# Transaction Costs of Project-Based Carbon Sequestration

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## Setting: Ag/Forest Mitigation Requires Solving Technical Issues & Aggregation

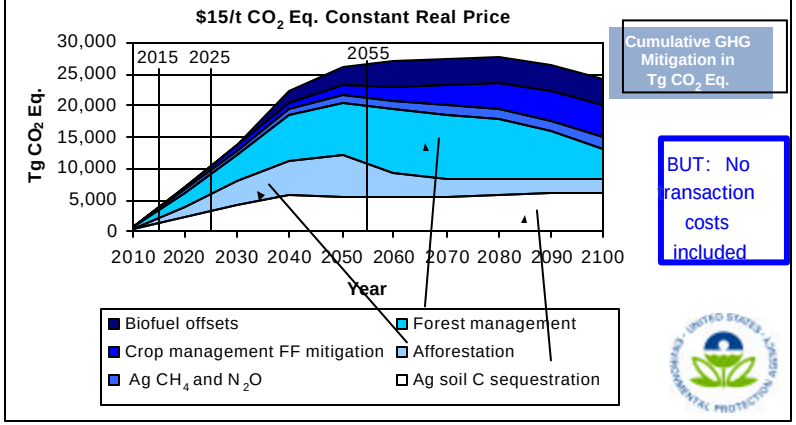
- **Sinks mitigation potential large, but uncertain:**
  **IPCC TAR: Global afforestation potential 200 – 584 MMTC/y in 2010, & avoided deforestation potential 1,790 MMTC/y**
- **US and global climate economic models need improved representation of ag/forest mitigation.**
- **Unresolved sinks technical issues have limited eligibility and investment: baseline setting, additionality, leakage, duration of GHG benefits, costs.**
- **Voluntary registries taking different approaches to sinks reporting.**
- ***Solving key issues determines how much of biophysical potential is realized, and by whom:***
  **- bundling heterogeneous land parcels**
  **- Measurement, monitoring, verification**
  **- Transaction costs of both**

## EPA study: *Greenhouse Gas Mitigation Potential in US Forestry & Ag*, Nov. 2005

- FASOM-GHG ag & forest sector partial equilib. model (Texas A&M: McCarl, RTI: Murray et al, EPA, USFS)
- Land use competition, perfect foresight (landowner knows C prices in future & acts)
- Driven by Landowner response to C prices
- Time frame: 2010 – 2110
- C prices: constant prices & rising prices, eg:
  - $1/t CO2 eq. in 2010 throughout period = $3.6 / tC
  - ~~$5/t CO2 = $18 /tC~~
  - $15/t CO2 = $55 /tC
  - $30/t CO2 = $110 /tC
  - $50/t CO2 = $$183 /tC
- Details: epa.gov/sequestration EPA 430-R-05-006

## Forest-Ag Mitigation Potential Varies w/ C Price, Activities Eligible, & Region

(EPA, 2005, Murray et al.)



## U.S. Mitigation Programs & GHG Registries Emerging, But Guidance Varies. Thus: Transaction Costs Will Vary.

| Issue | DOE 1605b | California GHG Registry | Chicago Climate Exchange |
|---|---|---|---|
| **Addition-ality** | Not addressed. | Requires logical argument. | General guidelines. |
| **Baselines** | Guidance. Default values for ag soils & forests | General guidance. Identifies types of tools. | General Guidelines |
| **Leakage** | Not addressed. | Direct activity shifting required. | Filters to avoid leakage. |
| **Reversi-bility** | Entity reporting captures some. | List of risks to assess. Permanent easement required. | Not addressed. 4-year program. |

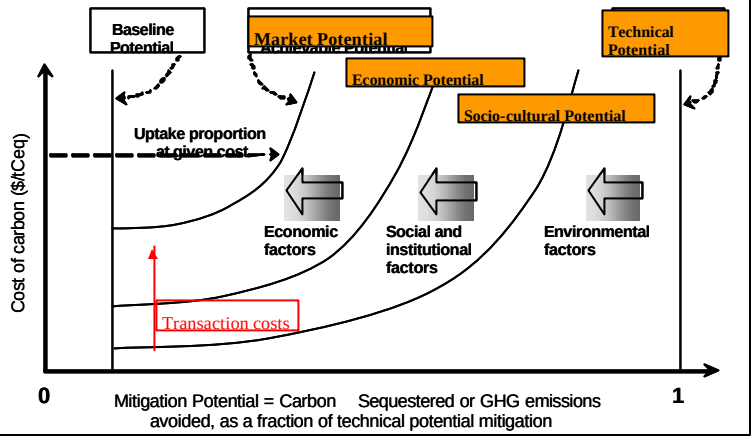
## Estimated Credits in 3 Registries' Rules: Afforestation of Rangelands in California Case. Range of estimates: 5x

