# FACTSHEET FOR PARTNERSHIP FIELD VALIDATION TEST

| | |
|---|---|
| **Partnership Name** | Big Sky Carbon Sequestration Partnership |
| **Contacts:**<br>DOE/NETL Project Mgr. | Name Organization E-Mail<br>David Lang NETL lang@netl.doe.gov |
| Principal Investigator | Lee Spangler |
| **Field Test Information:**<br>Field Test Name | Rangeland Sequestration |
| Test Location | Eastern Wyoming |
| Amount and<br>Source of $CO_2$ | Tons Source: Terrestrial |
| Field Test Partners<br>(Primary Sponsors) | University of Wyoming, USDA-ARS |

**Summary of Field Test Site and Operations:**

The Rangeland Sequestration Assessment Potential Group (RSAPG) is evaluating and quantifying carbon sequestration potentials of different rangeland practices in eastern Wyoming. This study was initiated in 1982 and continued by the Big Sky Carbon Sequestration Partnership to determine carbon sequestration potential of rangelands. Grazing rangelands can influence plant community structure, soil chemical and physical properties, and the distribution and cycling of nutrients within the plant-soil system. Proper management of rangelands offers opportunities to partially mitigate the rise in atmospheric carbon dioxide concentrations through sequestration of this additional carbon via storage in biomass and soil organic matter. Field-scale studies are being conducted in native northern mixed-grass prairie sites of Wyoming. The purpose of these studies is to determine the effect of grazing intensity (none, light, heavy) on season long grazing and rotationally grazed pastures.

Improvement practices are also being implemented on a degraded northern mixed-grass prairie that has a high abundance of the exotic, invasive annual grass, downy brome. Management practices being studied include interseeding with falcata alfalfa, interseeding with cool-season perennial grasses, herbicide treatments, and herbicide plus interseeding with cool-season perennial grasses.

**Research Objectives:**

The overall goal of this project is to demonstrate that terrestrial sequestration in rangeland is a safe and permanent method to mitigate greenhouse gas emissions. The Partnership's objectives for rangelands are focused on quantifying carbon sequestration potential for several best management practices in support of the overall goal.

Specific objectives include:

- Quantify rangeland soil carbon sequestration (annual rate per hectare) due to reduced grazing.
- Quantify rangeland soil carbon sequestration (annual rate per hectare) due to reduced grazing seasonality.

- Quantify rangeland soil carbon sequestration (annual rate per hectare) due to improvement practices.
- Estimate sampling density to detect carbon sequestration for potential enrolled rangelands.

**Summary of Modeling and MMV Efforts: (Use the table provided for MMV)**

For the study on the effects of Grazing Intensity, 320 soil samples were collected in 2006

The grazing study includes 2 replicated pastures that each contain 2 sampling areas with 50-m transects from which long-term annual vegetation data has been collected. In addition, 5 soil sample sites have been located along each of these transects and were sampled in 1993 and 2003, and re-sampled in June 2006. Each soil sample was divided into 5 depths: 0-3.8, 3.8-7.6, 7.6-15, 15-30, and 30-60 cm. All samples were air dried and passed through a 2-mm sieve to remove rock fragments, surface plant litter, and coarse root material. Fine roots and organic matter were separated by hand picking material and by using air elutriation. Both the soil and root samples were ground to a fine powder using a roller mill, with the analysis of total carbon and nitrogen by dry combustion by either a Vario MACRO Elemental analyzer (Elementar Americas, Inc., Mt Laurel, NJ) or a Leco Tru Spec CN analyzer (Leco Corporation, Saint Joseph, MI). Inorganic carbon will also be determined on the soil samples using the procedure of Sherrod et al. (2002). Soil organic carbon is being calculated by subtracting inorganic carbon from total carbon. Two cores were also taken on each transect for bulk density in order to convert carbon concentration to carbon mass. The timing of this soil sampling capitalizes on sampling that occurred previously under a different project in the two replicated pastures beginning in 1993 and sampling that has been in place on the rotationally grazed pastures that have been in place since 1982 (short-duration 8 pasture heavy stocking rate).

