

### 3.2.1.5 RESTORATION OF DEGRADED RANGELANDS

#### Technology Description

Degraded rangelands have low levels of soil carbon and diminished potential for biomass production to increase storage, but represent potentially large carbon sinks. Degradation is usually the result of inappropriate management, especially during extended periods of drought or unusual weather events. Symptoms of degradation include poor soil cover, dominance of undesirable species, low soil quality, or, in the extreme, topsoil erosion. In many arid and semi-arid rangelands, the cost of restoring land may far exceed the potential returns from livestock production. In addition, restoration technologies are unreliable in environments where precipitation is unpredictable. In more mesic areas, many rangelands are occupied by invasive species, which may be native or exotic. Technologies for managing invasive species to increase carbon storage in rangelands are expensive and require significant investment as well as careful post-treatment management.

- Increasing carbon storage on degraded arid and semi-arid rangelands depends on reestablishing vegetation in areas that have lost productivity.
- In many cases, soil may be intact, but beneficial microbial activity has been lost and must be restored simultaneously with vegetation reestablishment.
- In more mesic areas, rangeland degradation is due largely to the dominance of invasive species. The association between increased competition of shrubs and carbon fluxes and other greenhouse gas emissions in rangelands is poorly understood and very difficult to manage.

#### Representative Technologies

- Reestablishment of vegetation.
- Vegetation management.
- Restoring soil function.

#### Technology Status/Applications

- Each of these technologies has been researched and implemented for purposes other than carbon sequestration, primarily to prevent erosion and conserve soil.

#### Current Research, Development, and Demonstration

##### RD&D Goals

- Gain reliable understanding of the relationship between soil microbes and vegetation establishment and growth in arid and semi-arid areas.
- Develop low-cost, reliable technologies for the restoration of vegetation on degraded arid and semi-arid rangelands.
- Improve decision support for the application of low-cost technologies, such as fire, to control invasive species and to reduce greenhouse gas emissions from mesic rangelands.
- Develop seed production technology to produce low-cost seeds for reestablishing desired rangeland species. Currently costs are high and seed supply is limited for many cultivars.
- Develop new risk management and liability tools for use in prescribed burning systems on rangelands.

##### RD&D Challenges

- Measuring and monitoring procedures need to be improved for accurate, efficient, and low-cost determination of range and pasture land soil carbon status and determination of the effectiveness of carbon sequestration practices.
- Integrate complex and multisource data to develop better models and decision support systems.
- Develop more accurate estimates of the impacts of these management practices on soil carbon, particularly for the purpose of monitoring carbon sequestration following management adjustments.
- Develop new technologies to restore semi-arid and arid rangelands suffering from degradation, including soil-quality microbe interactions.

#### Recent Progress

- Estimates of the potential for range and pastureland soils to sequester soil carbon have been published and provide a baseline for future activities.
- Research programs already have been established in the USDA Agricultural Research Service, Natural

Resources Conservation Service, Land Grant Universities, DOE, national labs, and U.S. Geological Survey to study soil carbon sequestration.

- New technologies for the measurement of greenhouse gas fluxes have been developed.
- New herbicide technologies and fire management practices have the potential to reduce the high costs associated with pretreating restoration sites.

#### **Commercialization and Deployment Activities**

- While current costs of rangeland restoration are high, restoration is likely to be economically feasible if there is demand for carbon sequestration.
- Currently, the cost of most seeds is high for species and varieties that are needed in grazing land restoration.
- USDA has provided technical assistance to landowners for implementing these technologies.