- After 50 years:
  - CCAR: 40,835 t C (149,728 t $CO_2$ e)
  - CCX: 7,210 t C (26,437 t $CO_2$ e)
  - 1605 (b): 14,274 t C (52,338 t $CO_2$ e)
- Rules make a difference in $/tC benefits !
- Q: How do rules affect transaction costs & comparative advantage??

Source: Sandra Brown, Winrock , analysis with EPA support, 2005

## Effects of economic, environmental and social-institutional factors on mitigation costs and potential

*(based on Raupach et al. 2004)*

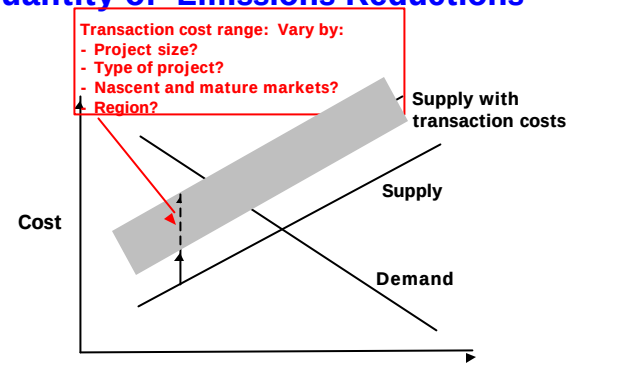



## Transaction Cost Components: Organizational, non-production

- Project search costs: Identification and stakeholder consultation
  - May be spread over many projects
- Feasibility studies: engineering, economic, and environmental assessments
  - GHG Baseline estimation and establishing additionality
- Negotiations: obtaining permits, negotiating and enforcing contracts for fuel supply, arranging financing
  - Marketing GHG credits, carbon contracting and enforcement
- Insurance – project risk insurance
  - GHG credit insurance (Difficult to get or too expensive today)
- Regulatory approval (GHG): Project validation and government review
  - (May include both domestic and international validation costs)
- Monitoring and verification (GHG) – During project implementation
  - Monitoring including equipment cost, verification and certification (Spread over many years of project life)

**Source: Based on OECD, 1997; Stratus Consulting, report to EPA, 2003; analysis work supported by Economic Analysis Branch, Climate Change Division, US EPA, 2004-05.**

## Transaction Costs: Affect Price and Quantity of Emissions Reductions




## Example: TR Cost Component-- Cost of monitoring –depends on area & variability w/in strata

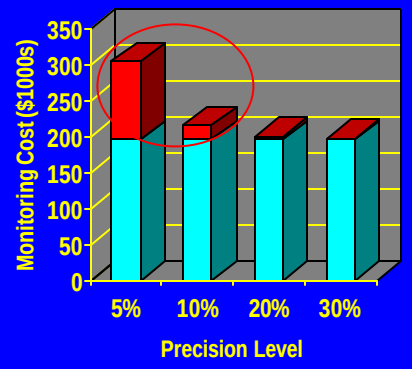
Costs for afforestation project in the USA—aboveground and belowground biomass pools

| Project size (ha) | Coefficient of Variation (%) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 10 | | 20 | | 30 | | 40 | |
| | Sample size | Cost $/ha | Sample size | Cost $/ha | Sample size | Cost $/ha | Sample size | Cost $/ha |
| 10 | 3 | 327.18 | 7 | 328.78 | 8 | 329.18 | 9 | 329.58 |
| 100 | 4 | 32.76 | 14 | 43.88 | 26 | 55.07 | 39 | 66.31 |
| 1,000 | 4 | 3.28 | 16 | 4.40 | 34 | 5.54 | 58 | 7.78 |
| 10,000 | 4 | 0.33 | 16 | 0.44 | 35 | 0.55 | 62 | 0.89 |

