socio-ecological resilience in grazing ecosystems?

Applied Ecological Services, Inc.
Texas A&M AgriLife Research
ecdysis
TerraNimbus
Colorado State University
NM State University
University of Arkansas
ASU
The Future Grows Here
carbon nation
Michigan State University

The **AMP Grazing Research Project (AMP Research)** seeks to find out whether this grazing method can regenerate soils, clean water supplies, feed many more people on much less land while drawing down enormous amounts of CO_2 from the atmosphere.

Based on early data showing significant soil carbon storage, we believe it is well worth the time and expense to conduct robust systems science to better understand whether grazing management alone can produce resilient farmland ecosystems.

AMP Research will be coordinated by carbon nation, in collaboration with Arizona State University. AMP Research development was funded by Shell GameChanger, Rodel Foundation, Jim & Paula Crown, Sarah & Evan Williams Foundation, The World Bank, The Thornburg Foundation and The Rob and Melani Walton Sustainability Solutions Initiatives.

Adaptive Multi-Paddock (AMP) Grazing

Background Info

(please watch *Soil Carbon Cowboys*)

- AMP grazing mimics predator/prey relationship of roaming herds
- Small paddocks grazed quickly, then long rest periods
- Photosynthesis pumps carbon from the air, through plants into soil

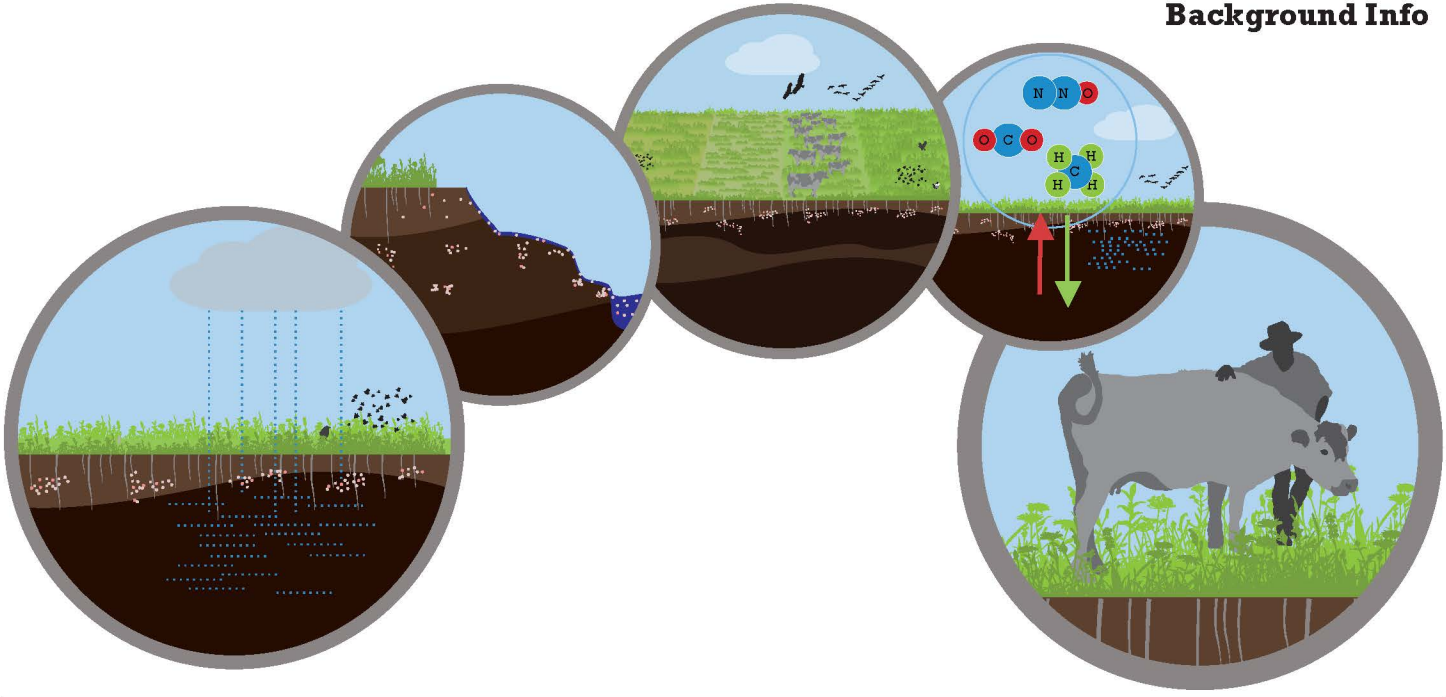
Photosynthesis Brings Carbon Into The Ground

Background Info

- Photosynthesis spikes during rest after AMP grazing, increasing CO_2 uptake
- Plants exhale oxygen & send carbon to feed soil microbes
- Leads to significant build up of organic carbon in soil

Carbon Is The Currency

Background Info

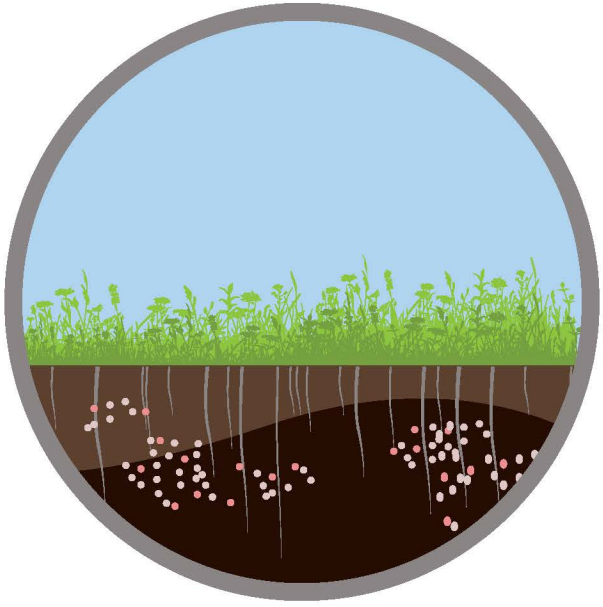


- Carbon rich soils benefit whole ecosystem
- Increased water retention & biodiversity: microbes, plants, insects & wildlife
- Reduced soil erosion & GHG emissions (CO_2, methane, nitrous oxide)
- Improves both livestock and rancher well-being
- We will conduct rigorous scientific measurement of all the above

Will The Carbon Stay In The Soil?

