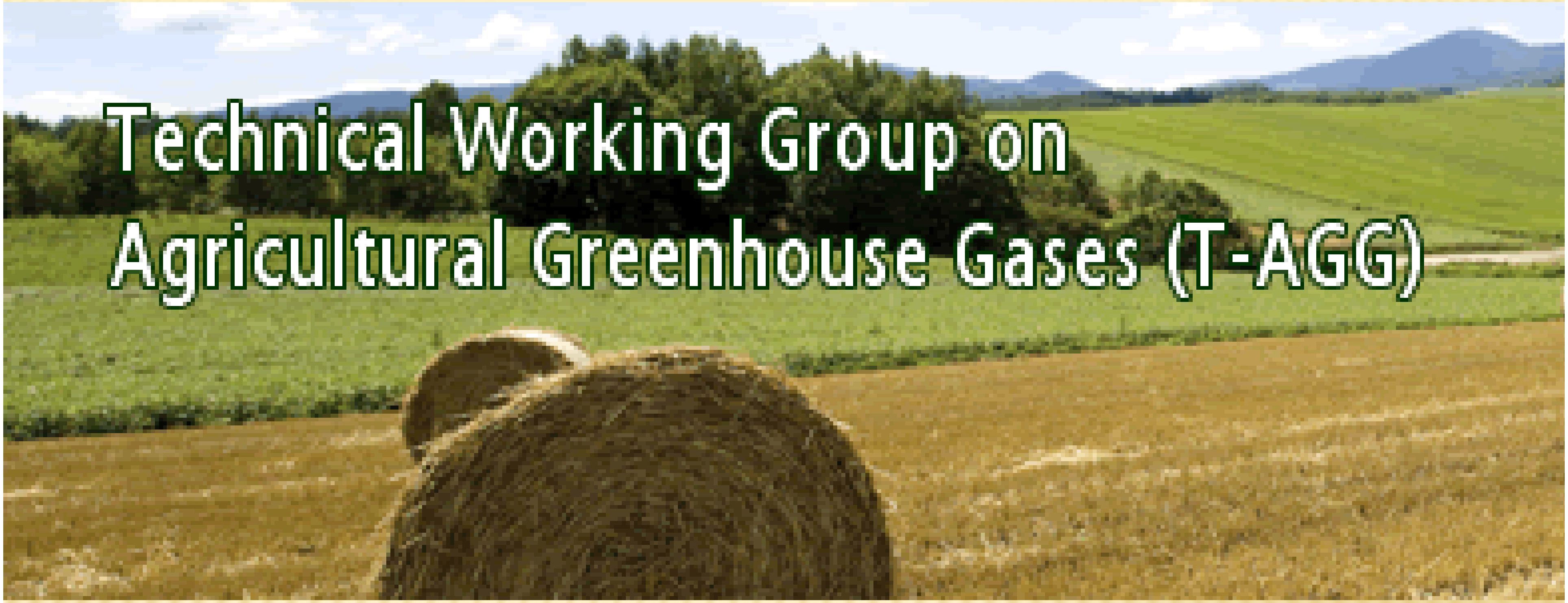


Technical Working Group on Agricultural Greenhouse Gases (T-AGG)

T-AGG UPDATE

Lydia Olander, Nicholas Institute, Duke University

Sept 30, 2010 – EPA, AAQTF RTP North Carolina

WHAT IF.....?

- ...private or voluntary GHG market
- ...cap & trade legislation
- ...incentive program to mitigate GHGs
- ...corporate-driven supply chain requirements
- ...low carbon biofuels

- All require technical and background scientific information to ensure environmental progress is achieved and farmers are fairly compensated
- Information needs are context-specific

T-AGG PURPOSE AND PROCESS

Lay the scientific and analytical foundation necessary for building a suite of methodologies for high-quality greenhouse gas (GHG) mitigation for the agricultural sector.

- Side-by-side assessment of biophysical and economic agricultural GHG mitigation potential; barriers and co-effects and feasibility of implementation for the US
- Review of scientific complexities planned (C, N2O)
- Producing **technical reports** with executive summaries for stakeholders and decision makers (publishing)
- Outreach and engagement
- Similar process for international opportunities

COLLABORATIVE AND TRANSPARENT

- Advisory board and Science advisors
  - researchers, government agencies, agriculture & agri-business, NGOs
  - Many years of experience in carbon & other GHGs
- Broader network
  - Email list and website
  - Information gathering meetings, Protocols -Nov ’09, Experts -Apr ‘10
  - Frequent interaction with protocol developers, model developers, policy makers and others working in this space
  - Open review process and outreach meetings
  - C-AGG/M-AGG

Physical Potential

- Net GHG/ha, total ha available, and over what time frame
- Significant upstream or downstream GHG impacts (lifecycle analysis)

Scientific Certainty

- Is information sufficient by practice and geography?
- Does directional certainty exist for net GHGs?

