

Soil organic matter and climate change adaptation and mitigation:

Can we have our cake and eat it too?

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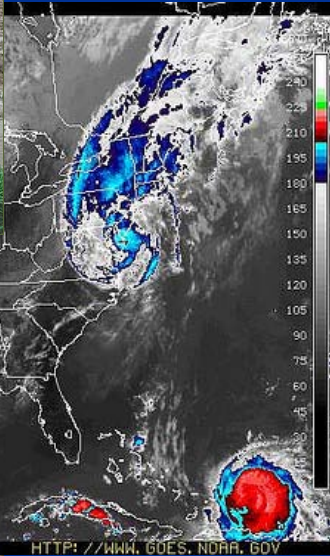
The value of soil organic matter



- Soil Fertility
- Nutrient cycling
- Infiltration
- Water-holding capacity
- Cation exchange
- Aeration
- Tilth
- Structure
- Detoxification
- Soil biodiversity

Soils rich in organic matter are better able to withstand climate stresses

Drought



Extreme events

Depleting Soil Organic Matter

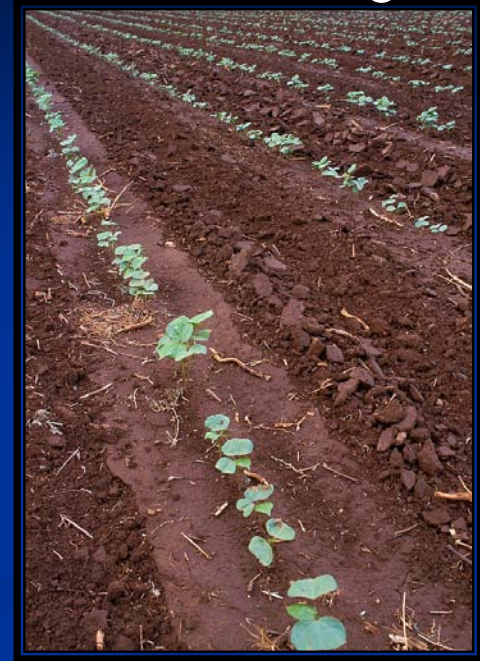
Erosion



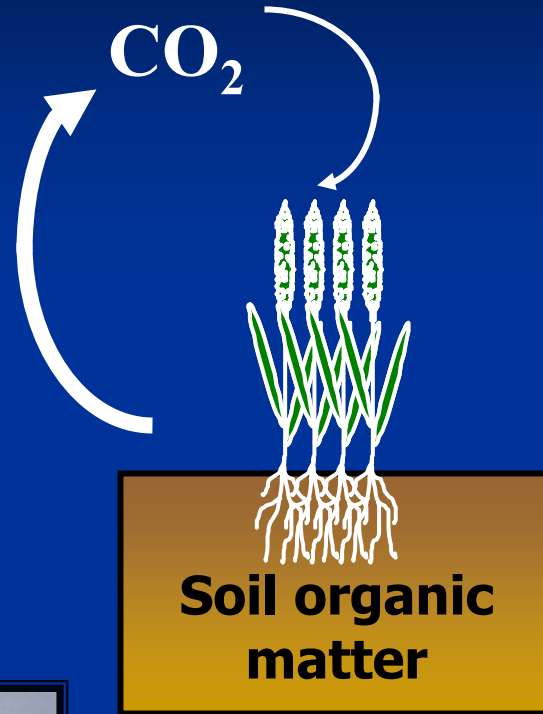
Deforestation



Intensive tillage



Low Productivity



Rebuilding Soil Organic Matter

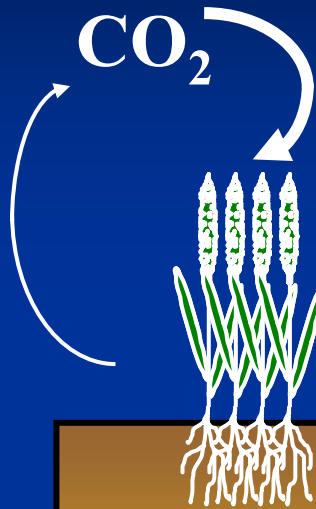
Conservation buffers



Conservation tillage



Cover crops



Soil organic matter

Agroforestry



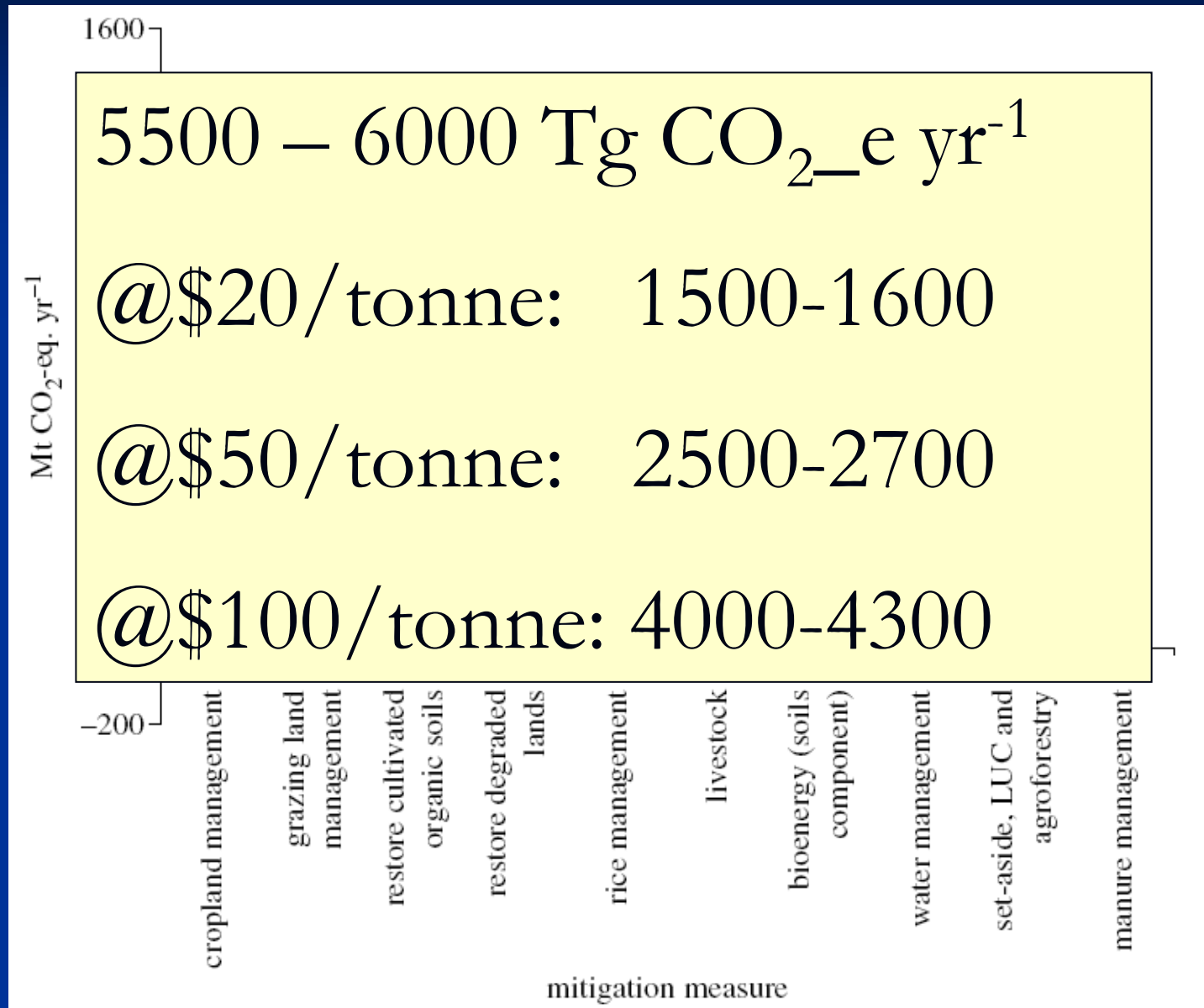
Improved rotations



Having our cake and eating it too

Engaging agriculture in mitigating CO₂ through rebuilding soil organic matter will strengthen adaptation and resilience of agricultural systems to climate change.

What and where are the potentials?



What are the perceived barriers to broad participation of land use activities in GHG mitigation?

- Concern about whether they will weaken efforts to reduce FF emissions.
- Concern about whether emission reductions will be 'real'
 - Will they be additional ? (to BAU)
 - Will they be permanent?
 - Can they be effectively measured and monitored?

