

# TERRESTRIAL CARBON SEQUESTRATION OPPORTUNITIES IN COLORADO

## RANGELAND OPPORTUNITIES AND CHALLENGES

JOEL BROWN  
NRCS  
JORNADA  
EXPERIMENTAL  
RANGE

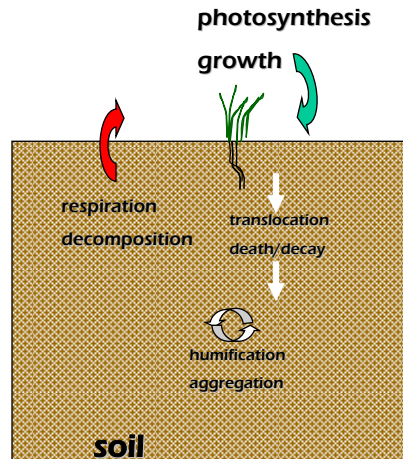
## MANAGING RANGELAND FOR CARBON SEQUESTRATION

- *WHAT IS CARBON SEQUESTRATION?*
- *HOW CAN WE DO IT?*
- *HOW CAN WE MEASURE IT?*
- *SOME PROJECT CONCERNS*

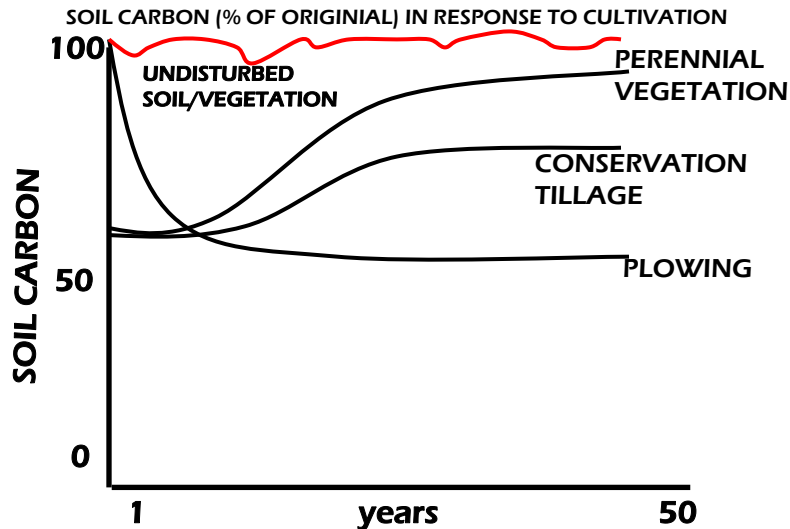


## WHAT IS SOIL CARBON SEQUESTRATION?

- THE LONG-TERM STORAGE OF CARBON IN THE SOIL VIA THE PROCESSES OF PHOTOSYNTHESIS, HUMIFICATION AND AGGREGATION
- EXPOSING CARBON COMPOUNDS TO THE ATMOSPHERE RELEASES CO<sub>2</sub>
- THREE FORMS-SHORT (ANNUAL), **MEDIUM (DECADES)**, LONG (CENTURIES TO MILLENNIA) TERM



## SOIL CARBON DYNAMICS IN RESPONSE TO TILLAGE



## POTENTIAL OF US GRAZINGLANDS TO SEQUESTER CARBON

☞ 54% LAND RESTORATION

☞ 5% UNMANAGED INCREASE

☞ 41% IMPROVED MANAGEMENT

☞ 130-300 MMTCO<sub>2</sub>e/y

LAL ET AL 2000

2-4% of US annual emissions



## MANAGING RANGELANDS FOR CARBON SEQUESTRATION

### SOME BASIC PRINCIPLES

- NET PRIMARY PRODUCTION (INPUTS) - RELATIVELY INVARIAT
  - PRECIPITATION, INHERENT SOIL FERTILITY DETERMINE RATES
- EXTREME OVERGRAZING (SOIL LOSS, DEGRADATION) RESULT IN C LOSS
  - REQUIRES SUBSTANTIAL EFFORT AND TIME TO RESTORE CAPACITY
- WEATHER VARIABILITY OVERRIDES MANAGEMENT



