Recent Data Supports Soil Health Benefits of Adaptive High Stock Density Grazing

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A new research project is underway to closely examine the soil, ecosystem, and environmental impact of Adaptive Multi-Paddock Grazing Principles (AMP). Adaptive Multi-Paddock Grazing (AMP) involves managing livestock using multiple small paddocks to provide periods of short duration/high stock density grazing followed by adequate forage rest & recover periods. The purpose is to mimic as closely as possible the predator-influenced herd migrations of wild ruminants such as ancestral bison, elk and equids.

The project is headquartered out of the Arizona State University (ASU) School of Sustainability and involves a consortium of leading experts in soil health, grass-based livestock production, ecosystem biodiversity and management, and socio-economic experts. Institutions, companies, and organizations involved include ASU, Texas A&M AgriLife Research, Michigan State University, New Mexico State University, AgBioResearch, and Applied Ecological Services.

The purpose of the research is to answer the question: "What are the best grazing management practices that would enable sequestering significant amounts of carbon in grassland soils while simultaneously reinvigorating soil health and improving grassland social-ecological systems?

In order to answer the primary question, the research team proposes to find how and where AMP grazing is actually improving farm/ranch ecosystems by measuring: 1) soil carbon stored, 2) soil water infiltration, retention, and soil erosion, 3) populations/biodiversity of fungi, bacteria, protozoa, plants, insects and wildlife, 4) greenhouse gas fluxes (carbon dioxide, nitrous oxide and methane), and 5) farmer/rancher and animal well-being.

Prior peer-reviewed research by Dr. Richard Teague, Texas A&M AGriLIfe Research, shows that north central Texas ranches practicing AMP grazing principles have been able to sequester 30 more tons of carbon per hectare (12.14 tons per acre) over a ten year period when compared with more conventional grazing practices. Anecdotal evidence indicates similar potential for carbon storage in different eco-regions, so this proposed research is designed to provide the data needed to validate.

In order to collect the necessary data needed to provide the true differences in soil carbon sequestration and soil health parameters, the research team will compare a triad of neighboring farms/ranches within each designated region of the country. Grazing systems compared will be AMP, and conventional continuous grazing practices with either high stocking rates (HCG) or low stock rates (LCG). The regions will consist of four diverse eco-regions within the U.S. and southern Canada. Within each region, data will be collected on three separate farm/ranch triads for a total of 36 farms/ranches participating in the study.

The first set of data was collected in the Fall of 2014 using a triad of farms located in Northeast Mississippi. The farms selected have agreed to participate in a multi-year study. The farms are in close proximity to each other and are comprised of the same soil types, topography, and annual average rainfall. The only primary difference was the grazing strategy employed by each farm.

The three farms selected were:

1. **Farm 1** – Practicing Adaptive Multi-Paddock Grazing (**AMP**) for the past five years. Prior to that the farm was alternately in row crop, dairy, and CRP for the last several decades. Stock density for the AMP grazing over the past five years was strategically alternated between 100,000 lbs/acre and over 500,000 lbs/acre, with cattle being moved either daily or multiple times a day to fresh pasture. Starting soil organic matter at the beginning of AMP grazing five years ago was 1.5 to 1.6%. A cow/calf operation has been maintained on the farm for the past five years with the cattle being used as a tool for land improvement.
2. **Farm 2** – Practicing a more conventional grazing methodology of continuous grazing with high stocking rates **(HCG)**. The cattle are rotated to fresh pasture once every two to four weeks. The farm has been continuously in pasture and grazing for the past 50 years, alternating between cow/calf and stocker grazing.
3. **Farm 3** – Practicing continuous grazing with low stocking rates **(LCG).** Cattle are free to graze the majority of the farm without restriction to movement. This farm has been in continuous grazing (primarily cow/calf) for the past 40 years.

In early November of 2014, a team of scientists collected soil data from each farm on the same day. Random locations were selected on each of the three farms and soil pits were dug to a depth of three feet. Soil samples were collected for analysis within every six inch layer from the soil surface down to three feet (36 inches). Observations were made and recorded pertaining to root structure and development, presence of soil organisms, soil texture, and soil aggregation.

Immediate observations were that root structure and development, including root depth and mass, were significantly greater at the AMP farm compared to the HCG and LCG farms. Root growth was observed all the way down to and past the three foot depth on the AMP farm. On the other farms, root growth did not reach the three foot depth. In addition, there were noted differences in apparent soil life with earthworms immediately present in the soil of the AMP farm. Earthworm populations were significantly lower at the HCG and LCG farms. Likewise, soil texture, aggregation and appearance was significantly better at the AMP farm when compared to the HCG and LCG farms.

