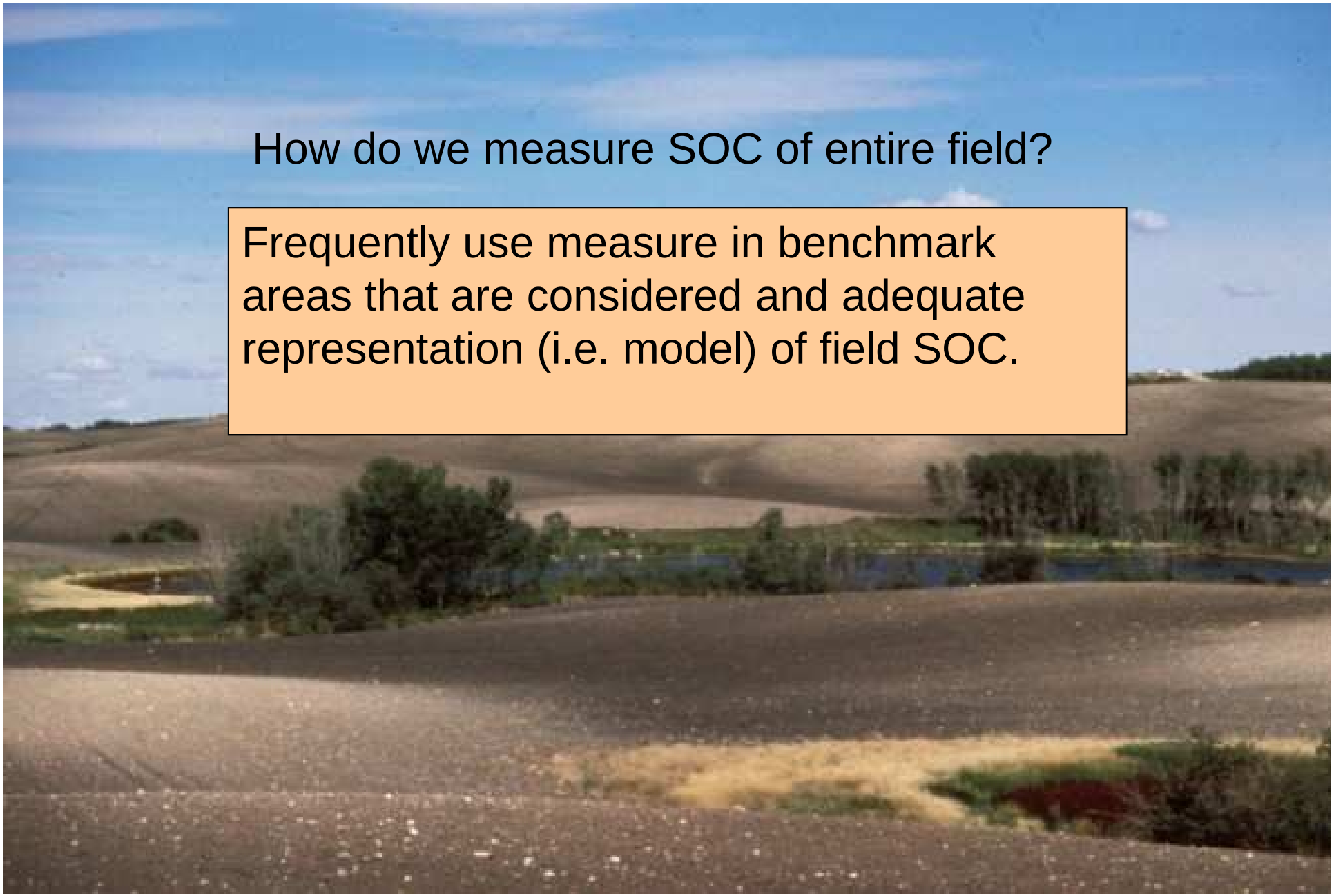
Measurement and Monitoring

Brian McConkey
Agriculture and Agri-Food Canada
brian.mcconkey@agr.gc.ca

Canada

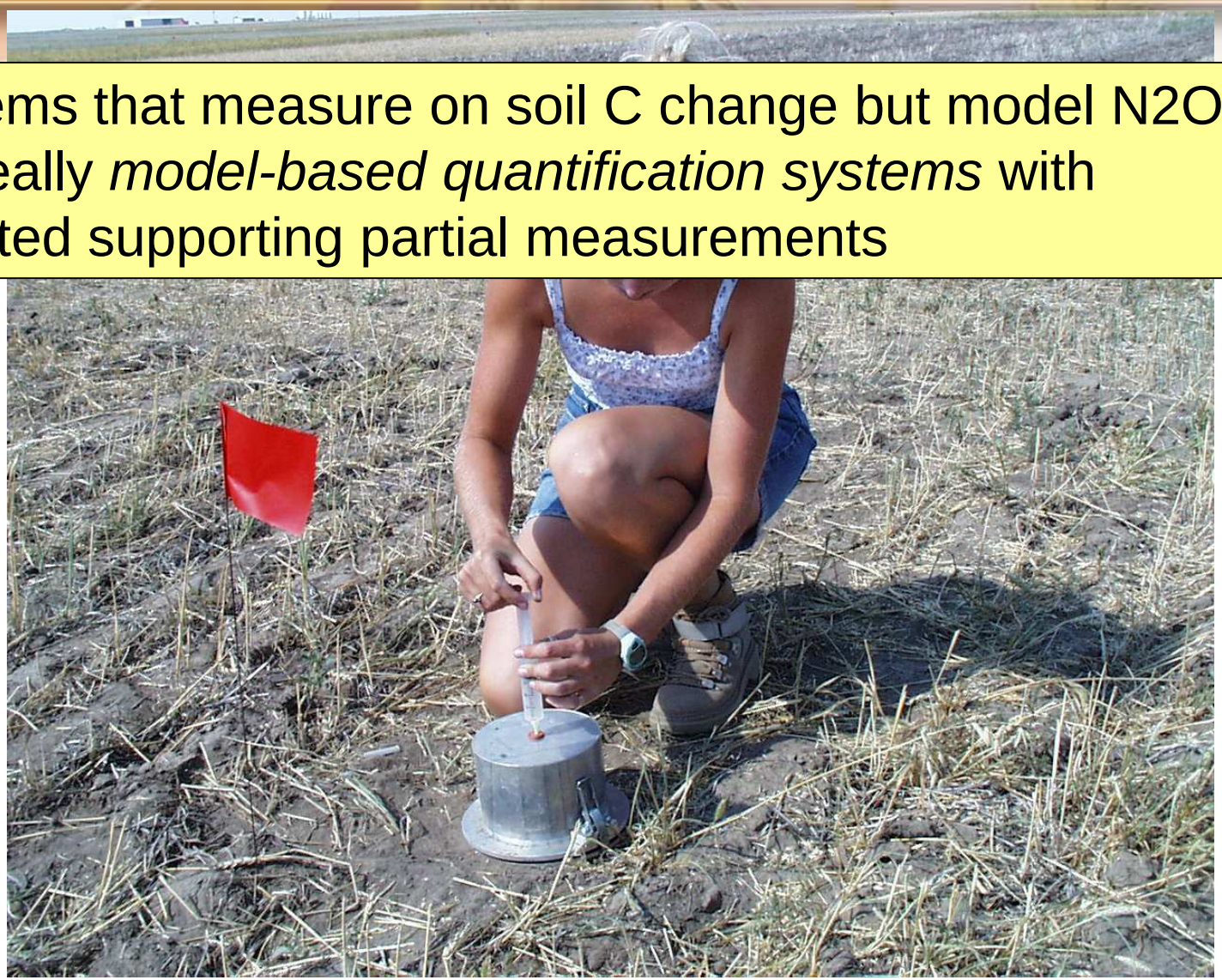


How do we measure SOC of entire field?

Frequently use measure in benchmark areas that are considered and