Soil Carbon Storage Pools

Background Info

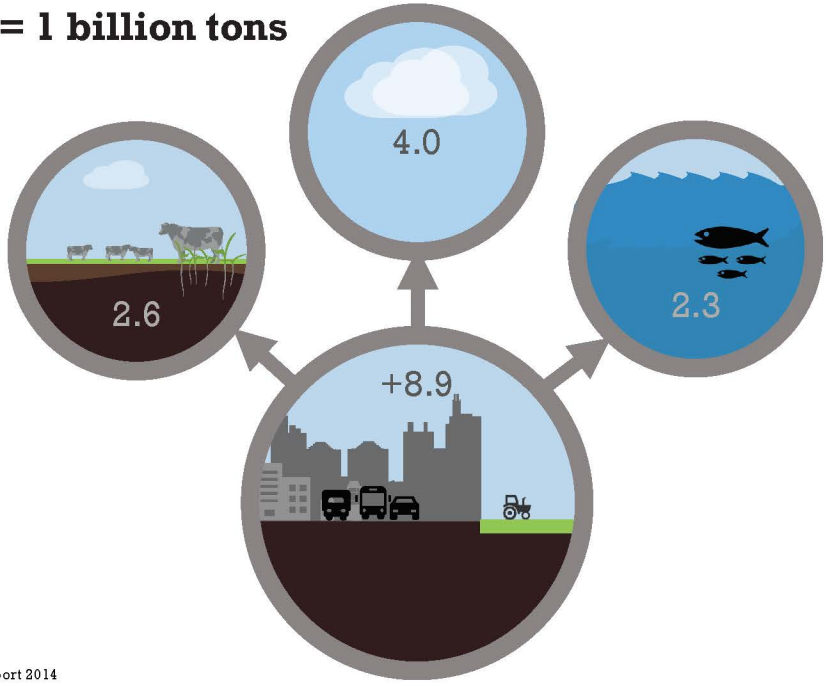


- Carbon stored in 3 basic pools in soil, where it stays for:
  - Days - microbes respire carbon; it returns to air as CO_2
  - Decades - carbon embeds in old root systems
  - Centuries - carbon binds to soil aggregates

Global Carbon Fluxes – Gigatons*/Year

***Gigaton = 1 billion tons**

Background Info

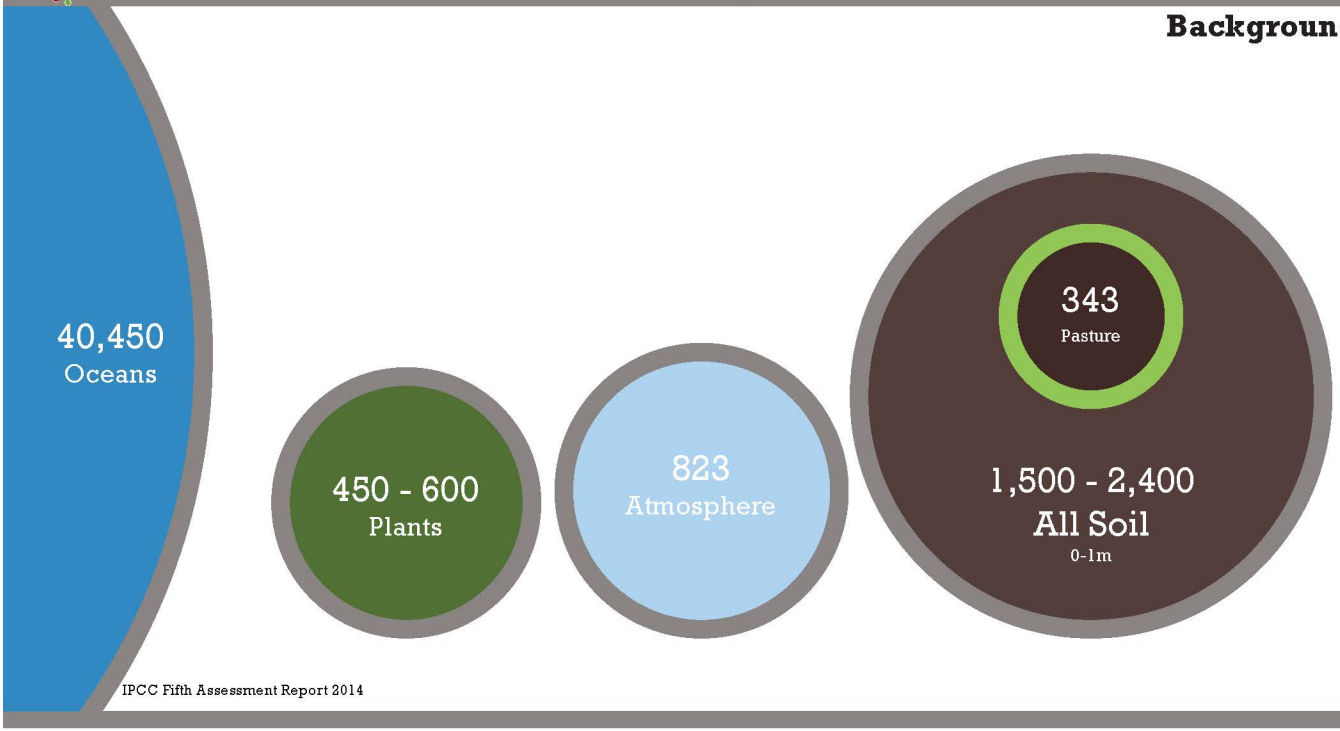


IPCC Fifth Assessment Report 2014

- Human activities emit 8.9 Gigatons of carbon (GtC) annually
- Soil+Plants absorb 2.6 GtC; Oceans absorb 2.3 GtC; 4.0 GtC remains in air
- Up to 1/5 of all this airborne carbon originates from poor soil stewardship
- Degraded soils have very high additional carbon storage potential

