Economics of Soil Carbon Sequestration:

Accounting for Permanence, Leakage, and Additionality at the Project Level

Brian Murray (RTI International)

Bruce McCarl (Texas A&M)

Third Annual Conference On Carbon Capture & Sequestration, May 3-6, 2004

Alexandria VA

RTI INTERNATIONAL

Funding and Collaborators

- **Funding:** US EPA, CASMGS
- **Collaborators**:
  - RTI: Allan Sommer, Brent Sohngen*, Martin Ross, Laurel Clayton
  - Texas A&M: Dhazn Gillig, Heng-chi Lee, Mankeun Kim
  - EPA: Ken Andrasko, Ben DeAngelo, Francisco de la Chesnaye, Steven Rose, Dina Kruger

** On sabbatical from Ohio State University*

RTI INTERNATIONAL

GHG Trading/Offset System

- **GHG emission constraints**
  - Regulatory
  - Voluntary (1605b, CCX, state programs)
- In general, constraints will be **limited in scope** (sources, sectors, regions)
- **Potential gains from trade**: Meet GHG constraints by purchasing emission reductions/sequestration elsewhere
  - Emissions/permit trading
  - Offset projects

RTI INTERNATIONAL

GHG Trading/Offset System (II)

- **Offset Projects**
  - Purposeful action to reduce GHGs/create offsets
    - Location-specific
    - Sector specific
      - **Agricultural sector**
        - **Soil carbon sequestration**
        - Other mitigation options (CO_2, CH_4, N_2O)
      - Other sectors and activities
  - Potential to generate tradable offset credits
  - Require special accounting rules to ensure proper crediting

RTI INTERNATIONAL

Offset Accounting Issues

- An offset project enables the constrained party to emit more GHGs
  - "Environmental Integrity"
    - Emission allowances should not exceed what is being reduced by the project
    - "Making the atmosphere whole"
- Design accounting rules to support system integrity
- Special challenges in Ag/Soil Carbon Sequestration Projects
  - **Permanence** of sequestered carbon v emission reduction
  - **Leakage** of emissions outside project boundary
  - **Additionality** of project reductions to business-as-usual (BAU) baseline

RTI INTERNATIONAL

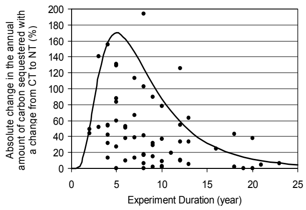
Ag. Soil Carbon Sequestration "Permanence" issues

- **Soil C flux is dynamic over time**
  - Initial gains taper off over time
  - Soil C reaches new equilibrium (aka "saturation", a misnomer)
- **Reversibility**
  - Soil carbon storage is volatile
    - can easily be released in the future if practice is discontinued or natural disturbance occurs
  - Practices need to be maintained to avoid release
- **Contractual terms**
  - Limited duration contracts and leases
  - Needed C replacement
- **Upshot**: a unit sequestered is not necessarily equivalent to a unit of emissions reduced

RTI INTERNATIONAL

Dynamics of Soil Carbon Sequestration

- Soil C sequestration over time after a change from conventional to zero-tillage operations (West and Post 2002)



RTI

Methods for Permanence Adjustments

- **"Pay as You Go" system**
- **Carbon leasing or rental**
- **Annuity-based contracts**
- **Permanence discounting**

** In all cases, these make Ag soil carbon sequestration less than 1:1 offset for emission reduction

=> Some sort of discount in terms of trade between emissions reduction and soil carbon offset

RTI

Leakage

- **Induced emissions outside the project boundary**
- **How induced?**
  - Economic forces: Supply/demand supplanted by the project is met elsewhere
    - Formal markets
    - Other institutional arrangements
  - Spatial extent
    - Wide: e.g., integrated commodity markets involved (regional, national, global)
    - Narrow: e.g., resources allocated by local forces and institutions
- **How to quantify?**
  - Economic modeling
  - Local case studies/examination

RTI

Leakage Estimates

- **International emissions leakage/energy**: ~10-20%
- **Forest carbon leakage/Afforestation**:

Table 3. Afforestation Program Leakage Estimates by Region (All Quantities Are Percentages)

Region	Leakage Estimate (%)
Northeast	23.2
Lake states	18.3
Corn Belt	30.2
Southeast	40.6
South-Central	42.5