“We don’t know how to measure soil carbon!”

Anonymous UNFCCC-SUBSTA delegate (2000)

Soil C measurement – some facts

- The carbon (C) content of soil can be measured with a high degree of accuracy and precision.
 - Instrument error < 0.1%; Overall lab measurement error < 1-2%
- Equipment and protocols for soil sampling are well documented and have been applied throughout the world for decades.
- The general response of soil C stocks to environmental variables and management practices is relatively well known.
 - 100s of long-term field experiments globally
- Sophisticated models of soil carbon dynamics have existed for > 20 years and are increasingly deployed for research, management and policy applications.

Soil C measurements - some challenges

- Soil carbon contents can be highly variable within an individual field.
- Annual changes are usually small relative to existing C stocks, e.g.,
 - Typical C stocks 20-80 tonnes/ha
 - Typical C changes 0.1-1 tonnes/ha/yr
- Multiple factors (e.g. soil type, climate, previous land use) influence soil responses at a specific location.
- Field experimental measurements are lacking for many crop, soil, climate and management combinations.
- There are virtually no 'inventory' measurement systems for soil C (e.g. compare with forest biomass)

Thus, the challenge is NOT with measuring soil C *per se*, but rather designing an efficient cost-effective SAMPLING and soil C stock ESTIMATION system.