Global Carbon Stocks – Gigatons

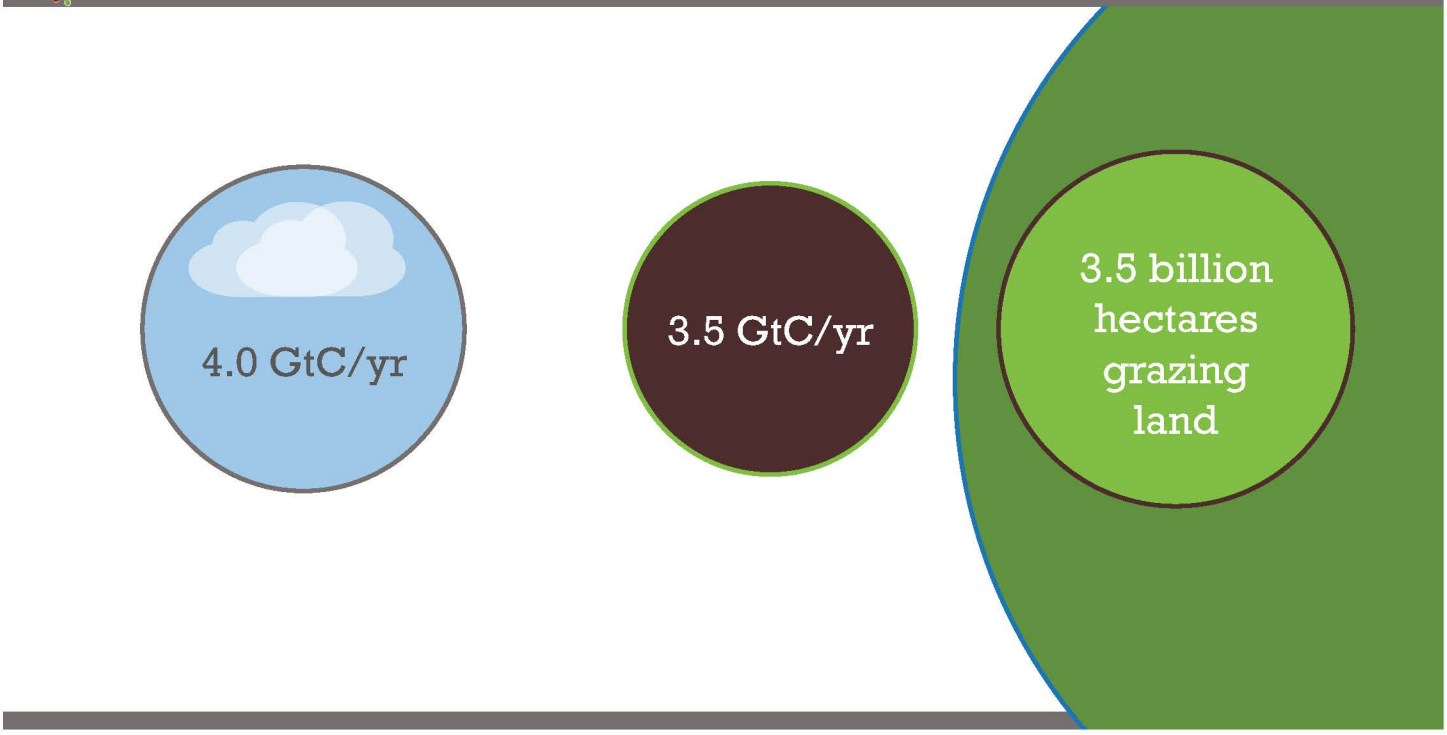
Background Info



IPCC Fifth Assessment Report 2014

- Soils already hold more carbon than plants and air: 1,500 to 2,400 GtC
- 343 GtC in pastures alone

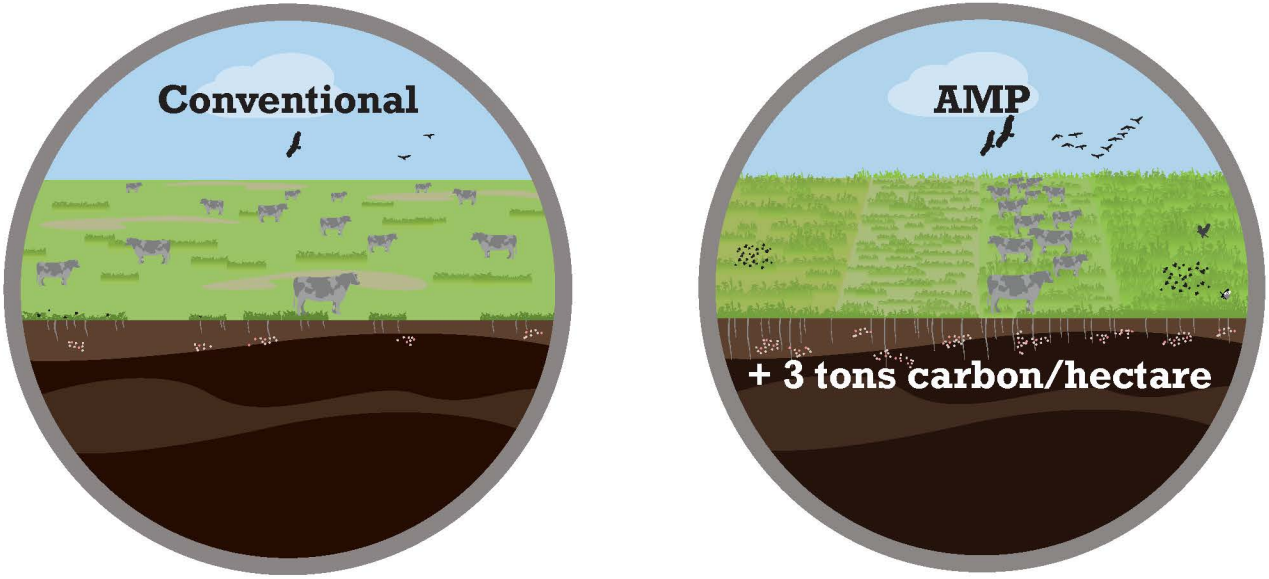
Opportunities for Scale



- 3.5 billion hectares of grazing land worldwide
- Capturing extra 1 ton of carbon/hectare/year on all 3.5 billion hectares would be 3.5 GtC, nearly equal to the 4 GtC excess carbon left in air

AMP Grazing•Soil Carbon Studies in North America

Background Info



*Teague et al (2011). Grazing management impacts on vegetation, soil biota and soil chemical, physical and hydrological properties in tall grass prairie.

- Peer reviewed TX study: AMP ranches store +3 tons more carbon/hectare/yr
- Alberta, Canada data showing +1.2 to +2.2 tons more C/ha/yr - soon to be submitted for publication
- Anecdotal evidence shows success in varying regions, soil types & rainfall
- More rigorously collected scientific data is needed
- AMP Research will compare conventional & AMP grazing to get this data

AMP Grazing Research Hypothesis

Water Resilience

Reduces Soil Erosion

Biodiversity

Food Quality & Health

Improved Farm Economics

Can Adaptive Multi-Paddock (AMP) grazing contribute to sequestering carbon in soils and improve delivery of ecosystem services & socio-ecological resilience in grazing ecosystems?