adequate representation (i.e. model) of field SOC.

N_2O as least as important GHG as CO_2 from soil C change

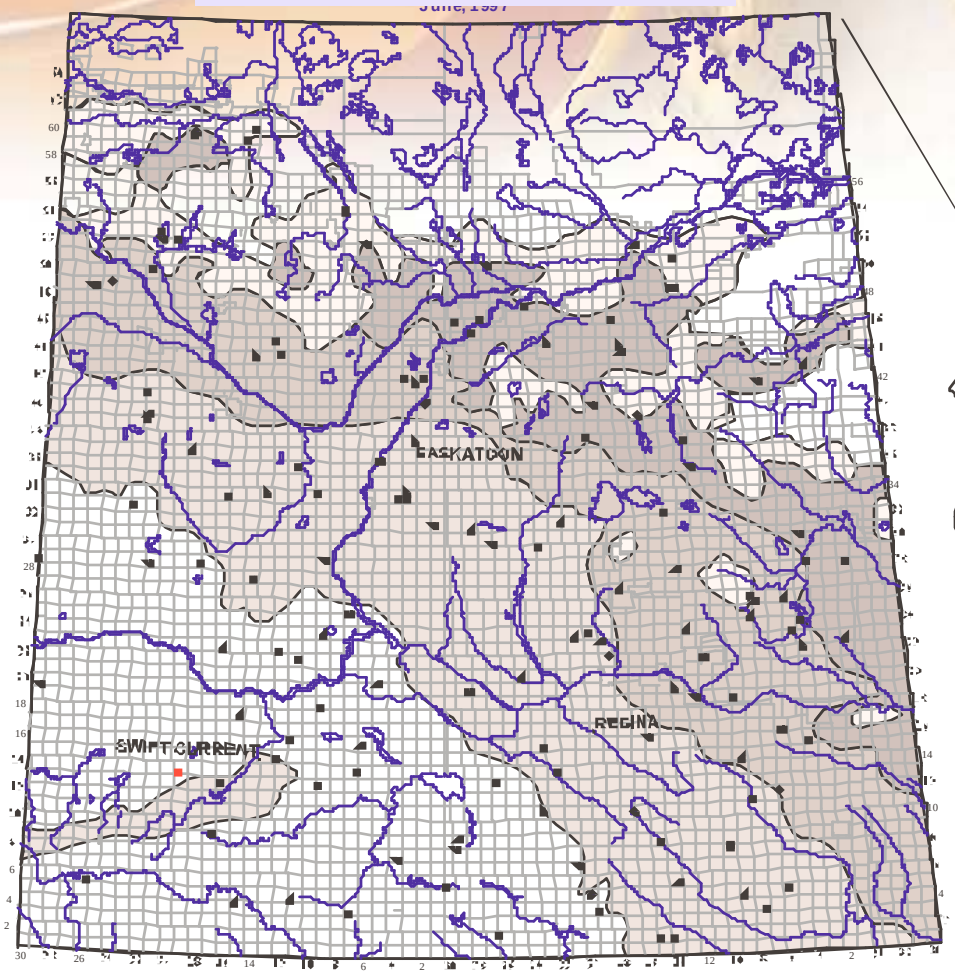
Systems that measure on soil C change but model N2O are really *model-based quantification systems* with selected supporting partial measurements