Source: Murray, McCarl, Lee. 2004. Estimating Leakage from Forest Carbon Sequestration Programs. *Land Econ: 80(1):109-124*

- **Tillage change/Ag Soil Carbon leakage (prelim)** ~ 0-5%

RTI

Project Additionality and Baselines

- **Premise**: Only reductions/sequestration other than what would have occurred without the project are considered additional
  - Crediting programs may exert additionality requirement for offset crediting (e.g., CDM and JI/Kyoto Protocol, Climate Trust)
- To determine additionality, you need a project baseline

RTI

Project Baselines

- **A quantification of what would occur (over time) on the project land if no project were adopted**
  - Practice adoption (e.g., tillage adoption)
  - Carbon consequences (dynamic)
- **Basic approaches**
  - Project-specific
    - Structured case study of project conditions
    - "Bottom-up"
  - Performance standard
    - Analysis of cohort group data to determine prevailing practices and GHG performance
    - "Top-down"

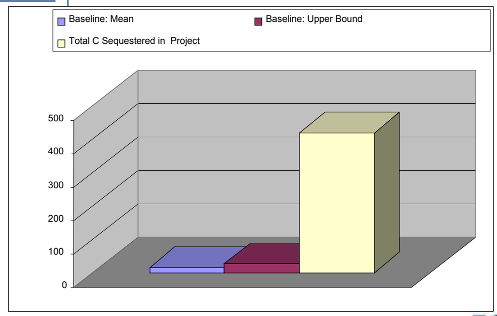
RTI

Estimating Baseline for Ag Soil C Tillage Project I

- **Performance Standard Approach**:
  1. Obtain data on tillage practice adoption
  2. Segment relevant cohort group (e.g., farmers in a specific region, state, district, county,…)
  3. Estimate probability of no-till adoption for relevant cohort group
  4. Predict adoption forward over project period
  5. Quantify adoption to soil carbon effects using biophysical models (e.g., Century, EPIC) or emission factors (IPCC)
  6. Combine (4) and (5) to quantify soil C baseline over time

RTI

Performance Standard Baseline Calculation



RTI

Estimating Baseline for Ag Soil C Tillage Project II

- **Project-specific Approach**:
  1. Barriers test: determine if there are any legal, institutional, technological, or market barriers to no-till adoption on the project site
     - If so, then the project is completely additional
  2. Compare no-till to conventional tillage on traditional economic grounds for the project site
     - If conventional-till is more profitable without carbon payments, it should be the baseline and the no-till project is additional
     - If no-till is more profitable without carbon payments
       - ⇒ No-till is baseline
       - ⇒ Project is not additional

RTI

Baseline selection issues

- **Value of extra precision**
  - Landscape heterogeneity
  - Uncertainty reduction for buyer and seller
- **Cost of extra precision**
  - Data collection
  - Analysis
- **Incentive compatibility**
  - Do subjective evaluations leave too much discretion and opportunity to game the system ?
  - Adverse selection: Will set standards favor entry of "bad" (non-additional) projects?
- **Updatable?**

RTI

How much do permanence, leakage, and additionality cut into the proceeds?

DISCOUNT ADJUSTMENTS (%) *

	Ag Soil Carbon	Afforestation
Permanence	35-50	5-20
Leakage	-5 to 5	20-30
Permanence + Leakage	**30-55**	**25-50**
Additionality	0-100 ?	0-100 ?

Bottom line: ***perhaps a third to a half or more*** of credit can be attenuated by these factors, depending on program rules

*Preliminary central tendency estimates, based on my ongoing work with Bruce McCarl and colleagues

RTI

Conclusions

- A project-based offsets/trading system seeks assurance that the emissions allowance correctly corresponds to the reduction by the project
- For Ag Soil C projects, the main factors that may disrupt this correspondence are
  - Permanence
  - Leakage
  - Additionality
- Methods are now being developed to address each of these factors, but there is debate about how far to go

RTI

Conclusions II

- Early empirical evidence suggests
  - ~1/3 to ½ of Ag Soil C offset credits may need to be adjusted for permanence, leakage, additionality combined
  - Depending on program accounting rules
- Other factors to deduct: uncertainty and transaction costs
- Q: Is this enough to make these investments uneconomic?
  - Depends on the price and on the discounts applied to other offset credits
- Design projects to minimize these factors
- Centralized efforts needed to harmonize approaches to these issues

RTI INTERNATIONAL