Viresco Solutions

End-to-end sustainability

"SOC markets and quantification"

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Viresco Solutions

Carbon Summit, Saskatoon, April 2, 2019

Overview

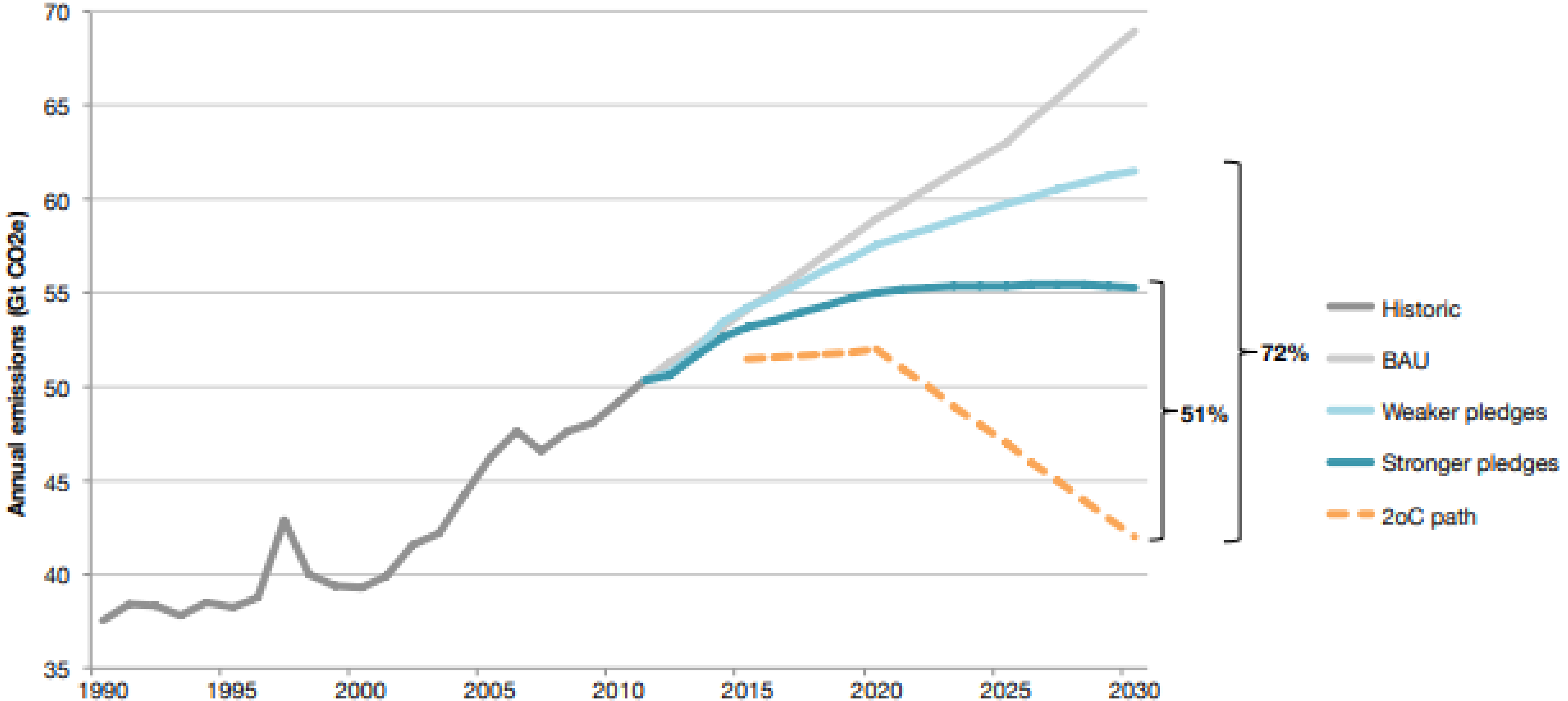
1. About Viresco
2. Market drivers
3. Improving Estimates of SOC change through Investing in Soil Carbon Measurements?
   - Selecting Best Strategy to Support the Quantification Approach and Purpose
   - Prairie Soil Carbon Balance Project

About Viresco

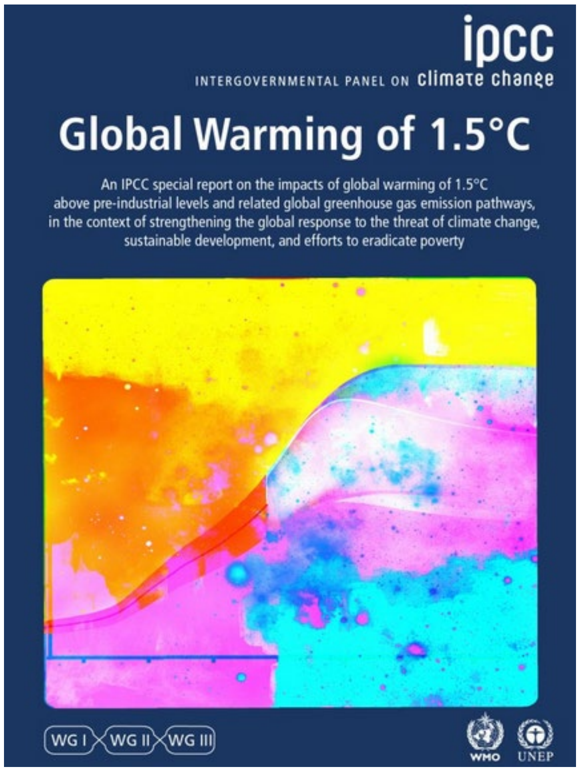
- Environmental consulting firm working in agriculture, bioenergy and agri-food sectors
- Assist clients in navigating the complex and evolving world of sustainability
- Experts in developing science-based metrics and solutions to enhance social license and public trust
- Vision: "Mainstream Sustainability"