Measurement, Monitoring & Verification

- ~~Direct measurements on each farm~~
- Need 'practiced-based' approaches that:
 - integrate effects of multiple practices (e.g. rotation, tillage, N management) and land use history
 - are soil- and climate-specific
 - utilize direct measurements to produce unbiased estimates with known uncertainty
- Model-based systems supported by a coordinated measurement system

COMET-VR (CarbOn Management and Evaluation Tool – Voluntary Reporting)

 United States Department of Agriculture

Contributors

- ▶ USDA
- ▶ USDA GCPO
- ▶ NRCS
- ▶ ARS
- ▶ CSU NREL

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Change text: [A](#) [A](#) [A](#)

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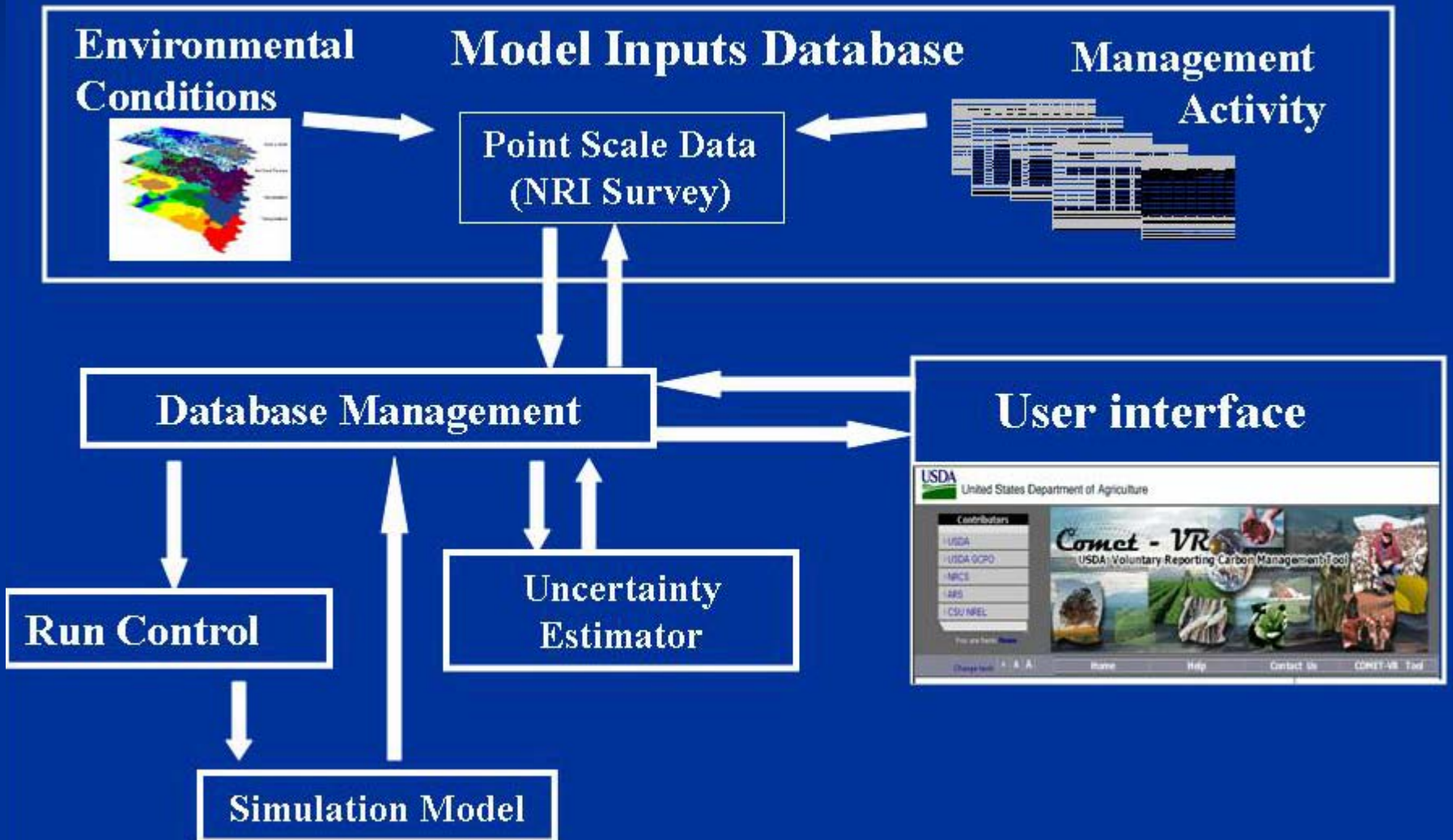
[Contact Us](#)

[COMET-VR Tool](#)

- First developed for cropland/grassland soil C & fuel use
- New version will include:
 - N₂O emissions
 - Agroforestry
 - Orchards and vineyards

COMET-VR model

(www.cometvr.colostate.edu)



Online Tool for Agriculture & Range

COMET-VR is the first OnLine Carbon Estimator Tool from Natural Resources Conservation Service (NRCS) and Natural Resource Ecology Laboratory, (NREL), Colorado State University, (CSU), developed in response to global climate change. This tool estimates carbon that is sequestered in the soil based on land management in agriculture. COMET-VR gives you an idea of the magnitude of agricultural management practices on carbon sequestration. The management practices covered are limited to the most predominant in the MLRA. NRCS specialists and the NRCS NRI were used to identify each practice.