Sites converted to No-Till in 1997

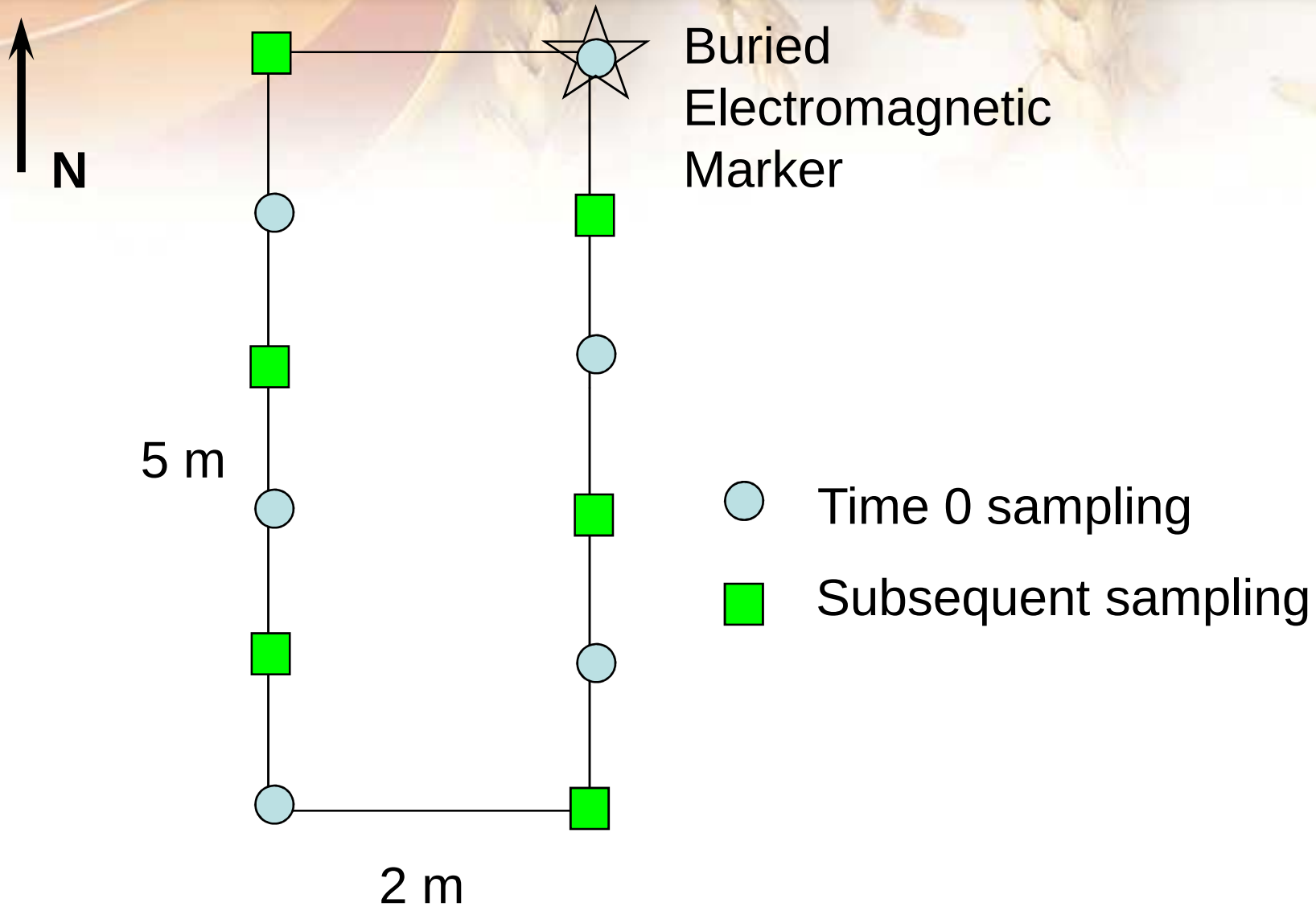
Saskatchewan

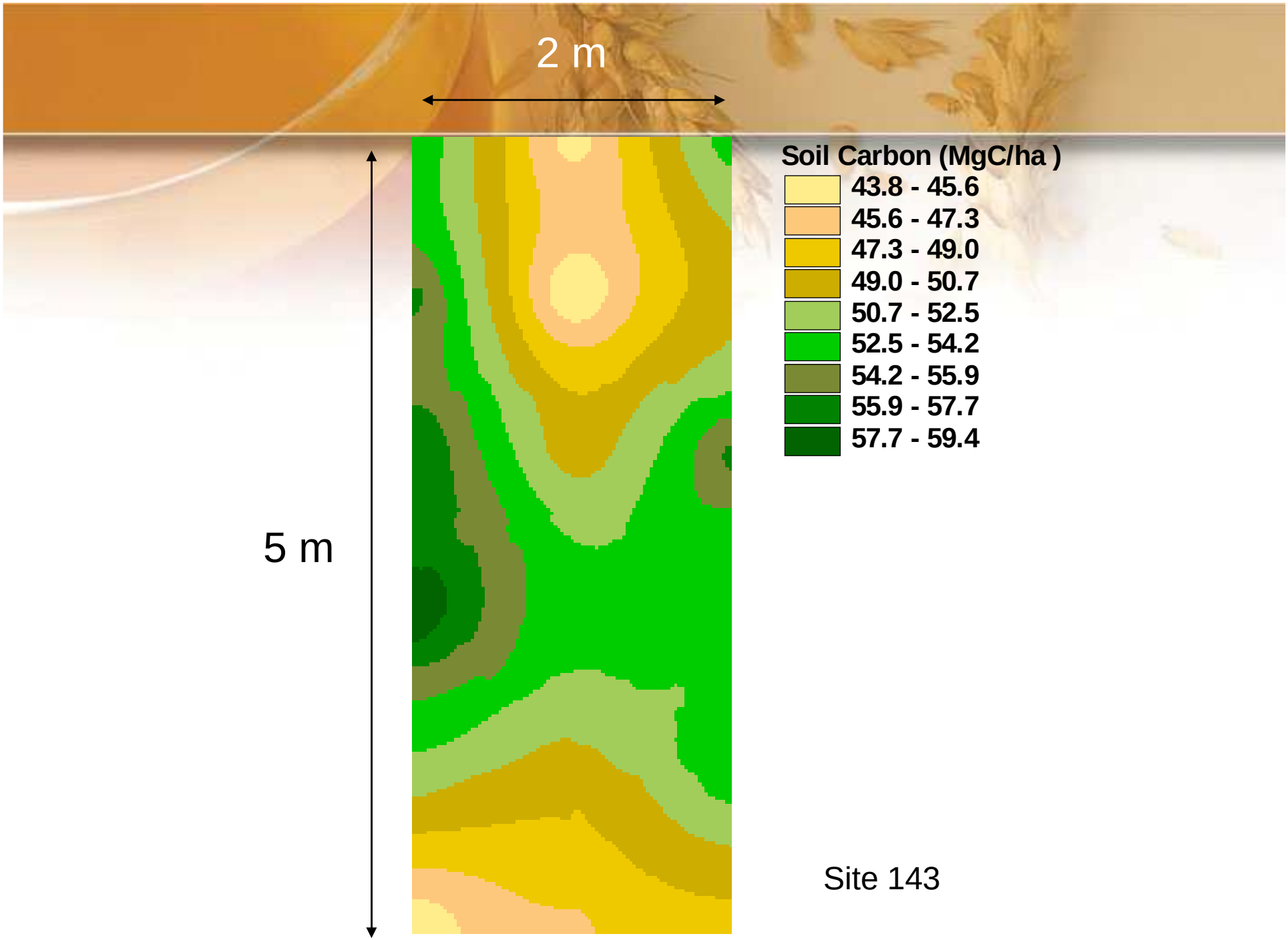
Benchmark Locations



CANADA

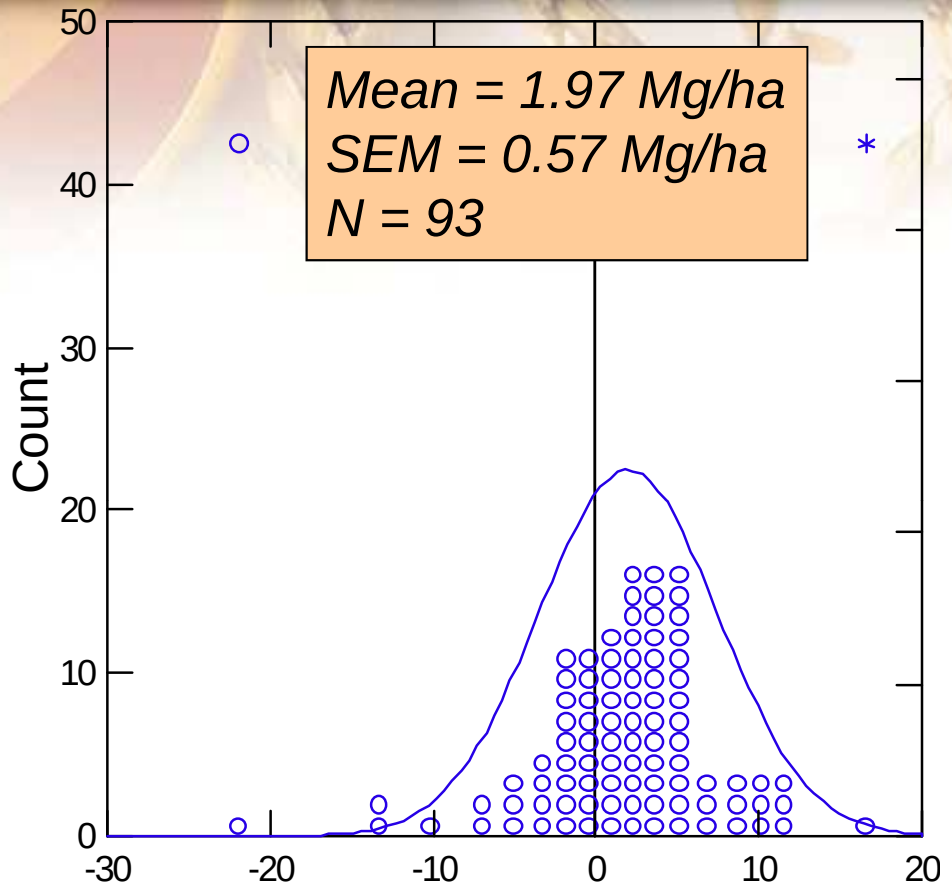
Benchmark


N
Buried
Electromagnetic
Marker
5 m
2 m
Time 0 sampling
Subsequent sampling


2 m
5 m
Soil Carbon (MgC/ha)
43.8 - 45.6
45.6 - 47.3
47.3 - 49.0