Problem: The Gap

Figure 1. Impact of Known and Anticipated Domestic Pledges



And Then…



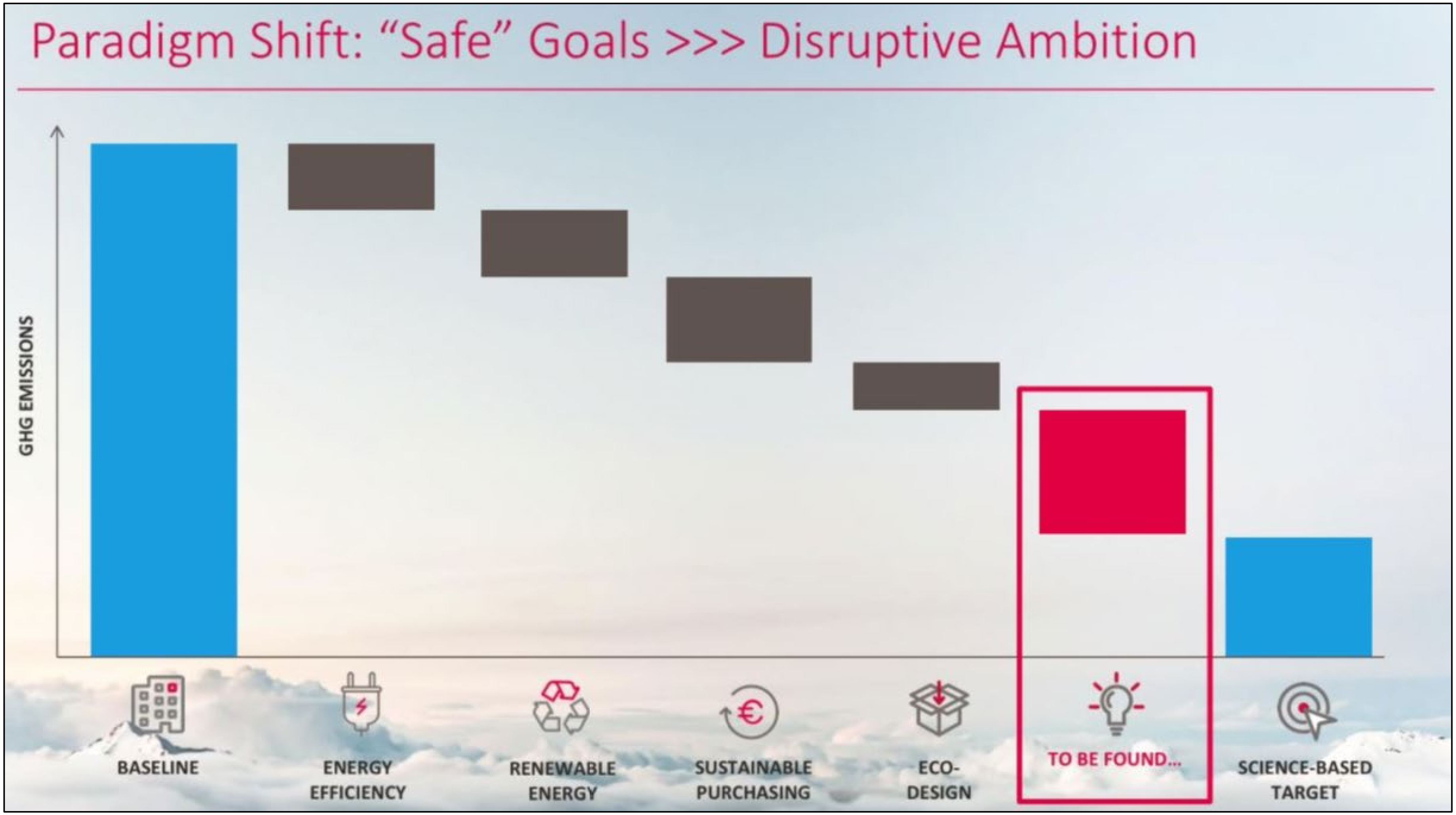
1.5°C Modelled Pathway

- Decline of ≈ 45% in CO_2 from 2010 levels by 2030
- Net zero: ≈2050

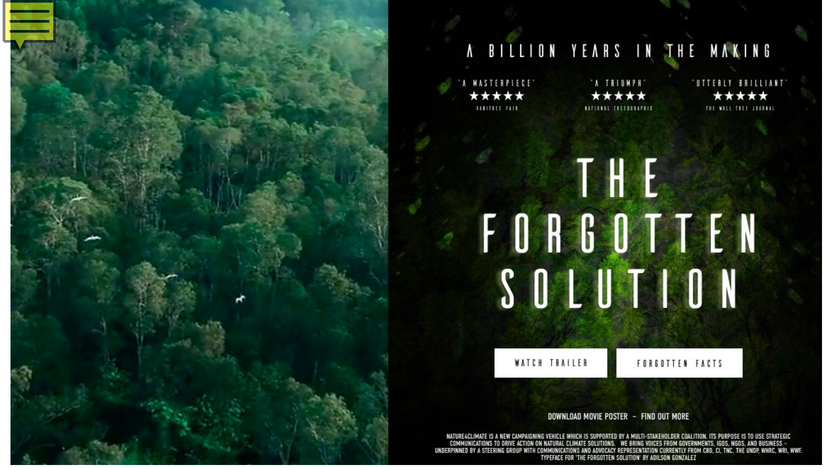
2.0°C Modelled Pathway

- Decline of ≈ 25% in CO_2 from 2010 levels by 2030
- Net zero: ≈ 2070
- Pathway for non-CO_2 emissions similar in both scenarios

(Source: IPCC, Headline Statements from the Summary for Policymakers)



Source: Quantis, 2019



The Biological Bridge

- AFOLU (Agriculture and Forestry) responsible for approx. **25% of global anthropogenic GHG emissions** (Smith et al., 2014)
  - Need to feed 9 billion by 2050
- **Concept:** Switch AFOLU sector from problem to solution, while also transitioning energy
  - Protection: Avoided conversion (forests, grassland, wetlands, etc.)
  - Improved Management: Fertilizer (4R Nutrient Stewardship), livestock (feed use efficiency, manure management), cropping (no-till, cover crops),etc.
  - Restoration: Reforestation
- **Potential:** 30+ % of solution in next 10-15 years (Bronson et al., 2017)

CARBON PRICING – POTENTIAL OPPORTUNITIES

Different Carbon Pricing Structures

Compliance Markets	Voluntary Markets	Insetting/Supply Chains
Created through regulations and laws at the National or Sub-National level (e.g Alberta, BC, Quebec, California) **Buyers:** Large emitters required to reduce emissions by law **Price:** $15 - $50 **Risks:** Policy uncertainty, invalidation	Usually managed through a third party registry (e.g Climate Action Reserve, Verra (VCS), Gold Standard, etc.) **Buyers:** Any individual, business, non-profit, municipality, utility, etc. voluntarily reducing emissions **Price:** $1 - $45+ **Risks:** Finding buyers, price uncertainty	An investment in an emission reducing activity within a company's supply chain. The emission reduction (i.e. inset) can be claimed by the company that sponsored the activity. (Gold Standard, Carbon Accounting and Insetting Framework)

Market Pull

Alberta's Carbon Pricing Framework – The First 10+ Years

- A series of Firsts:
  - Economy-wide Baseline-Credit System w/hybridized Offset System
  - Based on ISO 14064/14065 Standards
  - Over 30 Protocols/Methodologies
  - Over 145 Offset Projects for over 40 Mt of registered reductions
  - Technology Fund (>$500M invested)
  - Proving ground for other systems: *Australia, Poland, California, United States, Brazil, Korea, China, British Columbia, Ontario, Quebec*

"What we have to learn to do, we learn by doing"

-Aristotle

Alberta's Agricultural Protocols

Over 20 Million tCO_2e reduced and over $200 million cash injection!

- Aerobic Composting
- Agricultural Nitrous Oxide Emission Reductions (4R's)
- Anaerobic Decomposition of Agricultural Materials
- Biofuel Production and Usage
- Emission Reductions from Dairy Cattle (Recently adapted into Kenya)
- Energy Efficiency Projects
- Reduced Age at Harvest of Beef Cattle
- Reducing Greenhouse Gas Emissions from Fed Cattle
- Selection for Low Residual Feed Intake Markers in Beef Cattle
- Conservation Cropping (**SOC!**)

Market Drivers – Supply Chains

SCIENCE BASED TARGETS

DRIVING AMBITIOUS CORPORATE CLIMATE ACTION

Collaboration between:

WORLD RESOURCES INSTITUTE

CDP DRIVING SUSTAINABLE ECONOMIES

WWF

UN GLOBAL COMPACT United Nations Global Compact

WE MEAN BUSINESS

- Encourages emission reduction targets in line with level of decarbonization required to keep global temp. increases below 2°C vs pre-Industrial levels

- AgriFood Corporations with SBTs

Walmart

MARS

Carlsberg

General Mills

Cargill

MOLSON Coors

Nestlé

McDonald's

DANONE ONE PLANET. ONE HEALTH

Kellogg's

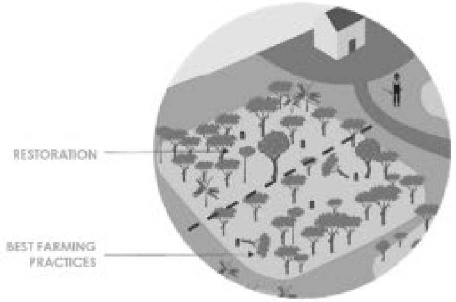
Coca-Cola

PEPSICO

Supply Chain Insetting 2018 –Enabling Investment

Credible accounting of emissions reduced by your interventions in your supply chain

Example - Corporate implements a series of restoration projects, maximising soil sequestration



- Part 1 - How to account for intervention (boundary, scope, baseline, MRV etc)
- Part 2 - How to include intervention emissions in corporate report
- Part 3 - How to communicate about the intervention and its relationship with carbon credits

Developed by:

Gold Standard, Climate-KIC, Livelihoods Funds, World Resources Institute, CDP, MARS, Danone, Science Based Targets, WWF

First Corporate Working Group (Oct 2018) - Mars, Danone, General Mills, Cargill, Barry Callebaut, Ben&Jerry's, McDonald's, Chanel and L'Oreal