Step 1. Enter the State Information: Select the State where the parcel is located from the list of State Names.

Go to | Reset | State |

State Selection:

Select a State: Indiana ?

- Indiana
- Colorado
- Connecticut
- Delaware
- Florida
- Georgia
- Idaho
- Illinois
- Indiana
- Iowa
- Kansas
- Kentucky
- Louisiana
- Maine
- Maryland
- Massachusetts
- Michigan

Next

USDA COMET-VR Online Tool Version: 1.0-012007

Selection

Session Information: ?

- ID: 1
- ID: 2 122271884
- ID: 3 122272107

Enter Session ID: Go

Location Information:

Parcel Information:

Select state and county



You are here: Home /

Online Tool for Agriculture & Range

Go to | Reset | State | County |

Step 2. Enter the County Information: Select the County where the parcel is located from the list of County Names.

Indiana County Selection:

Select a County: GIBSON ?

- GIBSON
- FAYETTE
- FLOYD
- FOUNTAIN
- FRANKLIN
- FULTON
- GIBSON
- GRANT
- GREENE
- HAMILTON
- HANCOCK
- HARRISON
- HENDRICKS
- HENRY
- HOWARD
- HUNTINGTON
- JACKSON
- JASPER

Back

Next

USDA COMET-VR Online Tool Version: 1.0-012007

Selection

Session Information: ?

- ID: 1
- ID: 2 122271884
- ID: 3 122272107

Enter Session ID: Go

Location Information:

- State: Indiana

Parcel Information:

You are here: Home / Online Tool

Online Tool for Agriculture & Range

Go to | Reset | State | County | Parcel | Soil | Rotation | Tillage | Submit | Summary | Fuel | File |

Step 4. Enter the Soil Information: Select the dominant soil texture and hydric information for your parcel.

GIBSON County, Indiana Soil Selection

Select the surface soil texture:

- sandy clay loam
- sandy loam
- silt
- silt loam
- silty clay
- silty clay loam ?

Is this a hydric soil? Select No or Yes: No Yes ?

Back

Reset

Next

USDA COMET-VR Online Tool Version: 1.0-012007

Selection

Session Information: ?

- ID: 1
- ID: 2 122271884
- ID: 3 122272107

Enter Session ID: Go

Location Information:

- State: Indiana
- County: GIBSON
- Fips: 18051
- MLRA: 115A
- LRR: M

Parcel Information:

- Report Date: 2/1/2007
- Name: North Forty
- Size: 40 Acres
- Type: Agriculture

Soil Information:

- Texture: silty clay loam
- Hydric: N

Select soil type and drainage condition



Step 5. Enter the land management information: Choose a rotation for the four time periods. [?]

The following cropping systems were identified as having the greatest harvested crop acreage in your county using production data from the National Agricultural Statistics Service and the NRCS Natural Resource Inventory. They may not be the most common cropping systems in your immediate neighborhood but are the most significant cropping systems in your county.

Please select the system that most closely resembles your land management practice. Choose a rotation that is most like your land management that produces a similar residue, and fertilizer application. Or select **Other**. Other represents the most dominate cropping system for your county according to current data.

GIBSON County, Indiana Management History for North Forty:

Choose A Rotation for each Management Time Period:

All Rotations

1. Landscape position and historical management:

- Livestock Grazing (pre 1970s)
- Lowland Non-Irrigated (pre 1970s)
- Upland Non-Irrigated (pre 1970s)

Sort By: Non-Irrigated Irrigated Grazing AgroForestry All

Number of Records: 3

All Rotations

2. 1970s through mid-1990s:

- Livestock Grazing: seasonal, heavy grazing, low fertilizer
- Livestock Grazing: year round, heavy grazing, low fertilizer
- Non-Irrigated: corn-soybean
- Non-Irrigated: corn-soybean-winter wheat
- Other

Sort By: Non-Irrigated Irrigated Grazing AgroForestry OTHER ALL

Number of Records: 5

Conservation Reserve Program (CRP) Enrollment during 1980s? Select the CRP type:

- 100% grass
- grass/legume mixture
- None

All Rotations

3. Base (Current Management):

- Non-Irrigated: corn-oats-5 yrs grass/legume pasture
- Non-Irrigated: corn-sorghum
- Non-Irrigated: corn-soybean
- Non-Irrigated: corn-soybean-5 yrs legume hay
- Non-Irrigated: corn-soybean-winter wheat
- Non-Irrigated: corn-winter wheat

Sort Non-Irrigated Irrigated Grazing AgroForestry CRP OTHER

By: ALL

Number of Records: 35

All Rotations

4. 2007 Report Period:

- Non-Irrigated: corn-oats-5 yrs grass/legume pasture
- Non-Irrigated: corn-sorghum
- Non-Irrigated: corn-soybean
- Non-Irrigated: corn-soybean-5 yrs legume hay
- Non-Irrigated: corn-soybean-winter wheat
- Non-Irrigated: corn-winter wheat

Sort Non-Irrigated Irrigated Grazing AgroForestry CRP OTHER

By: ALL

Number of Records: 35

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[Reset](#)

[Next](#)

Selection

Session Information: [?]

