How can we vertically integrate biophysical, economic, and policy analyses into credible mitigation programs?

Case Study 1
Canadian Prairies: Soil C management
Biophysical information

M. Boehm, B. McConkey & H. Janzen
Agriculture and Agri-Food Canada

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Kyoto Protocol created a need for GHG mitigation science and policy

but, the policy environment was uncertain

- **Would the Kyoto Protocol include sinks?**
- **Will Kyoto become international law?**

Needed "no-regrets" policy options

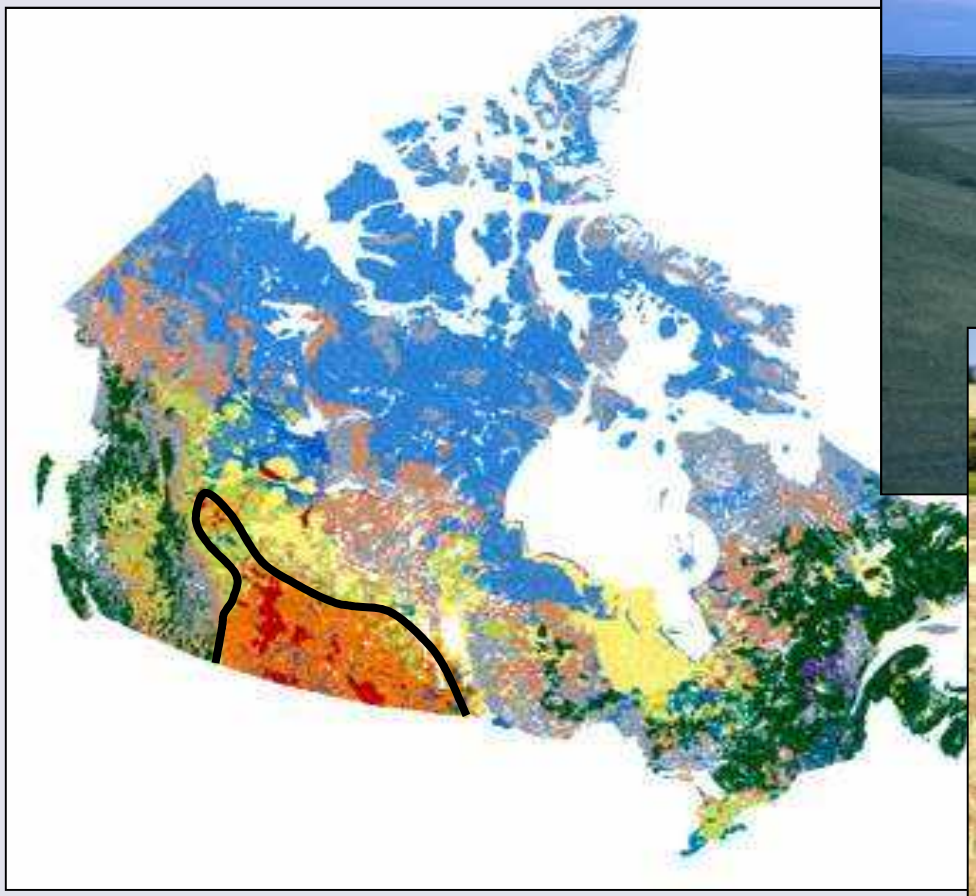
Outline

1. Soil C management on the Prairies as GHG mitigation - background & national circumstances

2. Current knowledge and models

3. How models can contribute to further understanding

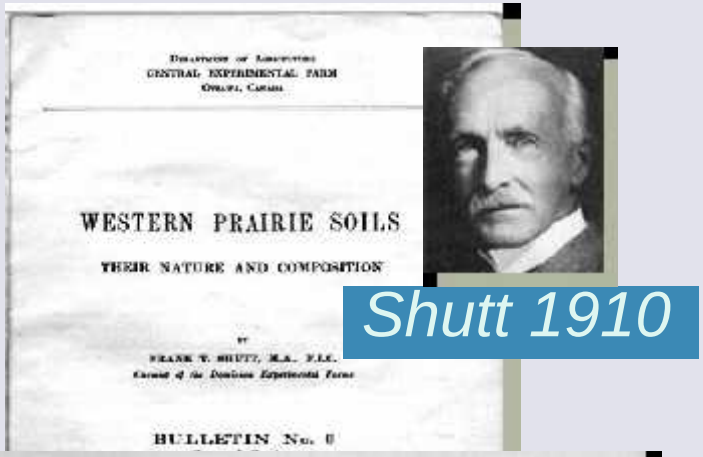
~80% of Canadian agricultural land is on the Prairies



with young grassland soils ...

Chernozems (Mollisols) with high organic C and N contents

and young agriculture.
Farmers and scientists arrived together



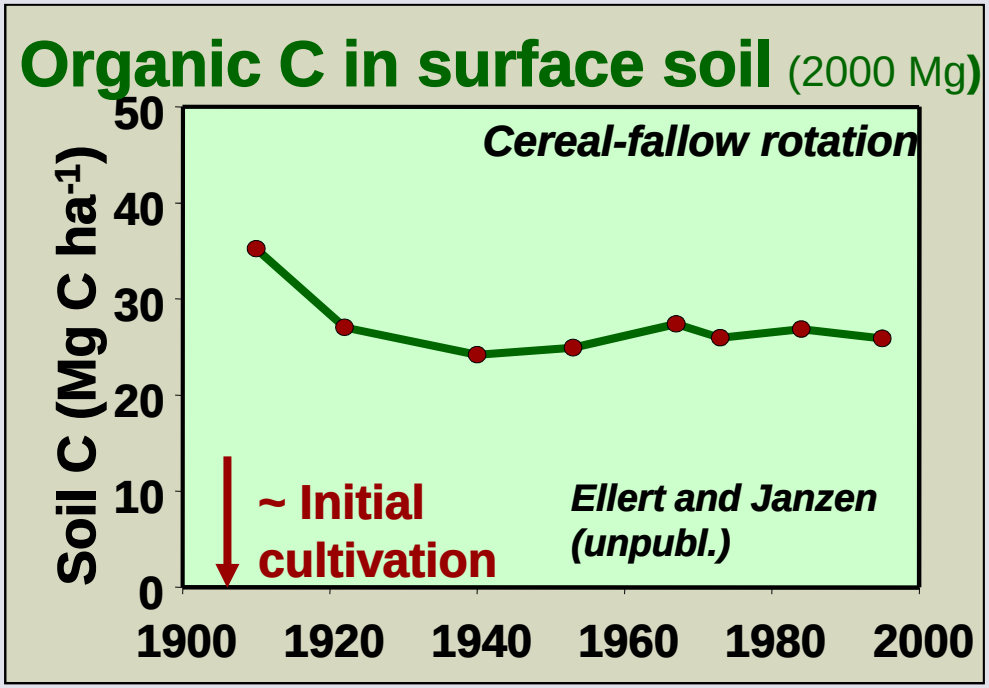
Shutt 1910

Indian Head Experimental Farm, 1899

Photo: saskinteractive.usask.ca

Photo: Henry Janzen

and the impact of agriculture on SOC and land quality was documented



Indian Head Experimental Farm

Photos: **saskinteractive.usask.ca**

Early research led to recognition that maintaining SOC (soil conservation) is a key to maintaining land quality …

No agricultural country has ever prospered for more than a generation or two that has not made provision for maintaining the nitrogen and organic matter content of the soil.

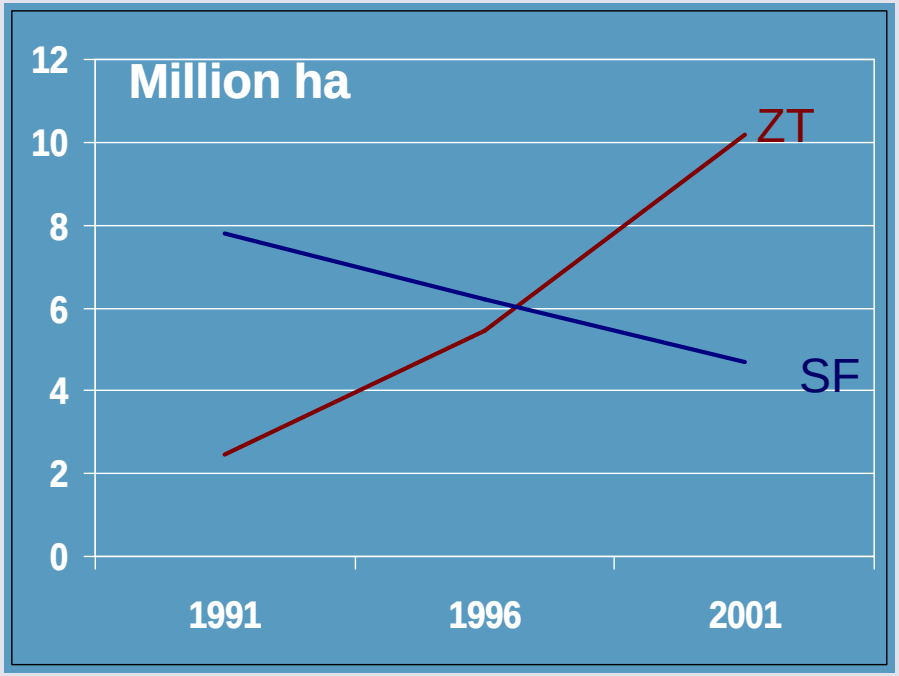
John Bracken. 1920
Professor, Univ. Sask.

Photo – Henry Janzen

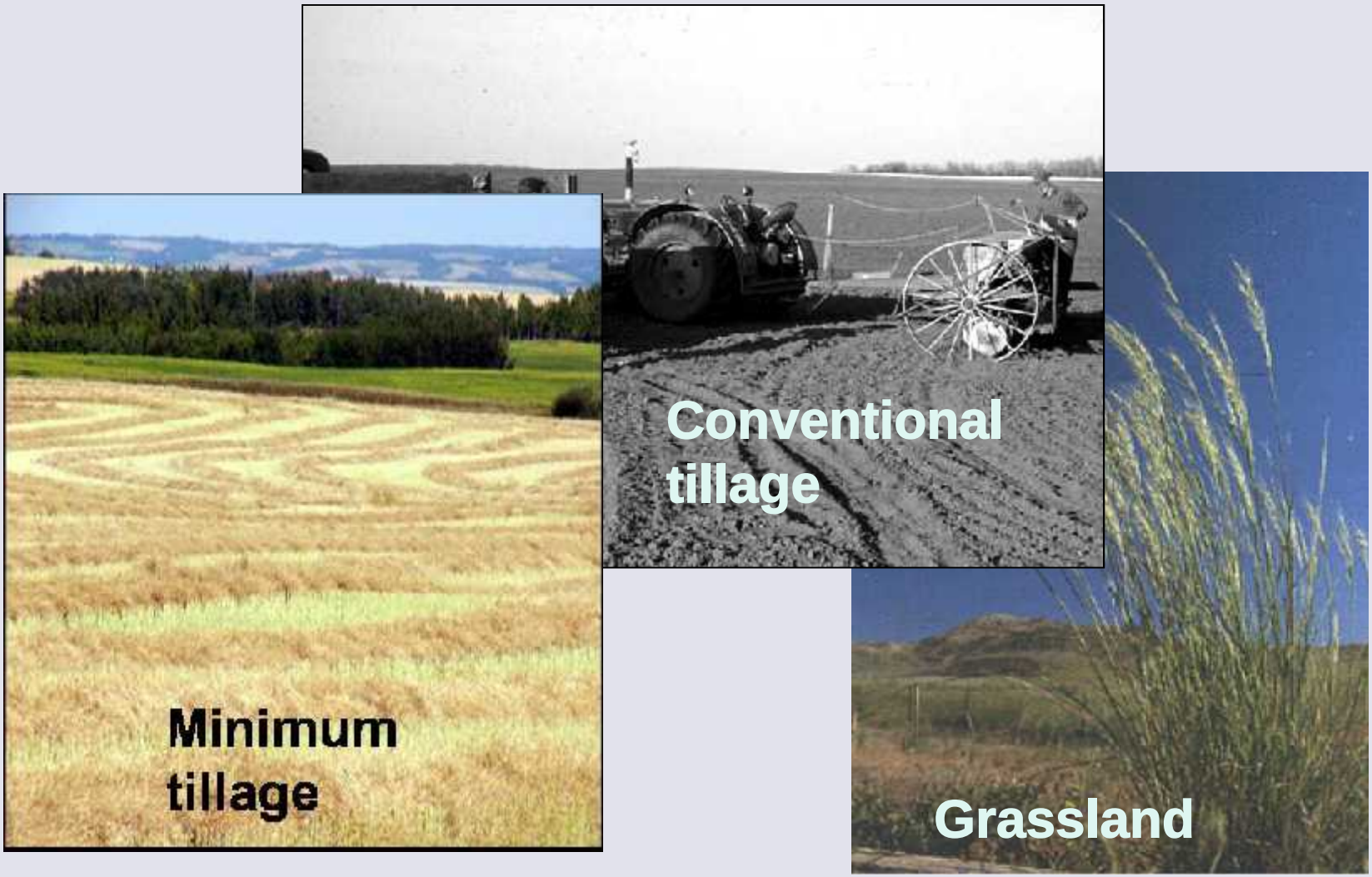
… and now, SOC is also linked to atmospheric quality

Changes in land management that farmers are making for economic and conservation reasons have become GHG mitigation strategies

Reduced summerfallow
Minimum and ZT
Permanent cover
Forage production

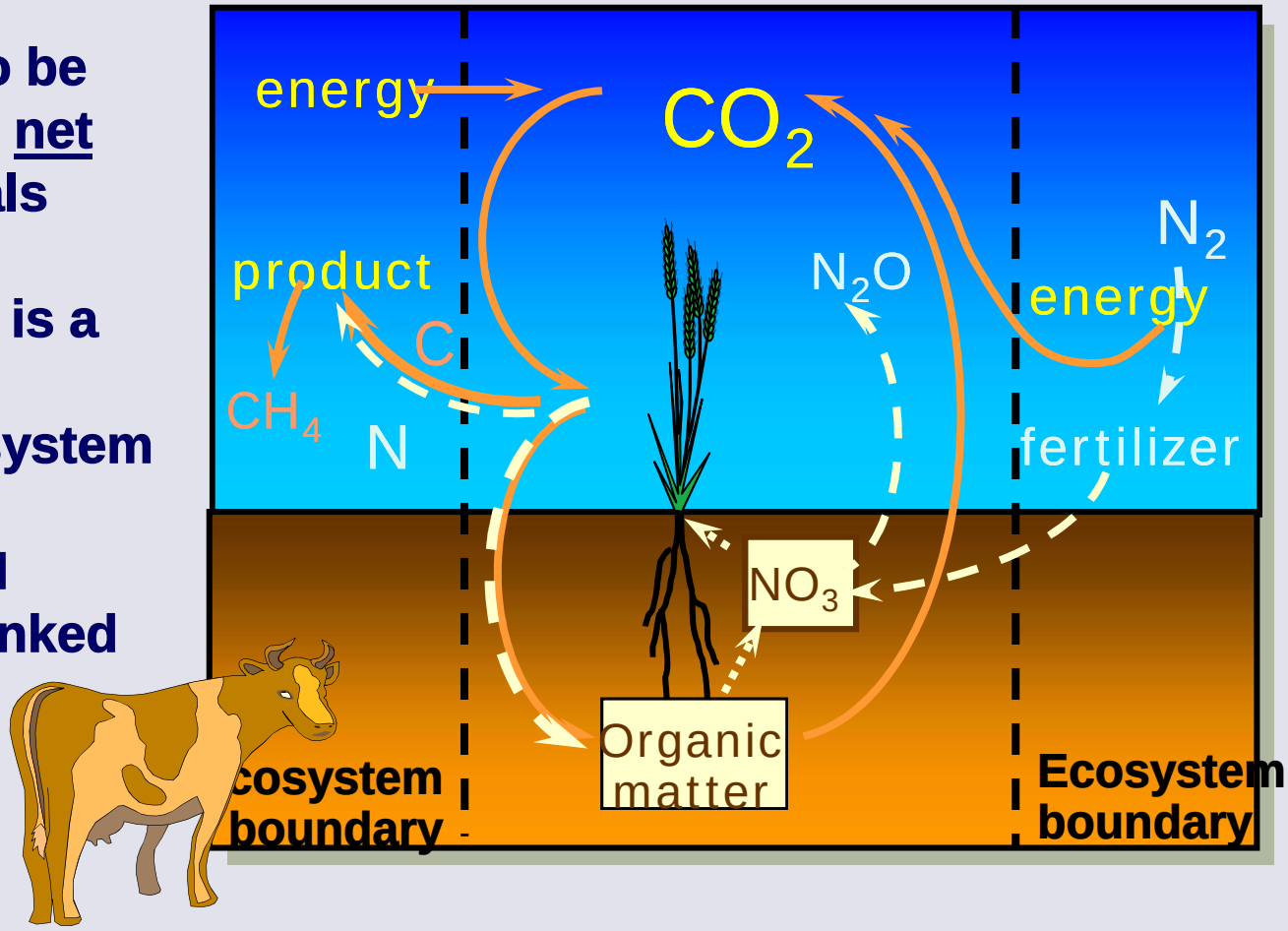


But, agriculture most soil sinks only recover CO_2 that was emitted after cultivation – not an offset for fossil emissions



and GHG mitigation through land management is more than C sequestration

- **Land has to be managed for net GHG removals**
- **Agriculture is a biological production system**
- **The C and N cycles are linked**



Current models and knowledge

Reasonable understanding of SOC change

Depth (cm)	1996 to 1999 SOC change (Mg ha^{-1})				
	Prairie Soil Carbon Balance Project Measurements		CENTURY Simulation of PSCB fields	C factors from long-term experiments	IPCC Guidelines (1996)
	Mean	95% C.L			
0-15			--	1.05	--
0-20	1.02	+/-0.67	0.91	--	--
0-30	1.21	+/-0.80	--	--	0.97

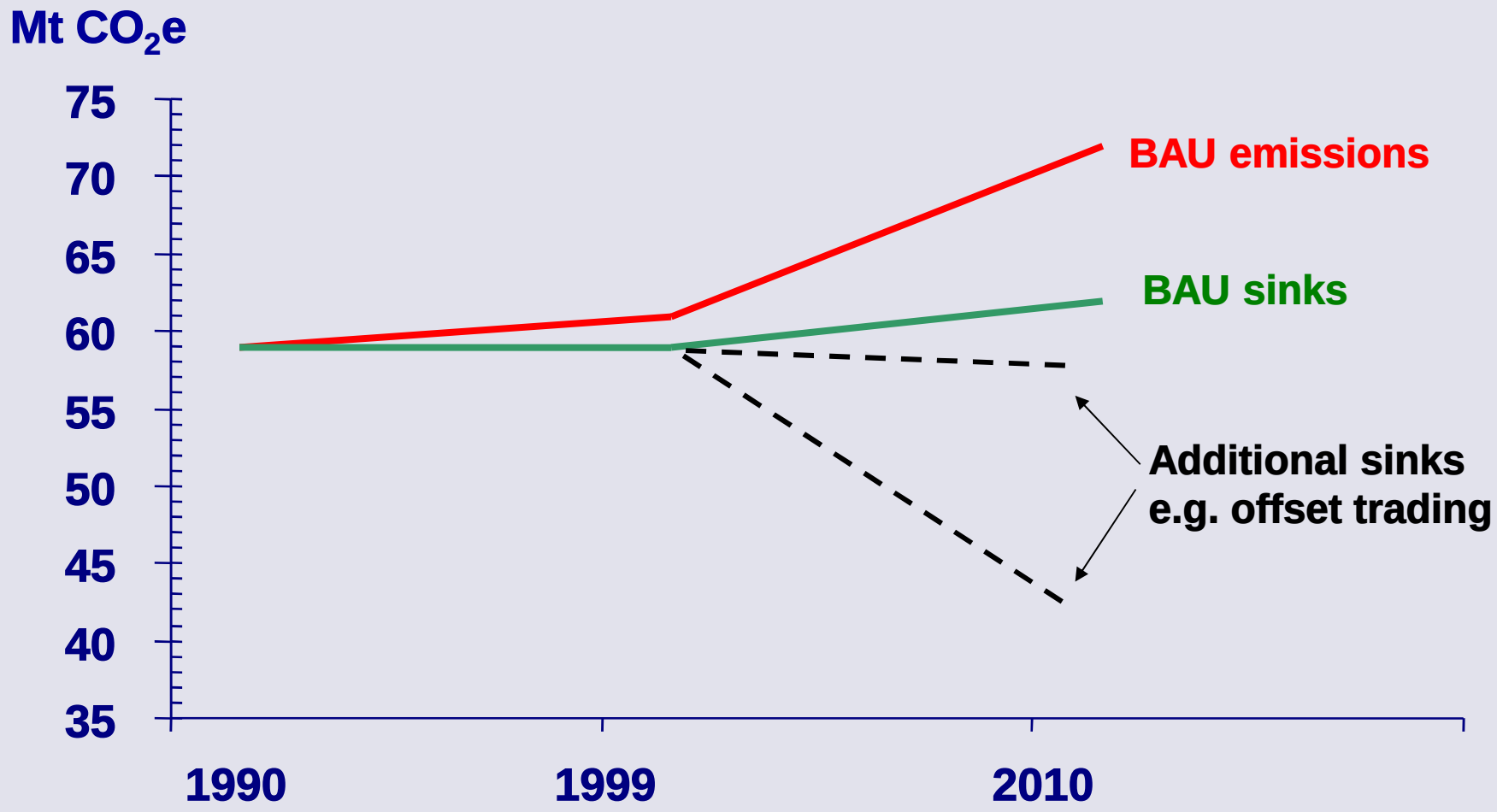
N2O emission rates more uncertain

Canadian Economic and Emission Model for Agriculture (CEEMA)

- Policy tool – estimate national GHG mitigation potential
- Canadian Regional Agricultural Model + GHG module

SINK ACTIVITIES	PRAIRIE SOIL ZONES			NON-PRAIRIES
	BRN	D BRN	BLK	
	(Mg CO_2 ha^{-1} yr^{-1})			
Zero Tillage	0.73	0.73	1.34	0.54
Reduce SF*	0.15	0.16	0.08	
Increase forage		0.94	2.44	2.44
Permanent cover	0.88	1.15	3.3	3.3

C management mitigation potential for first commitment period



Next generation of models – greater spatial and activity resolution

- **NCGAVS - National Greenhouse Gas and Carbon Accounting and Verification System (for agriculture)**
- **Component of the national Land Use, Land-use Change and Forestry - Measurement, Accounting and Reporting System ? LULUCF MARS**
- **Reporting LULUCF sector E/R under the UNFCCC and Kyoto Protocol**
- **Mitigation testing**
- **Develop factors – eg., for offset system protocols**

NCGAV System

CanSIS

SLC Polygon Land Quality Database

+

Ag. Census Remote sensing

SLC Polygon Land Use-Management Database

Factors - Estimators of ?SOC and N_2O emissions

SLC Land Use-Management-Landscape – N_2O- ? C Database

Carbon sink/source and N_2O Account for SLC Polygon

Regional Account (Grouped SLC Polygons)

Provincial Account

National Account

C and N_2O Factors

Activity changes:

- Tillage (eg., ZT, minimum till)
- Summerfallow frequency
- Perennial crops
- Crop mix

Century
DAYCENT
DNDC
Empirical data

NCGAV System

SLC Polygon Land Database

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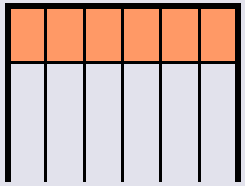
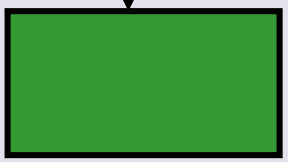
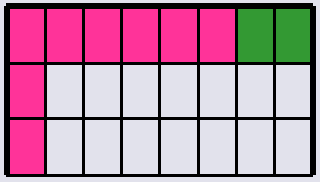


SLC Polygon Land Use-Management Database

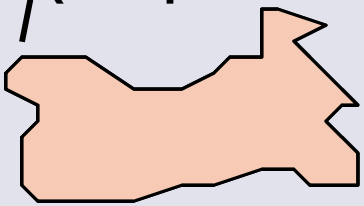


Factors - Estimators of ?SOC and N_2O emissions



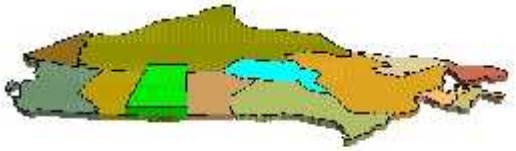
SLC Land Use-Management-Landscape – N_2O- ? C Database

Factor x Area



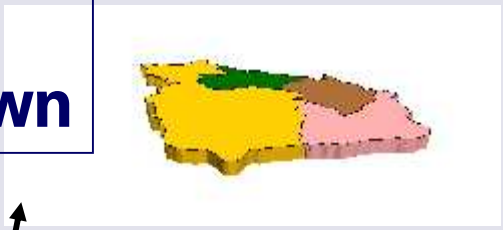
Carbon sink/source and N_2O Account for SLC Polygon

Scale up or drill down



National Account

Provincial Account



Regional Account (Grouped SLC Polygons)

What can modeling contribute to what we don't know yet?

It can held us look beyond laboratory research and field plots

- **scale across space and time**
- **integrate across systems – net GHG emissions**
- **estimate uncertainty**

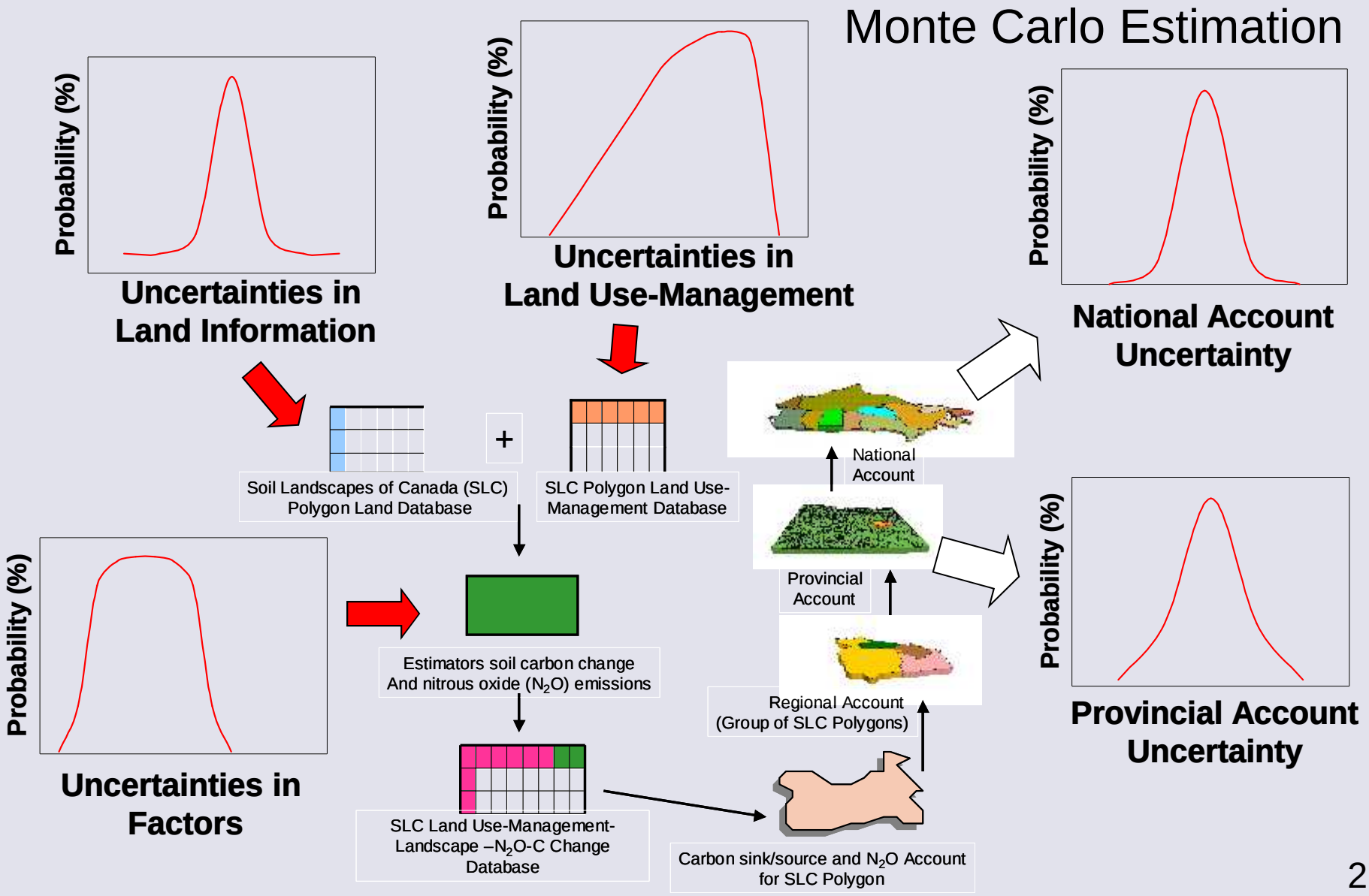
Integration:
Model Farm Research Project

- systematically integrate what we know
  - predict emissions as a function of farm properties/practices and land quality
  - establish boundaries and assess leakage associated with a change in management

- address gaps – i.e., research to reduce (large) uncertainty around N_2O emissions

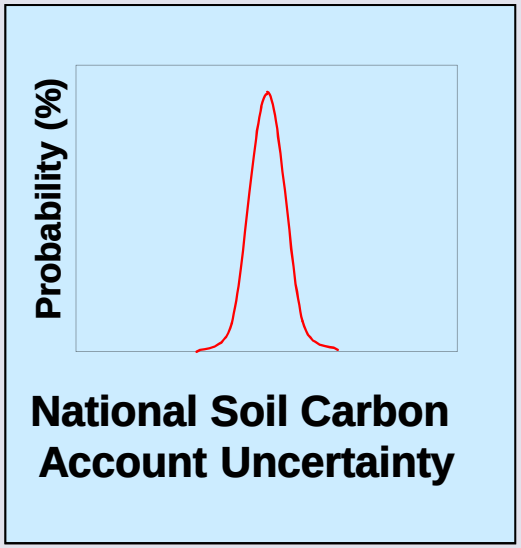
- better factors – net GHG emissions/removals and "rules of thumb"

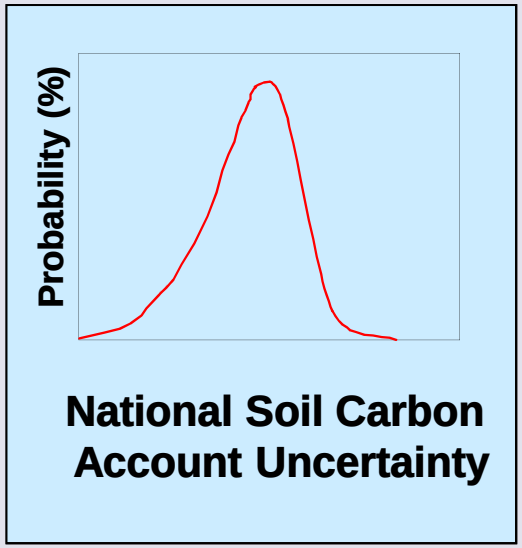
Estimating uncertainty

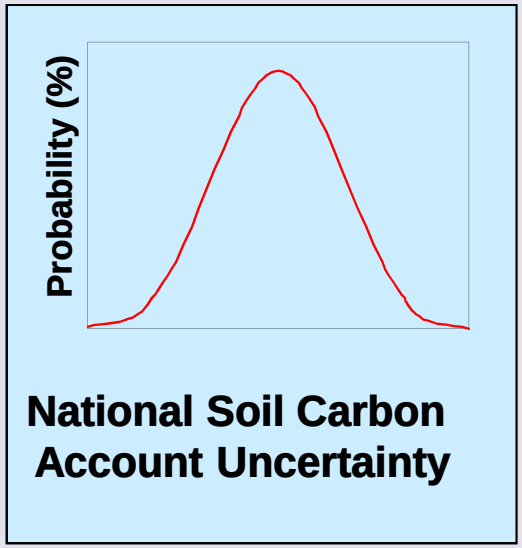


Making decisions under uncertainty

Is soil carbon management good mitigation policy?

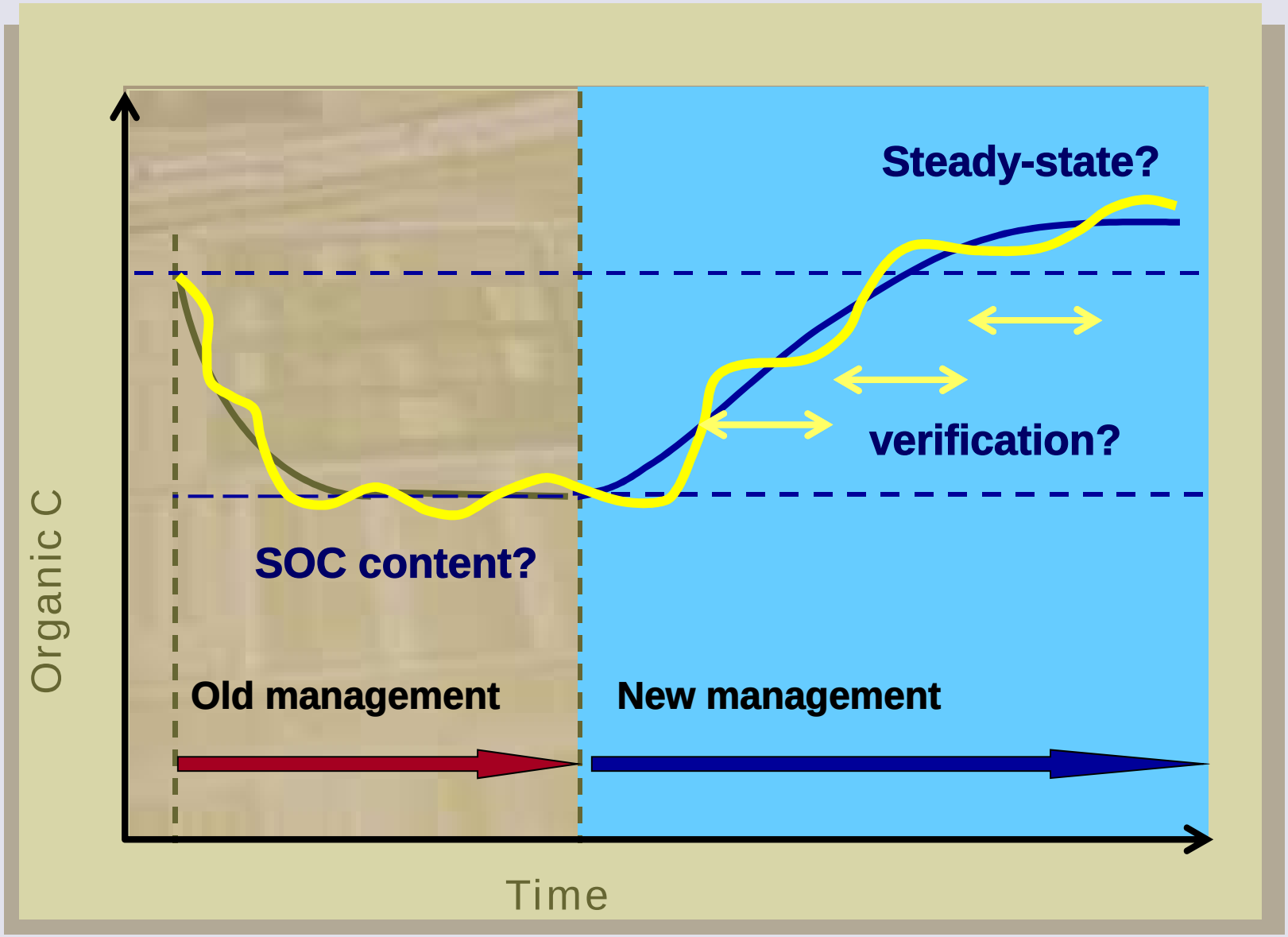




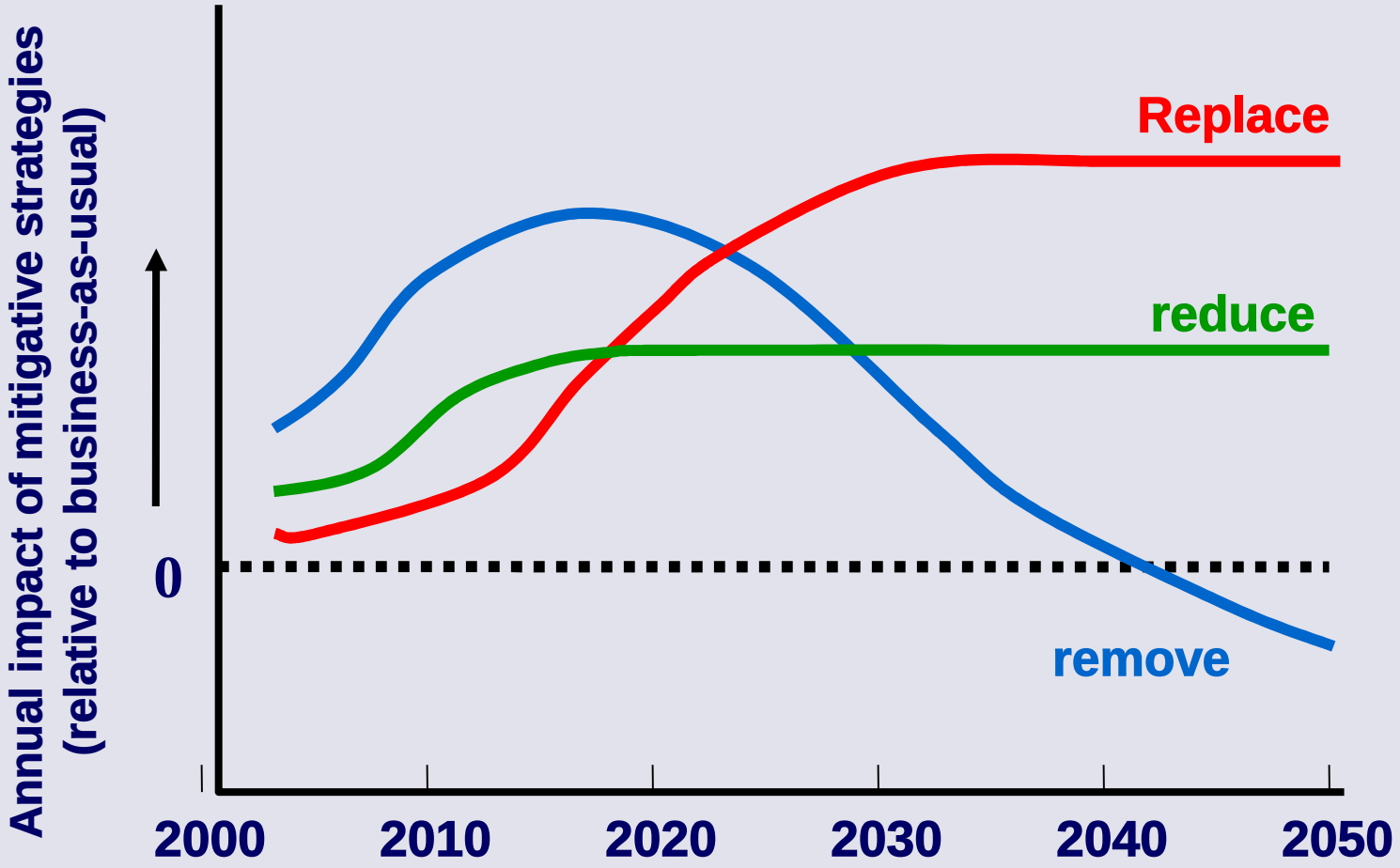


Answer will depend on the cost and efficacy of alternatives

Representing time



What can our models contribute to what we don't know yet - new mitigation strategies

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