## MANAGING RANGELANDS FOR CARBON SEQUESTRATION

### WHAT PRACTICES DO WE USE?

- **STOCKING RATE**

- LIGHT TO MODERATE STOCKING RATES MAINTAIN PRODUCTIVITY

- **DISTRIBUTION**

- AVOID SPOT OVERGRAZING/ DEGRADATION

- **SEASON OF USE**

- SPECIES COMPOSITION CHANGE

- **DROUGHT RESPONSE**

- AVOID DEGRADATION AND ALLOW FOR RECOVERY

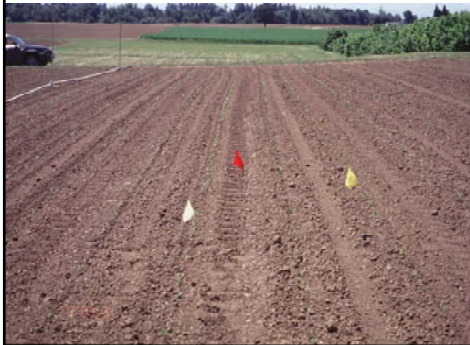


## MEASURING CARBON ON RANGELANDS

### Soil carbon in an agricultural field in Saunders County NE

- Collected 110 random samples over 1 ha
- Minimum 8.5 g C/kg soil
- Maximum 18.5 g C/kg soil
- Mean 15.3 g C/kg soil
- About 70 samples/ha for 95% Confidence Level

Tom Reinsch, Soil Scientist National Soil Survey Center, Lincoln NE



## Soil carbon in an arid rangeland

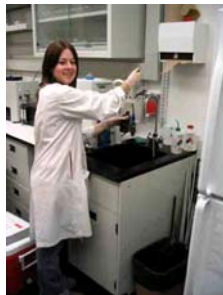
• Playa	90.5	TCO <sub>2</sub> e/ha
• Arroyo	22.7	
• Grassland	17.2	
• Dunes	13.5	
• Under Mesquite	43.99	
• Interspace	31.74	

Bird et al 2000



## WHAT DOES IT COST TO SAMPLE SOIL CARBON?

- |                         |                   |
|-------------------------|-------------------|
| 1. GETTING TO SITE      | VARIES            |
| 2. EXTRACTING CORE      | \$2/SAMPLE        |
| 3. PREPARATION          | \$2/SAMPLE        |
| 4. CHEMICAL ANALYSIS    | \$10/SAMPLE       |
| 5. STATISTICAL ANALYSIS | <u>\$1/SAMPLE</u> |
|                         | \$15/SAMPLE       |



## WHAT WILL IT COST TO ESTIMATE CARBON CHANGE?

- CARBON CHANGES  $\leq 1 \text{ T C/y}$
  - SOIL CARBON STOCKS VARY FROM 100 to 400 T C/ha (1m depth)
  - DETECT CHANGE OF  $< 1\%/y$
  - CONTRACT PERIOD VARIES FROM 5-20y
  - 95% CONFIDENCE LEVEL
- 
- 5 y -PRACTICALLY IMPOSSIBLE ( $> 100$  samples/field)
  - 20y-20 (samples/field)

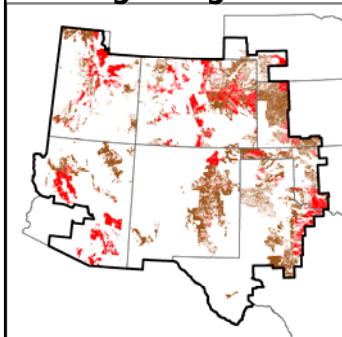
**We are not going to directly measure C**



## MODELLING RANGELAND CARBON SEQUESTRATION

EXISTING MODELS  
UNCERTAINTY ESTIMATES SPATIALLY DISTRIBUTED  
COMMON PRACTICES

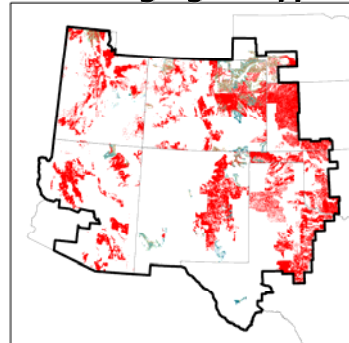
**Grazing Management**



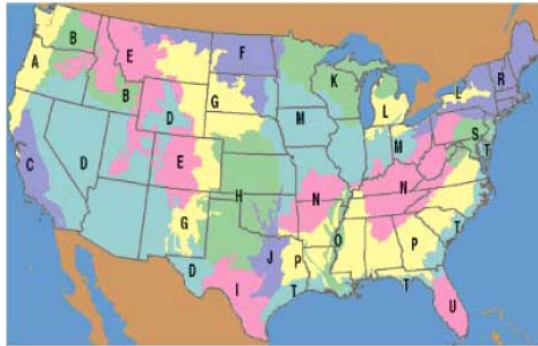
Uncertainty (%)