- ID: 1
- ID: 2 122271884
- ID: 3 122272107

Enter Session ID: [Go](#)

Location Information:

- State: Indiana
- County: GIBSON
- Fips: 18051
- MLRA: 115A
- LRR: M

Parcel Information:

- Report Date: 2/1/2007
- Name: North Forty
- Size: 40 Acres
- Type: Agriculture

Soil Information:

- Texture: silty clay loam
- Hydric: N

Management History:

See Also

- NRCS Energy Estimator for Tillage
- NREL Agroecosystems
- CASMGs Consortium for Agricultural Soils Mitigation of Greenhouse Gases
- ARS Research
- U.S. Agriculture & Forestry Greenhouse Gas Inventory
- Greenhouse Gas Reporting Guidelines
- Greenhouse Gas Guidance for FARMS and FORESTS
- Draft 1605b Technical Guidelines
- 1605b Voluntary Reporting Program
- COLE Forestry Model
- COLE Lite Forestry Model

Select management sequences

Select tillage management sequence

You are here: [Home](#) / [Online Tool](#)

Online Tool for Agriculture & Range

Go to | [Reset](#) | [State](#) | [County](#) | [Parcel](#) | [Soil](#) | [Rotation](#) | [Tillage](#) |

Step 6. Enter the land management information: Choose a tillage for the three time periods.

GIBSON County, Indiana Tillage History for North Forty

Enter the management history for this parcel: [?]

Tillage For this Time Period:

1970s through mid-1990s:

Base (Current Mgmt.):

2007 Report Period:

[Back](#) [Reset](#) [Next](#)

Selection

Session Information: [?]

- ID: 1
- ID: 2 122271884
- ID: 3 122272107

Enter Session ID: [Go](#)

Location Information:

- State: Indiana
- County: GIBSON
- Fips: 18051
- MLRA: 115A
- LRR: M

Parcel Information:

- Report Date: 2/1/2007
- Name: North Forty
- Size: 40 Acres
- Type: Agriculture

Soil Information:

- Texture: silty clay loam
- Hydric: N

Voluntary Reporting

Carbon Management Tool COMET-VR

Carbon Storage Report ?

Report Year: 2008

Session ID: 80747966

Parcel Description

Parcel Type:	Agriculture
Total Parcels for this Entity:	1
Parcel Name:	Parcel 1
Parcel Size:	100 Acres
Location:	GIBSON, Indiana
Soil:	Non-hydric loam

Parcel Management History

Historic:	Lowland Non-Irrigated (pre 1970s)
70s to 90s:	Non-Irrigated: corn-soybean; Intensive Tillage
Current:	Non-Irrigated: corn-soybean; Intensive Tillage
Report Period:	Non-Irrigated: corn-soybean; No Till Tillage

Predicted Change in Soil Carbon for the Parcel

Annual Change for 2008

	Carbon Change	Uncertainty ?		
		Avg Percent	Lower Bounds CI*	Upper Bounds CI*
Total Tons Carbon per year:	15.27	30.16 %	10.79	20.00
Total Tons CO2 Equivalent per year:	56.00	30.16 %	39.57	73.34

Values recorded in English units. One **ton** of carbon is equivalent to 3.667 **tons** of carbon dioxide.

Please report the **Large Bolded Values** on your 1605(b) report for carbon change and uncertainty. We are 95% confident that your average carbon change value is within (+-) 30.16 % of the modeled carbon change value shown on this report.

- o MLRA: 115A
- o LRR: M

Parcel Information:

- o **Report Date:** 9/29/2008
- o **Name:** Parcel 1
- o **Size:** 100 Acres
- o **Type:** Agriculture

Soil Information:

- o **Texture:** loam
- o **Hydric:** N

Management History:

- o **Historic:** Lowland Non-Irrigated (pre 1970s)
- o **70's - 90's:** Non-Irrigated: corn-soybean, Intensive Tillage, CRP: None
- o **Current:** Non-Irrigated: corn-soybean, Intensive Tillage,
- o **Report Period:** Non-Irrigated: corn-soybean, No Till Tillage,