High$ Low$

Source: Sandra Brown, Winrock , 2006

## Cost of monitoring to different precision levels




Example for a complex tropical forest in Bolivia

Variable
Fixed

**Point: Programs or projects can select precision level, but trade-off against cost.**

Source: Sandra Brown, Winrock , 2006

## What We Need: Transaction Cost Components, by Mitigation Activity, by Region (examples)

| Cost Component | Tillage Change: Soils | Methane Digestors | Afforestation: AGB & BGB, | Forest Mgmt.: AGB, BGB |
|---|---|---|---|---|
| **Measurement** | $0.10 - $0.3 / tC for 1 MMTC (Mooney et al., 2004) | | | |
| **Monitoring** | | | $3.28 / ha 1,000 ha US (Winrock) $0.33 / ha 10,000 ha US (Winrock) | |
| **Aggregation** | ?? | ?? | ?? | ?? |

Notes: AGB = Above-ground biomass, BGB = Below-ground biomass

## LBNL & EPA Studies on Transaction Costs: Methods: Collect Data on Forest Mitigation Projects

- Forestry Project Identification: Thanks to groups below + Stratus Consulting:
- Data: 11 projects (9 actual, 2 feasibility studies):
  - The Nature Conservancy: Bolivia, Belize, Brazil 5 projects
  - Climate Trust (Oregon): Pacific NW, Ecuador 3
  - Natural Resources Canada: Chile 1
  - Indian Institute of Science: India (feasibility) 2

Transaction cost analysis supported by Climate Analysis Branch (TNC) and Economic Analysis Branch (rest), Climate Change Division, US EPA, 2004-05.

## LBNL-EPA Study (due 2006) Methods: Energy Efficiency & Forestry Sectors

- Literature review to identify Transaction Cost components
- Built spreadsheet model for comparability (Stratus; LBNL)
- EPA defined 2 scenarios of project implementation & transaction costs, with and w/out insurance:
  - Nascent Market Scenario:
    - Project developers have minimal experience in baselines, leakage assessment;
    - Few GHG accounting tools;
    - Limited stringency of or guidelines for govt. approval
  - Mature Market Scenario:
    - Project developers experienced in C market;
    - GHG accounting, baseline etc. tools avail., inc. regional baselines or benchmarks;
    - Govt. guidance and requirements for MMV extensive

LBNL Transaction cost analysis supported by Climate Analysis Branch (forestry) and Economic Analysis Branch (rest), Climate Change Division, US EPA, 2004-05.

# LBNL Study- 2

- 11 Forestry projects
- 88 energy efficiency, methane, renewables, transportation projects
- Found: **Transaction costs range from 1% to 19% of project costs**

Study Title and Source: Antinori C., Sathaye J. and Smith E. (2005). *Assessing Transaction Costs in of Project-based Carbon Mitigation.* LBNL-57316 *(Forthcoming)*

## 5 TNC Belize, Bolivia and Brazil Forest Projects (C Benefits are preliminary)

| Project Name | Rio Bravo, Belize | Noel Kempff Climate Action Project, Bolivia | Guaraquecaba Climate Action Project, Brazil | Atlantic Rainforest Restoration Project, Brazil | Antonina Pilot Reforestation Project, Brazil |
|---|---|---|---|---|---|
| Project type (AIJ Category) | Forest preservation | Forest preservation | Forest restoration | Forest restoration | Forest restoration |
| Host Country | Belize | Bolivia | Brazil | Brazil | Brazil |
| Project developer | TNC, PfB* | TNC, FAN, GOB* | TNC, SPVS* | TNC, SPVS* | TNC, SPVS* |
| Carbon credit buyers | US utility companies | AEP, Pacificorp, BP Amoco | AEP, CCX | GM | Texaco |
| Carbon sellers | Private landowners | Bolivian Government | GOB | GOB | GOB |
| Institutional status | USIJI, AIJ | USIJI, AIJ | Voluntary | Voluntary | Voluntary |
| Project Size | 50,328 ha | 634,286 ha | 8,100 ha | 12,000 ha | 1,000 ha |
| Non-GHG goals | No | No | No | No | No |
| Project duration (years) | 40 | 30 | 40 | 40 | 40 |
| Initial Start Date | 1996 | 1997 | 2000 | 2001 | 2001 |
| Est. total carbon benefit — low tons (C) | 2.4 million | 6 million | 339,600 | 660,000 | 106,000 |
| Est. total carbon benefit— high (tons C) | 2.4 million | 8 million | 566,000 | 1.1 million | 162,000 |
| Frequency of monitoring/ verification | 3 years | Annual | 5 years | 5 years | 5 years |