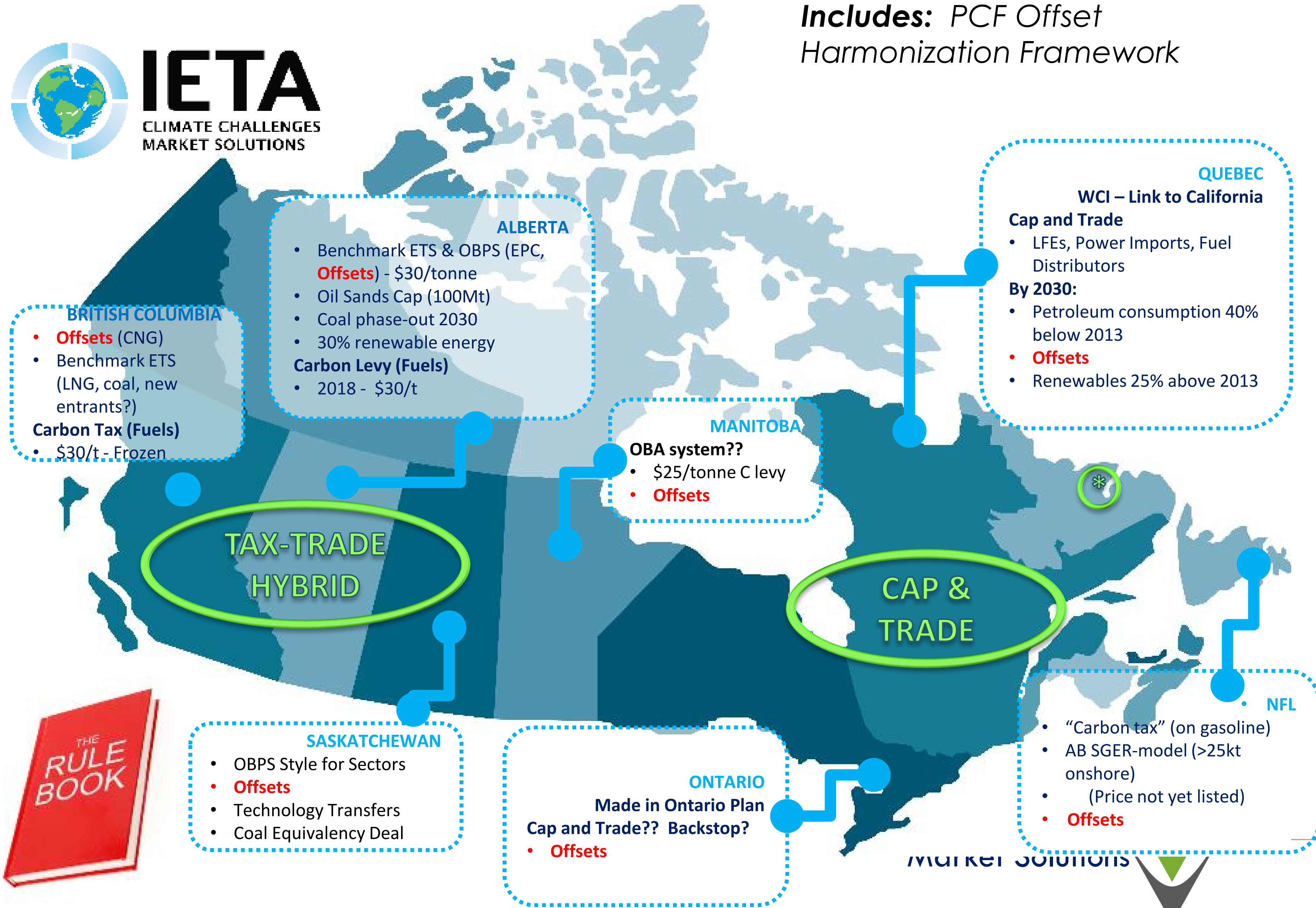
Common Approaches Desired
Example: Cool Farm Tool

- Widely used by global agribusinesses to source sustainable products
- Multiple metrics: water, carbon, biodiversity, economics
- Currently being adapted into North America (starting with beef and nutrient management)
- Objective: trace sustainability metrics through supply chains
- Driven by McDonald’s, Alberta Beef, and others

CARBON PRICING – CHALLENGES

Pan Canadian Patchwork ;-)

Includes: *PCF Offset Harmonization Framework*

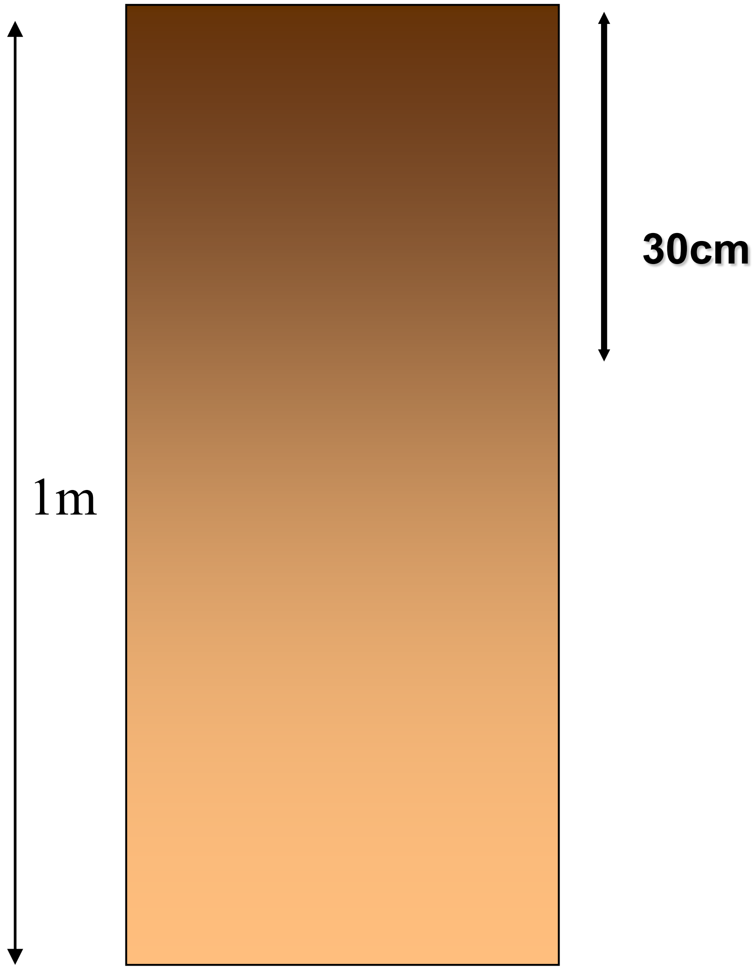


Ag Challenges – Risk, Cost and Scale

- Agricultural projects are not metered - risk/cost
- Reliance on Modeling and Estimates – good, but general
- Each farm has small emission reductions and are diffuse on the landscape – cost (needs to be quantified at scale)
- Soil sequestration is reversible – risk (100 years+?)
- Revenue stream is small – scale/cost
- Activities can shift – risk (leakage)
- Additionality can be difficult to meet– risk (arbitrary, barriers)

IMPROVING ESTIMATES OF SOC CHANGE THROUGH INVESTING IN SOIL CARBON MEASUREMENTS?

Typical Soil (Carbon) Profile
Grassland Soil



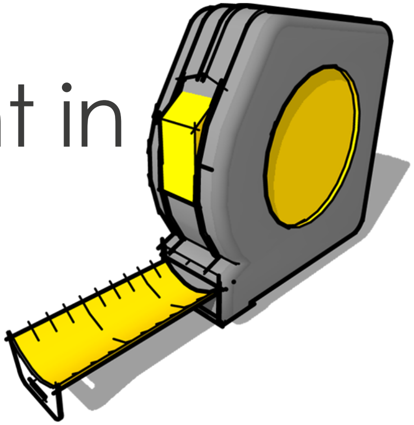
- Soil C content decreases with depth
- Soil C content more secure with depth
- C content dynamic near soil surface
- C content dependent on balance between decomposition and C input from plant roots and residue
- CO_2=soil C x 3.67

Soil Organic C (SOC)

- Soil organic matter = soil organic C x 1.72
- Soil organic matter is heterogeneous
  - Recent crop residues and living microbes to humus that is 1000s of years old
- For every ton of SOC , about 200 lb of N is tied up
- All soil organic carbon in soil was once CO_2 in the atmosphere
  - Increasing SOC thus is a removal of CO_2 from the atmosphere
- *The amount of SOC changes because something changed the balance between C input to the soil and C loss from organic matter decomposition by soil microbes*
  - *Large SOC change requires large change in that balance*