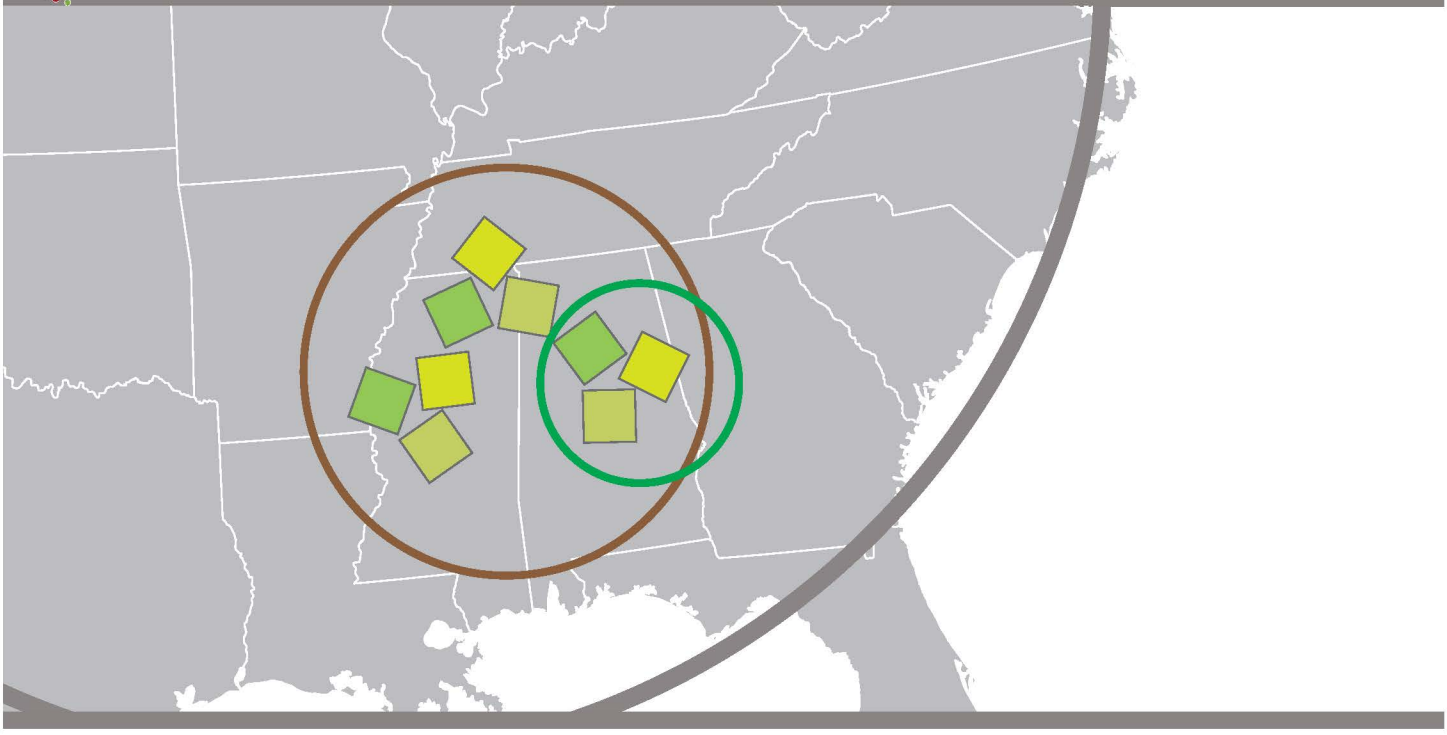
AMP Research – Systems Science: 12 Modules

- Data collection, analysis, modeling and communications in 12 Modules
- 1) Soil carbon & water; 2) Greenhouse gas cycling; 3) Vegetation; 4) Soil microbiology; 5) Arthropods; 6) Grassland Birds; 7) Livestock well-being; 8) Farmer/rancher well-being; 9) Resilience; 10) Life cycle analysis; 11) Simulation modeling; and 12) Film and communications

Experimental Design: 2 Regions - Landscape Scale

- Research is landscape scale as opposed to small plot scale
- Research conducted in the Southeast U.S. (in 2018) represents a warmer, wetter climate with longer growing season & lower latitude
- Research conducted in the Upper Great Plains U.S. (in 2019) represents a cooler, drier climate with shorter growing season & higher latitude

Experimental Design: Triads of Grazing Methods

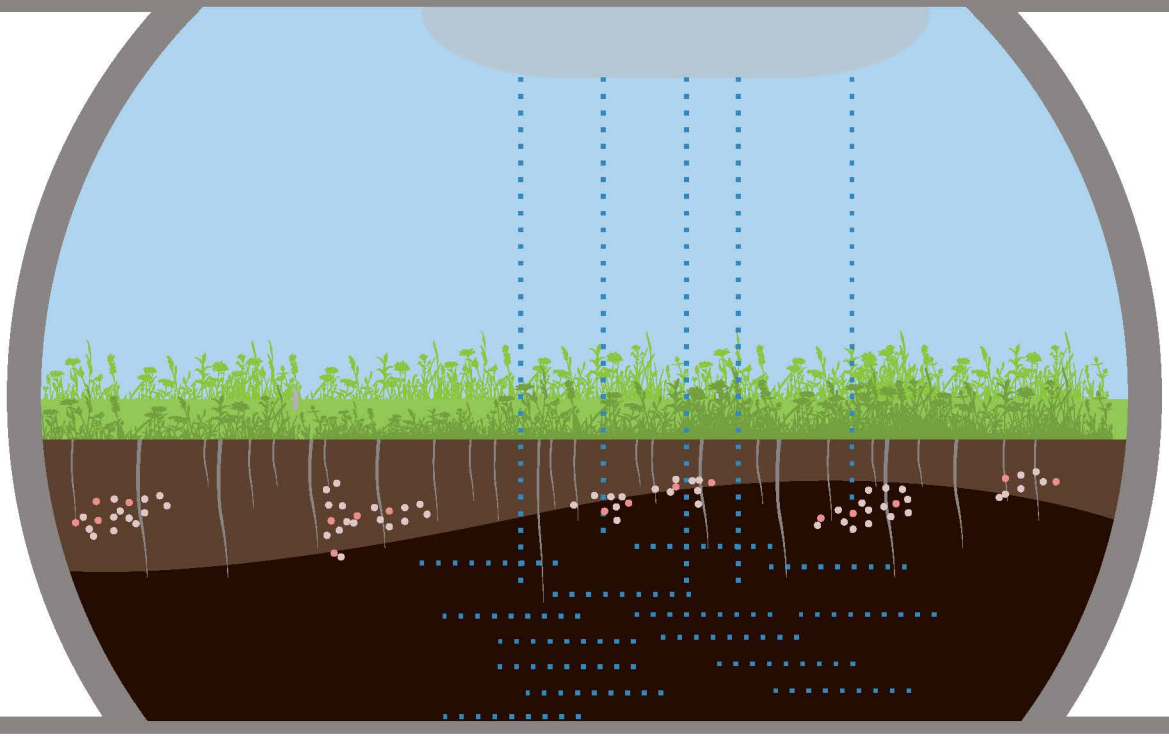


- Research compares AMP grazing with High-Stock Continuous (HCG) and Low-Stock Continuous (LCG) grazing, a Triad of Grazing Methods
- 'Apples to Apples' comparisons wherever possible: similar size operations; similar # of cattle; same soil types; same slopes on hillsides
- 3 replicates of triads per region