*Abbreviations: PfB: Programme for Belize FAN: Fundacion de Amigos de la Naturaleza
SPVS: Sociedade de Pesquisa em Vida Selvagem e Educacao Ambiental (Society for Wildlife Research and Environmental Education) GOB: Government of Brazil

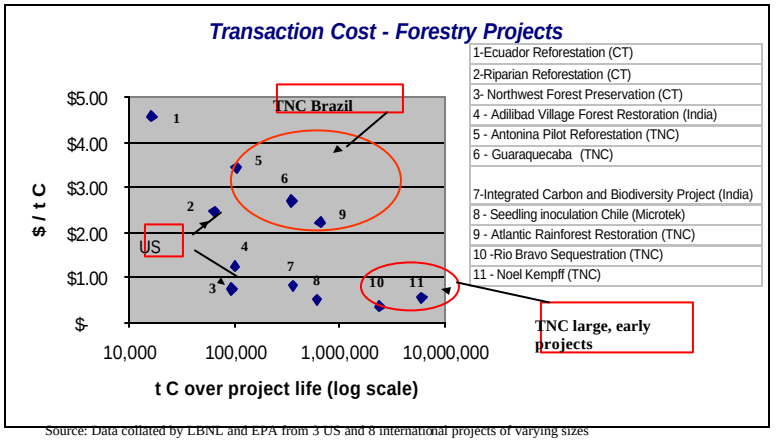
Transaction cost analysis work supported by Economic Analysis Branch, Climate Change Division, US EPA.

## FORESTRY: Descriptions of India, Chile, Ecuador and US Projects

| Project Name | Village Based Forest Restoration, India | Integrated Sink Enhancement & Biodiv. Conservatn India | Seedling Inoculation, Chile | Rainforest Reforestation Project, Ecuador | Pacific Northwest Forest Preservation Project | Riparian Zone Reforestation Project, Oregon |
|---|---|---|---|---|---|---|
| Project type (AIJ Category) | Forest restoration | Forest restoration | Afforestation | Forest restoration | Forest preservation | Forest restoration |
| Host Country | India | India | Chile | Ecuador | USA | USA |
| Project developer | Canadian Government | Karnataka Forest Department | Mikro-Tek, Instituto Forestal (Chile) | Climate Trust | Climate Trust | Climate Trust |
| Carbon credit buyers | Open market | Open market | Open market | Climate Trust partners | Climate Trust partners | Climate Trust partners |
| Carbon sellers | Local residents | Local residents | Local landowners | Jatun Sacha Foundation, Conservation International | Lummi Indian tribe | Private landowners |
| Institutional status | None | None | Canada's Voluntary Challenge & Registry | Oregon $CO_2$ program | Oregon $CO_2$ program | Oregon $CO_2$ program |
| Project Size | 2000 ha | 13,000 ha | 5000 ha | 275 ha | 700 ha | 830 ha |
| Non-GHG goals | Yes | No | No | No | No | No |
| Project duration (years) | 40 | 5 | 12 | 99 | 100 | 52 |
| Initial Start Date | 2002 | 2002 | 1980 | 2002 | 2002 | 2001 |
| Est. total carbon benefit — low (tons C) | 100,000 | 358,800 | 600,000 | 16059 | 95446 | 63631 |
| Est. total carbon benefit— high (tons C) | Same | Same | 1,440,000 | 16059 | 95446 | 63631 |
| Frequency of monitoring/ verification | Annual | Annual | Annual | | | |

Transaction cost analysis work supported by Economic Analysis Branch, Climate Change Division, US EPA.

## Preliminary Results: Project Transaction Cost by Project Lifetime Carbon Benefits

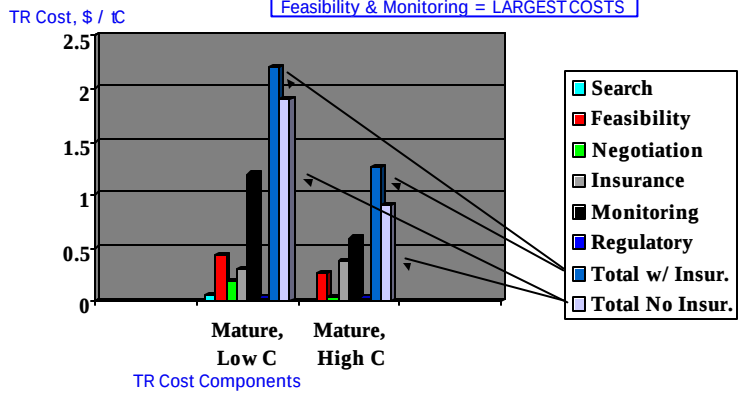



Source: Data collated by LBNL and EPA from 3 US and 8 international projects of varying sizes

Transaction cost analysis work supported by Economic Analysis Branch, Climate Change Division, US EPA.

