Strategies to Transition to Organic Grain: Impacts on Soil Health

Biwek Gairhe and Ray Weil

Department of Environmental Science and Technology

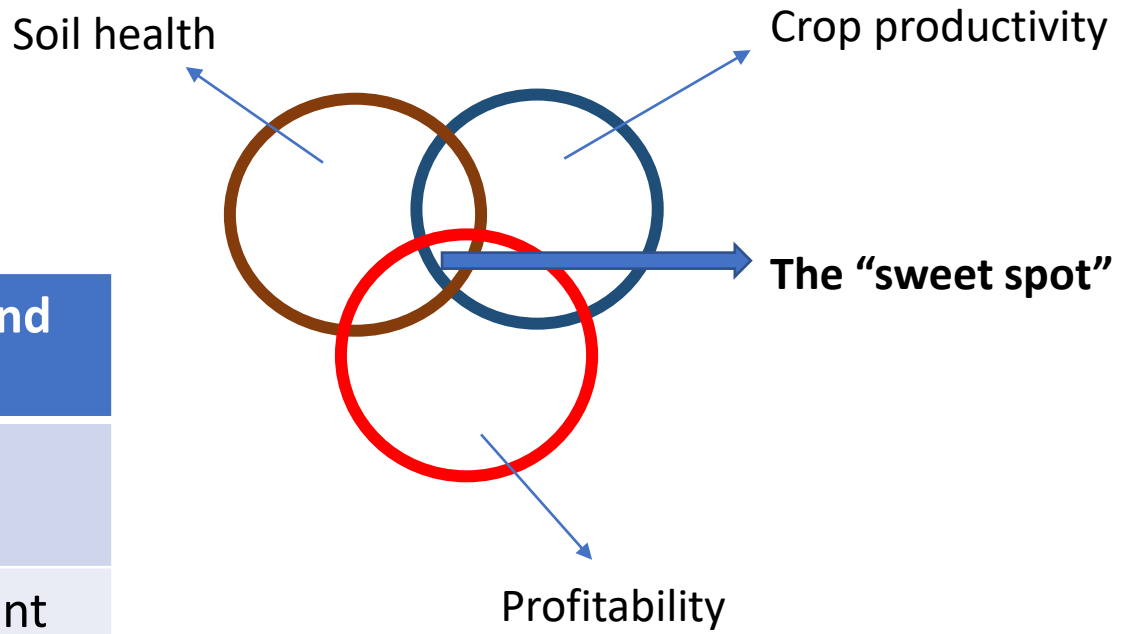
University of Maryland – College Park

Background

Organic transition:

✓ Opportunities vs. Challenges

Typical organic grain farmers	"Conventional" Maryland grain farmers
Tillage for weed control, making seedbeds	No-till (74% of cropland)
Animal manures, legumes for soil fertility	Strict nutrient management plans, Cover crops including legumes (41% of the cropland).



Study approach

Four transition strategies that differ in degree of soil disturbance, soil cover and input use intensity.

Treatment 1: Standard organic tillage, cultivation for weeds, maximize harvestable crops, minimal cover crops.

Treatment 2: Reduced-till Medium disturbance. Moderate cover crop intensity and biomass.

Treatment 3: Minimum-till with precision-zoned high biomass diverse cover crops.

Treatment 4: Perennial alfalfa-grass hay, untilled No soil disturbance after initial establishment. Multiple hay harvests per year.