Economic Potential

- Costs for management shifts (opportunity costs, break even price, yield impacts…)

Possible Barriers

- Economic – capital costs
- Technical – monitoring, adoption, or production barriers
- Social – negative community or farmer impacts, resistance to change
- Negative ecological impact

Implementation & Accounting – Sufficient methods and data?

- Measurement, monitoring and verification – Are there good methods for measuring or modeling GHG outcomes on a project scale? and for verifying projects?
- Additionality – Can it be assessed sufficiently?
- Baseline – Are there viable approaches for setting baseline? Sufficient data?
- Leakage risk – Is there leakage risk (life cycle analysis)? Can it be accounted for?
- Reversal risk – Is there risk? Can it be estimated? Is it too high?

Significant Co-benefits?

May consider activity with lower GHG potential if it provides other social, economic or environmental co-benefits

MITIGATION ACTIVITIES CONSIDERED

Cropland Management.	Grazing Land Management	Land Use Change
Conservation till and no-till	Improved grazing land management	Cropland → grazing land
Fallow management	Change species composition	Cropland →natural landscape
Diversify and/or intensify cropping systems	Irrigation management	Convert pasture to natural (cease grazing)
Change crop type (annual or perennial)	Rotational grazing	Restore wetlands
Short rotation woody crops	Fire management	Restore other degraded lands
Application of organic soil amendments (incl. biochar)	Fertilization	
Irrigation management		
Improve fertilizer NUE and reduce N rate		
Rice water management and cultivars		
Reduce chemical inputs		
Improve organic soil management		
Agroforestry		
Herbaceous buffers		
Improve manure management		
Drain agricultural land in humid areas		

METHODS: LITERATURE

- Over 800 papers (mostly peer reviewed)
- Soil carbon, N_2O and CH_4
- Upstream and process emissions
- Showing range of values
- Scaled up to national rate using weighted averages



BIOPHYSICAL GHG MITIGATION POTENTIAL

	Soil C	N_2O& CH_4 Emissions	Upstream & Process	Net Impact	Maximum Area
	---- t CO_2e/ha/yr ------				Mha
No-till*	1.09 (-0.26–2.60)	-0.18 (-0.91–0.72)	0.14 (0.07–0.18)	1.04	71.9
Reduce N fertilizer	0.00	0.40 (0.14–1.32)	0.06 (0.04–0.08)	0.46	124.0
Winter cover crops*	0.83 (0.37–3.24)	0.25 (0.00–1.05)	0.61 (0.41–0.81)	1.69	73.9
Diversify annual crop rotations*	0.58 (-2.50–3.01)	0.07 (-0.04–0.65)	0.00	0.65	100
Improved rangeland management*	1.01 (-0.10–4.99)	0.28 (0.27–0.31)	No data	1.30	166

**Carbon sequestration may saturate over time*

METHODS: DATA AVAILABILITY AND GAPS

- Quantify valid comparisons in research
- Highlights where research is missing

Mitigation Practice	Number of Comparisons	Regional Representation
No-till	477	All U.S. regions, best data for Southeast, Great Plains, Corn Belt
Winter cover crops	67	Only regions with sufficient growing season
Reduce N fertilizer rate	29	Corn Belt, Lake States, Rocky Mountains, Great Plains – much other data that is not side-by-side comparisons
Change N source to slow release	11	Lake States, Rocky Mountains – no data for other regions

SURVEY OF SCIENTIFIC CERTAINTY

- Begin with literature review
  - Average biophysical potential, # of studies, # of field & lab comparisons, regional coverage
- Use survey of experts (Nov/Dec 2010) to determine level of certainty with existing data
  - Areas of expertise/focus (soil C, N_2O, grazing land, CH_4/multiple)
  - Obtain certainty measures for (1) direction of impact, (2) level of impact, (3) regional or soil or climate caveats
  - Assess agreement among experts

With support from the Natural Resources Defense Council

MODELING FOR ECONOMIC RESPONSE

- Land use competition & implementation costs – not all activities can achieve full biophysical potential
- Optimization model - FASOMGHG
- Full GHG accounting – assumes that all sources and sinks are counted in the market
- Other factors (social, environmental, capital cost barriers) considered qualitatively