SELECTING BEST STRATEGY TO SUPPORT THE QUANTIFICATION APPROACH AND PURPOSE

Rationale For Producer Investment in SOC Measurement



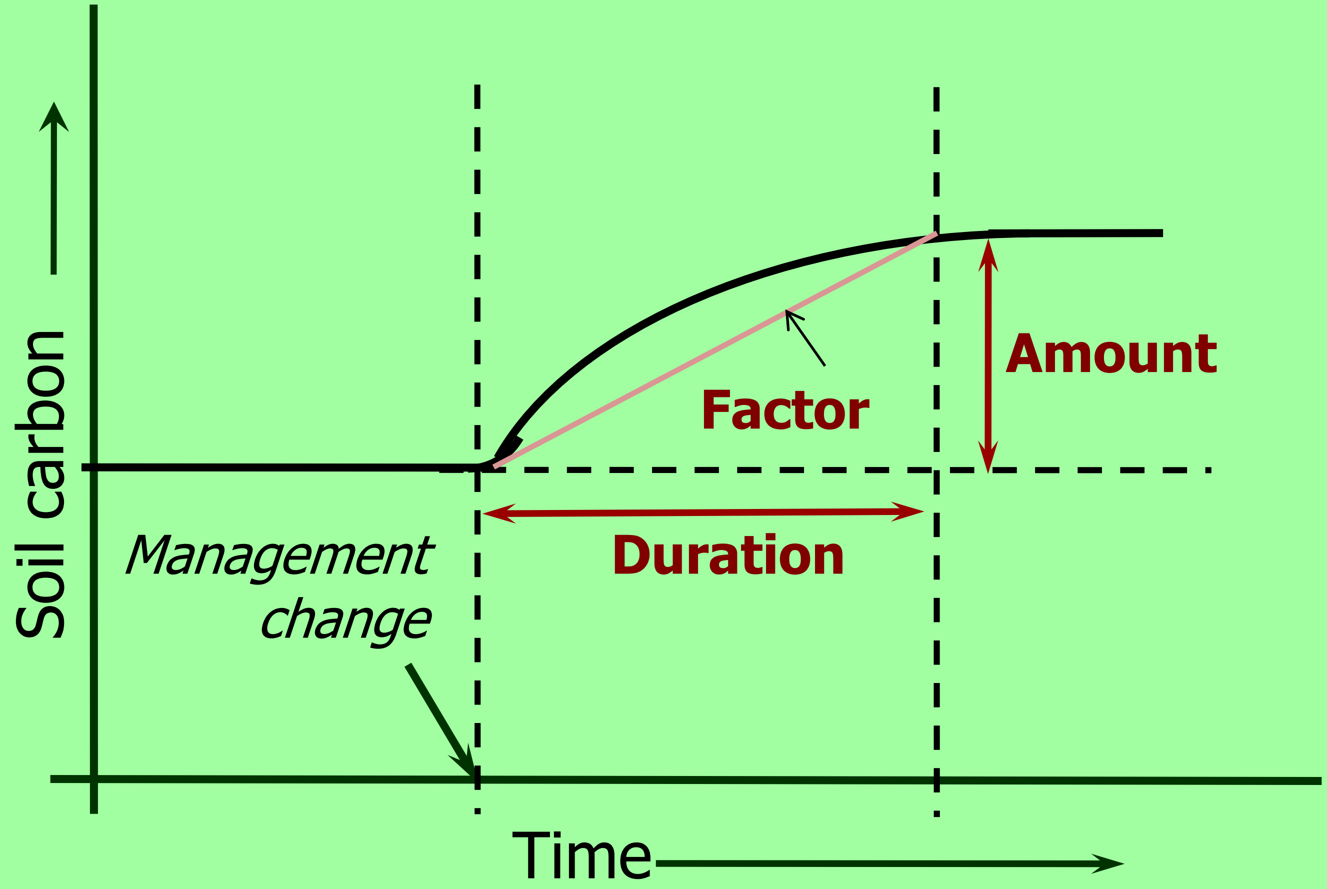
- Address issue
  - Replace/improve available methods to estimate SOC change, particularly to address suspected underestimating SOC increases
  - Provide greater confidence in the SOC change to those who pay for SOC increases
- Before designing measurement strategy, need to know
  - What ***quantification approach*** will be supported by new measurements
  - ***Purpose*** for improved quantification approach

QUANTIFICATION APPROACH

Three basic approaches to account for SOC change

- **Practice based factors**
  - Factor of SOC change based on known SOC change from measurements and/or models validated from measurements applied to the land under specific land management practice changes
    - E.g. no-till from reduced till, reduce fallow, etc.
- **SOC process model based**
  - Can deal with multitude of combinations of land management practices, soil type, weather, etc.
  - Local derived measured inputs can be used, such as initial SOC, weather, yields, land practices, etc., give the estimates some site specificity
- **Measurement based** SOC change on land in a "project"
  - Site-specific SOC change measured
  - Not necessary to know exactly how the land was managed

Factor is a Simplified Representation of the Real World



Total SOC Change = Area x C Factor

Practice Factor-based

- Basically a simple model (representation) of reality
- Factors can be derived from
  - Dataset of observed SOC change (e.g. IPCC methodology)
  - Process models (e.g. Comet-VR)
  - an ensemble of models or models and measurements (e.g. Canada's GHG inventory)
- Practices can be very general or very specific
  - Direct seeding in Saskatchewan or
  - Direct seeding with low disturbance direct seeding all fertilizer applied at time of seeding, on hummocky clay-loam soil in the Black soil zone with a well fertilized cereal and canola dominant rotation.
  - Greater specificity requires more supporiting data to derive reliable factors

Practice Factor-based

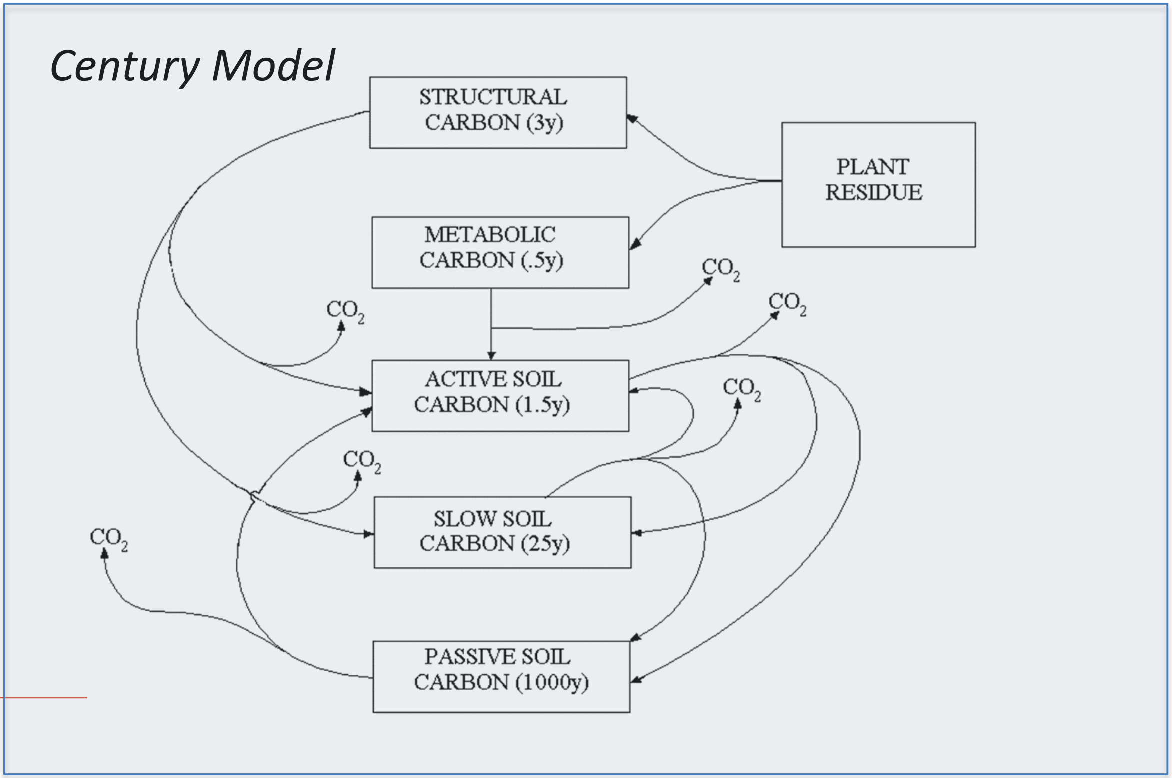
- Has many advantages
  - Practice change is often simplest to document
    - When combined with factor then C change documentable
  - Relatively simple to use and understand
    - E.g. linear rate of 0.25 ton CO_2 per acre per year
  - Readily comparable with factors for same practice change derived by alternate methods
  - Enable SOC change estimate for future scenario

Factor Disadvantages

- Everyone who follows the practice gets the same SOC change factor
    - *Not specific to unique conditions of the farm*
- If the practice changes over time or the conditions change such as new crop types and/or genetics then the relevancy of the old C change factor becomes suspect