Experimental Design: 25 Additional AMP per Region

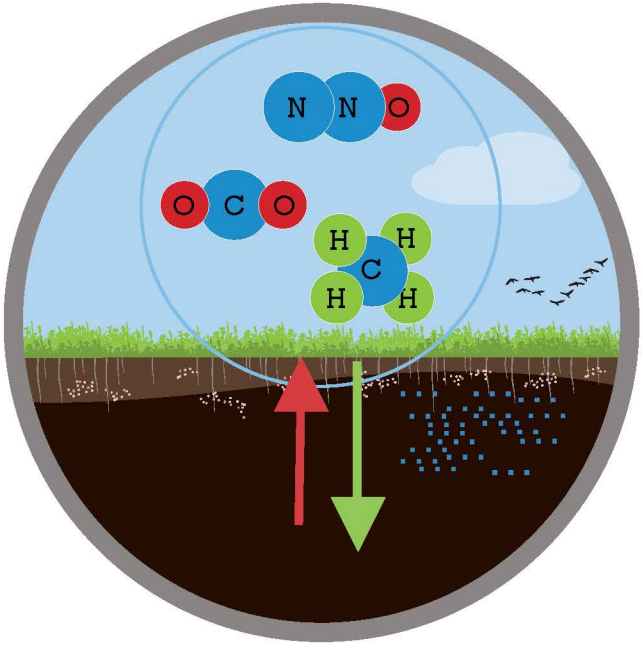
- 25 AMP ranches (per region) will be measured for soil carbon accrual with a baseline Time Zero sampling and 3 years later, a Time One sampling
- This is to see whether AMP grazing sequesters carbon, and if it does, whether this accrual can be measured in a short, 3 year period of time

Module 1: Soil carbon & water



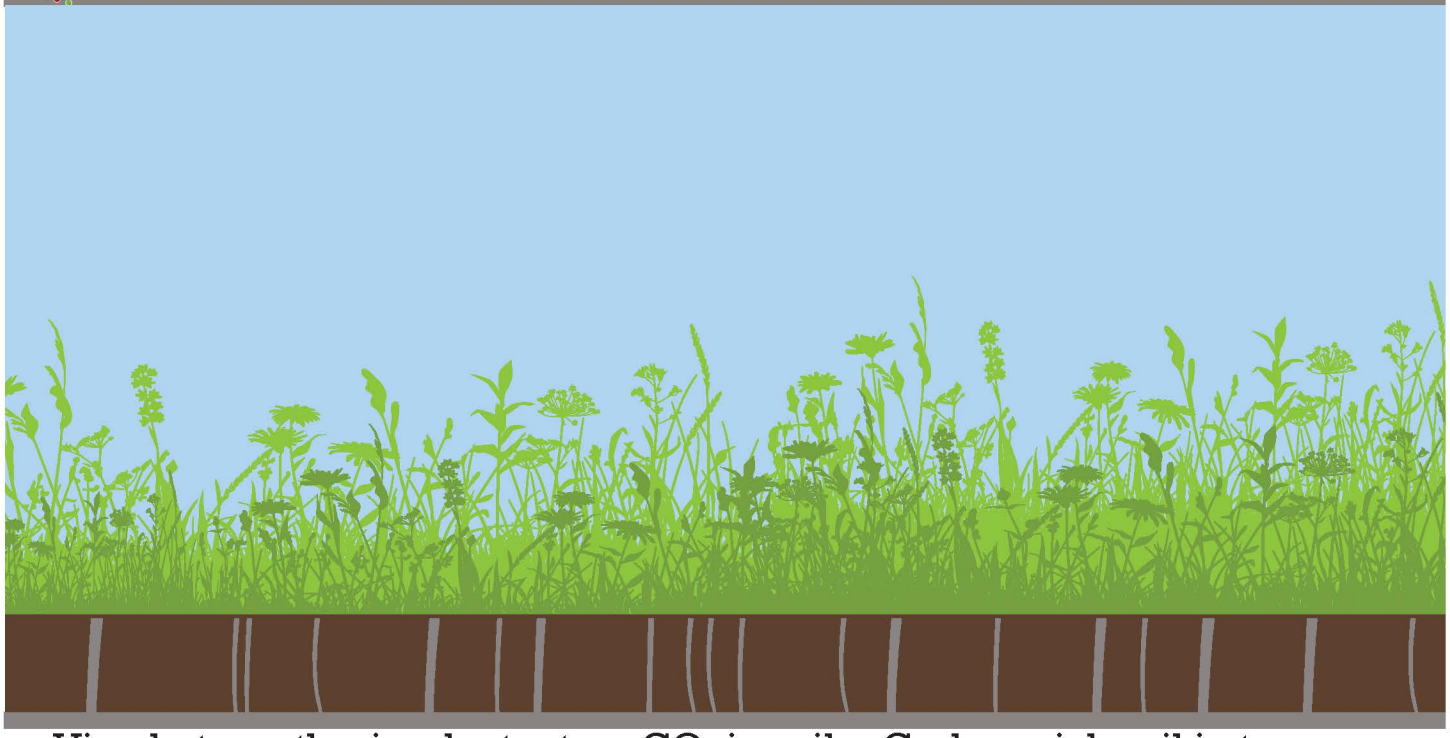
- Soil carbon is a key indicator of healthy soils.
- Essential to understand which grazing systems either increase or decrease soil carbon levels & how long increased soil carbon will remain there.
- Amount of carbon in soil is closely associated with the capacity of land to absorb and retain water & thus directly associated with resilience to drought and flood.