49.0 - 50.7
50.7 - 52.5
52.5 - 54.2
54.2 - 55.9
55.9 - 57.7
57.7 - 59.4

Site 143

SOC change is variable

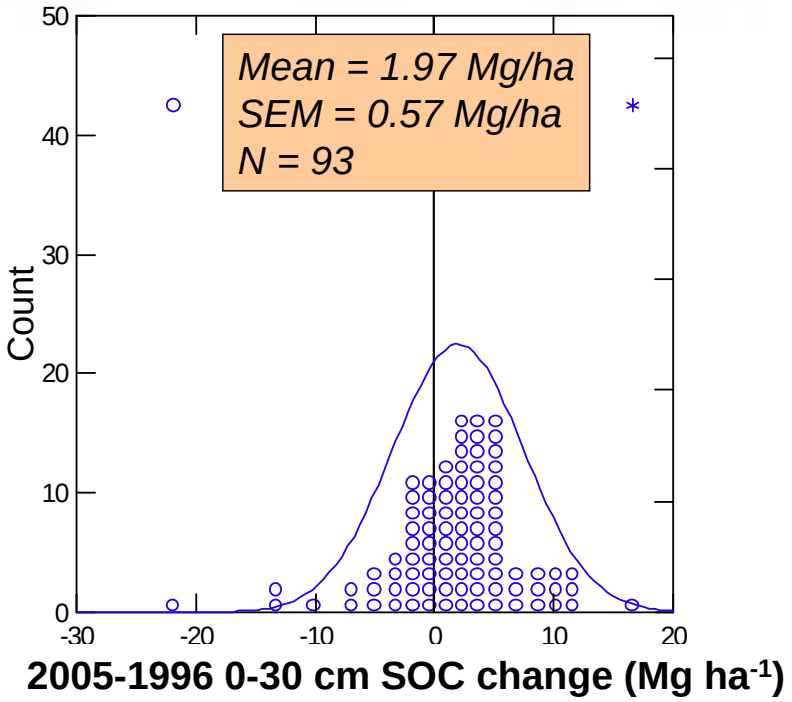


2005-1996 0-30 cm SOC change (Mg ha^{-1})

- Large (unexpected) differences consistent with normal distribution of changes
- obviously due to within-benchmark spatial variability rather than temporal change

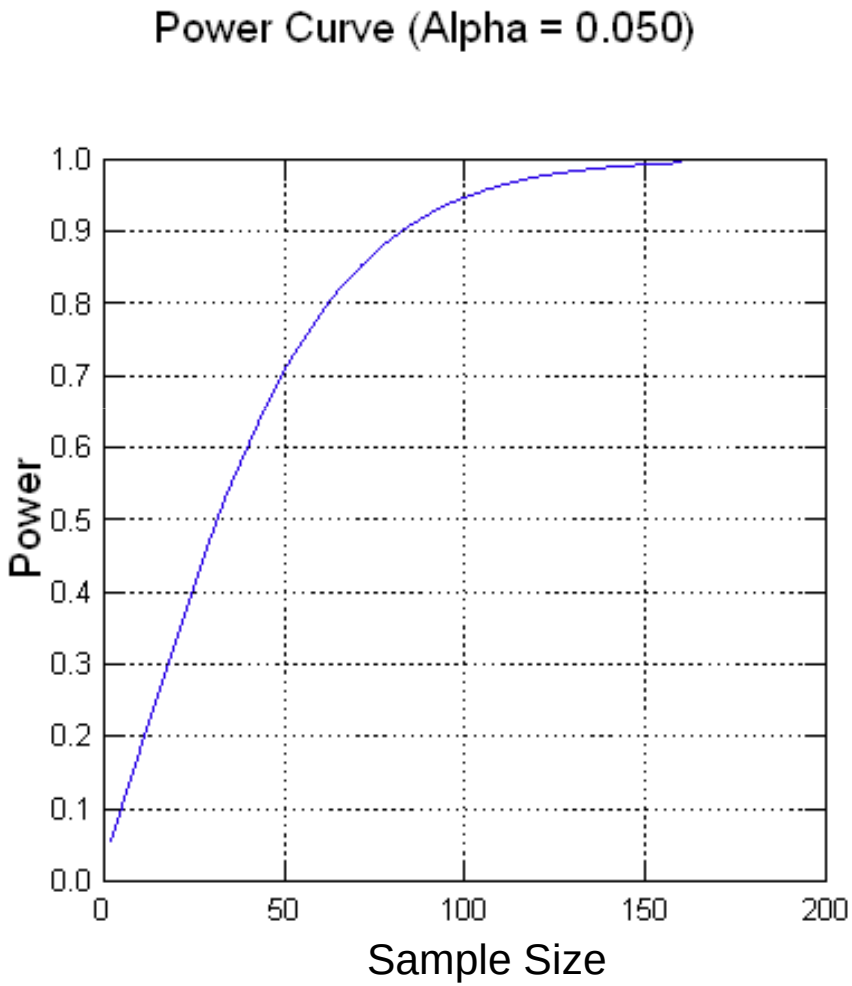
Viewpoint of SOC offset buyer

- Want to protect against Type 1 error (alpha) of concluding difference when no difference
  - i.e. wrongly rejecting the null hypothesis
- N required to detect difference of 2 Mg ha^{-1} with 5% chance of wrongly stating a difference = **32**

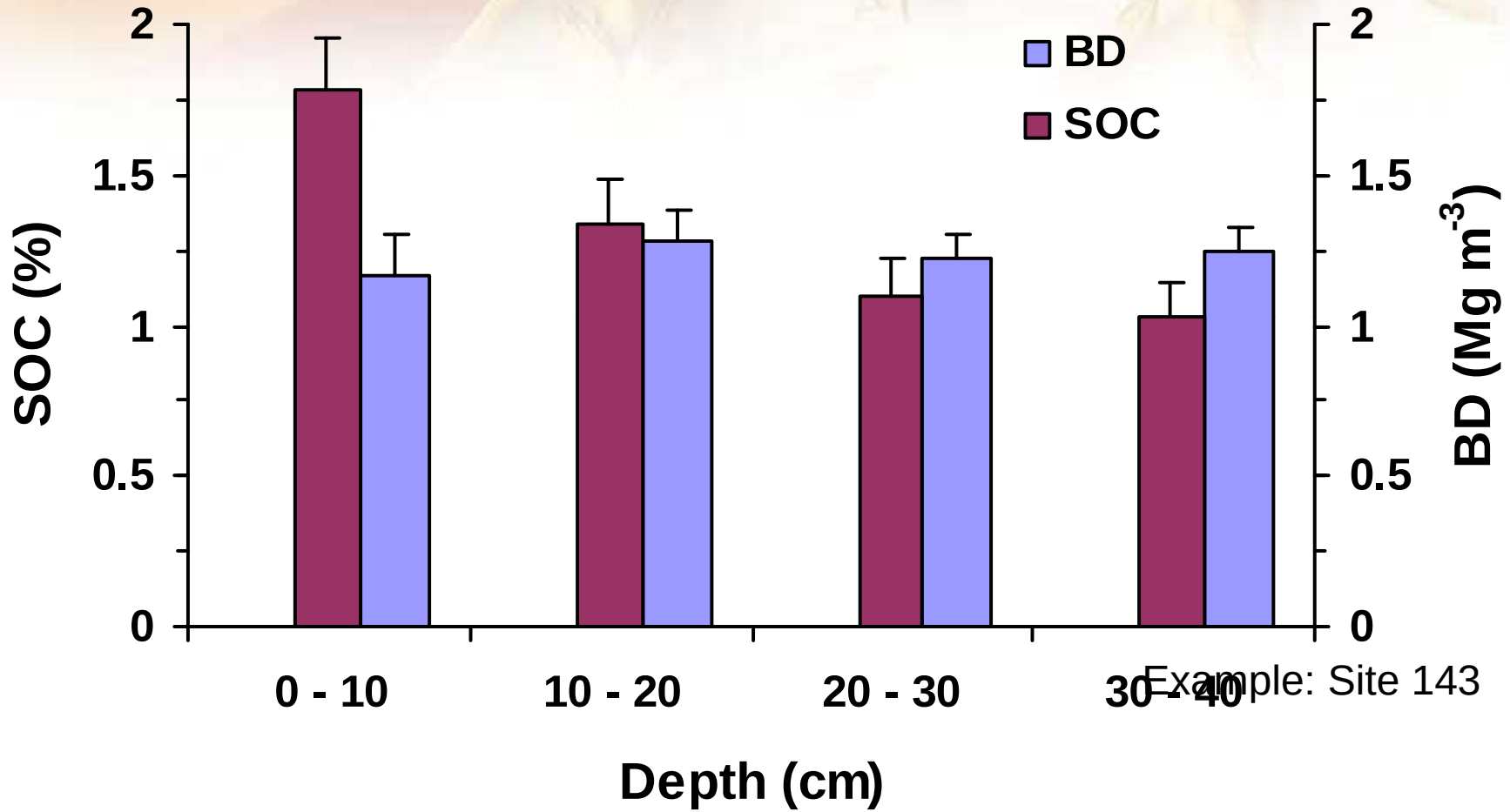


Viewpoint of SOC Offset Seller

- More concerned about probability (beta) of wrongly failing to detect a difference
  - Failing to pay (i.e. properly rejecting null hypothesis)
- Probability of failing to wrongly declaring no difference for N of 32 is **49%**
  - Almost coin toss of whether seller with real C change of 2 Mg ha^{-1} will receive credit
- Require **N=102** to have probability of 5% of wrongly failing to detect a difference



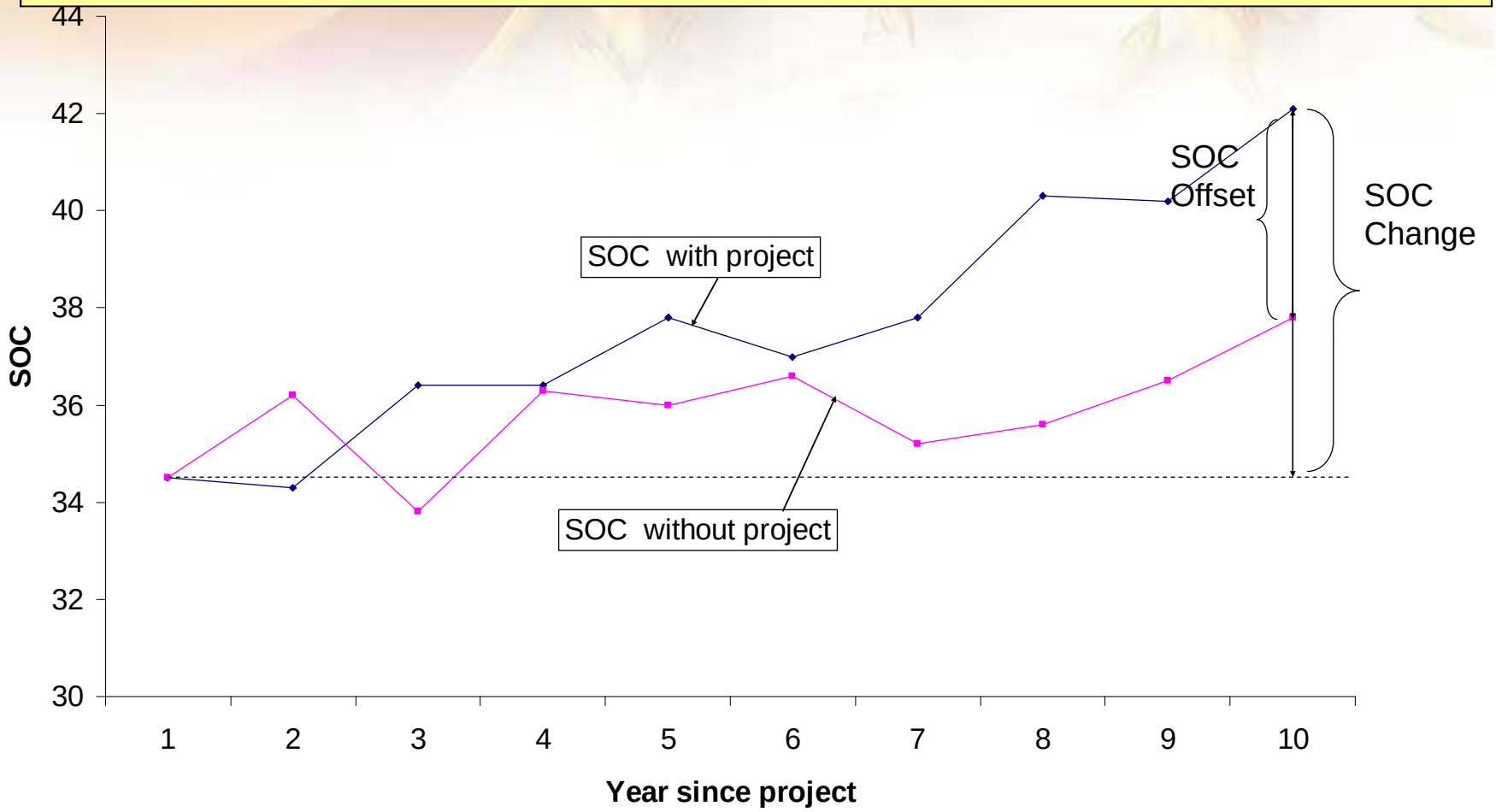
BD as important as SOC concentration in terms of overall SOC variability so low cost SOC concentration determination (LIBS, IR reflectance) is not a "Get of Jail Free" card



Example: Site 143

Under ISO 14064-2, offsets are the difference in controlled, related or affected GHG emissions and removals between "with project" and "without project";

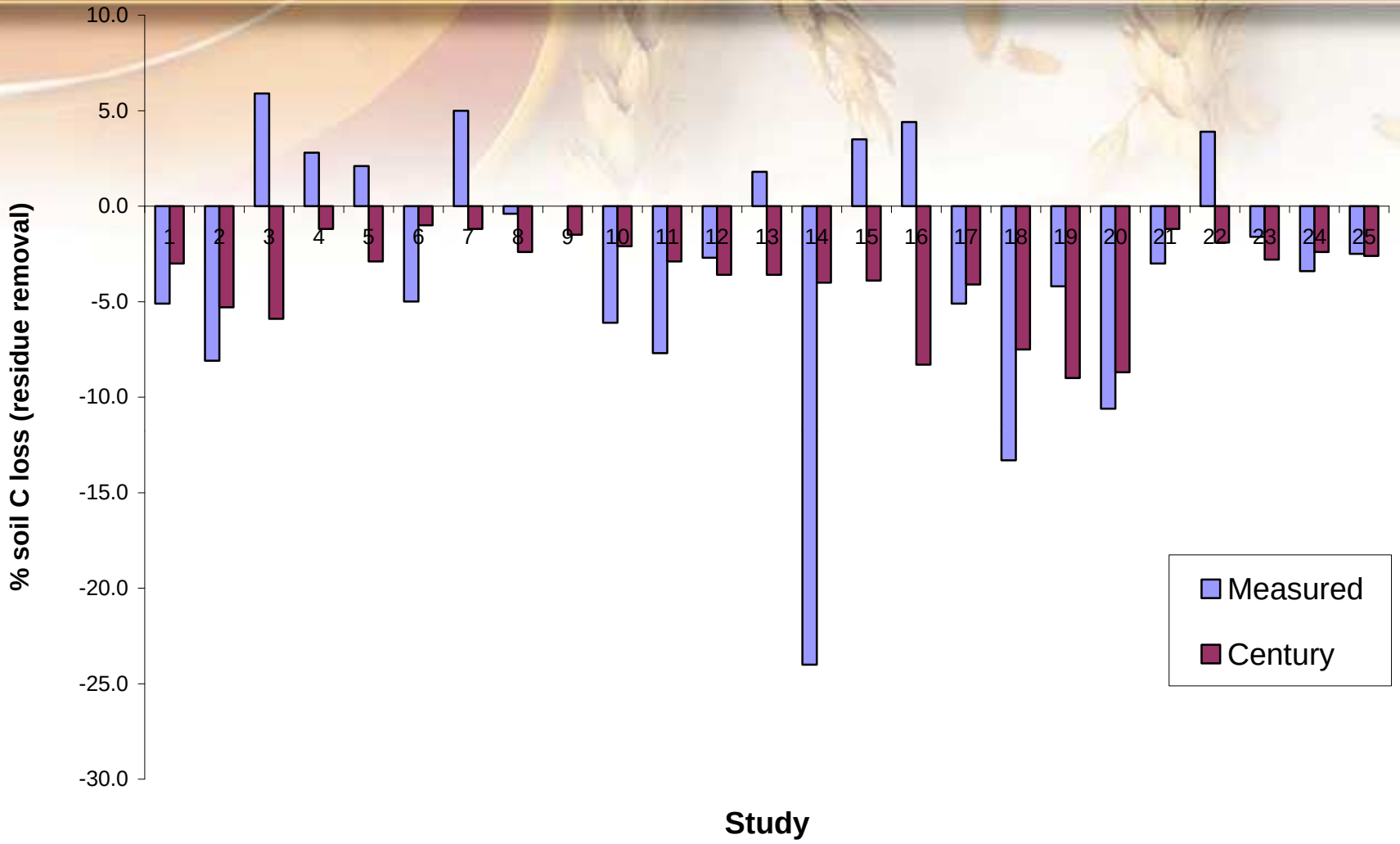
SOC measurements are absolute change with time and establishing an unbiased "without project" baseline is problematic.



Intensively and continuously validated models **of GHG emissions and removals are essential to practical offset systems**

- Few quantification systems are truly only measurement based
  - Models have to be used anyway
- Measurements are expensive
  - Use strategically (i.e. well designed replicated comparison of systems over regions)
- Measurements best for large aggregations of land that are as similar as possible in soil situation and in past and current management (i.e. reduce variability)
  - Measurements not well suited to innovative, unusual practices or soils
- Models allow flexibility as to the “without project” baseline for systems based on ISO 14064-2

Crop residue removal effects on SOC



Canada