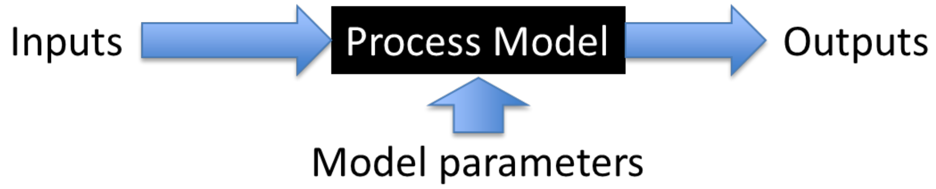
Model

- Models the in-soil processes of decomposition and stabilization that affect inputs of organic matter to the soil
  - It is definitely a "black box" that is difficult to understand



Model

- Many do not trust the SOC change estimates from models
  - Healthy skepticism is well founded
  - Models must be properly calibrated and the soil conditions properly initialized to work well
  - Models must be shown to make good estimates against real-world SOC change measurements across the range of conditions for which it will be applied (well-validated models only are acceptable)
    - Models never predict SOC change at multiple sites perfectly using common set of parameters



Model based Approach Advantages

- Potential to be standardized globally, attractive to multinationals in food retail and service
- Able to estimate expected future behaviour
- Able to model both with and without intervention conditions,
- Can use measured site data as input such as practices, initial SOC, soil texture, weather, yields, etc. so site specific
- Highly flexible, better models can be easily used when become available
- Estimates rate of change over time
- Estimates are reproducible by someone else give the same inputs and parameters
- Some models (DayCent, DNDC) link C and N dynamics

Model based Approach Disadvantages

- Easy to have incorrect SOC change estimates if using model that is not validated, calibrated, and initialized properly for conditions it is applied
- Modelling the complexities of C change for perennial vegetation generally, and for multi-species pastures particularly, is uncertain
  - Roots
  - few SOC change measurements to calibrate or validate

Models and Factors are Favoured by Multinationals with Global Supply Chains

SOC quantification based on SOC models and/or factors only feasible approach for smallholder farms in the supply chain

Measurement-based Pros and Cons

- Pros
  - Result-based estimate, it is what it is
  - Well done measurements are most widely accepted by all stakeholders
  - No major assumptions about appropriateness necessary
  - Can be adapted to use to support factor- or model-based quantification
- Cons
  - Very high cost
  - Don't know results until measured
  - Inflexible, initial design constrains possible future modifications
  - Integrity of the measurer critical since deliberate biasing possible and results inherently not reproducible

I THOUGHT TOTALLY MEASUREMENT-BASED APPROACH WAS INFEASIBLE BUT ….

Press release March 18, 2019

First soil carbon credits could unlock millions of offset supply in Australia

The Clean Energy Regulator issued offsets to a soil carbon project, a global first that could unlock millions more carbon credits from Australia's project pipeline.

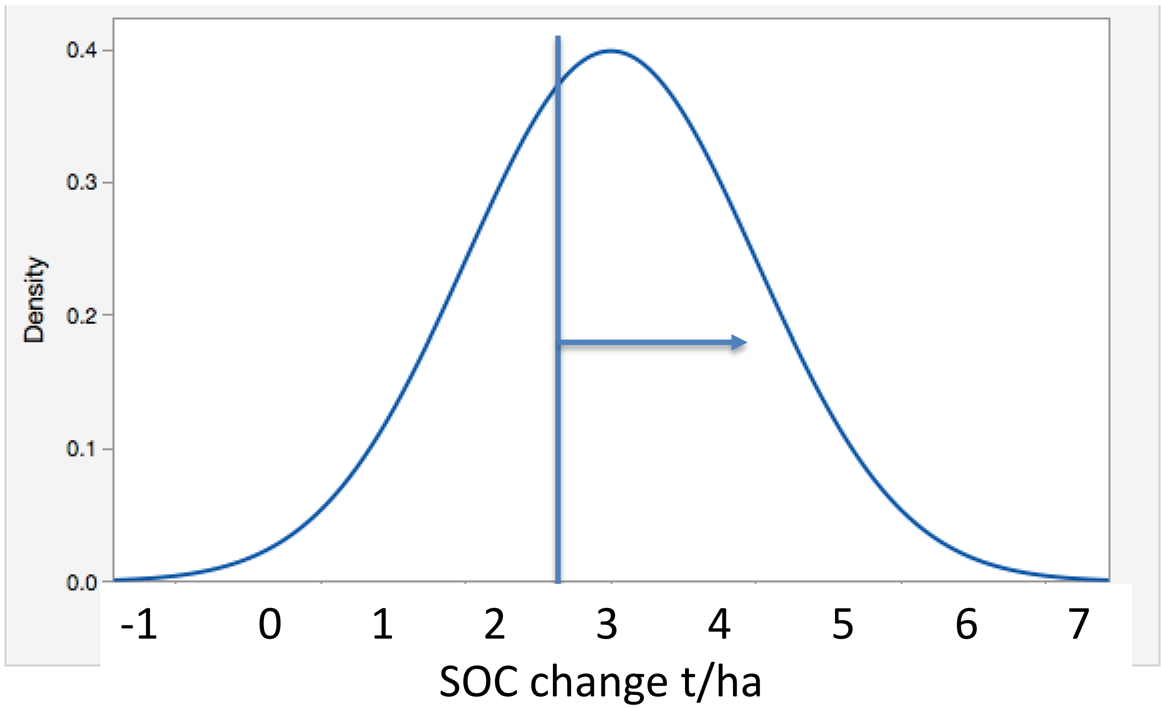
The regulator issued 406 Australian Carbon Credit Units (ACCUs) to the Victoria-based Grounds Keeping Carbon Project, owned by developers Corporate Carbon and farmers Niels and Maria Olsen.

The project combines cultivation, mulching, aeration, and mixed species seeding to improve grazing systems and build soil carbon, the owners said in a press release.

Australian SOC offset protocol

- First working protocol with actual measured SOC change over individual properties
- Only specific practices allowed, mostly pasture
- Baseline is the initial SOC but other GHG emissions (N_2O, CH_4) as difference between with and without intervention
- Change discounted to the SOC amount with 60% probability of exceeding set SOC change
  - Arbitrary, no scientific precedent
  - Produces an increasing discount as uncertainty of measurement increases
  - Measured change of zero would become a loss of SOC due to discount
- 50% of SOC increase is placed in a buffer that can be recovered after three measurements (minimum 1 yr apart and maximum 5 yr) without a loss of SOC

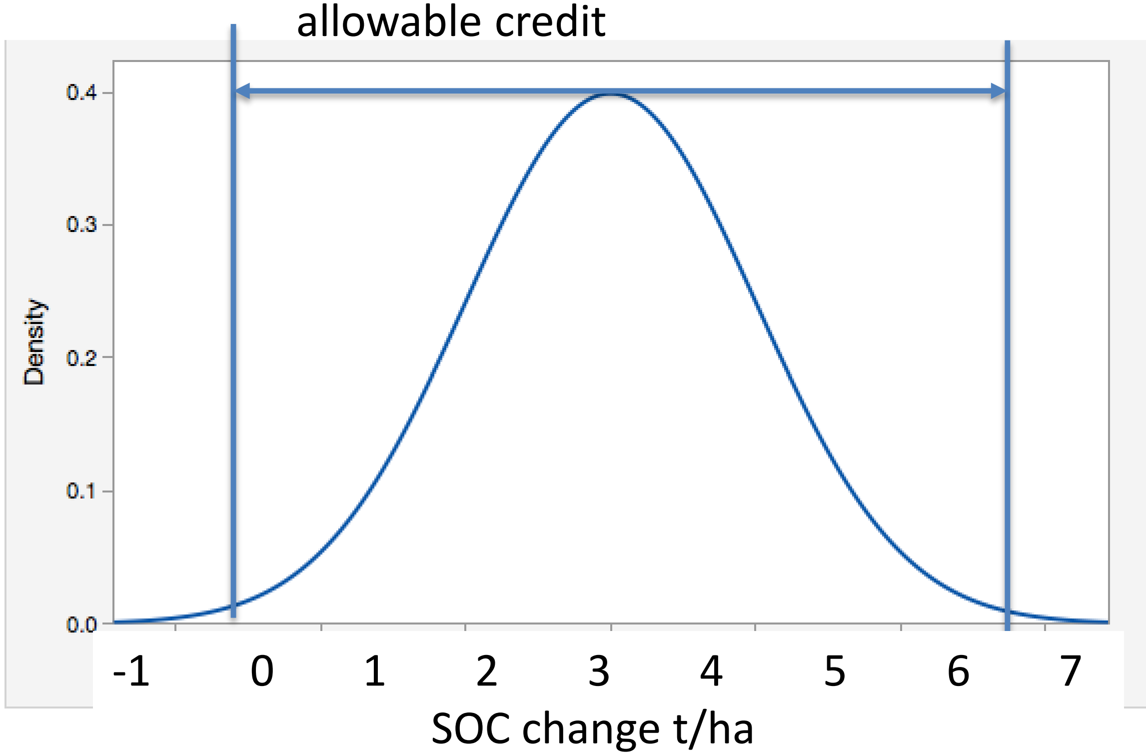
Discount is the value that 60% of expected values exceed