Module 2: Greenhouse (GHG) Gas Cycling



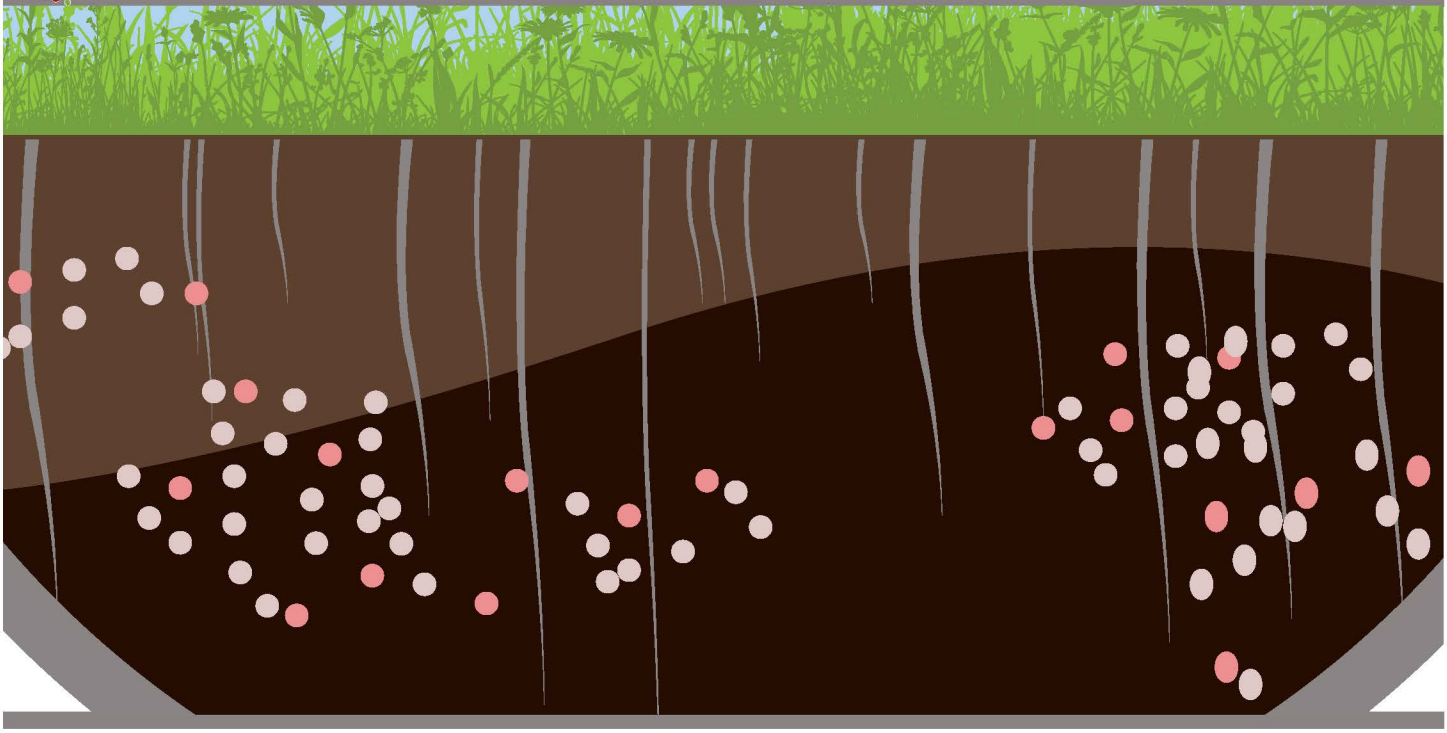
- Grazing cattle act as ecosystem engineers.
- Understanding how cattle affect the ranch ecosystem requires study of GHG cycles and whether these grazing systems are net emitters or net sinks of GHG, specifically carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_20).
- Discover if, how & why ranchers are capturing significant soil carbon.

Module 3: Vegetation



- Via photosynthesis, plants store CO_2 in soils. Carbon-rich soil in turn increases plant productivity, diversity and nutrient-density.
- Healthy livestock depend on healthy and diverse vegetation.
- Healthy vegetative cover reduces carbon loss from soil erosion, regulates soil temperature, creating an environment conducive for soil microbial life.
- The more biodiverse the vegetation, the more carbon stored in soils.

Module 4: Soil Microbiology



- Bacteria, viruses, and fungi (the soil microbiome) break down plant and animal material & contribute to the formation of soil organic matter.
- Arbuscular mycorrhizal fungi can help form & stabilize soil aggregates, further increasing soil organic matter durability.
- Soil microbes make nutrients available, improve water storage and are themselves a huge carbon reservoir, especially with higher biodiversity.

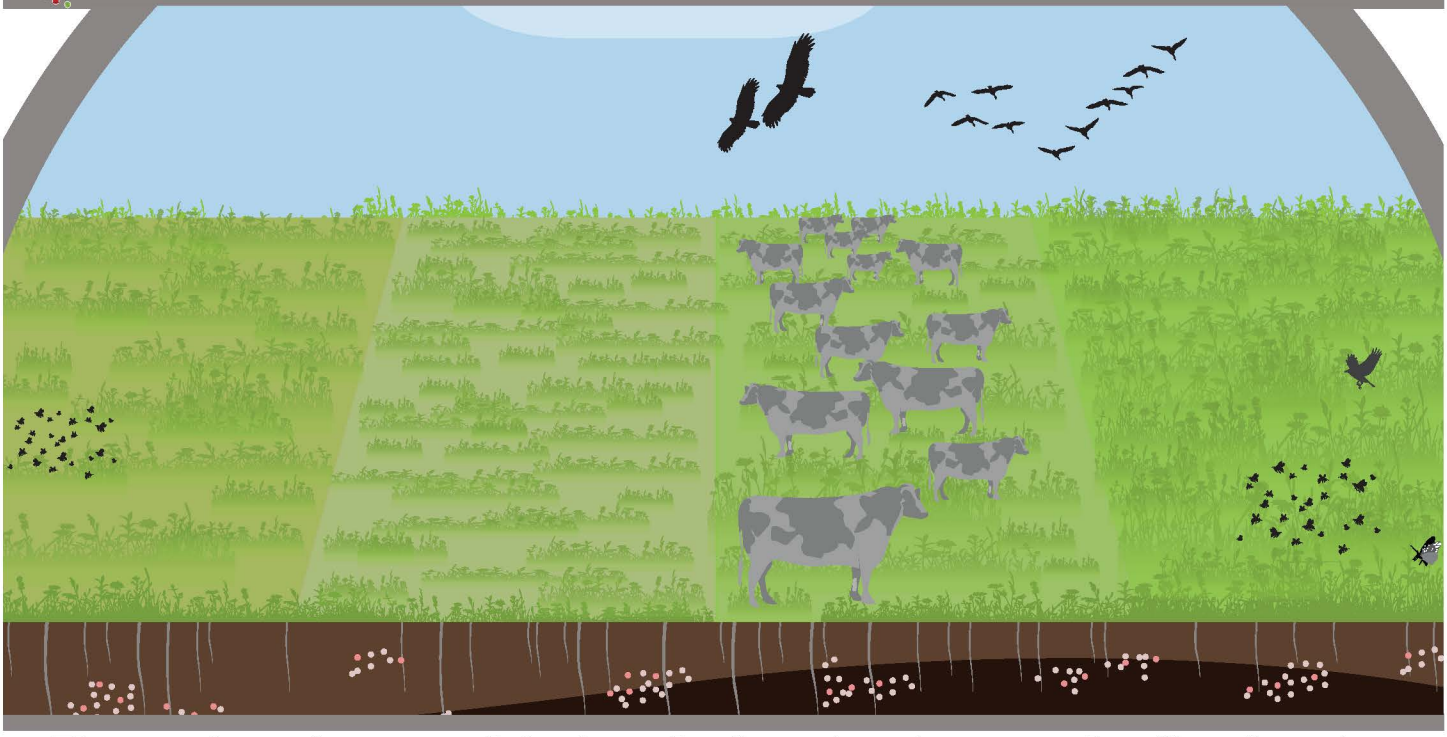
Module 5: Arthropods

- Insects (i.e.: pollinators, dung beetles) and other arthropods are essential for making above and below ground plant tissue available for soil microbial communities and are key players in soil health, water infiltration & retention, and soil carbon storage.
- Via pollination, insects help create and benefit from diverse forage production, which lays the foundation for diverse wildlife.