Laboratory analysis of the soil samples from each farm revealed even more startling differences. **Table 1** shows the difference in soil pH between the three farms. Soil data are presented in Horizons with each Horizon representing 6 inches (Horizon 1 equals the top 6 inches of soil, Horizon 2 equals the second 6 inches, etc.). On the AMP farm, soil pH was a constant 7.8-7.9 from the top six inches down to

36 inches. On the HCG farm, soil pH ranged from 5.8 in the top 12 inches to 7.0 at 36 inches. On the LCG farm, soil pH ranged from 5.6 in the top 12 inches to 4.9 at 36 inches.

Table 1: Soil pH on Three Sampled Farms to Depth of 36 inches.

Soil Carbon Data – Soil pH

Horizon	AHSD	CG - Rotation	CG - Cont
1	7.9	5.9	5.5
2	7.9	5.8	5.6
3	7.9	6.2	5.3
4	7.8	6.3	5.1
5	7.8	6.8	5.1
6	7.9	7.0	4.9

Table 2 shows the result of analysis for Total Soil Carbon from each of the three farms (represented in percent soil carbon). The AMP farm had total soil carbon measurements ranging from 4.67% in the top 6 inches to 1.42% at 36 inches. The HCG farm had a range in Total Soil Carbon from 1.64% in the top 6 inches to 0.41% at 36 inches. The LCG farm had Total Soil Carbon measurements ranging from 1.36% in the top 6 inches to 0.34% at 36 inches. So, on the AMP farm, Total Soil Carbon was significantly higher all the way down to 36 inches. On the HCG and LCG farms, Total Soil Carbon dropped sharply with samples taken at greater depths.

Table 2: Total Soil Carbon to Depth of 36 Inches.

Soil Carbon Data – Total Soil Carbon

Horizon	AMP	HCG	LCG
1	4.67	1.64	1.36
2	4.00	1.88	1.37
3	2.95	1.03	0.40
4	2.04	1.02	0.54
5	1.71	0.38	0.40
6	1.42	0.41	0.34

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Table 3 shows the soil organic matter (SOM) results from the three farms (represented in percent soil organic matter). On the AMP farm, SOM was 4.26% in the top 6 inches and 1.98% at 36 inches. As stated earlier, the AMP farm started 5 years ago with an average of just 1.5% SOM in the top 6 inches, so the SOM has increased almost 3 times within a 5 year period (SOM from five years ago was not available for the HCG and LCG farms. It is estimated that the current SOM on the HCG and LCG farms was approximately the same as it was five years ago since management has been static). On the HCG farm, SOM ranged from 3.28% in the top 6 inches to 0.82% at 36 inches. On the LCG farm, SOM ranged from 2.72% in the top 6 inches to 0.68% at 36 inches.

Table 3: Soil Organic Matter to a Depth of 36 Inches.

Soil Carbon Data – Soil Organic Matter

Horizon	AMP	HCG	LCG
1	4.26	3.28	2.72
2	3.22	3.76	2.74
3	3.10	2.06	0.80
4	2.98	2.04	1.08
5	2.80	0.76	0.80
6	1.98	0.82	0.68

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Table 4 shows the Carbon Assessment per acre in terms of KG of carbon per square meter, toms of carbon per acre, and tons of CO_2 equivalent per acre. The AMP farm had a total of 51.41 tons of carbon per acre, whereas the HCG had 28.71 tons/acre and the LCG farm had 22.16 tons/acre. In tons of CO2 Equivalent per acre, the AMP farm had 188.13 tons/acre while the HCG and the LCG farms had 105.07 and 81.09 tons per acre, respectively.

Table 4: Carbon Assessment Per Acre Down to 36 inches.

Soil Carbon Data – Carbon Assessment Per Acre

Farm Descrip	Carbon (kg/sq meter	Carbon (Ton/ac)	Carbon (Ton CO2 Equiv)
AMP	12.69	51.41	188.13
HCG	7.09	28.71	105.07
LCG	5.47	22.16	81.09

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In summary, results show that with just 5 years of AMP grazing, significant results can be achieved in terms of building soil organic matter, soil carbon, and overall soil health. Even with what are considered good grazing practices by traditional standards, AMP grazing appears to yield results and benefits that far exceed more relaxed grazing rotations (HCG). The ability to build such significant differences within a relatively short period of time make AMP grazing an attractive tool for land improvement and remediation.