In addition to ANOVA tests to discern significant differences with these treatments, the variability of soil carbon values within these pastures will be modeled to provide an estimate of the number of samples required to detect carbon sequestration in rangelands.

| Measurement technique | Measurement Parameters | Application |
|---|---|---|
| Soil samples processed with the methods described above | Soil organic carbon, soil total carbon, nitrogen | Detection of carbon storage in soil profile and relation to nitrogen cycling |
| Root analyses | Organic carbon, total carbon, nitrogen | Detection of carbon storage in soil profile and relation to nitrogen cycling |
| ANOVA statistical analyses | Treatments / collected data | Detection of best management practices and seasonality on carbon sequestration rates in rangeland ecosystems |

**Accomplishments to Date:**

- **Literature review and synthesis of findings on carbon sequestration in rangelands**
  A review of rangeland literature suggests proper management of rangelands offers opportunities to partially mitigate the rise in atmospheric carbon dioxide concentrations through sequestration of this additional carbon via storage in biomass and soil organic matter. Findings of from the literature include:

1. Carbon sequestration decreases with increasing mean annual precipitation in native rangelands of the North American Great Plains
2. A general trend for grazing was a decrease in carbon sequestration with longevity of the grazing management practice
3. Carbon sequestration increased with time since interseeding of a nitrogen-fixing legume, illustrating the

importance of nitrogen in carbon sequestration.

- Increase of carbon in the soil carbon content at 0-30 cm depths with grazing treatments

Studies initiated in 1982 at the High Plains Grasslands Research Station near Cheyenne, Wyoming, have shown that after 12 years of continuous, season-long grazing at light (CL) and heavy (CH) stocking rates, the total carbon mass of the belowground plant-soil (0-60 cm) system was not affected when compared to a non-grazed treatment. However, significant increases in the mass of carbon in the primary root zone (0-30 cm) of the soil were evident in the grazed treatments (CL: 58.0 Mg C/ha, and CH: 58.3 Mg C/ha) compared to 47.9 Mg C/ha in the non-grazed exclosure (EX).

- Plant community shifts evident in heavy grazing treatment

When grazing/no grazing treatments were sampled in 2003 (21 years of treatments), which included 7 years of below normal precipitation during the last 10 years, 27-30% of the soil organic carbon was lost from the CH grazed treatment in the various soil depths. The CH grazing treatment shifted the plant community from one dominated by cool-season perennial grasses to one dominated by the warm-season grass blue grama, which represents 42% of the production in the CH compared to only 4 and 11% in the EX and CL treatments, respectively. In 2003, soil organic carbon and nitrogen contents were significantly higher in the CL treatment compared to the CH and EX treatments.

- Recent data shows grazing has a significant influence on soil organic carbon within 0-15 and 0-60 cm soil depths

In 2006 and 2007 (data from 2007 is preliminary and still undergoing analysis), grazing had a significant influence on soil organic carbon within 0-15 and 0-60 cm soil depths. Soil organic carbon content in the CH treatment (29.2 Mg C/ha) was higher than CL treatment (25.3 Mg C/ha) at 0-15 cm depth and was significantly higher than CH and CL treatments (69.4 and 73.7 Mg C/ha, respectively) within 0-60 cm soil depth. Comparisons of SOC content among different treatments between 2003 and 2006 revealed soil organic carbon decreased at all depths for the CL treatment and increased in the CH treatment at all three depth increments.

**Summarize Target Sink Storage Opportunities and Benefits to the Region:**

There are over 7 million hectares of BLM rangelands in Wyoming with additional privately held rangelands throughout the Big Sky region. Findings from this study should also be generally relevant in Montana and eastern Colorado. Though potential sequestration per acre for rangeland is low, the large acreage potentially available for sequestration makes rangeland sequestration worth exploring.
This project will make an initial assessment of sink potential for these rangelands, with potential benefits to ranchers and regulator agencies that are interested in rangeland carbon sequestration.

**Cost:**

**Total Field Project Cost: $328,659**

**DOE Share: $220,000 67%**

**Non-Doe Share: $108,659 33%**

**Field Project Key Dates:**

**Baseline Completed: NA**
**Drilling Operations Begin: NA**
**Injection Operations Begin: NA**

**MMV Events: Continuous through project**

**Field Test Schedule and Milestones (Gantt Chart):**

| Task 9.0 - | Q1-06 | Q2 | Q3 | Q4 | Q1-07 | Q2 | Q3 | Q4 | Q1-08 | Q2 | Q3 | Q4 | Q1-09 | Q2 | Q3 | Q4 | Q1-10 | Q2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Task 9.1 - Planning | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| Task 9.2 - Controlled Test Soil Carbon Sampling and MMV | | | | | | | | | | | | | | | | | | |
| | | | | | | Tm3 | | | | Tm7 | | | | | | Tm12 | | Tm17 |
| Task 9.3 - GIS Integration | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | Tm9 | | | | | | | |
| Task 9.4 - Rangeland Best Management Practice Handbook | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |