Agroforestry: Accounting for Windbreak's Climate Change Contributions

Michele Schoeneberger - USDA FS/NRCS National Agroforestry Center
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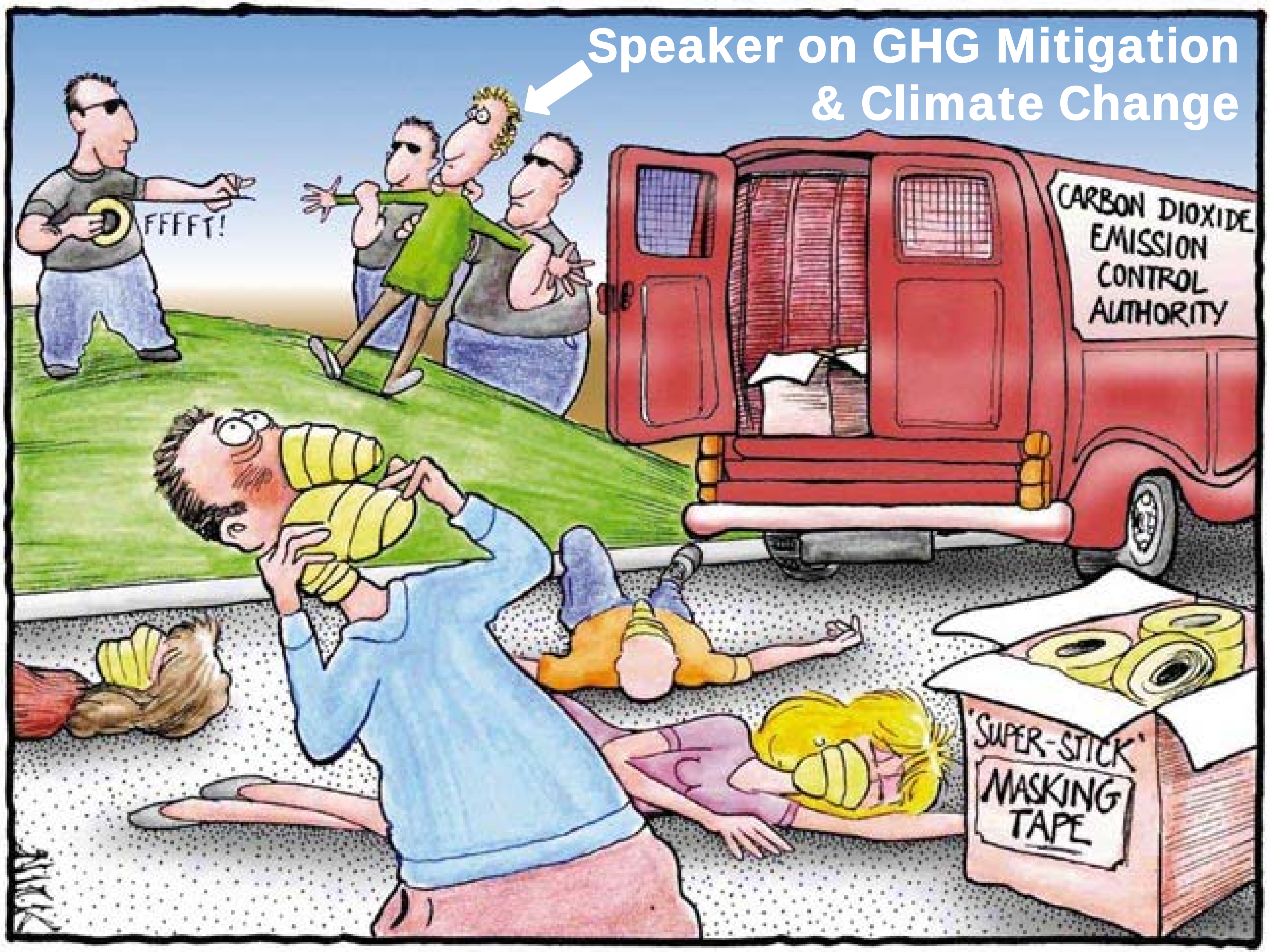
John Kort – AAFC-AES Agroforestry Development Centre
Tom Sauer – USDA ARS Natl Lab for Agriculture & the Environment

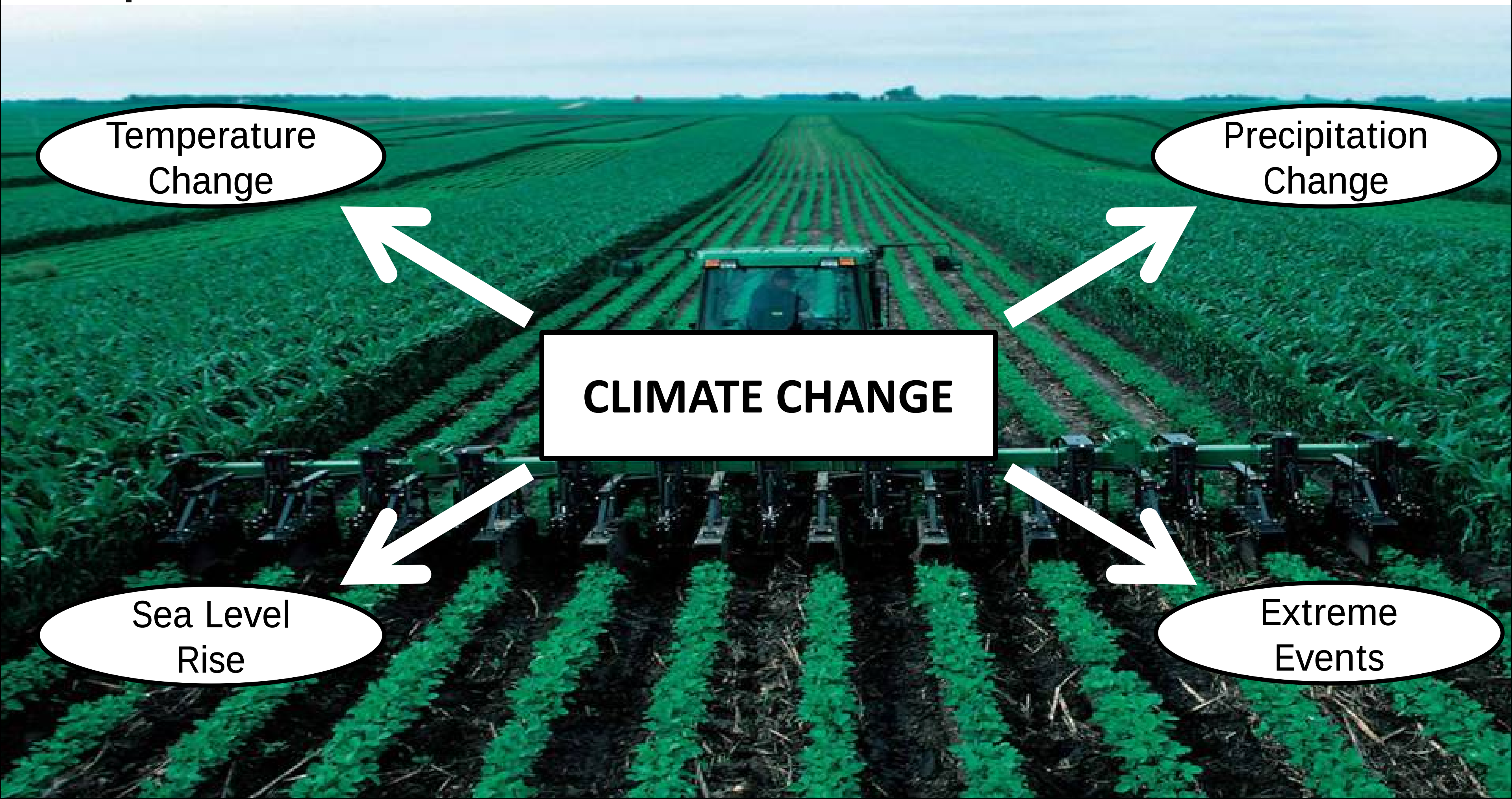
Great Plains Windbreak Renovation & Innovation Conference – International Peace Garden - July 24-26, 2012

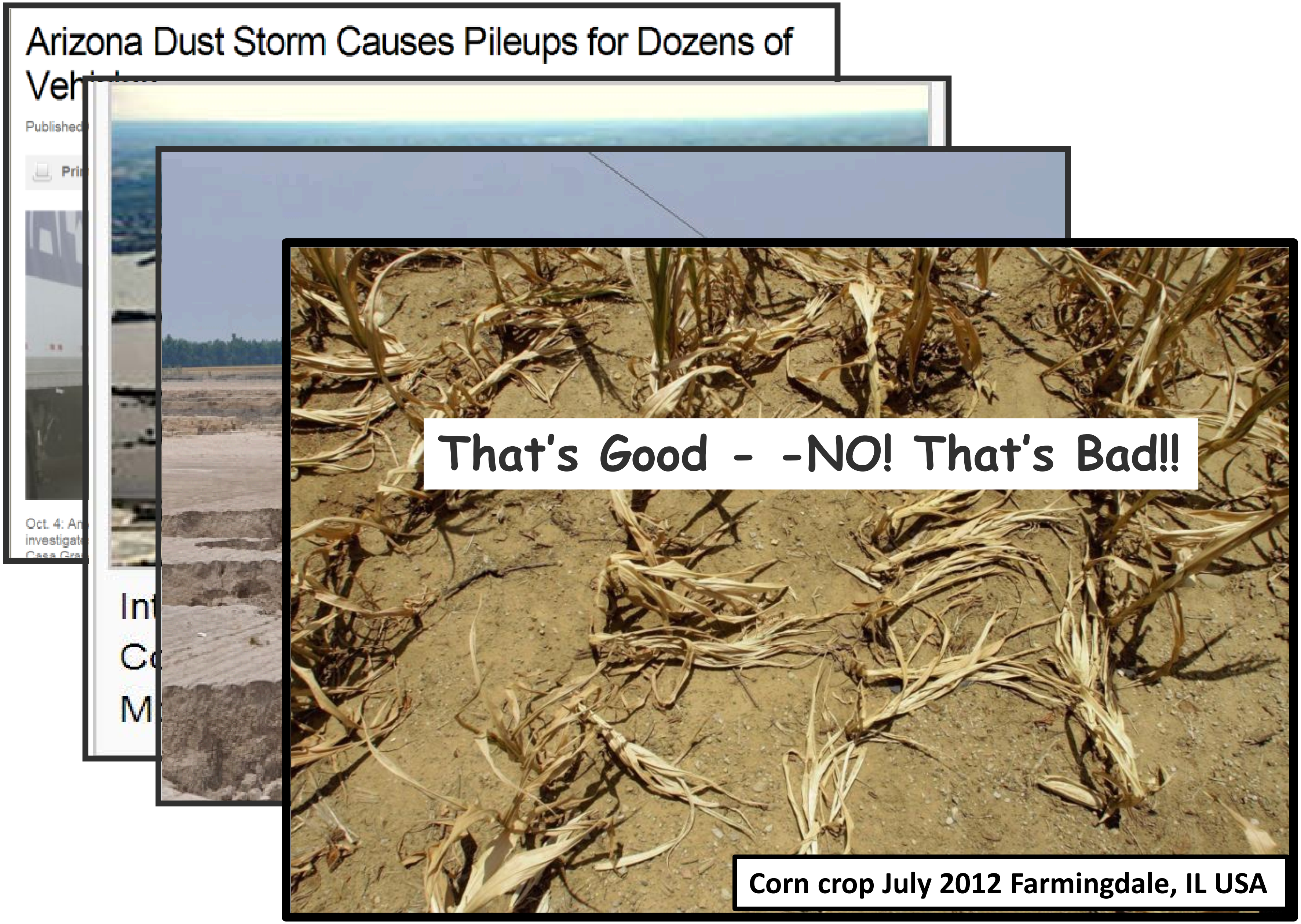

Speaker on GHG Mitigation & Climate Change
FFFFT!
CARBON DIOXIDE EMISSION CONTROL AUTHORITY
'SUPER-STICK' MASKING TAPE

Agroforestry: Accounting for Windbreak's Climate Change Contributions

Counting Carbon

Realizing Agriculture's Potential under Climate Change?





- Extreme weather events

Corn crop July 2012 Farmingdale, IL USA

U.S. News

U.S. drought pushes world to food crisis

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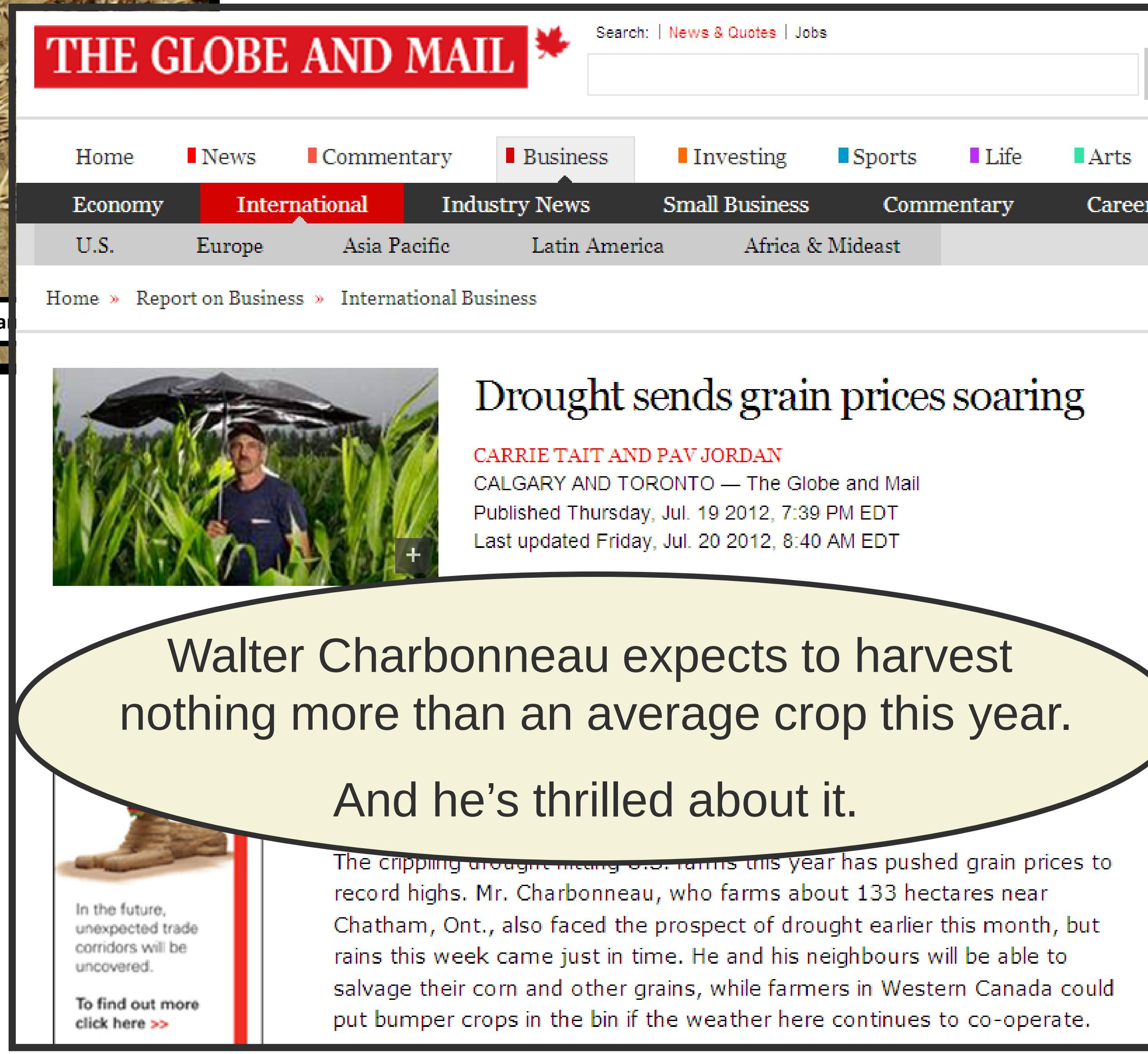
Agriculture Secretary Tom Vilsack speaks on the drought impacting American farmer during a briefing at the White House on July 18, 2012 in Washington, D.C. UPI/Kevin Dietsch

License photo

Published: July 20, 2012 at 3:30 AM

LINCOLN, Neb., July 20 (UPI) - - The worst U.S. drought in 56 years is pushing the world to a food crisis, officials said as scorching Midwest heat sent corn and soybean prices to record highs.

- Extreme weather events



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Drought sends grain prices soaring

CARRIE TAIT AND PAV JORDAN

CALGARY AND TORONTO — The Globe and Mail

Published Thursday, Jul. 19 2012, 7:39 PM EDT

Last updated Friday, Jul. 20 2012, 8:40 AM EDT

Walter Charbonneau expects to harvest nothing more than an average crop this year.

And he's thrilled about it.

The crippling drought hitting U.S. farms this year has pushed grain prices to record highs. Mr. Charbonneau, who farms about 133 hectares near Chatham, Ont., also faced the prospect of drought earlier this month, but rains this week came just in time. He and his neighbours will be able to salvage their corn and other grains, while farmers in Western Canada could put bumper crops in the bin if the weather here continues to co-operate.

- Extreme weather events

Realizing Agriculture's Potential for Meeting Multiple Demands under Climate Change?

Climate Change ?

- **Erratic/Extreme weather:** timing, frequency & intensity
- **Stressors:** Drives many stressors & interacts w/ many non-climatic stressors.

- **Food production**
- **Water & soil quality**
- **Wildlife habitat**
- **Rural vitality**
- **Bioenergy**
- **GHG mitigation**

Climate Change Impacts - Exact outcomes hard to predict in any general way

GLOBAL RESEARCH ALLIANCE

ON AGRICULTURAL GREENHOUSE GASES

- Established out of the 2009 UN Climate Change Conference in Copenhagen (COP 15)
- 30+ countries - including Canada & U.S.
- Incoming GRA Chair: Jamshed Merchant, Assist. Deputy Minister AES-AAFC

www.globalresearchalliance.org

GLOBAL RESEARCH ALLIANCE
ON AGRICULTURAL GREENHOUSE GASES

GLOBAL RESEARCH ALLIANCE
ON AGRICULTURAL GREENHOUSE GASES

GRA is focused on the RDA of technologies and practices that will help deliver ways:

1. to grow more food
2. more climate-resilient food systems
3. without increasing GHG emissions

GLOBAL RESEARCH ALLIANCE

ON AGRICULTURAL GREENHOUSE GASES

- CROPLANDS includes AGROFORESTRY (United States & Brazil)
- PADDY RICE (Japan & Uruguay)
- LIVESTOCK SYSTEMS (New Zealand & Netherlands)

- Inventories & Measurement (Canada & Netherlands)
- Soil Carbon & Nitrogen (France & Australia)

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GLOBAL RESEARCH ALLIANCE
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- Improve measurement & estimation of GHG emissions and C sequestration
- Develop ways to reduce emissions
- Develop ways to increase C sequestration

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Agroforestry: A Tool w/in the 'CC-Integrated' Conservation Toolbox for Ag

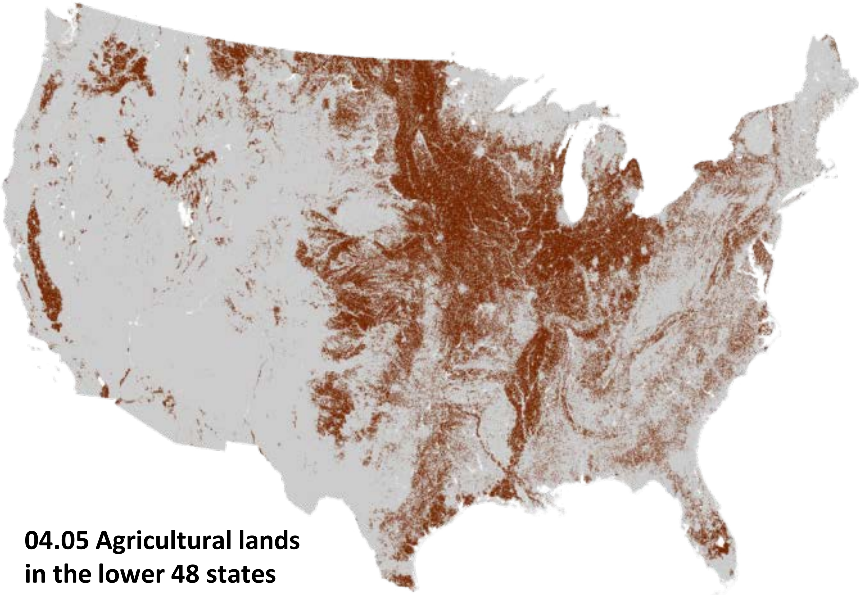
MITIGATION

1. Sequester carbon
2. Reduce emissions of greenhouse gases

ADAPTATION

3. Make it better for things to remain
4. Make it easier to get 'out of Dodge'

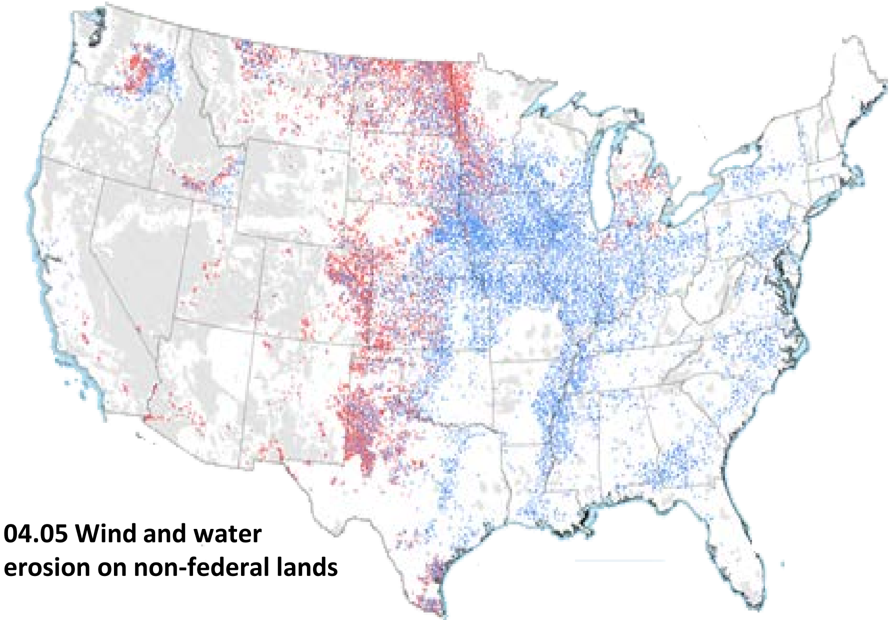
….All while doing their other jobs



04.05 Agricultural lands in the lower 48 states

Agricultural lands

CONUS Map
Data Source: NLCD 2006



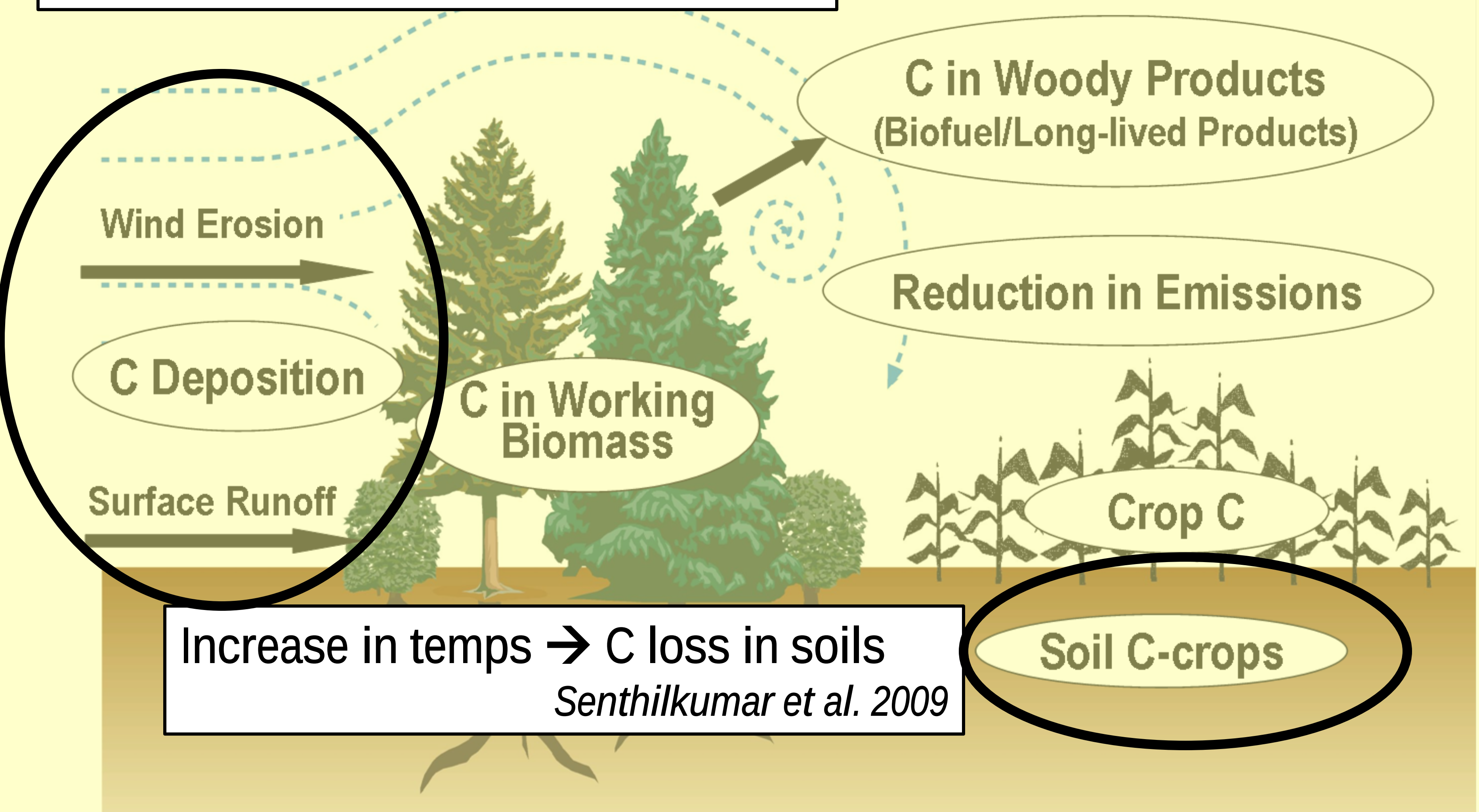
04.05 Wind and water erosion on non-federal lands

CONUS Map **Data source:** http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/technical/nra/nri/?&cid=stelprdb1041887

- Agricultural landscapes: over 22 % of the land use in the lower 48 states.
- ***Soil erosion by water and wind*** is just one of the threats that is being predicted to be exacerbated by climate change shifts.

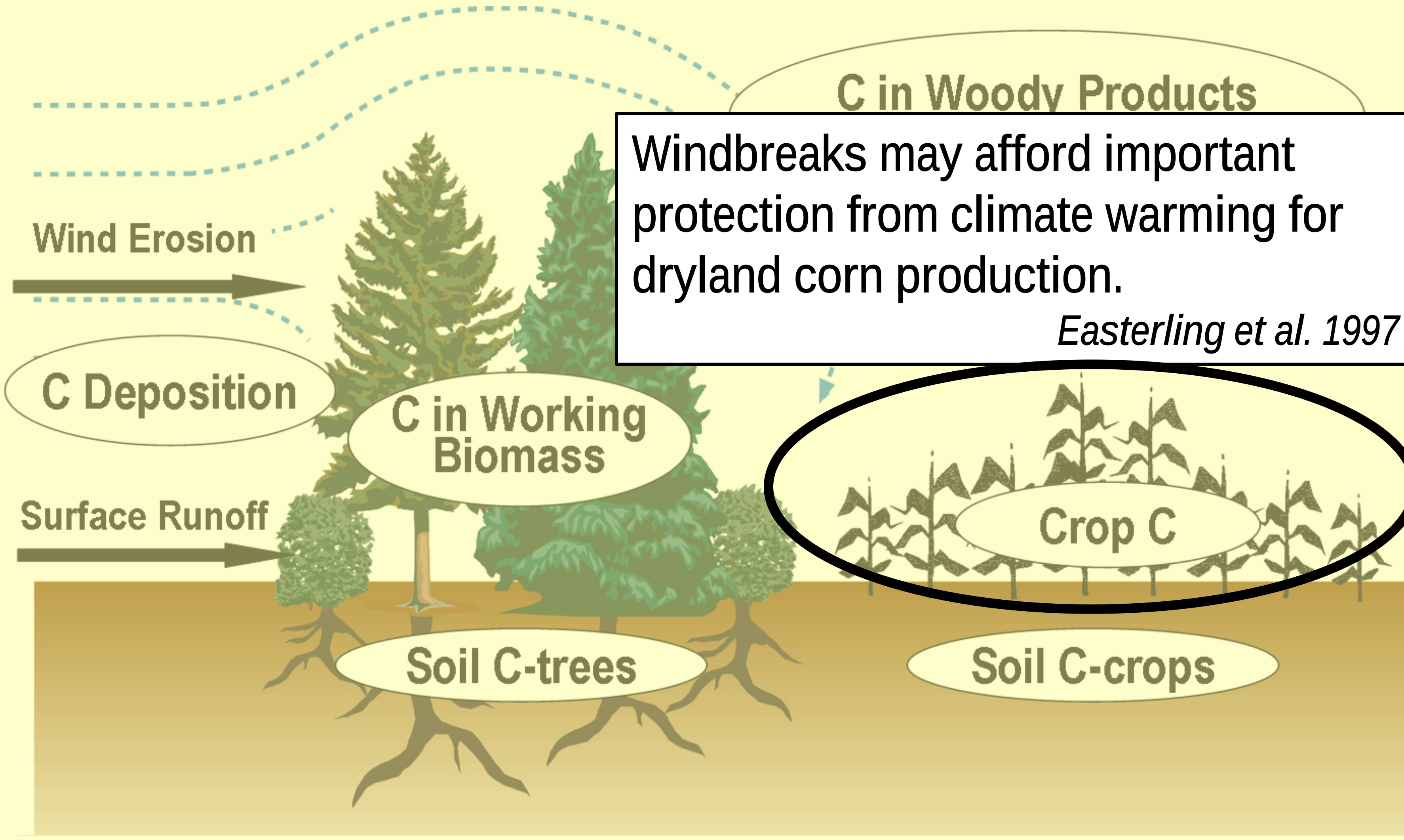
urces in Windbreaks

2º C increase → greater wind erosion
CO_2 increase → greater water erosion
Lee et al. 1996



Increase in temps → C loss in soils
Senthilkumar et al. 2009

Major Carbon Sinks & Sources in Windbreaks



Windbreaks may afford important protection from climate warming for dryland corn production.

Easterling et al. 1997

Agroforestry:

Accounting for Windbreak's Carbon

WHY?

REMINDER: ***Counting C***

C stocks versus C sequestered:

(Change in C stocks)

[UNCERTAINTY > C VALUE]

Agroforestry:
Accounting for Windbreak's Carbon

WHY?

- C is sequestered regardless of intent: CO-BENEFIT.
- C sequestration potential of soils and trees is significant.
- Indirect C savings may be even more significant.

Carbon Sequestration Potential – 2 Options

Mead Farm – Nebraska (50 years)

Option	Ha	%total	MT CO_2	MT CO_2/ha/yr
Conservation tillage only	254 No-tillage	100	9,203*	1.17-0.18
			9,203	




*COMeT-VR (Brenner et al.)

Schoeneberger, Brandle & Zhou

Carbon Sequestration Potential – 2 Options

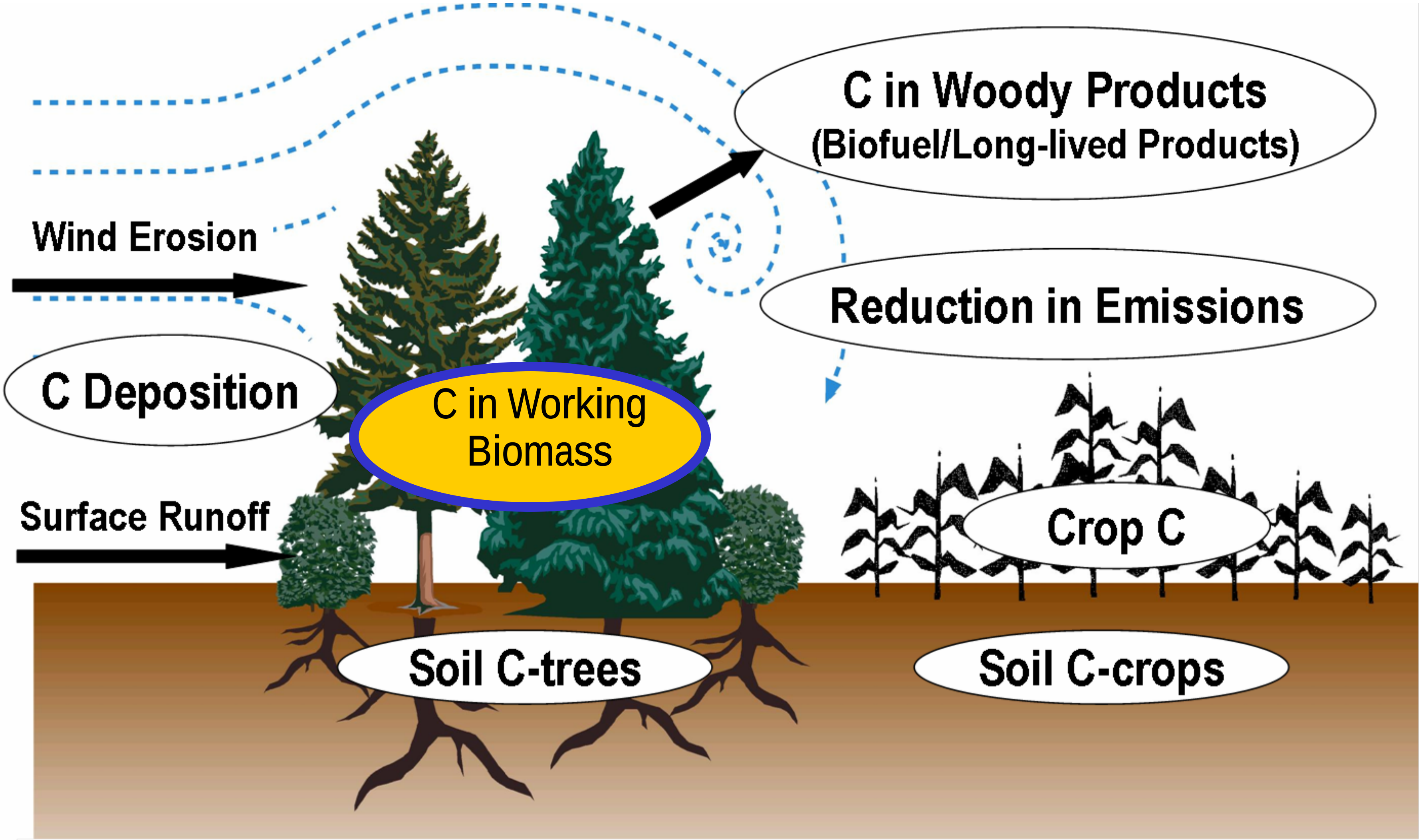
Mead Farm – Nebraska (50 years)

Option	Ha	%total	MT CO_2	MT CO_2/ha/yr
Conservation tillage only	254 No-tillage	100	9,203*	1.17-0.18
			9,203	
Conservation tillage & windbreaks	241 No-tillage	95	8,712*	1.17-0.18
	13 Windbreaks	5	7,416	2.36-17.23
			16,128	

*COMeT (Brenner et al.)

Schoeneberger, Brandle & Zhou

Major Carbon Sinks & Sources in Windbreaks

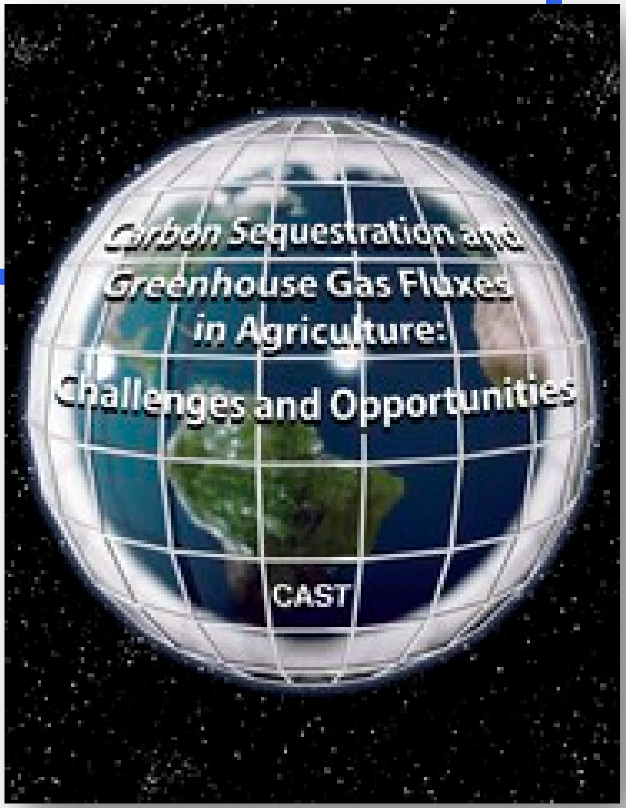


- Carbon Sequestration in Agricultural Lands of the US
  Journal of Soil & Water Conservation (2010)

- Carbon Sequestration & GHG Fluxes in Agriculture: Challenges & Opportunities
  CAST Taskforce Report #142 (2011)

  www.cast-science.org

AGROFORESTRY included



Agroforestry:

Accounting for Windbreak's Carbon

WHY?

1. Demonstrate windbreak's contributions

Agroforestry:
Accounting for Windbreak's Carbon

WHY?

1. Demonstrate windbreak's contributions

2. Credits, Markets and Payments
   - CCX no longer functioning but…….
   - Emerging interest/activities in C credits/markets and payments [ASK JOHN KORT: Conservation Cropping Protocol] [ASK BRUCE WIGHT: latest US FARM BILL(?)]

Agroforestry:

Accounting for Windbreak's Carbon

WHY?

Agroforestry:

- C is sequestered regardless of intent: CO-BENEFIT.
- C sequestration potential of soils and trees is significant.
- Indirect C savings may be even more significant.
- A means of payment for the many services provided by the tree plantings – especially windbreaks.

Carbon Sequestration Potential – 2 Options

Mead Farm – Nebraska (50 years)

Option	Ha	%total	MT CO_2	MT CO_2/ha/yr
Conservation tillage only	254 No-tillage	100	9,203*	1.17-0.18
			9,203	
Conservation [illegible]	[illegible]41	95	8,712*	1.17-0.18
[illegible]	[illegible]	5	7,416	2.36-17.23
			16,128	

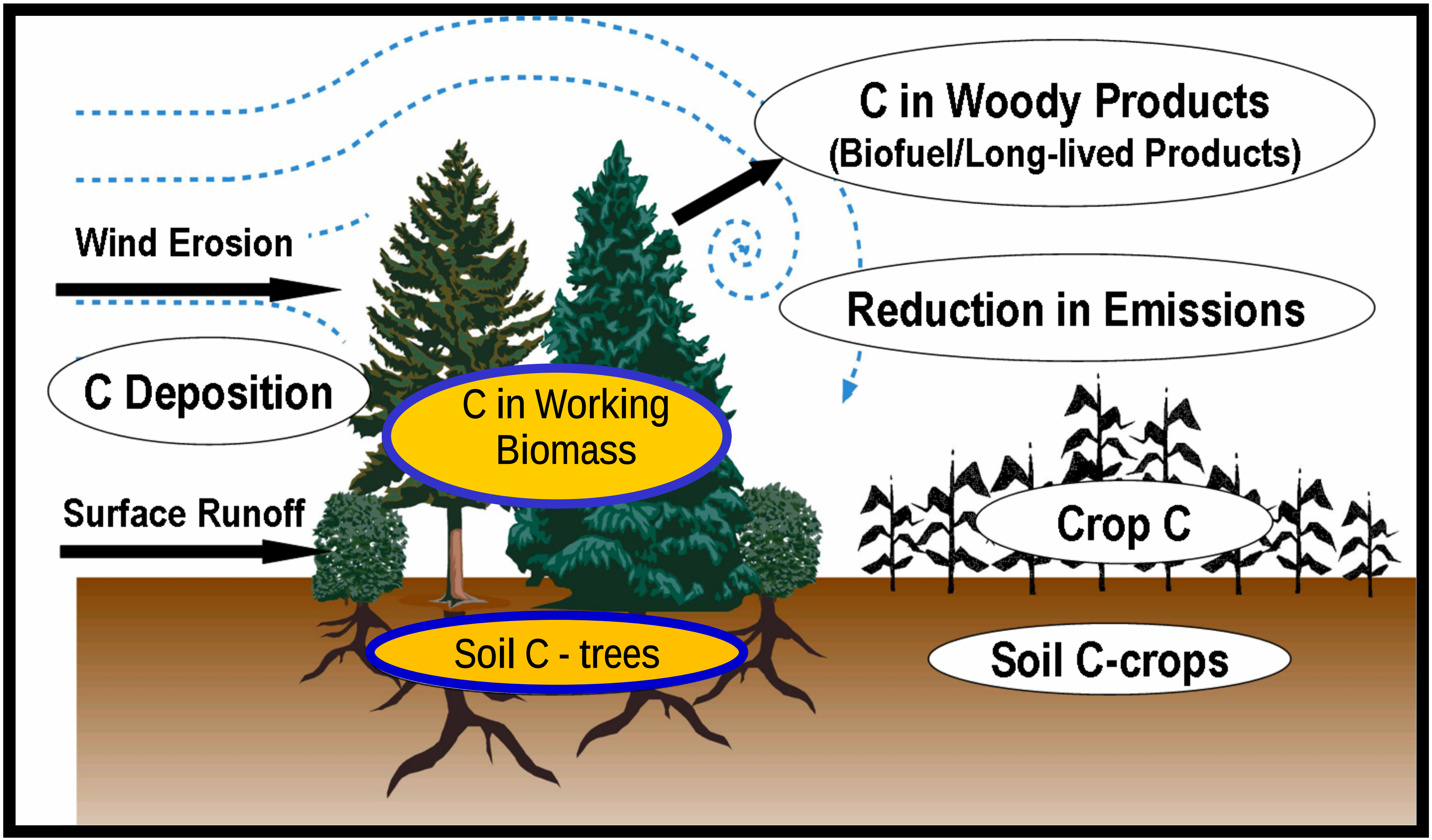
- Readily monitored/verified
- Does not change land use
- Provides OTHER benefits

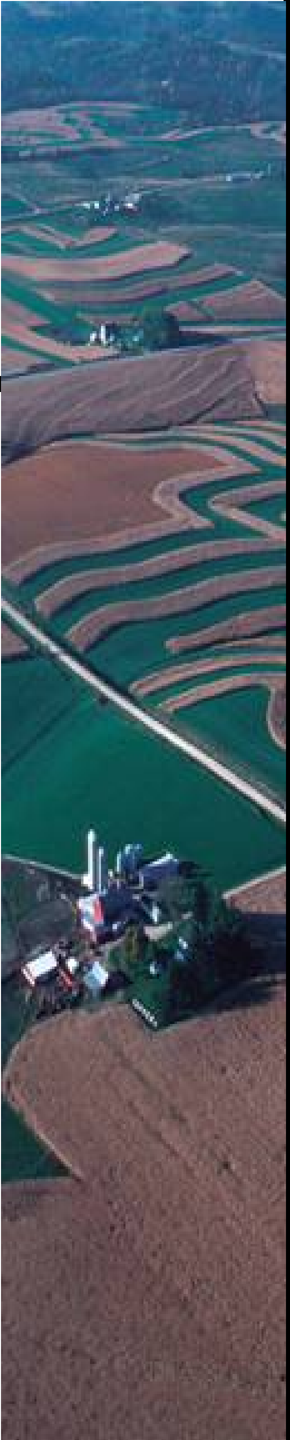



*COMeT (Brenner et al.)

Schoeneberger, Brandle & Zhou

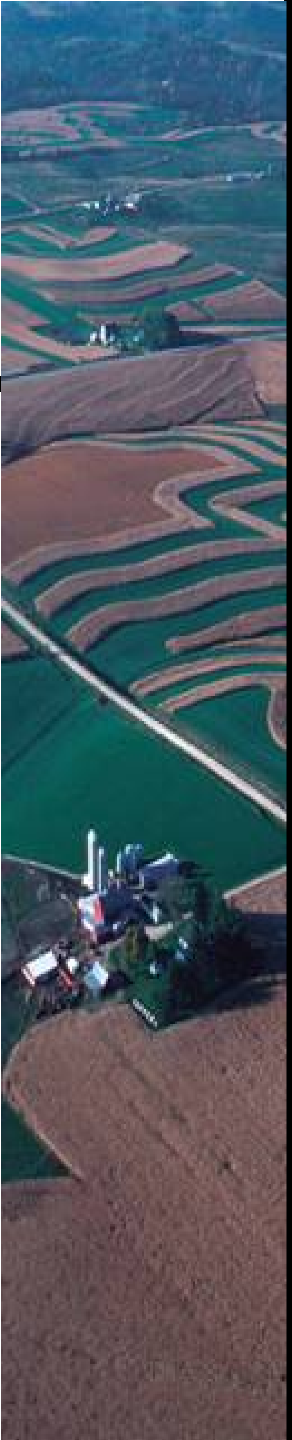
Major Carbon Sinks & Sources in Windbreaks





Accounting for Carbon Services in Agroforestry

- Not explicitly inventoried in FIA or NRI
- Equations for estimating biomass stocks not accurate for more open-grown plantings
- Soil C – complex & highly variable

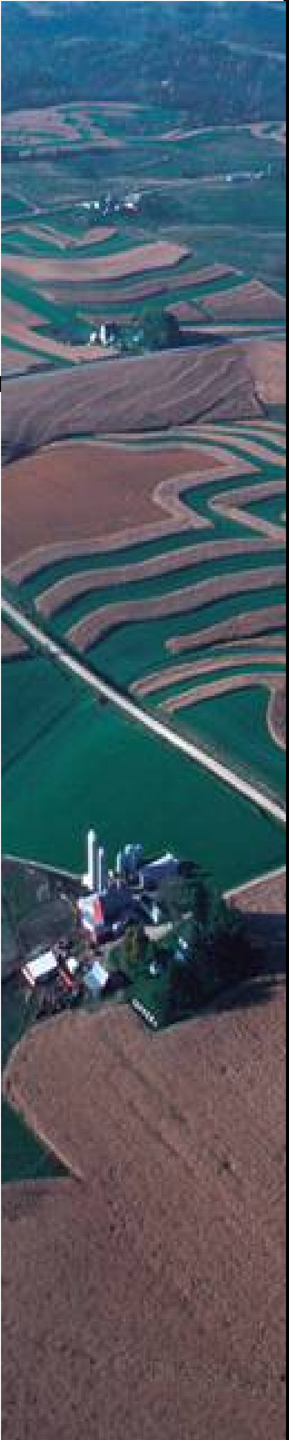


Carbon Pools

1605(b) Voluntary GHG Reporting

- Live trees
- Understory vegetation
- Standing dead trees
- Forest floor
- Soil carbon
- Harvested materials (in use/burned for energy/emissions – not for energy)

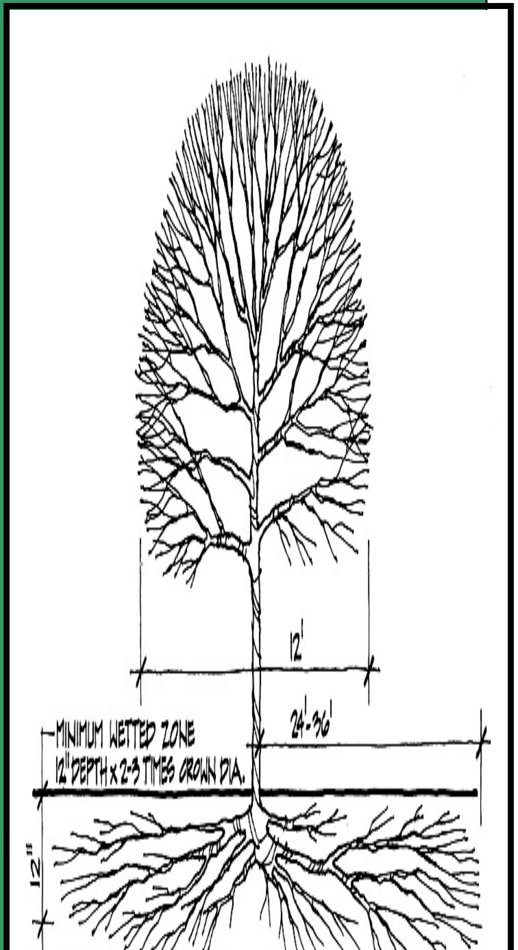
~~Default Tables~~



Agroforestry Carbon Pools

- Live trees
- ~~Understory vegetation~~
- ~~Standing dead trees~~
- ~~Forest floor~~
- ~~Soil carbon~~ ?
- ~~Harvested materials (i~~n use/burned for energy/emissions – not for energy)

Easy
Reliable
Economical



SOC Dynamics in Afforestation

(E.A. Paul et al. 2002, SSAJ Special Issue)

Up to 30% of seq-C may be in soil pools

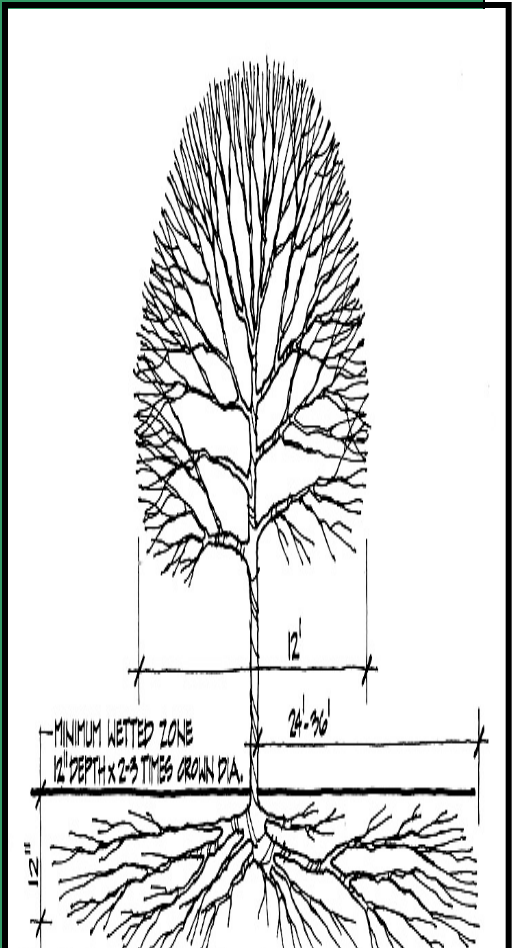
- 0.07 to +0.58 Mg/ha/yr in deciduous

- 0.85 to +0.56 Mg/ha/yr in conifer

Highly Variable

Soil Carbon in a Red Cedar-Scotch Pine Shelterbelt

Sauer, Cambardella & Brandle (2007)
Hernandez-Ramirez, Sauer, Cambardella, Brandle & James (2011)



- SOC shelterbelt > SOC cultivated field
- Patterns of C → inputs from tree litter and deposition of wind-blown sediment
- Stable isotope C analysis – 54% of SOC under trees derived from trees

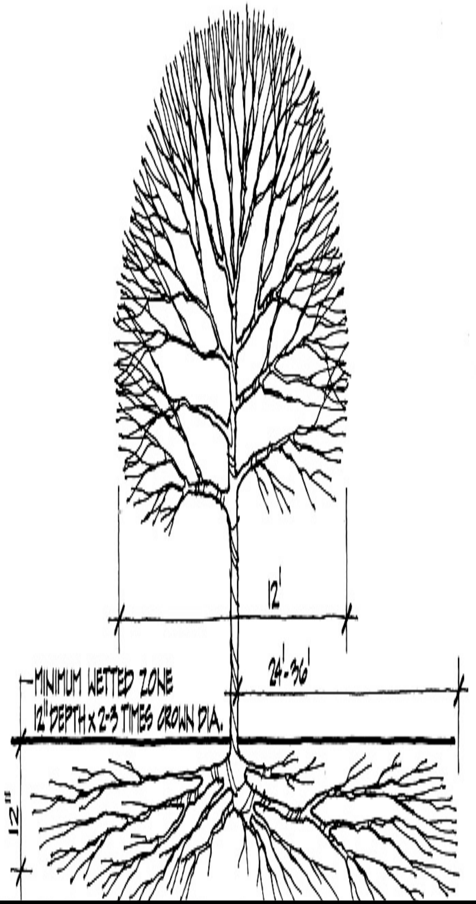
Soil Carbon in Shelterbelts

Sauer et al.(on-going):

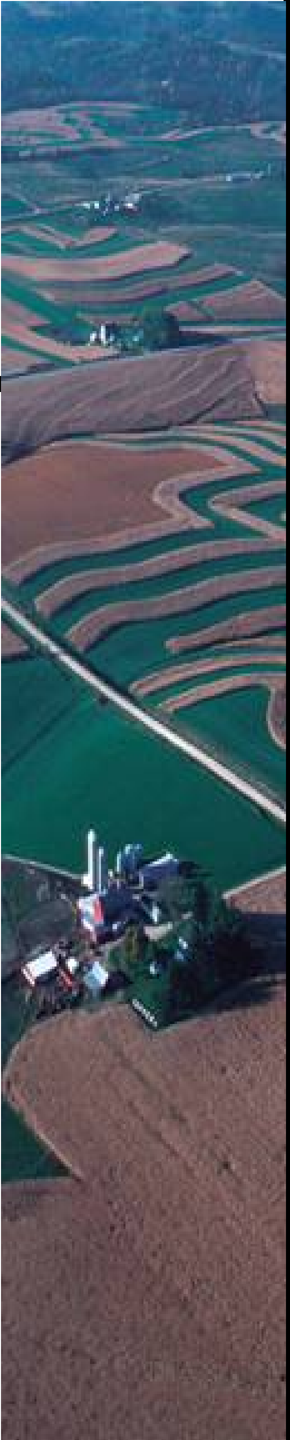
SOC in Windbreaks in the Great Plains (US) and Central Russian

70-yr old Windbreak System, Norfolk, NE (Sauer-USDA ARS 2012)

Accounting for Carbon Services in Agroforestry



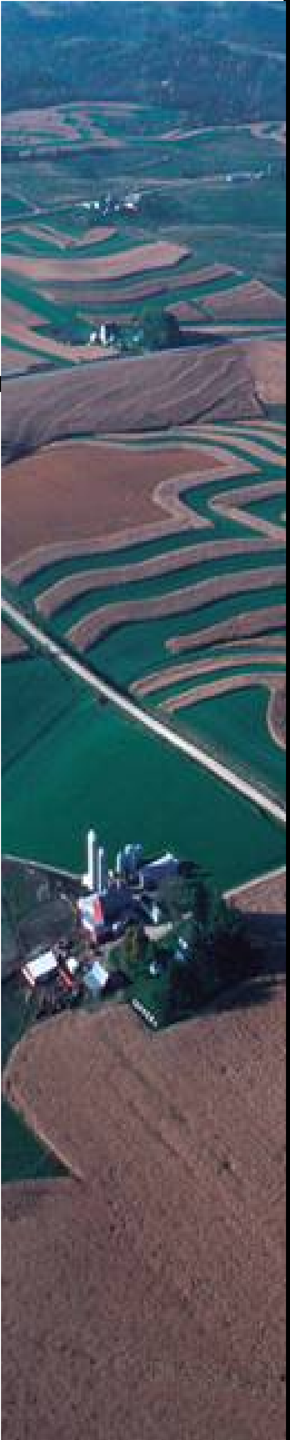
- *What to count?*
- *Majority of "new C" is in aboveground woody biomass*



Carbon Balance
NE Pine Forest vs Grassland

- Total ecosystem C increased from ~2,700 g/m^2 in grassland to 10,800 g/m^2 in the 70 yr-old forest.
- Aboveground biomass in forest accounted for 90% of this increase.

(Wedin, D. et al. 2000)



Accounting for Carbon Services in Agroforestry

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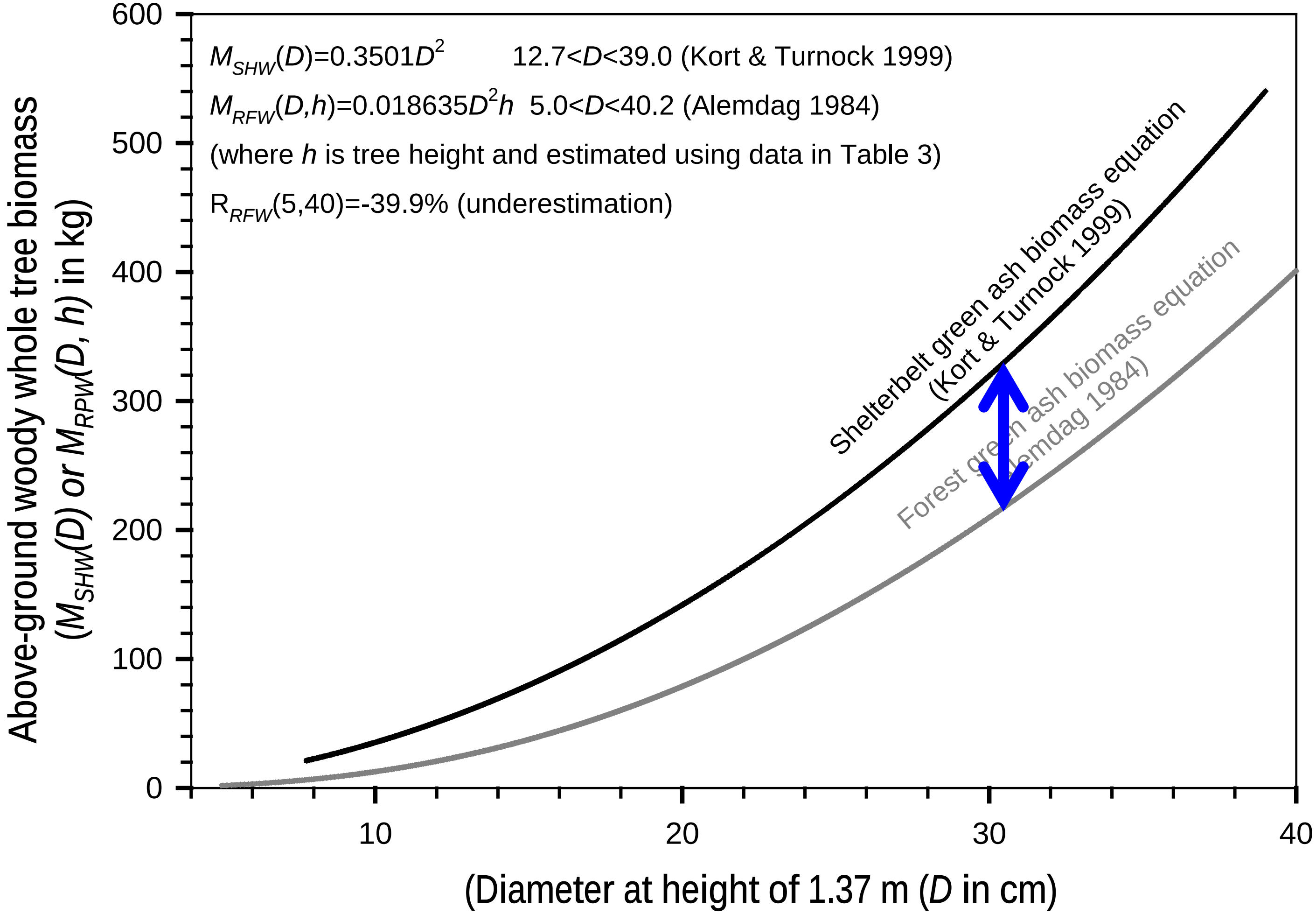
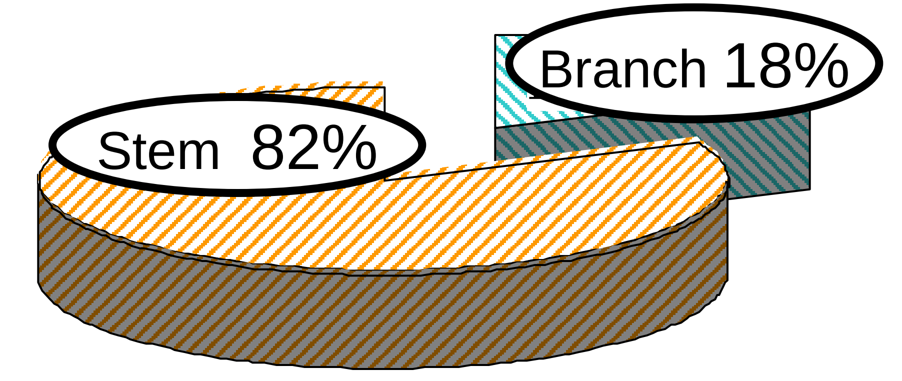


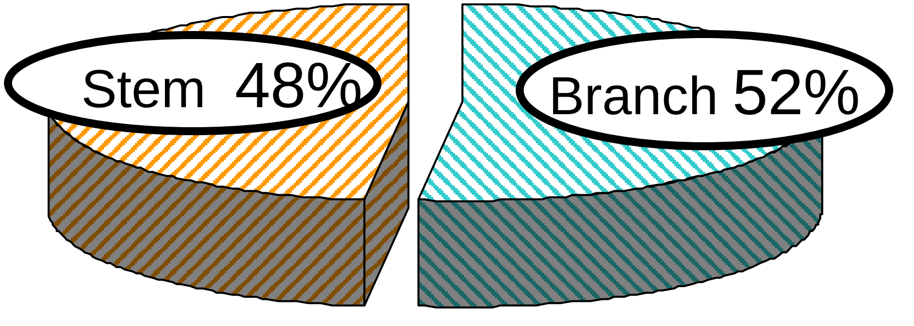
Figure 6 Comparison of above-ground woody whole tree biomass of green ash in Canada as estimated by forest-derived (Almedag) and shelterbelt-derived (Kort & Turnock) equations.

Volume proportion of stem & branches for green ash

Homogenous Forest Eq.
(Schlaegel, 1984)



2-Row Shelterbelt Eq.
(Zhou, 1999)



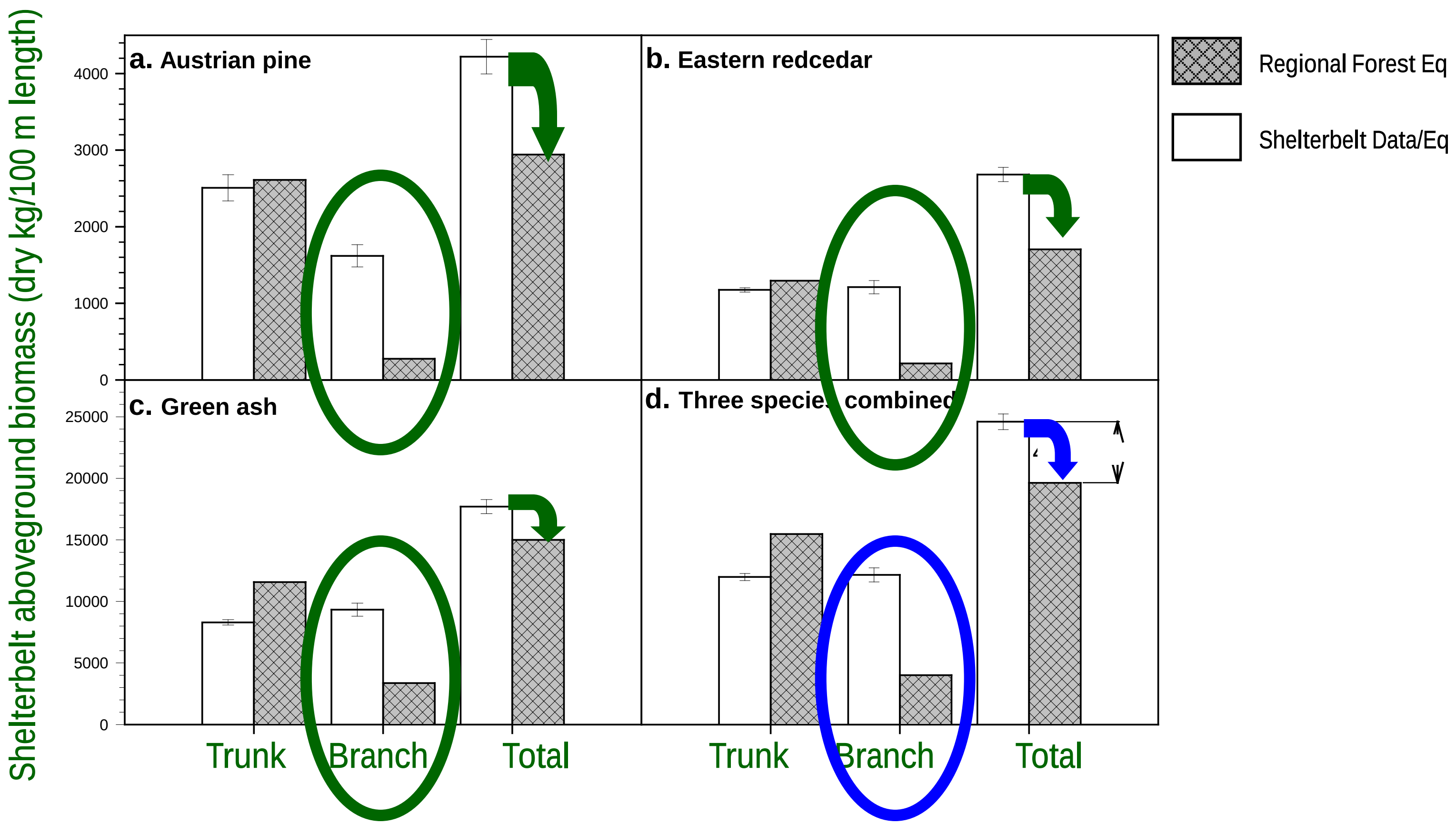
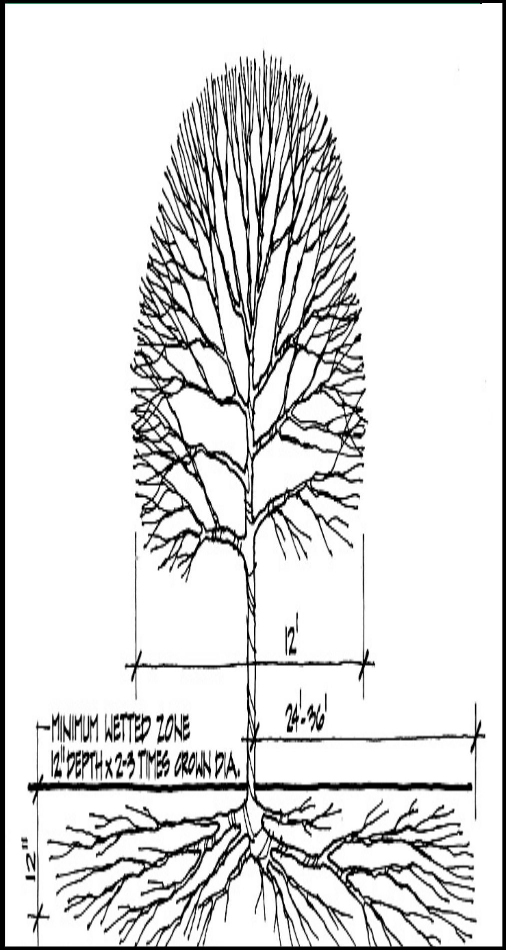


Figure 3 Comparison of regional forest-derived equations with shelterbelt-derived equations for shelterbelt network biomass estimations of individual species and the three species together.

(Zhou, Schoeneberger, Brandle, Awada, & Martin submitted)

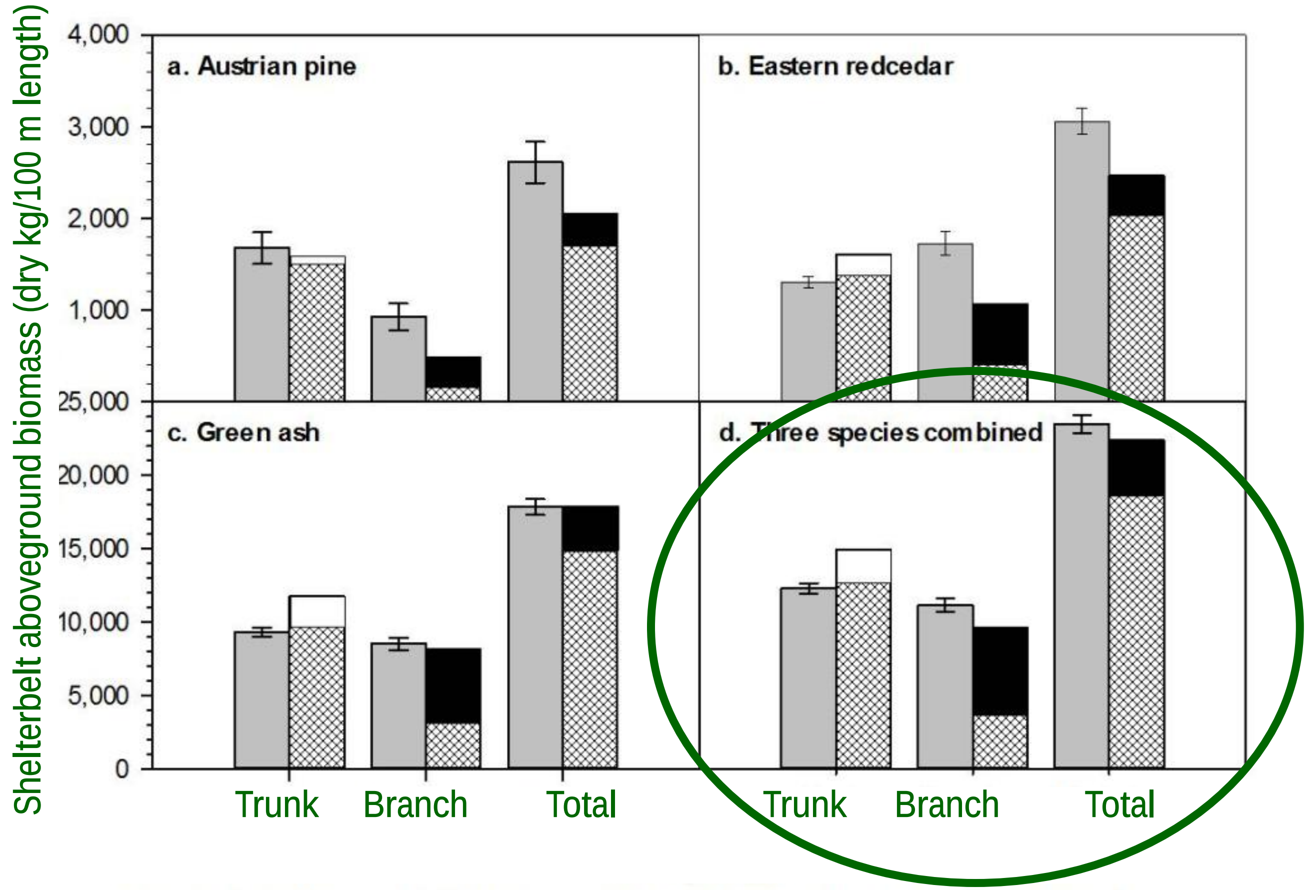
Accounting for Carbon Services in Agroforestry



SO WHY is this important?

- Majority of "new C" is in aboveground woody biomass.
- *BUT* belowground is generally estimated from aboveground.

Less C -> Less payment -> Less incentive



Estimated using the open-grown biomass equations. A 95% confidence interval was estimated based on the variance of our open-grown tree data and the method of Bates and Watts (1988).

Estimated using the regional forest-based biomass equations (Hahn and Hansen 1991, Smith 1985).

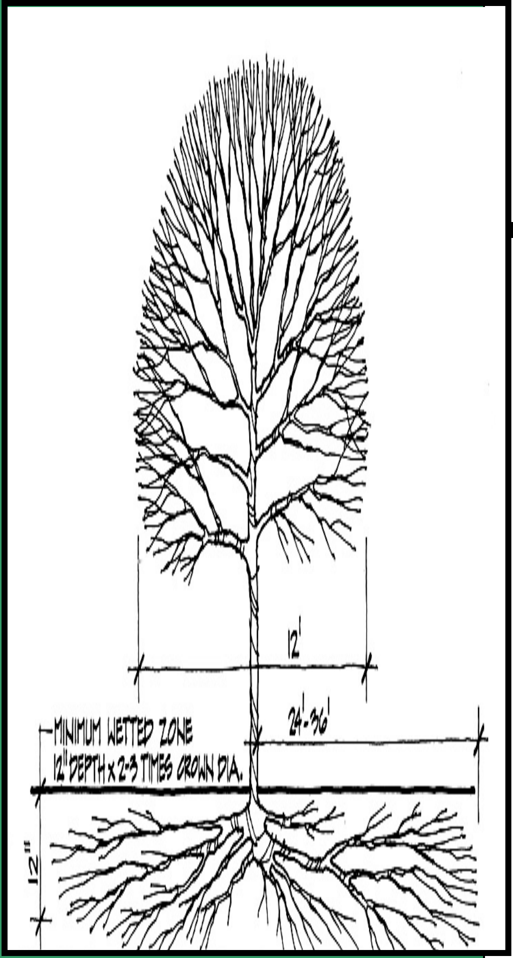
Correction Adjustments

A positive adjustment. Its top height represents the biomass value after the adjustment that was opriginally estimated using a forest-based biomass equation. See adjustment factors in Table 6.

A nagitive adjustment. Its bottom height represents the biomass value after the adjustmen that was opriginally estimated using a forest-based biomass equation. See adjustment factors in Table 6.

(Zhou, Schoeneberger, Brandle, Awada, & Martin submitted)

Accounting for Carbon Services in Agroforestry

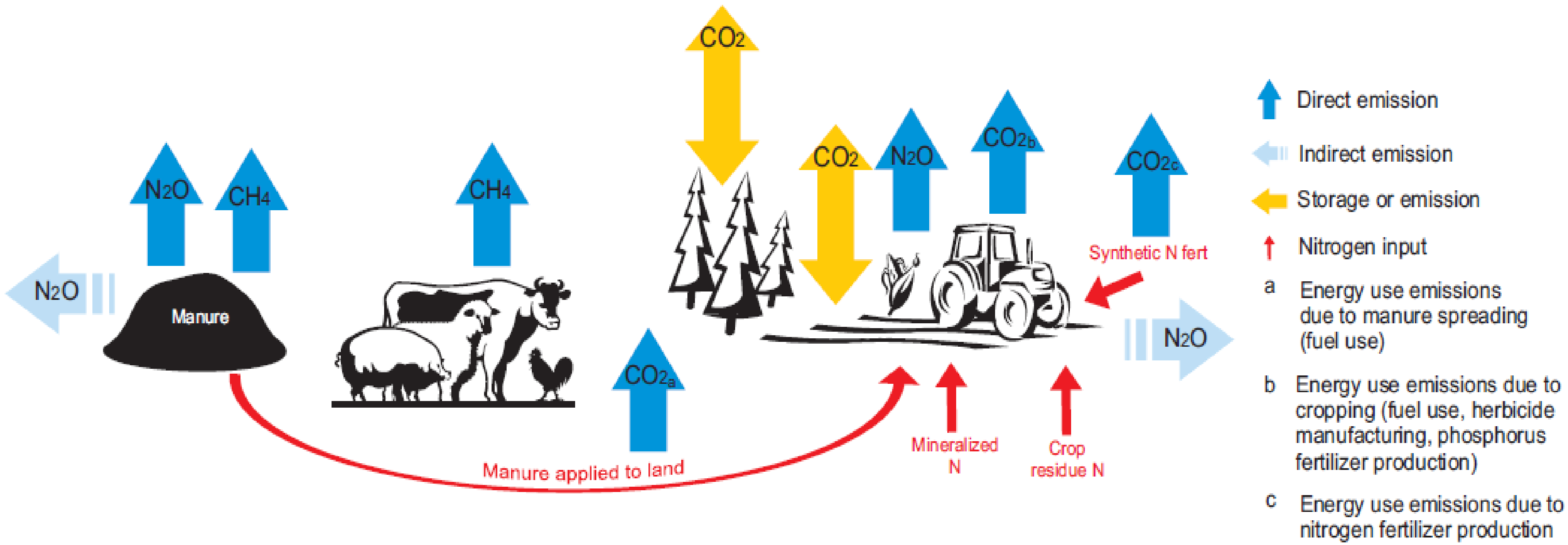


SO WHY is this important?