COMPARING MODELS AND LITERATURE

	Soil C	N_2O& CH_4 Emissions	Upstream & Process	Net Impact	Maximum Area
	---- t CO_2e/ha/yr ------				Mha
No-till, modeled (CENTURY/DAYCENT)	1.00 (-0.43–5.61)	0.04	0.59	1.63	79
No-till, literature	1.09 (-0.26–2.60)	-0.18 (-0.91–0.72)	0.14 (0.07–0.18)	1.04	72

EXAMPLE OF ECON RESULTS

Currently being updated

Carbon price				
	\$5/t CO_2e	\$15/t CO_2e	\$30/t CO_2e	\$50/t CO_2e
Reduced Agricultural Fossil Fuel Use	0.39	2.15	5.37	9.34
Changing Tillage Practices (2x)	**1.97**	8.67	18.12	**26.68**
Pasture N_2O Management*	0.49	0.87	0.94	0.93
Reduced N Use	0.20	0.33	4.75	**10.48**
Irrigation Management	0.08	0.29	0.49	0.79
Reduced Chemical Use	0.03	0.25	0.61	1.14
Manure Management	**1.10**	3.15	5.08	6.61
Improved Enteric Fermentation	**7.28**	19.66	30.71	**35.93**
Decreased CH4 from Rice Cultivation*	0.31	1.17	2.07	3.35
Total Mitigation	*12.13*	*37.74*	*70.56*	*99.25*

Net GHG Mitigation by Management type and Carbon price (Mt CO_2e) – totals indicate emission reductions or increased carbon sequestration per year in the US

Forest management, bioenergy and afforestation can generate anywhere from 210 (at \$5) to 550 MtCO2e (at \$50)

CO-EFFECTS EXAMPLES

- Environmental Co-effects of Agricultural GHG mitigation projects are primarily positive
  - Positive impacts expected
    - Better N fertilizer management -> reduced N loading -> improved water quality, reduce dead zones, reduce costs for farmers
    - No-till, buffers, cover crops ->Improved species habitat; soil stability, moisture conservation, and water filtration
  - Negative impacts expected
    - No till -> sometimes increases herbicide loading -> reduce water quality, development of glyphosate resistant weeds

KEY POINTS ABOUT QUANTIFICATION

- Quantifying GHG changes for projects
  - Field sampling and modeling used in combination
  - Practice based is performance based in this report
  - Are ways to account for multiple practices in combination

QUANTIFICATION OF NET GHG CHANGES

Complexity	Quantification approach	Aggregation Level/Uncertainty	Notes
Tier 1	IPCC Tier 1 default factors	Typically large spatial units; National scale; annual resolution	Suitable for rough overviews and where limited data is available
Tier 2	Hybrid of process-model; empirical data; some default factors	Finer spatial and temporal resolution than above; can be monthly time step; application will depend on available information	Can be suitable for project-based accounting and inventory roll-ups to national scale;
Tier 3	Process-based models	Site-scale with weekly resolution	Suitable for small-scale applications where local variability can be managed; complexity, cost and time spent applying the model may be beyond the average project developers expertise.
	Sampling and Measurement	Site scale uncertainty can be high if not applied correctly	Level of errors may become overwhelming in sites/projects with high variability can be most costly to implement

In T-AGG report, adapted by Jon Hillier & Karen Haugen Kozyra

MODELS: TIER 2 QUANTIFICATION

- Hybrid; mid level resolution
- Empirical Extrapolations, like Tier 1, but with more local/regional data
- Use process models at regional scales to generate regional estimates and factors
- Requires project inputs for management but not for site characteristics where national or regional data are used (soils properties, climate and crop data)
- May not integrate multiple practices easily

MODELS: TIER 3 QUANTIFICATION

- Using BGC process model at project scale (comparison of models DAYCENT/DNDC/APEX)
- Easily integrates multiple practices
- Requires some field data (slope, field capacity, C and N content of crop) as well as management data
- Rest of site/soil data can come from databases like NRCS SSURGO soil survey data or local weather stations
- Need some expertise to run the models in their full forms; very specific guidance or simplified interfaces that standardize application may be required for widespread use

Table 2. List of DNDC inputs with units and data source. Where two data sources are indicated, the choice rests with the Project Proponent.