See Also

- o [NRCS Energy Estimator for Tillage](#)
- o [NREL Agroecosystems](#)
- o [CASMGs Consortium for Agricultural Soils Mitigation of Greenhouse Gases](#)
- o [ARS Research](#)
- o [U.S. Agriculture & Forestry Greenhouse Gas Inventory](#)
- o [Greenhouse Gas Reporting Guidelines](#)
- o [Greenhouse Gas Guidance for FARMS and FORESTS](#)
- o [Draft 1605b Technical Guidelines](#)
- o [1605b Voluntary Reporting Program](#)
- o [COLE Forestry Model](#)
- o [COLE Lite Forestry Model](#)

CAALU/ALU – Integrated DSS for AFOLU

CAALU Tool - [CAALU]

File Edit View Insert Format Records Tools Window Help

Tahoma 8 B I U

Colorado State University Knowledge to Go Places

Welcome to the Central America Agriculture and Land Use Greenhouse Gas Inventory Tool (version 1.2.8)

Module I: Specify Activity Data	Module II: Specify Emission/Stock Change Factors	Module III: Inventory Calculations	Module IV: Reporting and Documentation
<p>Primary Data Specification</p> <p>Land Use and Management Statistics</p> <p>Livestock Statistics</p> <p>N Fertilizer Statistics</p> <p>Liming Statistics</p> <p>Sewage Sludge Amendments</p> <p>Finalize Primary Data</p> <p>Secondary Data Specification</p> <p>Rice Management</p> <p>Livestock and Manure Management</p> <p>Crop Residue Management</p> <p>Savanna/Grassland Burning</p> <p>Woody Plant Removal</p> <p>Finalize Secondary Data</p>	<p>Biomass C Stocks</p> <p>Soil C Stocks</p> <p>Soil Nitrous Oxide</p> <p>Manure Methane</p> <p>Manure Nitrous Oxide</p> <p>Biomass Burning Non-CO2 GHG</p> <p>Rice Methane</p> <p>Enteric Methane</p>	<p>Biomass C Stocks</p> <p>Soil C Stocks</p> <p>Soil Nitrous Oxide</p> <p>Manure Methane</p> <p>Manure Nitrous Oxide</p> <p>Biomass Burning Non-CO2 GHG</p> <p>Rice Methane</p> <p>Enteric Methane</p>	<p>Biomass C Stocks</p> <p>Soil C Stock Change</p> <p>Soil Nitrous Oxide</p> <p>Manure Methane</p> <p>Manure Nitrous Oxide</p> <p>Biomass Burning Non-CO2 GHG</p> <p>Rice Methane</p> <p>Enteric Methane</p>

Session Management Quit

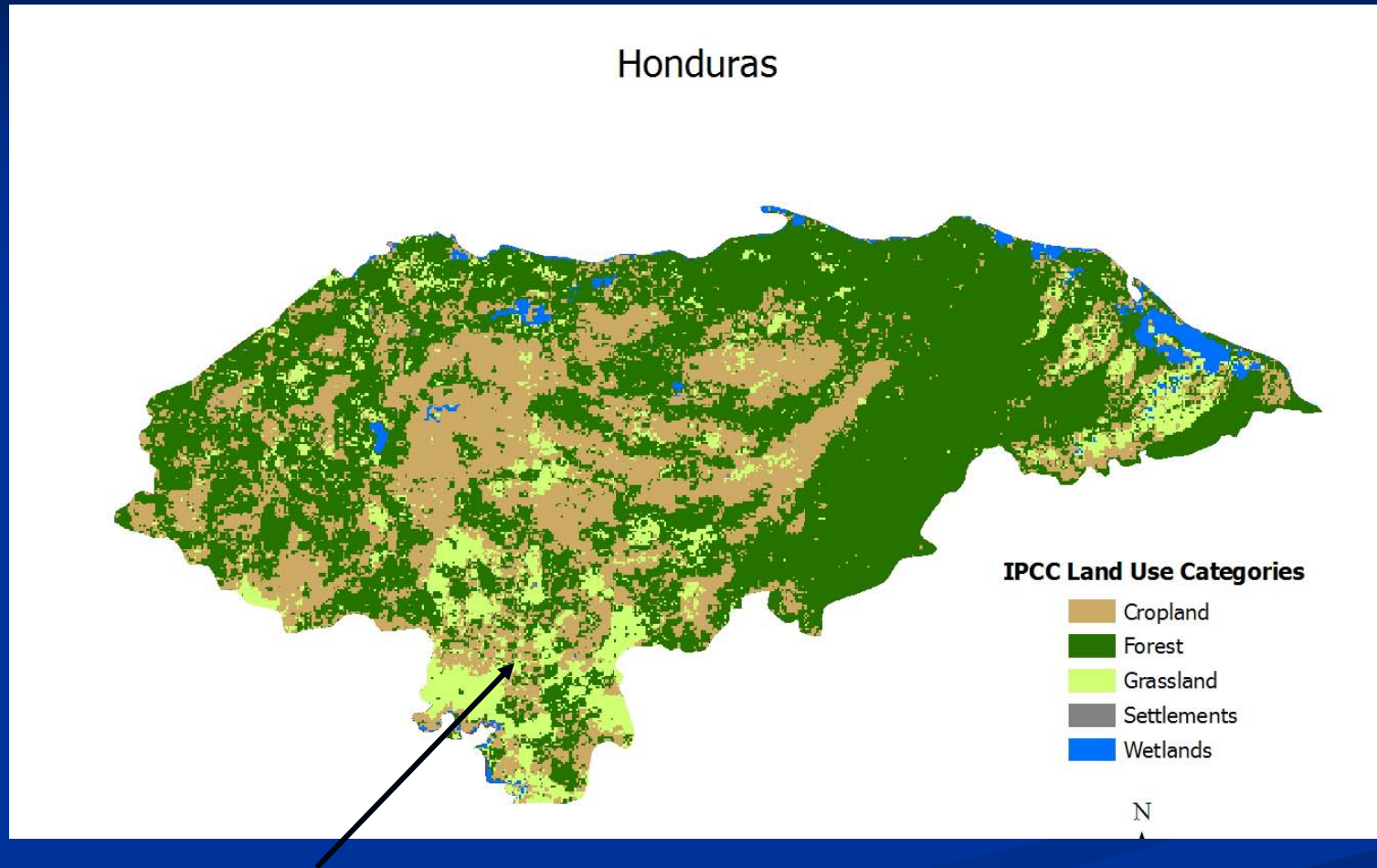
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Disclaimer: This tool is for the exclusive use of Central American Countries (Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, and Panama) to estimate greenhouse gas fluxes associated with land use and management of agricultural land, and report those results to the United Nations Framework Convention on Climate

Form View NUM

Start CAALU_Tool CAALU Microsoft PowerPol... 12:39 AM

Integrates spatial data into assessment framework



Land use areas from GIS data incorporated directly into program

Incorporates QA/QC, documentation, calculation and reporting functions

Module 3: Equation Calculations

Biomass C Stocks - Forest

Overview of QA/QC and Calculations Session Name: GIS Test Year: 1990 Notes

Select A Specific Computation: ?

Status	Equation	Subclass
+	Change in Forest Biomass C from growth	None
+	Forest Biomass C loss from fire	None
+	Forest Biomass C loss from hurricanes and windstorms	None
+	Forest Biomass C loss from other disturbances	None
+	Forest Biomass C loss from pest/disease outbreaks	None
+	Forest Biomass C losses from harvest	None
+	Forest Biomass C loss from fuelwood gathering	None

Select Computation

Equation

Equation:

$$\text{Change in Forest Biomass C from growth} = \text{area} * \text{aboveground biomass growth increment} * \text{Dry Matter C Fraction} * (1 + \text{root:shoot})$$

Factors and Result

Strata, Factors, & Results for: Change in Forest Biomass C from growth ? Data OK: No Errors

Strata 1	Strata 2	Strata 3	Factor 1	Factor 2	Factor 3	Factor 4	Result
Tropical moist long dry season	Deciduous Forest	<= 20 years	15767	4	0.5	0.42	44778.28
Tropical moist long dry season	Tropical Broadleaf	<= 20 years	14900	4	0.5	0.42	42316
Tropical moist long dry season	Tropical Broadleaf	<= 20 years	37805	4	0.5	0.42	107366.2
Tropical moist long dry season	Tropical Broadleaf Evergreen Forest	<= 20 years	971290	4	0.5	0.42	2758463.6
Tropical moist long dry season	Tropical Evergreen Needleleaf Forest	<= 20 years	1276807	4	0.5	0.42	3626131.88
Tropical, montane moist	Palm Forest	<= 20 years	18222	5	0.5	0.42	64688.1
Tropical, montane moist	Palm Forest	<= 20 years	3900	5	0.5	0.42	13845
Tropical, montane moist	Tropical Evergreen Needleleaf Forest	<= 20 years	38090	5	0.5	0.42	135219.5
Tropical moist long dry season	Deciduous Forest	> 20 years	8547	1	0.5	0.24	5299.14
Tropical moist long dry season	Tropical Broadleaf	> 20 years	41331	1	0.5	0.24	25625.22
Tropical moist long dry season	Tropical Broadleaf	> 20 years	89444	1	0.5	0.24	55455.28
Tropical moist long dry season	Tropical Broadleaf Evergreen Forest	> 20 years	1814000	1	0.5	0.24	1125242.58

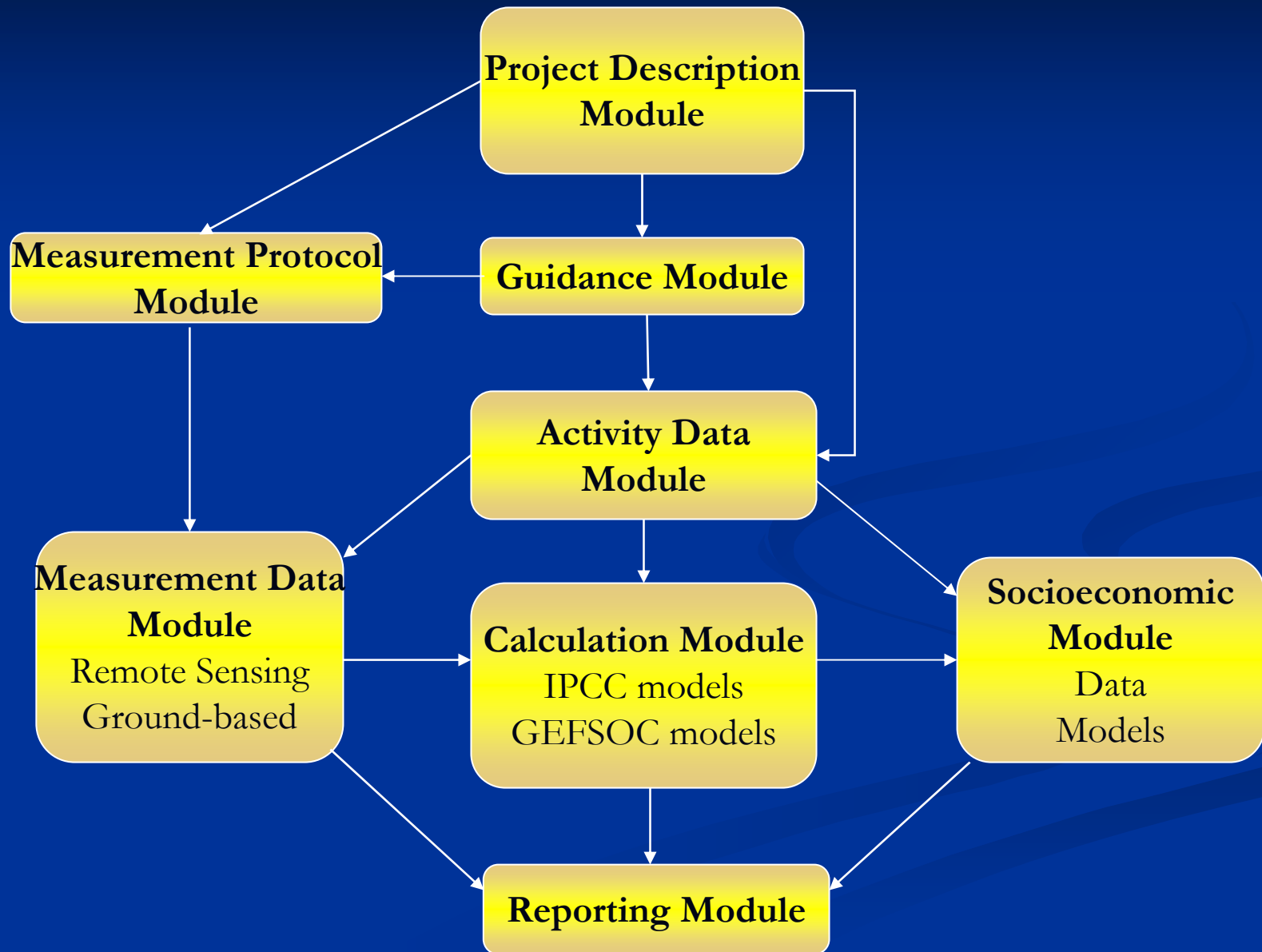
Number of Records: 16

Strata & Factor List Export Data to Spreadsheet File ?

Opens a window with strata, factors, units

? Continue: No Errors Found Stop: Error Identified Close

GEF-funded Carbon Benefits: Modelling, Measurement and Monitoring Project



Integrating soil measurements with model-based estimation systems

- Improving model-based systems requires integration with national- or regional scale measurement networks
- Should represent all major land use and management systems, climatic regions and soil types
- Should represent 'on-farm' conditions
- Needs to include data on land management practices
- Provide for precise re-measurement procedures and sampling protocols

Attributes of a measurement network

- Repeated measurements at permanent monitoring locations in farmer fields
 - 5-7 yr sampling intervals provides sufficient time for detectable changes
 - Remeasurement at permanent inventory plots reduces effects of spatial variability
 - Potential to leverage with soil mapping activities
 - Great advantages in pooling data from pilot projects, to reduce overall measurement.

Concluding remarks

- Improving soil organic matter stocks help buffer impacts of climate change.
- Inclusion of agriculture in GHG mitigation policies can provide impetus for achieving more sustainable practices.
- Acceptance of agricultural sinks require that they can pass the ‘environmental integrity’ test.
- While direct measurement at field-scale – for individual projects – is possible, in most cases it will not be practical, cost-effective, nor necessary.
- Integrated modelling-measurement systems can provide reliable, cost-effective quantification to support agricultural GHG mitigation policies.
- Efforts are needed to establish broad-scale, regional networks of soil C monitoring locations (via national efforts or ‘data pooling’ from pilot projects).