Module 6: Grassland Birds

- The biodiversity of birds is a key indicator of general wildlife biodiversity, over-all ecosystem health, including carbon-rich soil health.
- Carbon-rich soils with biodiverse microbial and insect populations, nutrient-dense forage, and structurally intact grasslands are key factors for diverse bird populations.

Module 7: Livestock Well-being

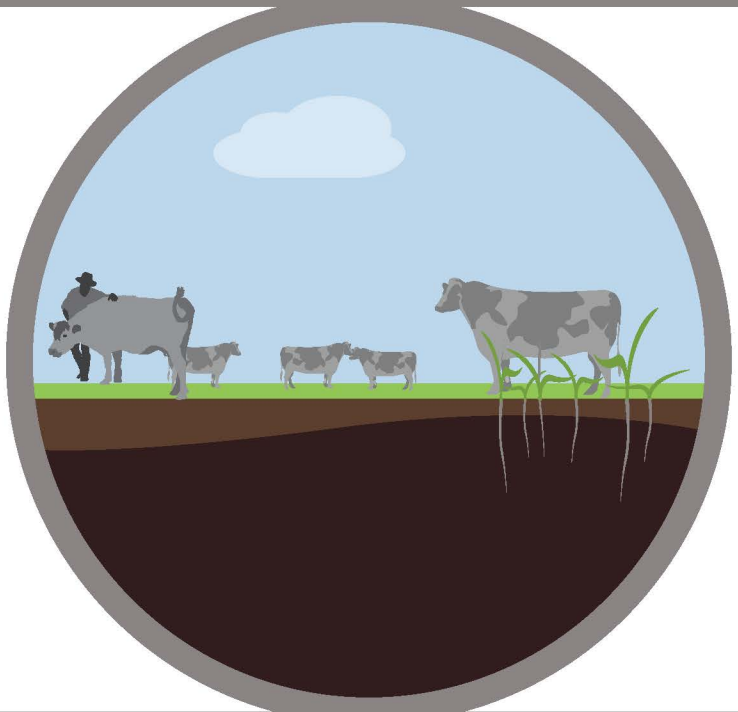


- The number of cows and the length of grazing time greatly affect farm/ ranch ecosystem & economic health.
- Cattle health is directly linked to forage quality and quantity, which is the product of soil carbon content, water retention, GHG cycles, microbial health, bug & bird biodiversity and rancher management decisions.
- We will measure average daily weight gain & use of medications.

Module 8: Farmer/Rancher Well-being

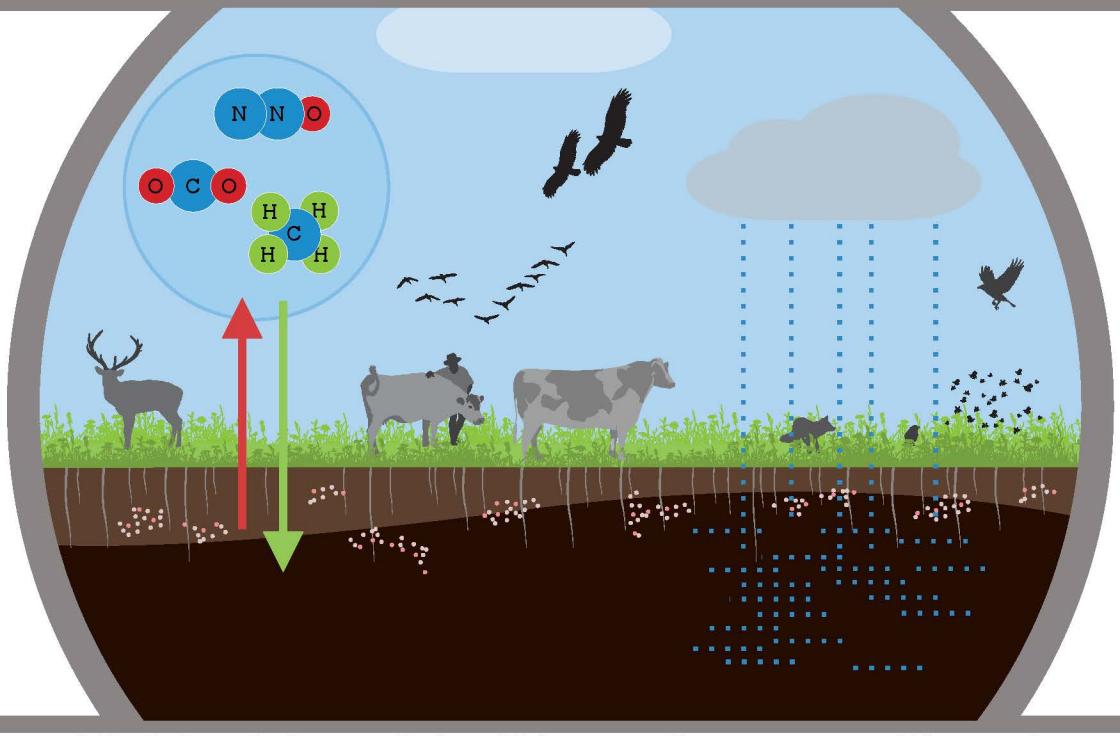
- Grazing methods (AMP, HCG, LCG) directly impact soil health, which is foundational for farm/ranch production and financial stability.
- This module will establish any differences in wellbeing of ranchers practicing AMP, HCG or LCG.
- This module focuses on gaining knowledge that will lead farmers/ranchers to adopt methods that increase soil carbon and improve ecosystem health.