Input Category	Code	Input	Units	Mandatory / Optional	Data Source			
					Project records	*Measured*	*Look-up*	*Default*
Location	*L1*	GPS location of stratum	decimal °	M		X		
Climate	*C1*	Atmospheric background NH_3 concentration	µg N/m³	M				X
	C2	Atmospheric background CO_2 concentration	ppm	M				X
	C3	N concentration in rainfall	mg N/l or ppm	M			X	
	C4	Daily meteorology	multiple	M		X	X	
Soils	*S1*	Land-use type	type	M	X			
	S2	Clay content	0-1	M		X	X	
	S3	Bulk density	g/cm³	M		X	X	
	S4	Soil pH	value	M		X	X	
	S5	SOC at surface soil	kg C/kg	M		X	X	
	S6	Soil texture	type	M		X	X	
	S7	Slope	%	M		X		
	S8	Depth of water retention layer	cm	M		X	X	
	S9	High groundwater table	cm	M		X	X	
	S10	Field capacity	0-1	M		X		
	S11	Wilting point	0-1	M		X		
Cropping system	*CR1*	Crop type	type	M	X			
	CR2	Planting date	date	M	X			
	CR3	Harvest date	date	M	X			
	CR4	C/N ratio of the grain	ratio	M		X		
	CR5	C/N ratio of the leaf + stem tissue	ratio	M		X		
	CR6	C/N ratio of the root tissue	ratio	M		X		
	CR7	Fraction of leaves and stem left in field after harvest	0-1	M		X		
	CR8	Maximum yield	kg dry matter/ha	M	X			
Tillage system	*T1*	Number of tillage events	number	M	X			
	T2	Date of tillage events	date	M	X			
	T3	Depth of tillage events	6 depths†	M	X			
N Fertilizer	*F1*	Number of fertilizer applications	number	M	X			
	F2	Date of each fertilizer application	date	M	X			
	F3	Application method	surface / injection	M	X			
	F4	Type of fertilizer	type‡	M	X			
	F5	Fertilizer application rate	kg N/ha	M	X			
	F6	Time-release fertilizer	# days for full release	M	X			
	F7	Nitrification inhibitors		M	X			
Organic Fertilizer	*O1*	Number of organic applications per year	number	M	X			
	O2	Date of application	date	M	X			
	O3	Type of organic amendment	type	M	X			
	O4	Application rate	kg C/ha	M	X			
	O5	Amendment C/N ratio	ratio	M				X
Irrigation System	*I1*	Number of irrigation events	number	M	X			
	I2	Date of irrigation	date	M	X			

FIELD SAMPLING: TIER 3 QUANTIFICATION

- Ensure payment for a real change (avoid false positive)
  - Integrates management changes
  - Seasonal and climate variability may require sampling over time.
  - Don't need accurate measure of soil C stock, just the change in soil C
  - High soil variability, small changes, large background SOC
  - Sample numbers can be high, but are techniques (stratified or repeat sampling) that greatly reduce this
  - Can still be expensive
  - Field measurement of other GHGs (N_2O, CH_4) not feasible
- Best option seems to be combining modeling with measurement at reference sites or on projects.

SOC only
$850.00 (10 samples)
$3,400.00 (40 samples)
$34,000.00 (400 samples)

Costs taken from Paragon Report
http://www.carbonoffsetsolutions.ca

Viability of methods for quantifying GHG Change using field measurement and modeling

	Field Based (Carbon only)	Model Based (Carbon, N20, and CH4)		
Management Type		**Tier 1***	**Tier 2**	**Tier 3**
Land Use Change	Yes-d		Yes	Yes
Managing soil carbon on crop land	Yes-d		Yes	Yes
Managing N use for N20 reduction		Yes	Yes**	Yes**
Managing CH4 through crop management		Yes	Yes	Maybe
Managing rangeland C by amendment	Yes-d		Maybe***	Maybe***
Managing rangeland C by animal management	Yes-d		Maybe***	Maybe***

Yes-d – depends because high SOC and spatial variability makes field sampling difficult and expensive especially if the annual changes in soil carbon are small relative to this background carbon.