Agriculture and Agri-Food Canada Agriculture et Agroalimentaire Canada

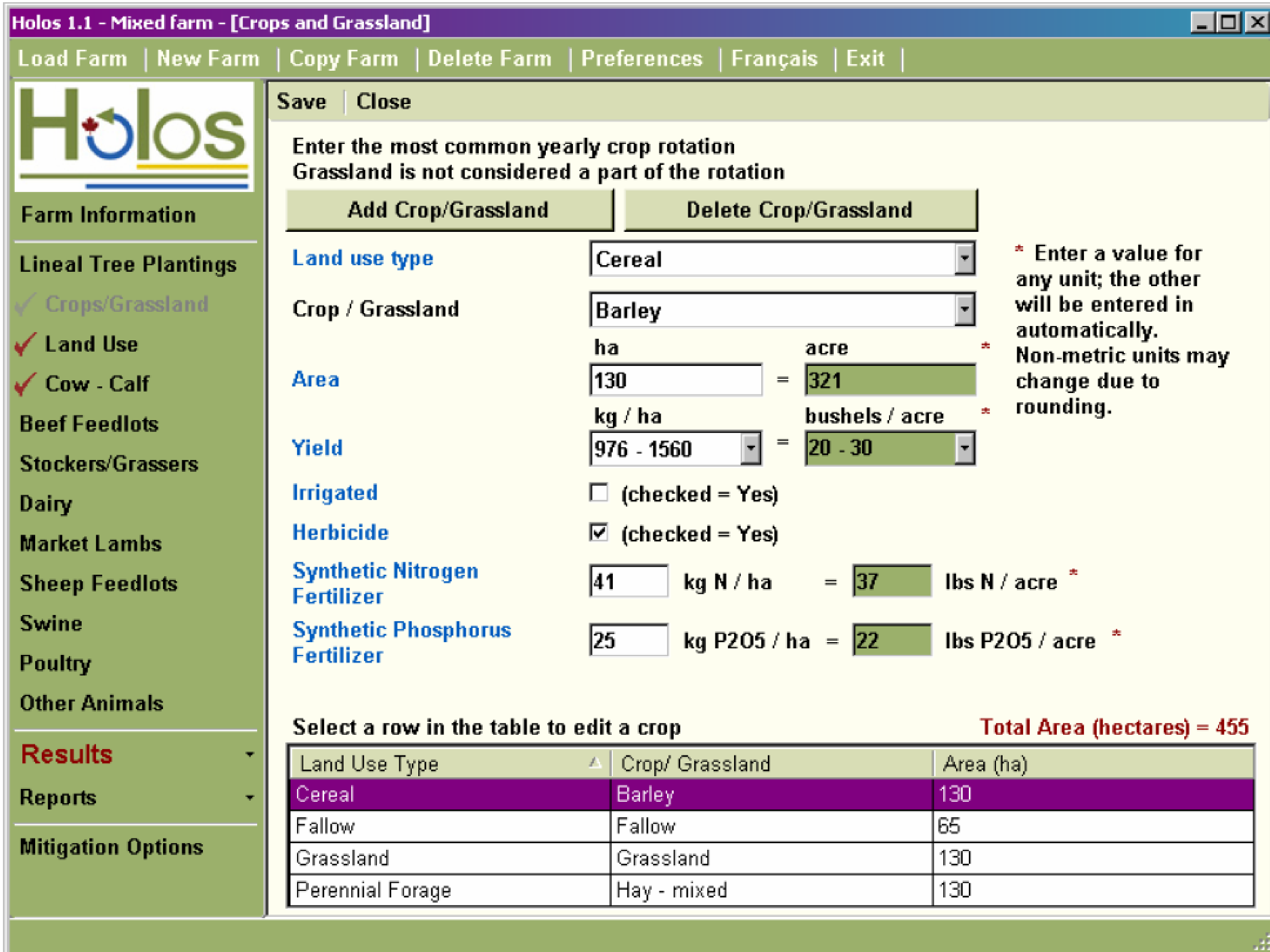
Holos: A tool to estimate and reduce GHGs from farms

The model and the tools



GHG emissions and sources included in Holos

- Fosters whole-systems approach
- Considers all GHGs from entire, integrated farm
- Based on IPCC (2006) methodology and recent research
- Focuses on details, practices & conditions that affect GHG emissions


Holos 1.1 - Mixed farm - [Crops and Grassland]
Load Farm | New Farm | Copy Farm | Delete Farm | Preferences | Français | Exit |
Save | Close
Holos
Farm Information
Lineal Tree Plantings
Crops/Grassland
Land Use
Cow - Calf
Beef Feedlots
Stockers/Grassers
Dairy
Market Lambs
Sheep Feedlots
Swine
Poultry
Other Animals
Results
Reports
Mitigation Options
Enter the most common yearly crop rotation
Grassland is not considered a part of the rotation
Add Crop/Grassland
Delete Crop/Grassland
Land use type
Cereal
Crop / Grassland
Barley
ha
acre
Area
130
=
321
kg / ha
bushels / acre
Yield
976 - 1560
=
20 - 30
Irrigated
(checked = Yes)
Herbicide
(checked = Yes)
Synthetic Nitrogen Fertilizer
41
kg N / ha
=
37
lbs N / acre *
Synthetic Phosphorus Fertilizer
25
kg P2O5 / ha
=
22
lbs P2O5 / acre *
* Enter a value for any unit; the other will be entered in automatically. Non-metric units may change due to rounding.
Select a row in the table to edit a crop
Total Area (hectares) = 455
Land Use Type
Crop/ Grassland
Area (ha)
Cereal
Barley
130
Fallow
Fallow
65
Grassland
Grassland
130
Perennial Forage
Hay - mixed
130

Welcome

- Accessibility Instructions
- Before you Start
- Run COMET-VR
- Contact Us
- Glossary of Terms
- News
- Requirements

Resources

- About the Database
- About Agroforestry Modeling
- Agroforestry
- Carbon Sequestration
- Internal Resources
- Major Contributors

Carbon Management Online Tool for Agriculture and AgroForestry Version 2.0

http://www.comet2.colostate.edu/

Go to | Introduction | Help | Whats New |

Introduction

COMET-VR 2.0 is a user-friendly, web-based tool that provides estimates of carbon sequestration and net greenhouse gas emissions from soils and biomass for US farms and ranches.

It links a large set of databases containing information on soils, climate and management practices to dynamically run the Century ecosystem simulation model as well as empirical models for soil N_2O emissions and CO_2 from fuel usage for field operations.

The system uses your farm-specific information to provide mean estimates and uncertainty for CO_2 emissions and sequestration from soils and woody biomass and soil N_2O emissions for annual crops, hay, pasture and range, perennial woody crops (orchards, vineyards), agroforestry practices, and fossil fuel usage.

- Click here! to find information on how to start the COMET-VR Tool or use the navigation link "**Help**" at the top of the page.
- To start COMET-VR, use the navigation link button labeled, "**Tool**" at the top of the page or Click the Blue "Run the Comet-VR Tool" button

Click this button to

Run the COMET-VR Tool

USGCRP - OCE

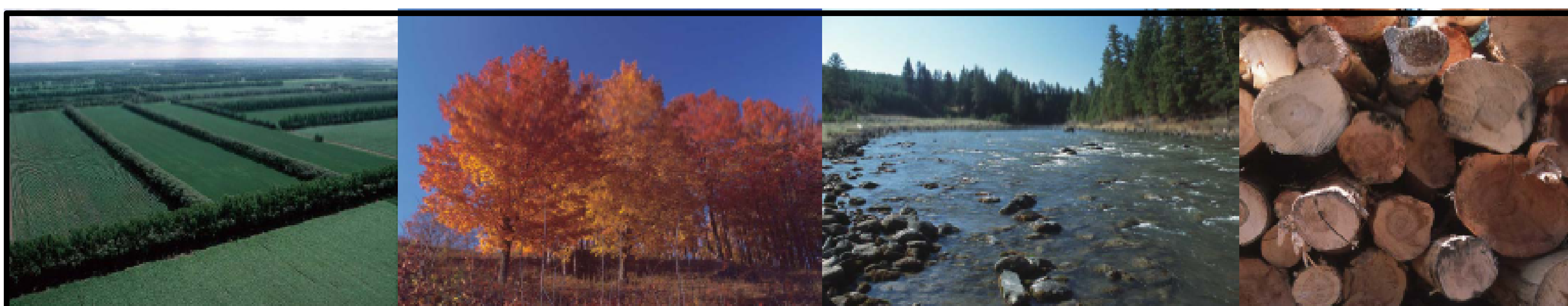
Developing Science-Based Methods & Technical Guidelines for Quantifying GHG Sources & Sinks in the Forest and Agriculture Sectors

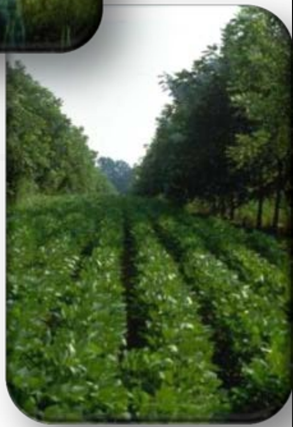
Order No. AG-3142-D-10-4020

The guidelines will result in a method for an integrated inventory at the farm/landowner scale for all agricultural and forest management activities:

NET GHG – CO_2e → C, NO_2, CH_4

- Cropland Soils
- Agroforestry
- Enteric fermentation
- Field residue burning
- Rice production
- Grazing land management
- Fertilizer management
- Forest management
- Manure management
- Lime applications
- Wetland soils





Branching Out: Agroforestry as a Climate Change Mitigation & Adaptation Tool for Agriculture

US-CAN presentation

Journal of Soil & Water Conservation (Sept/Oct 2012)
Special Issue: Conservation Practices to Mitigate Climate Change

….All while doing their other jobs

Agroforestry: Accounting for Windbreak's Climate Change Contributions

Rethinking the Windbreak Toolbox – next up:

Making Cents Out of Windbreaks

Summary of indirect GHG benefits provided by agroforestry practices on the Mead Family Farm. (Based on 50 yr)

Practice	Fuel Savings		Reduced Emissions		Natural gas savings from fertilizer manufacture (cu ft)
	diesel (gallons)	natural gas (cu ft)	from motor fuels (Mg CO_2)	from home heating fuels (Mg CO_2)	
Field windbreaks	7,324		74.7		2,272,399
Farmstead windbreaks		744,000		24.5	
Living snowfence	1,433		14.6		775,550
Whole Farm Total	8,757	744,000	89.3`	24.5	3,047,949

Schoeneberger, Brandle & Zhou, unpublished