

Underpinning reliable C credits protocols

a testcase from the Netherlands

ROS ET AL.

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2 solutions for nutrients analysis using sensor spectral technology

Our technology is based on sensor technology:

- Fast
- Affordable
- No reagents/consumables
- Staff is trained within a few hours (Scanner) or a few days (LiaB)
- Standardized



AgroCares Scanner
with NIR sensor



AgroCares Lab-in-a-Box
with MIR & XRF spectrometer

Today ... an illustration

Design of an accurate **SOC sampling and monitoring** protocol

- combination of satellite derived covariates and the handheld scanner (for spiking)
- tested on three farms in the Netherlands
- implemented for Rabobank Carbon Farming & Ecosystem Service Trade Initiative
- costs in the NL (with high spatial variability) vary between 2 – 4 euros per hectare

Given price of 40 euros per ton SOC, a change of 0.1% in SOC results in financial “income” of 156 euros per ha (assuming 50% uncertainty in C credits)

Farm trials done in 2021



Three farms with variable properties

- land use: arable (2x) and grassland
- soil type: clay, sand, peaty

Sampling protocol

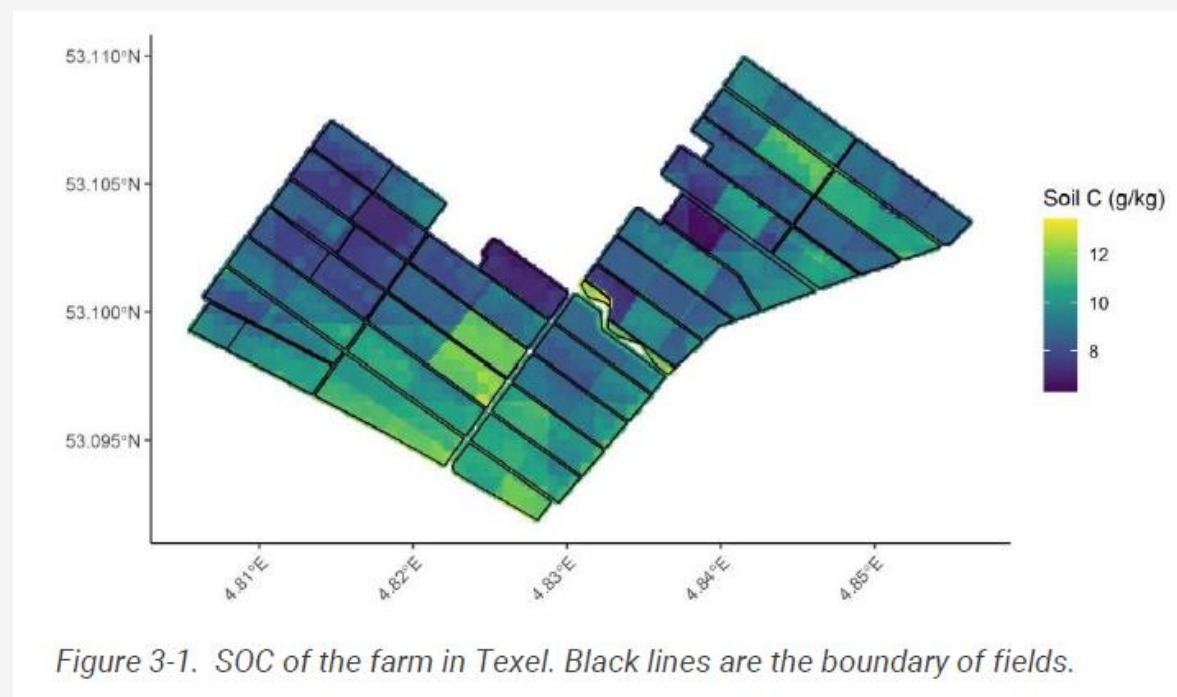
- maximize variation in SOC
- using existing farm data, open data and satellite data
- conditioned Latin Hypercube Sampling (cLHS)

Field measurements

- 0-30 cm depth, 100 samples per farm
- wet chemistry analysis and NIR via HandHeld Scanner

Results : C stocks per farm (1/2)

Spatial maps showing variation in SOC

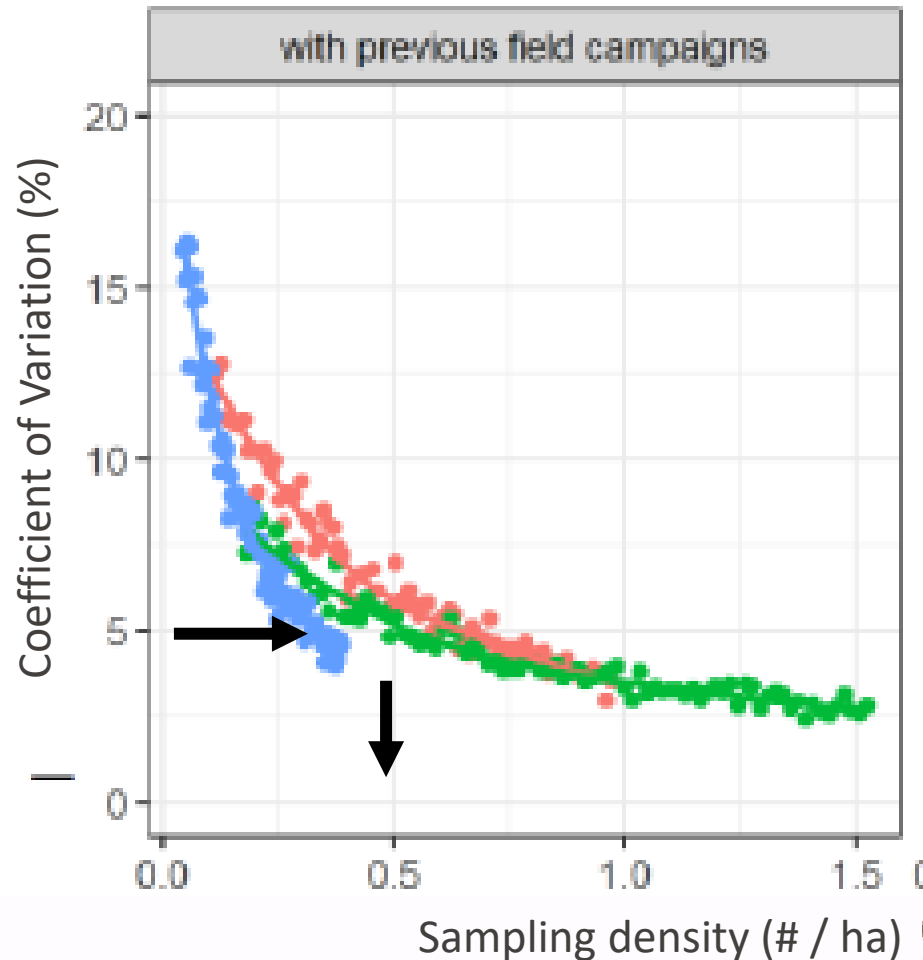


The estimated C stock on farm level

Table 3-2. Total C levels for the three farms evaluated.

Farm	Area (ha)	Carbon stock (ton C)	(ton C ha ⁻¹)
Brouwershaven	103	5434	53
Friesland	61	6172	100
Texel	254	9811	39

Precision C stock ~ sampling density



Lessons learned for NL

- 1 sample per 2 hectare is needed for CV of 5%
- cLHS is valuable to tailor-made sampling design including within-field information
- spiking with actual measurements is always needed
- precision increases with number of farms

Potential application

Protocol has high potential for upscaling

- accuracy increases with number of farms assessed
- costs over 20 years are estimated on 2 to 4 euro per hectare
- approach is globally applicable
- cLHS has advantages over common clustering methods (costs, accuracy)

Approach for high quality C crediting methodologies

- flexible use of biogeochemical models (for baseline estimates and future trends)
- hybrid approach from monitoring and modeling
- uncertainties can be (and must be) addressed, from both models as well as measurements