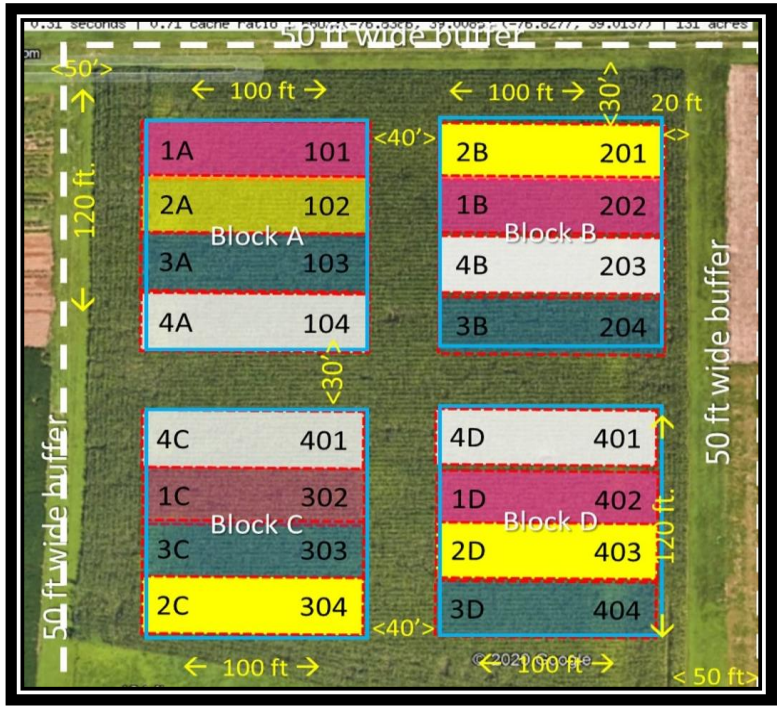
Crop rotation:

Spring oats (2020)- Corn (2021) – Soybean (2022)- Organic certified corn (2023)

Materials and Methods

- Organic transition initiated in Spring 2020 and will be completed in Spring 2023.
- RCBD with 4 replications of each treatment at each study location.

Farm name	Soil description	Individual plot size	Treatments
CMREC (UMD research station)	Moderately well drained sandy loam	9 m x 30 m	1,2,3,4
LESREC (UMD research station)	Moderate-well drained silt loam	9 m x 75 m	1,2,3,4
Commercial farm – A	Moderate-poorly drained sandy loam	9m ft x 90 m	1,2,3
Commercial farm – B	Well drained silt loam	18 m x 45 m	1,2,3

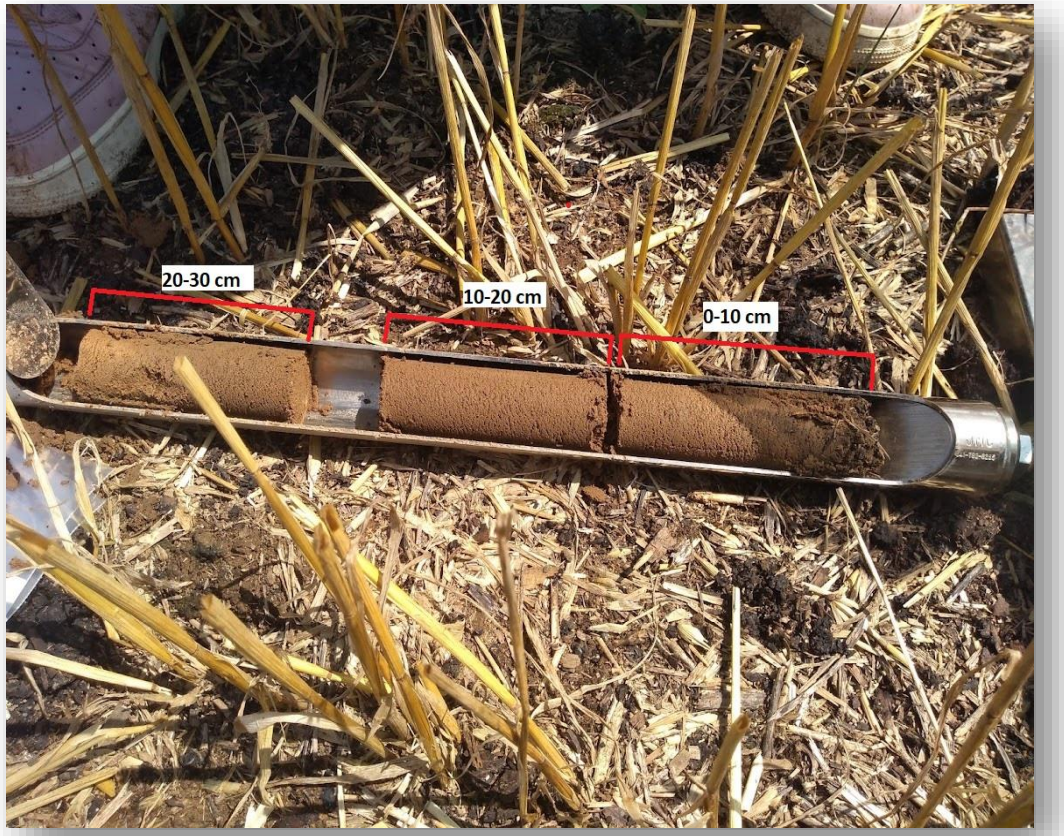


Experimental plot design at CMREC, Beltsville, MD

Data collection

1) Soil bulk density, 2) Labile Carbon (POXC), and 3) Tea bag decomposition study

- **Soil bulk density (Summer-Fall 2020, Fall 2022)**
  - 10 to 12 cores per plot
  - 3.1 cm diameter soil probe
  - Three depths (0-10, 10-20, 20-30 cm)
  - Composite samples



Data collection

- **Labile soil carbon (Fall-Summer 2020, Fall 2022)**

  - Permanganate Oxidizable Carbon (POXC) method (Weil et al., 2003)
  - Composite samples ground and sieved
  - Spectrophotometer at 550 nm
  - CMREC only

- **Tea bag decomposition study (Fall 2022) (Keuskamp et al., 2013)**

✓ Two tea types (Green and Rooibos) with contrasting decomposability
- Green tea: Hydrolysable fraction: ~84%,
  C:N ratio: 12.22
- Rooibos tea: Hydrolysable fraction: ~55%,
  C:N ratio: 42.87

✓ Decomposition measured by weight loss of plant material

✓ Decomposition curve using a single measurement in time

Green tea Rooibos (red) tea

✓ Tea Bag Index parameters: decomposition rate (*k*) and litter stabilization factor (*S*)

Decomposition rate (k)

$W(t)=ae^{-kt}+(1-a)$

where, W(t)=weight of substrate after incubation time t

a = labile fraction

1-a = recalcitrant fraction

k = decomposition rate constant

Litter stabilization factor (S)