Module 9: Resilience



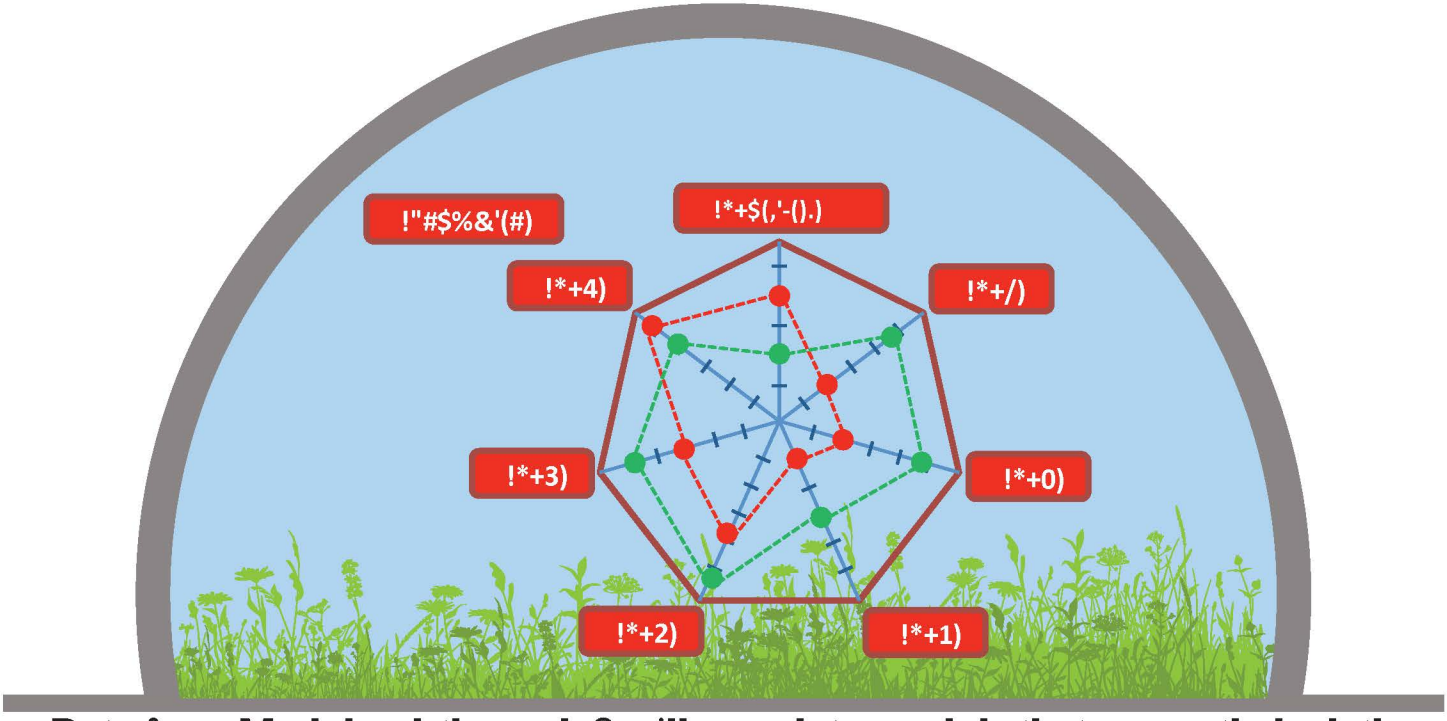
- The research data from Modules 1 through 8 will be synthesized and used to analyze which grazing system (AMP, HCG, LCG) is more resilient to droughts, floods and price shocks.
- The outcomes will be used to guide ranchers to more productive livelihoods that are socially, financially, and ecologically sustainable.

Module 10: Life Cycle Assessment



- Data from Modules 1 through 8 will be used to create a life cycle assessment (LCA) of all flows of energy, materials and nutrients into and out of AMP, HCG and LCG grazing systems to gauge financial and ecosystem efficiency for farmers/ranchers.
- This LCA will show if any of these grazing systems (AMP, HCG, LCG) could create green house gas (CO_2, methane, nitrous oxide) sinks.

Module 11: Simulation Modeling



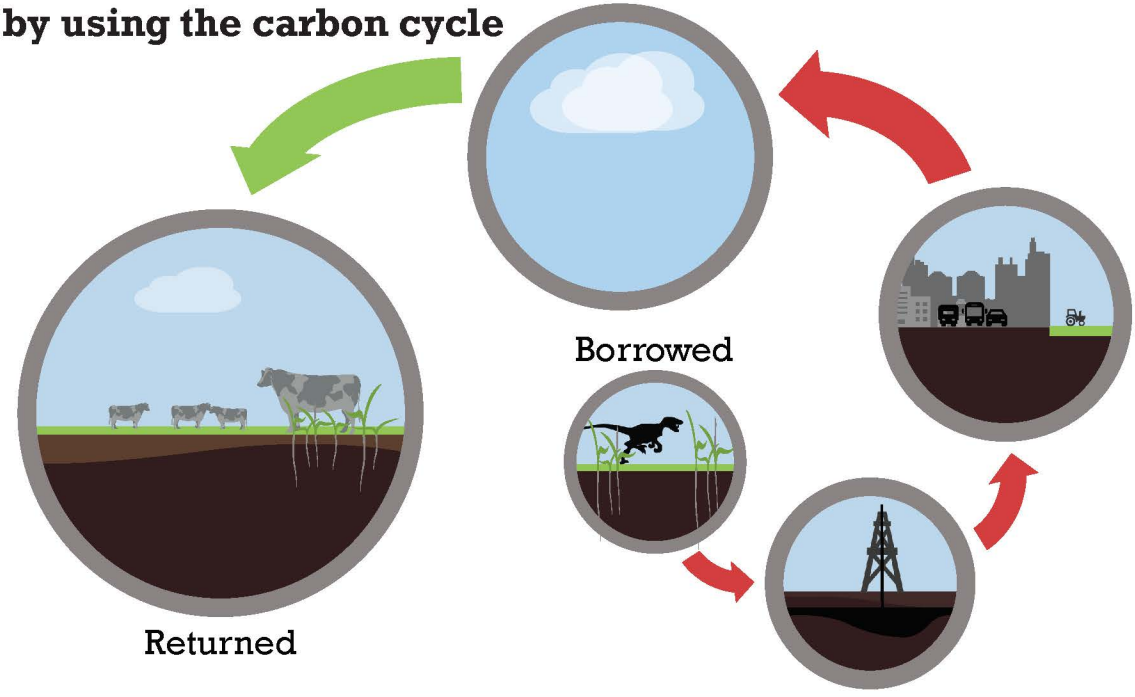
- Data from Modules 1 through 8 will populate models that currently lack the ability to simulate grazing management systems and their impacts on the carbon, water and GHG cycles, forage production and wildlife biodiversity.
- These models will enable farmers/ranchers to better understand how potential changes to grazing methods will affect land and animal health & will lay the groundwork for true soil carbon & ecosystem services markets.

Module 12: Film and Communications

- Film crews will capture farmers/ranchers and the scientists studying their grazing methods, giving context to all the data collected from Modules 1 through 11.
- Making the research results personal, approachable and understandable to all stakeholders (including farmers/ranchers, policymakers, educators, consumers and more) is a key component of the research.

Closing the Carbon Cycle

…by using the carbon cycle



- Fossil fuel carbon comes from ancient sunlight buried deep, long ago
- Soil carbon storage uses the same process to put that carbon back
- Worldwide, soils have potential to store significant part of human emissions

Click here to watch our Science Team Film: *Soil Carbon Curious*