## Preliminary Findings: Transaction Cost by Component, Mature Market: Low & Hi C (with Insurance), 11 Projects

Feasibility & Monitoring = LARGEST COSTS

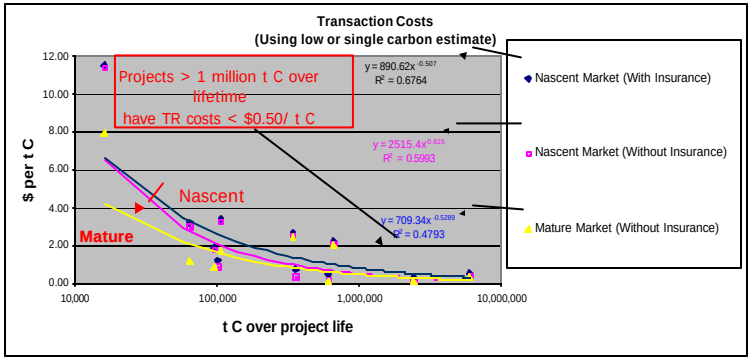



Transaction cost analysis work supported by Economic Analysis Branch, Climate Change Division, US EPA.

## Preliminary Findings:

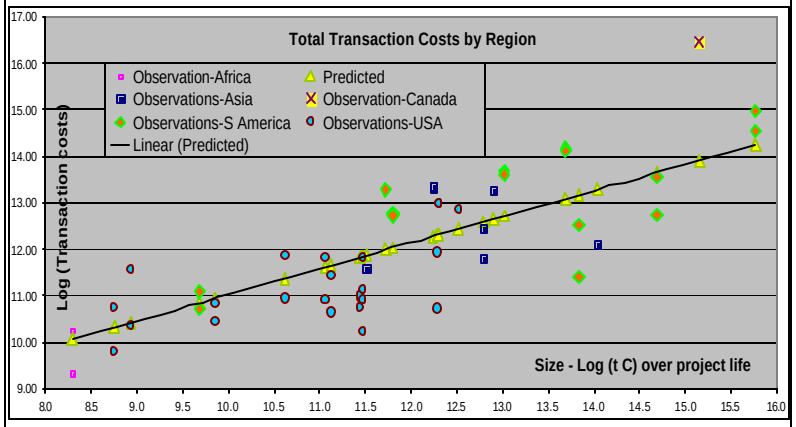
1) Transaction Costs (average) Decline with Project Size in GHG Tonnes.

2) Mature Scenario Costs < Nascent Market.



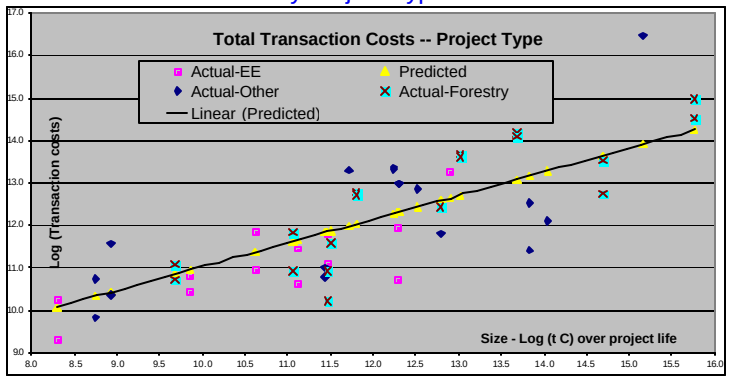

supported by Economic Analysis Branch, Climate Change Division, US EPA

## LBNL Study: Total Transaction Costs vs. Project Size, All Sectors




**Source: Antinori C.,** Sathaye J. and Smith E. (2005). *Assessing Transaction Costs in of Project-based Carbon Mitigation.* LBNL-57316 *(Forthcoming)*