- Extrapolated
- Not Evaluated
- 0 to 20
- 20 to 40
- 40 to 60
- 60 to 80
- 80 to 100

**Grazing Mgmt + spp**



# CHICAGO CLIMATE EXCHANGE RANGELAND CARBON OFFSETS PROGRAM



USDA Natural Resource Conservation Service

Rangeland Rates and Eligible Regions\*

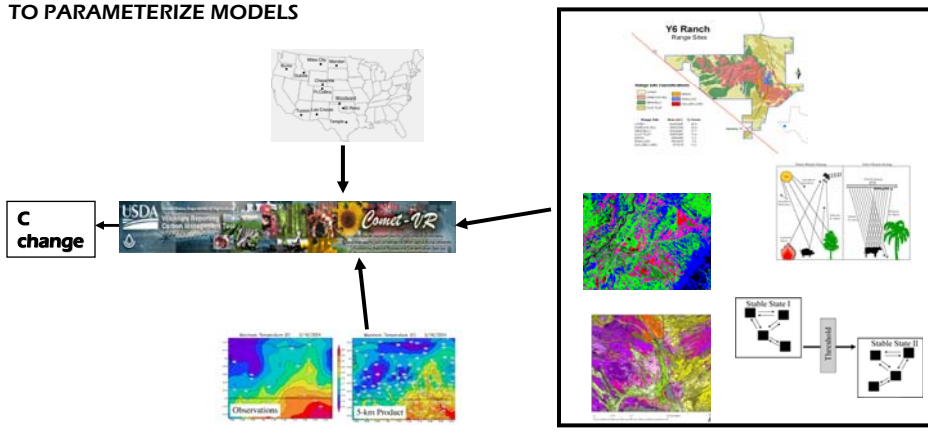
Land Resource Region	Previously Degraded	Improved Management
B	0.20	0.12
C	0.16	0.16
E	0.28	0.12
F	0.24	0.12
G	0.40	0.27
H	0.52	0.20

\*Additional regions may be added based on expert input.

WWW.CHICAGOCLIMATEEXCHANGE.COM

## AN ALTERNATIVE APPROACH TO ESTIMATING C

- INTEGRATED SYSTEM OF FIELD PLOTS, STATISTICAL SAMPLING, REMOTE SENSING, FIELD VERIFICATION, RECORD KEEPING AND COMPUTER MODELS APPLIED TO PROJECTS
- PROJECTS ARE ORGANIZED BASED ON SIMILAR SOILS, VEGETATION, CLIMATE, MANAGEMENT SYSTEMS
- CENTERED AROUND 'CORE SITES' WHERE DATA IS COLLECTED INTENSIVELY AND USED TO PARAMETERIZE MODELS



# **RANGELAND CARBON SEQUESTRATION**

- ☞ **RATES ARE LOW AND VARIABLE**
  - ☞ PRECIPITATION, FERTILITY DRIVEN
  - ☞ MANAGEMENT HAS LIMITED ROLE
  - ☞ TIME FRAMES ARE RELATIVELY LONG (10-25y)
  - ☞ HIGH VARIABILITY (3X VARIATION WITHIN MAP UNIT)
- ☞ **CONSISTENT WITH GOOD MANAGEMENT AND COMPATIBLE WITH EXISTING ECONOMIC PRODUCTION SYSTEMS**
- ☞ **PARTICIPATING IN A PRIVATE MARKET WILL REQUIRE A SYSTEMATIC APPROACH**
  - ☞ RECORD KEEPING
  - ☞ MONITORING
  - ☞ INTEGRATING SPECIFIC MEASURES OVER LARGE AREAS
- ☞ **SERIOUS ATTENTION TO NEW MONITORING SYSTEMS**