Hypothetical example, C credit = 2.7 t C/ha

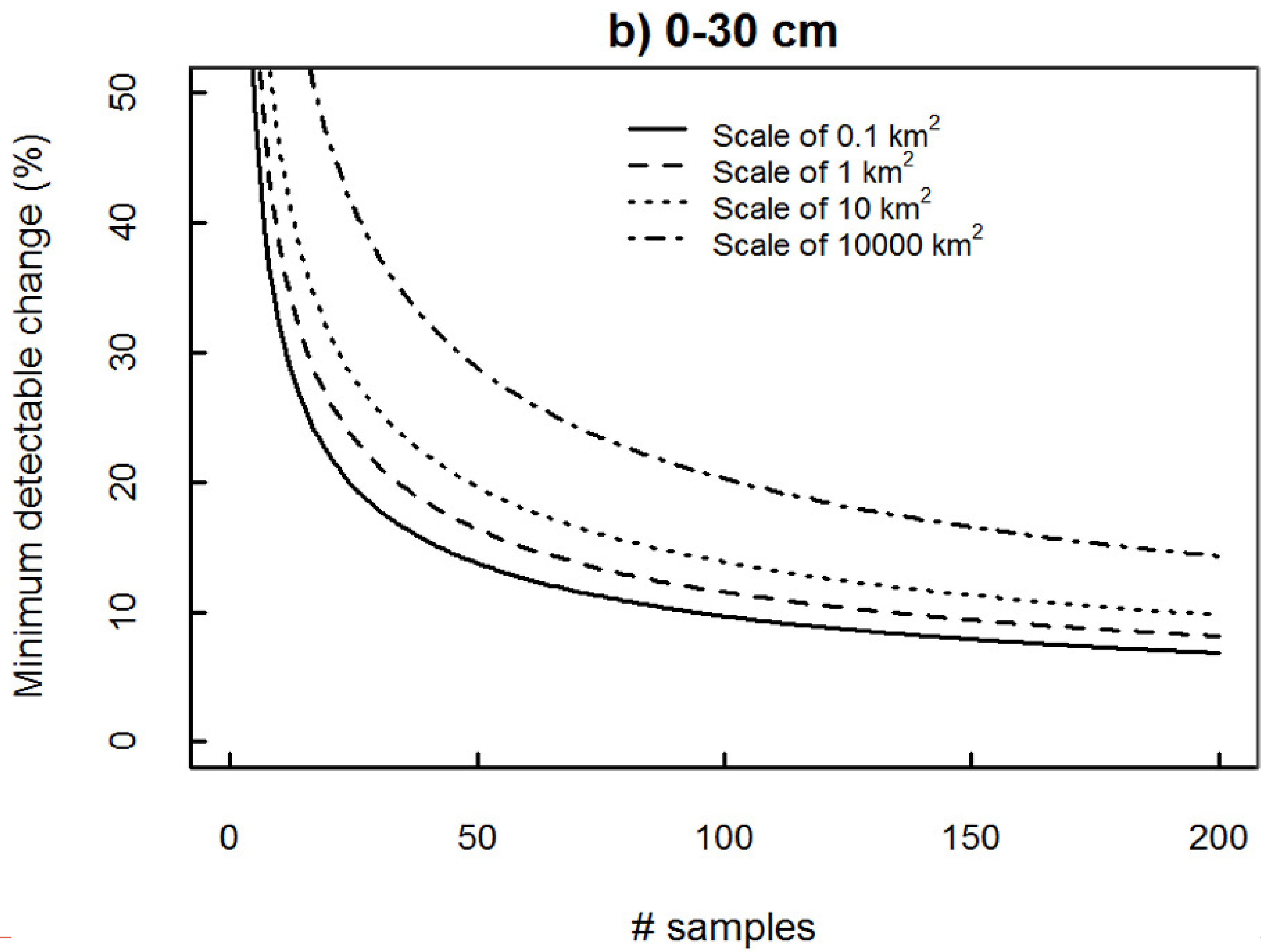
Other schemes based on classical statistics such as 95% confidence limits.

No allowable SOC credit if confidence limits encompass zero change, otherwise, mean is the allowable credit



Hypothetical example, no allowable C credit

Using Confidence Limits, detecting less than 10% SOC change impractical over large area; 10% is large change if SOC high (grassland example)



Source: Maillard et al. 2016. Agric. Ecosys. Environ. 236:268-276

First Successful Protocol Typically Becomes Model for Others

- Measurement based protocols have not been successful in past
  - Too expensive, returns too uncertain, risk that SOC decreases, estimating SOC change for without-intervention baseline
  - E.g. 2012 VCS Soil Carbon Protocol
-

PURPOSE FOR QUANTIFICATION

Purpose?

- Offset
  - Need to have an approach to estimate both the with-intervention and without intervention baseline
- Supply chain GHG reductions
  - Similar to offset since want to capture the effect of changes, possibly less rigor
- Document GHG emissions
  - Only need estimates of recent SOC change
- Document soil quality
  - SOC good general indicator of soil quality
  - Need to know amount and its change over time

SOC change Measurement to Support **Factor-Based Approach**

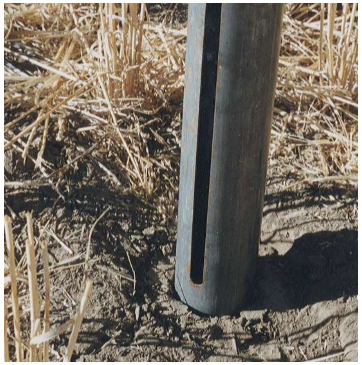
- Does not need measurements over whole land area involved
- Practices must also be measured and categorized
- Land-types (climate, soil type, topography) need to categorized
- Include practice-land type combinations expected to be important for possibly developing separate factors for each combination
  - Want sufficient (10+) high quality observations for each expected combination
- Measurements intended to be representative of whole of combination
- Desirable to have ongoing SOC change measurements on representative conditions to ensure the factor remains valid

Measurement to Support **Model-Based Approach**

- Require detailed data collection over small area to develop validation data-set
- Want measured sites to cover a wide range of practices and land types to test the model across the conditions for which it will be applied.
  - Not necessary to measure representative combinations but useful to have realistic combinations
  - Site selection is thus easier than for factor-based or measurement-based approaches
- Desirable to have ongoing SOC change measurements to ensure the model remains valid as conditions change (e.g. plant genetics)

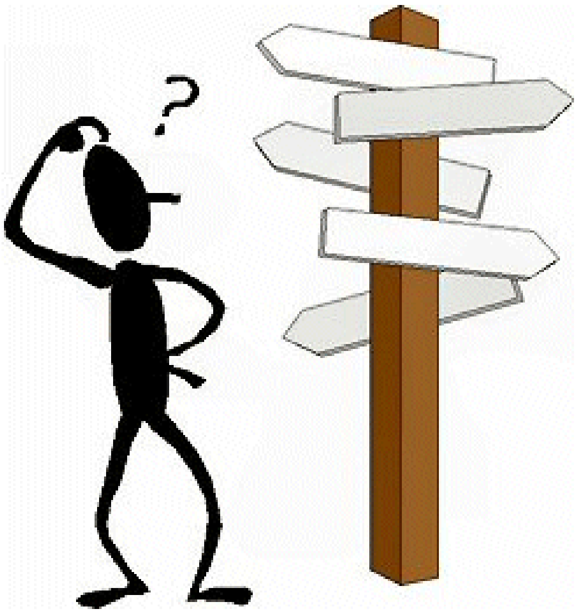
Measurement-based Approach

- Define and map all land involved exactly
- Develop measurement strategy that quantified SOC change over whole land area
  - Australian system mandates random stratified sampling be followed and documented how all land involved with intervention is included in measurements
  - Australian system requires Individual measurement plan for each property (field)
- Need to follow protocol if intended to estimate the effect the with-intervention minus the without intervention
  - Results become protocol specific



Prioritization of Measurements

- Identify gaps where current quantification is poor
  - Prioritize which gaps to fill
- Develop measurement-based strategies to address priority gaps based on the defined quantification approach and purpose(s)
  - Measurements must support both the quantification method and the purpose



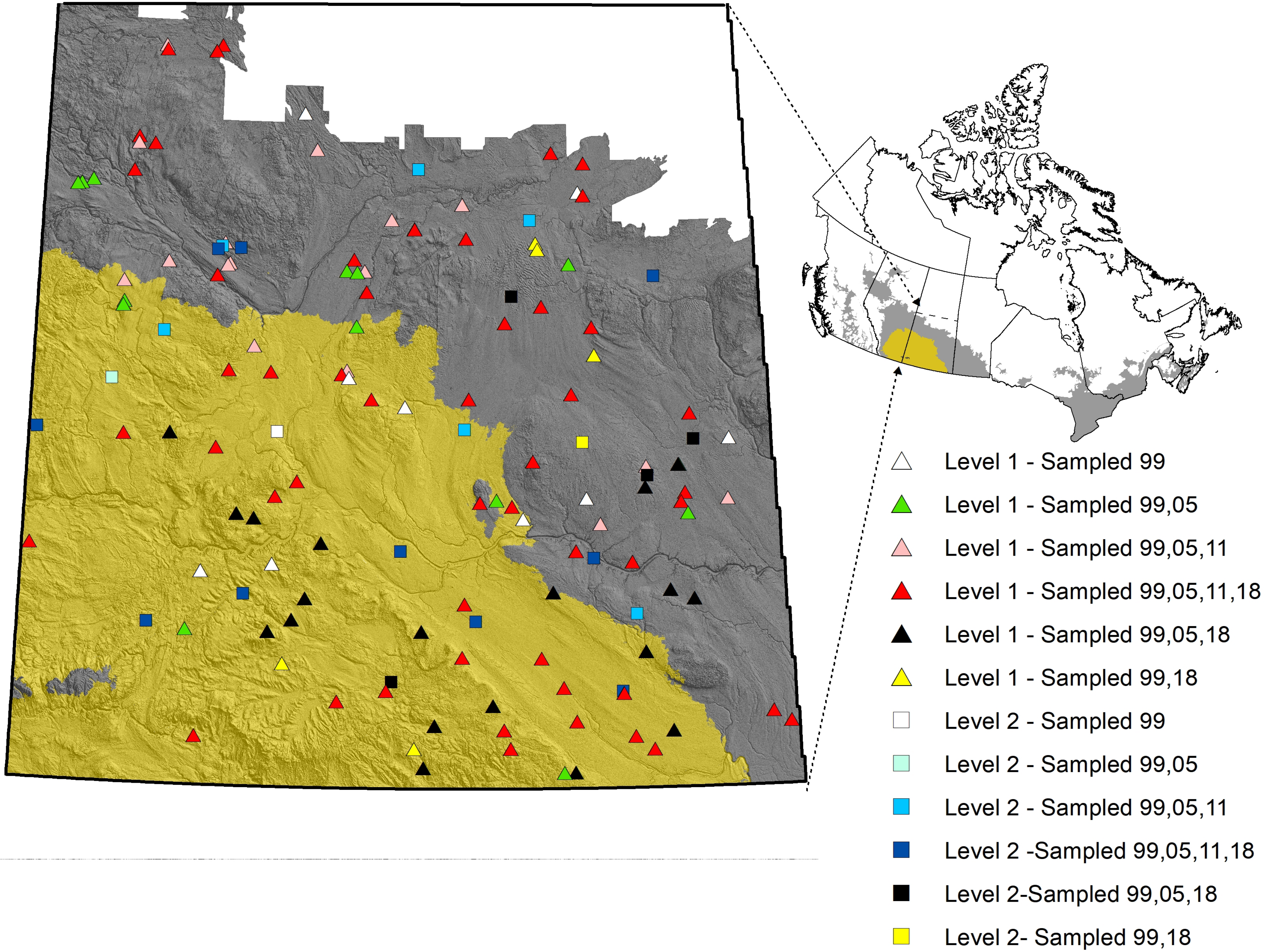
PRAIRIE SOIL CARBON BALANCE PROJECT

Prairie Soil Carbon Balance Project – Build Knowledge about SOC change on farmland

- Measure SOC change on network of fields converted to low disturbance direct seeding in 1997 throughout the Province of Saskatchewan
  - Measure in fall 1996 (139 fields), fall 1999 (137 fields), fall 2005 (121 fields), fall 2011(83 fields), spring 2018 (90 fields) on benchmark microsites
  - Number of fields in network decreased over time due to cooperator withdrawal and/or fundamental change in management (e.g. grass pasture)
- Collaborative project between
  - SSCA and Agriculture and Agri-Food Canada (AAFC) continually
  - GEMCO (GHG industrial emitters) and AAFC funding for 1996 & 99 samplings
  - AAFC funding for 2005 sampling
  - AAFC and Saskatchewan Pulse Growers for 2011 sampling
  - AAFC, University of Saskatchewan, SSCA, Saskatchewan Agricultural Development Fund, Checkoff-funded commodity groups for 2018