## LBNL Study: Total Transaction Costs vs. Project Size, All Sectors: by Project Type




**Source: Antinori C.,** Sathaye J. and Smith E. (2005). *Assessing Transaction Costs in of Project-based Carbon Mitigation.* LBNL-57316 *(Forthcoming)*

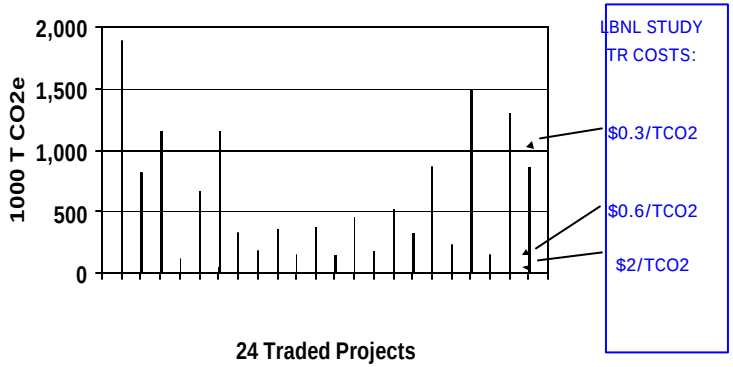
## Comparison to Estimated Transaction Costs from Other Studies

| Report | Project Type | TC Estimates (2002 US dollars) | | |
|---|---|---|---|---|
| Fichtner et al., 2003 | AIJ energy efficiency, renewable energy, forestry, afforestation, agriculture | $0.05-261/tC (no average) | | |
| Michaelowa et al., 2003 | JI energy: Gas<br>JI energy: Biomass | $2.4 - $5.6/tC*<br>$3.2 - 8.8/tC* | | |
| Woerdman, 2001 | AIJ /JI energy sector<br>AIJ/JI industrial sector | 12 - 19 % of initial investment<br>15 - 30 % of initial investment | | |
| Climate Trust, 2004 | Forestry | 7.6 - 34.2 % | | |
| This study<br>(note: cost varies by project size, & Scenario) | Forestry<br>Average Values: | | Nascent | Mature |
| | | Low | $2.58 /tC | $2.18 /tC |
| | | High | $1.06 /tC | $1.26 /tC |

*Assumes Swedish krona exchange rate of 8 krona per US dollar

## Project Size Experience: Example of Early CDM and JI Projects

**KYOTO TRADES: CDM & JI to 3/2/06**




(Source: http://www.ecosystemmarketplace.com 3/3/06 )

## Preliminary Findings: 1

- Methods Issues and Pros:
  - Minimal forestry data: N = 11, w/ 2 only feas. studies
  - Study offers *Comparability w/in dataset:* Consistent definitions of cost categories: unique in literature.
- Scope of this study: Include organization-type costs. But valuation of unforeseeable or intangible costs not included: (eg, enforcement costs). Aggregation inc.??
- Economies of scale: Find returns-to-scale phenomenon for transaction costs: Costs rise steeply for projects 100,000 TC size or smaller.
- Insurance is significant Trans. Cost:
  - Suggests development of insurance markets, or risk reduction via portfolios, could lower transaction costs

## Preliminary Findings (work in progress): 2

- Forestry appears low-cost investment in meeting GHG targets: $1.06 - $2.58 / tC (with insurance)
  - Forestry has low transaction costs vs. Micheolowa gas and biomass projects ($2 to $8 per tC).
- Trans. Costs likely to vary across GHG program requirements (eg, 1605b, CDM, CCX):
  - not assessed yet in literature
- Potential Next Steps?:
  - Increase n & universe of study: add c. 20 projects ?
    - » Add ag sector, biofuels, & more U.S. projects
  - Sensitivity case: different GHG program requirements?
  - Assess aggregation costs

## Potential Implications of Sinks Mitigation Programs for Transaction Costs ??

- Aggregation: Efficient solutions could drive down tr costs.
- GHG program rules will influence tr costs: not yet known.
  - Costs shift to programs? Or to developers?
- Measurement & monitoring methods emerging to drive down costs:
  - ag soils: COMET default tables in 1605b, by crop & region
  - soils: LIBS laser pulse sampling technology
  - forests: M3DADI aerial "radar": digital transects by plane
- Challenge affecting costs: Ability to stratify complex landscapes into homogeneous parcels and provide default tables from modeling or field work
- Targeting: Potential to co-locate co-benefits w/ C could reduce tr costs.