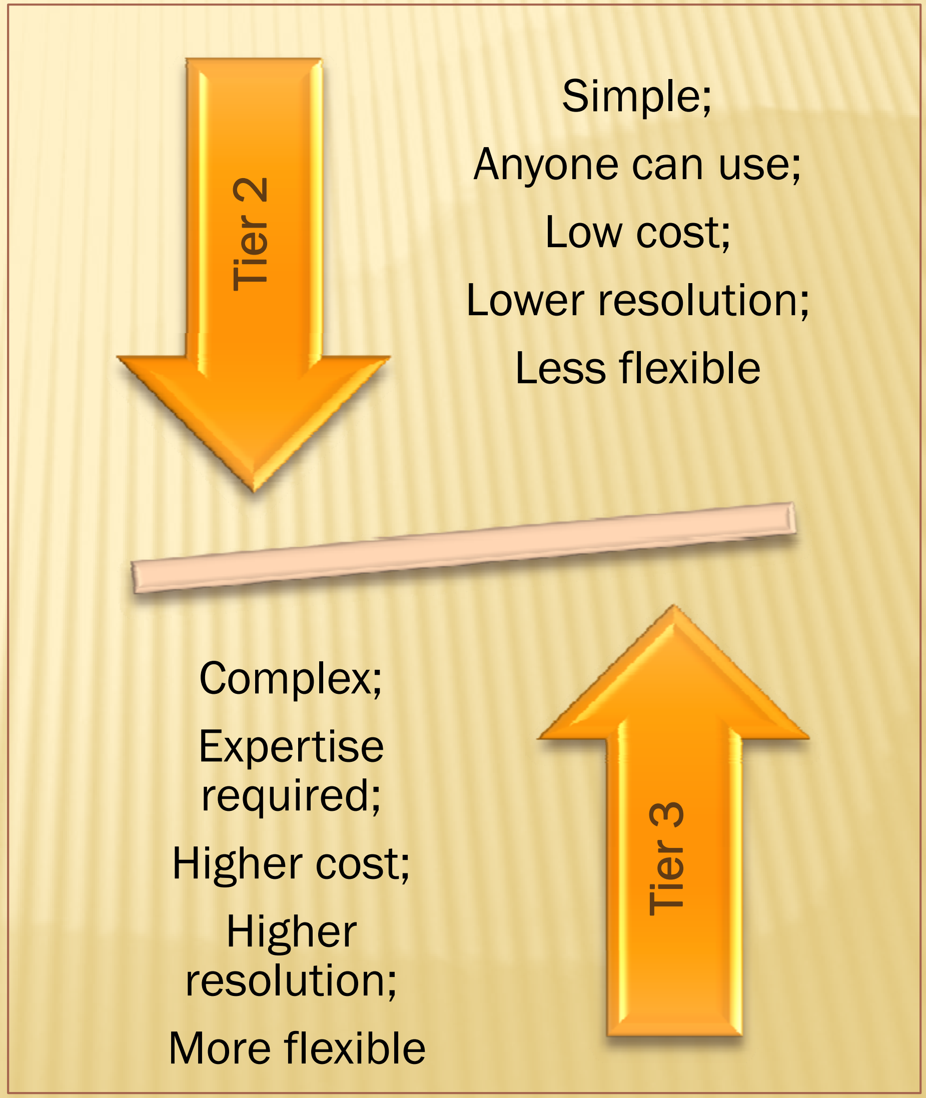
** Only use Tier 1 if no other more accurate method available. Tier 1 likely will not provide sufficient certainty for many protocols or programs in the US.*

*** Likely will need to use tier 1 for offsite N20 (from leached and volatilized N sources); and may require several measured field data inputs.*

****Process-based models that integrate pasture/range productivity and soil carbon dynamics with livestock-based emissions of nitrous oxide and methane are still under development.*

TAKE HOME ON QUANTIFICATION

- Models with field calibration and verification
- Want a standardized, repeatable process without bias
- Need standard process for assessing uncertainty
- Models may not have needed data for all cropping systems and practices
- Important choice regarding scale of use

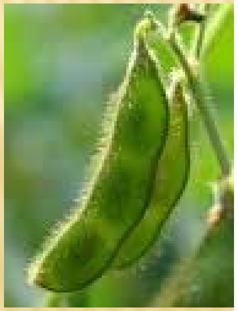


IMPLEMENTATION AND ACCOUNTING FEASIBILITY

- Additionality and Baseline
  - Regional vs Farm level approaches and data
- Monitoring and Verification
  - Visual assessments and farm records
- Leakage
  - Program vs project options (Output-based approach)
  - Estimation approaches
- Reversals
  - Small issue for agriculture (tillage, fire)

NEXT STEPS

- Obtain feedback on draft reports
- Draft new papers on complexities and latest science on C and N_2O
- Engage in meetings and briefings to share our reports and get feedback
- Initiating international project to test the waters
- Considering new project in livestock management



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