Objectives

- Can we determine SOC change for land that underwent conversion to direct seeding in 1997?
  - SOC change for individual fields?
  - SOC change for groupings of fields? What are differences between groupings?
  - How deep do we need to sample?
  - Do results from small research plots match what occurs on commercial farm fields?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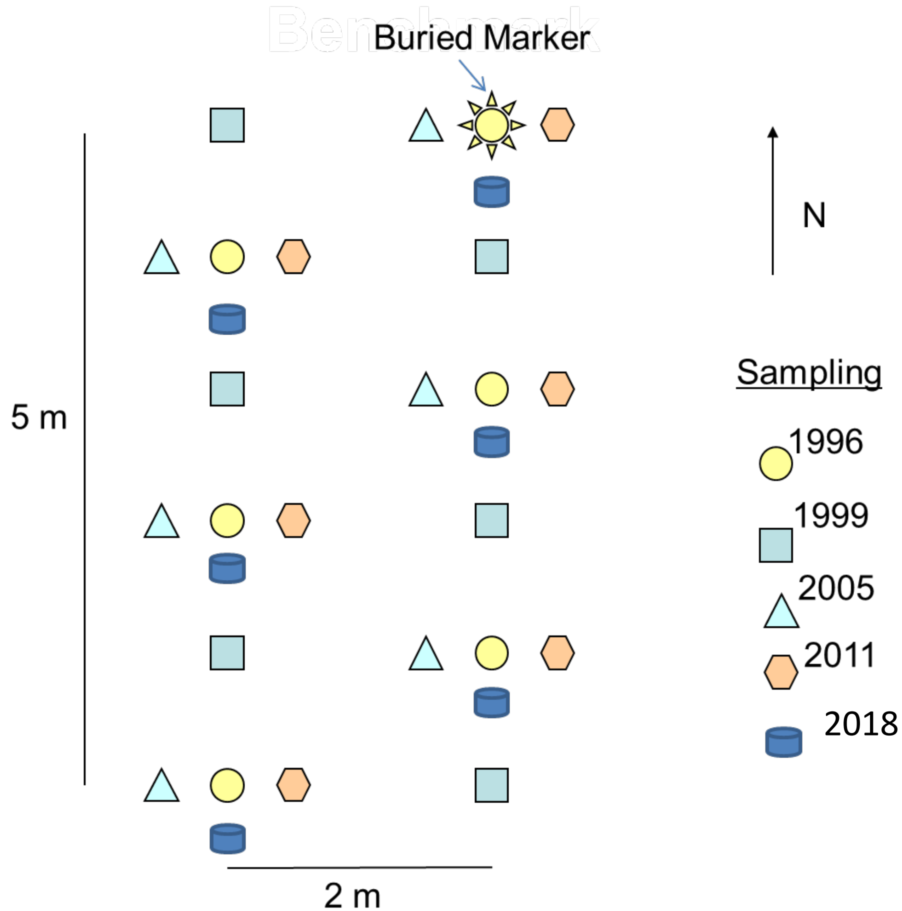
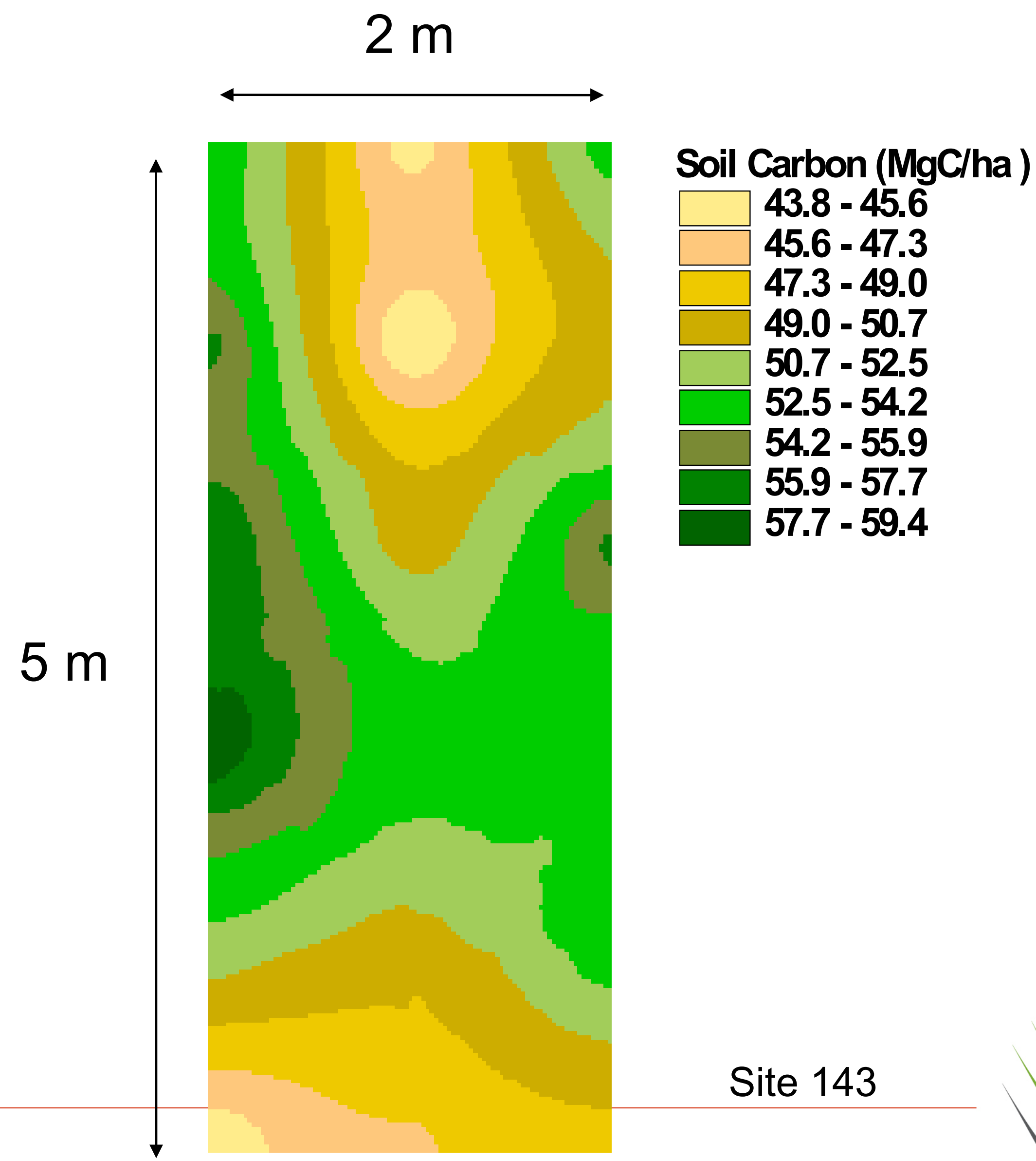
Benchmark Microsite

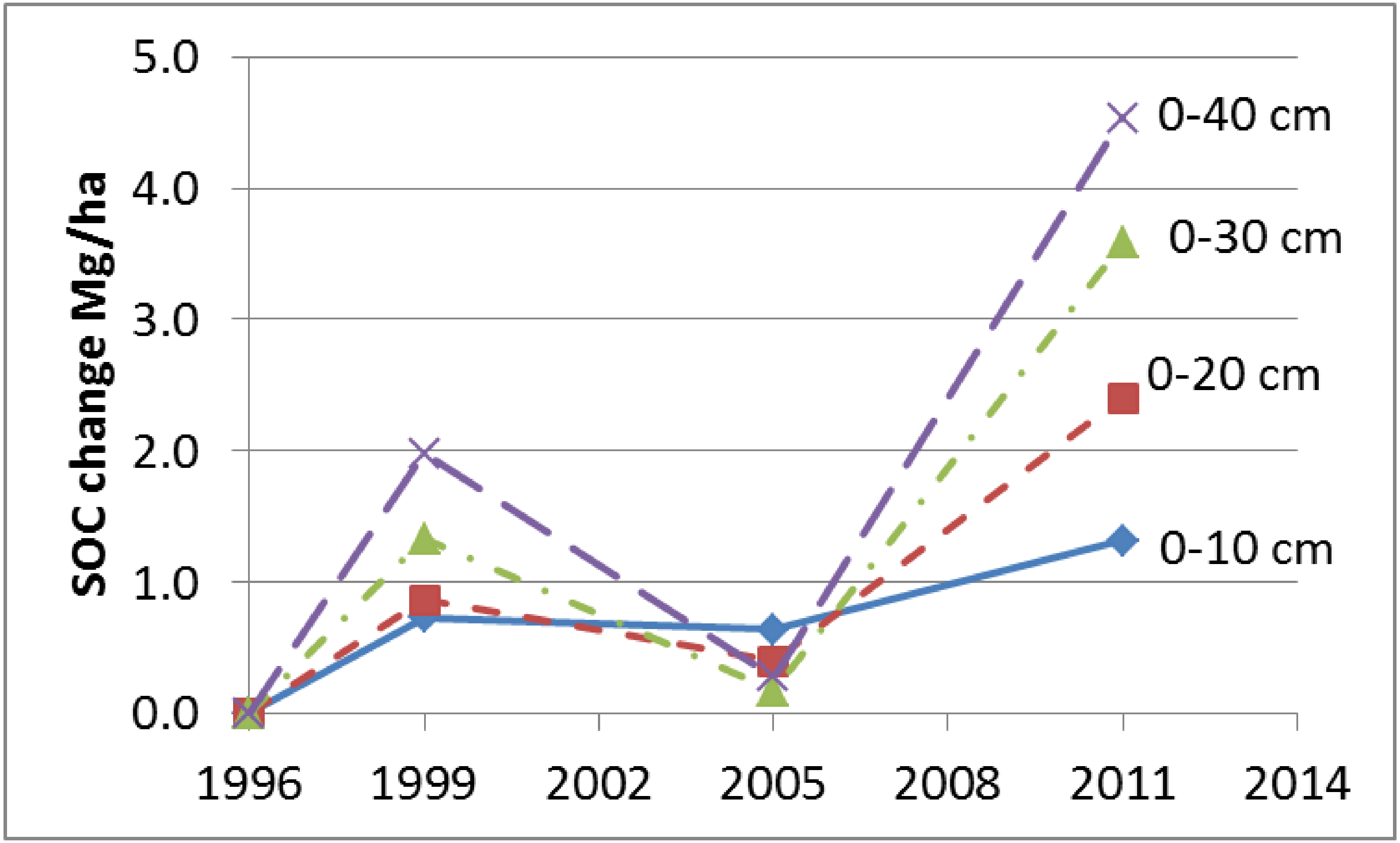


SOC Is Variable Spatially Within A Benchmark



Site 143

Results – SOC change 1996 to 2011



Results for 2018 resampling?

- TBD but we know a lot from PSCB already
  - Due to SOC spatial variability within a microsite, small spatial offset in sampling location prevents reliable estimate of SOC change for one field
  - Once group of about 30 microsites then the signal from land management change becomes discernable against background of spatial SOC variability
  - The PSCB method does not meet the Australian measurement protocol
    - Does not estimate SOC change rigorously for whole field
  - The PSCB method does not provide data good for model validation or calibration
  - The PSCB method best provides factor of SOC changes for conversion to conservation cropping

Summary

- Prediction: Emission reductions within the supply chain will eventually become more important than sale of offsets from unregulated to regulated sectors(?)
  - GHG emission become business mainstream
  - Supply chain is pushing quantification approach toward modelling, you can't easily measure GHG in smallholder farms
- SOC measurements are expensive and so need to be strategic and carefully implemented
  - Support the target quantification approach and purpose

Thank You!

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