$S = 1 - a_g/H_g$

where,

a_g = decomposable fraction,

H_g = hydrolysable fraction of green tea

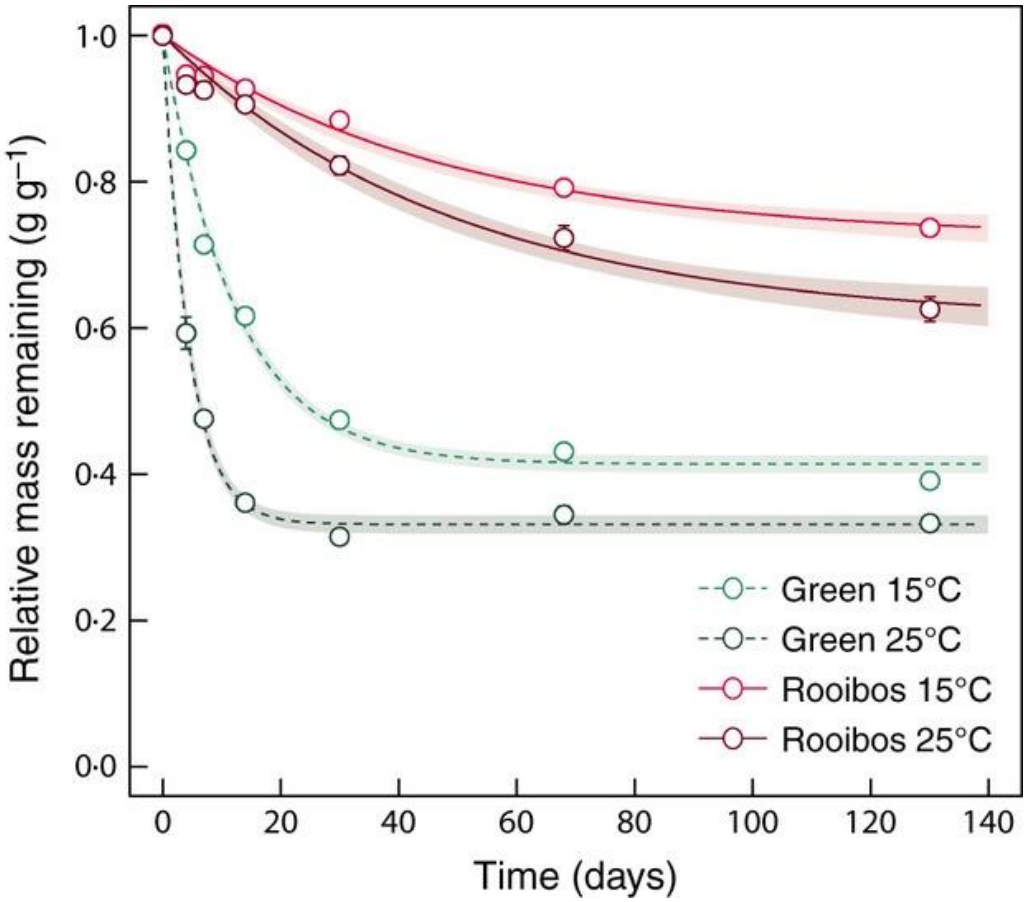


Figure source: Keuskamp et al. (2013)

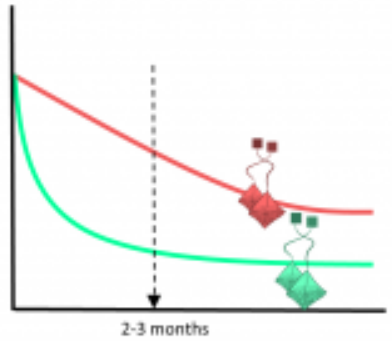
- **Tea Bag Study (Fall 2022) (Keuskamp et al., 2013)**

Take initial weight, put inside larger mesh bag, tag

Pairwise burial @ 8cm, 2 locations per plot

Recover after 3 months

Dry at 70 C for 48 h, open bag and weigh its content



Determine *S* and *k*

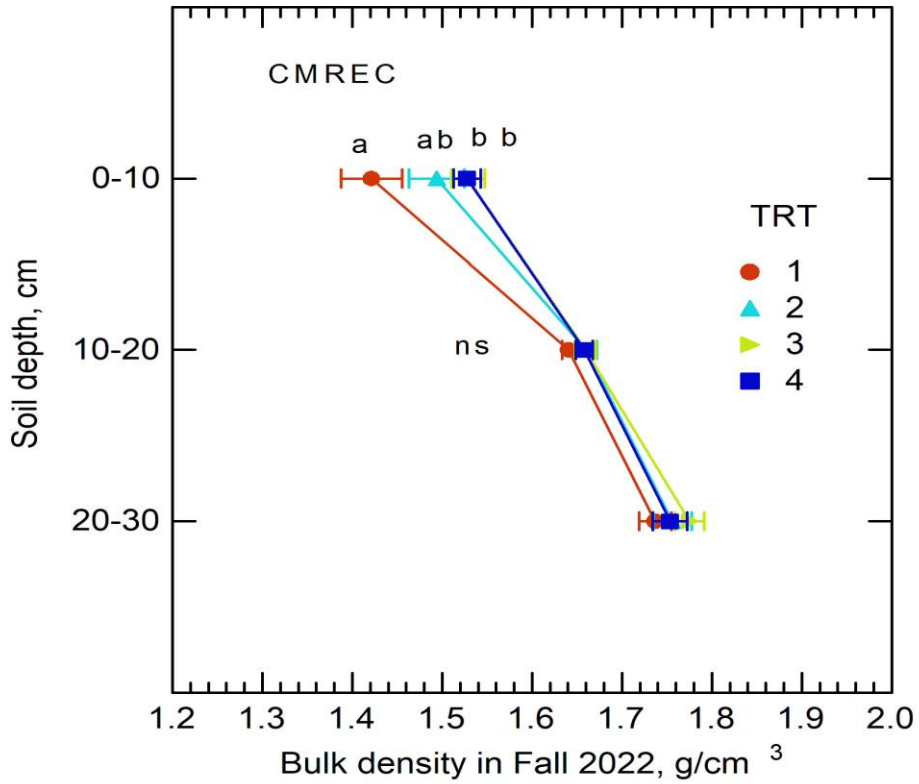
Statistical analyses

- Rstudio version 2022.07.2+576
- QQ-plots for normal distribution
- Levene’s test for Homogeneity of Variance
- Analysis of Variance (ANOVA)
- Post-hoc test: Tukey’s HSD
- Significance at P <= 0.05

Results and Discussion

1. Bulk density

Bulk density vs. soil depth in the four treatments at CMREC

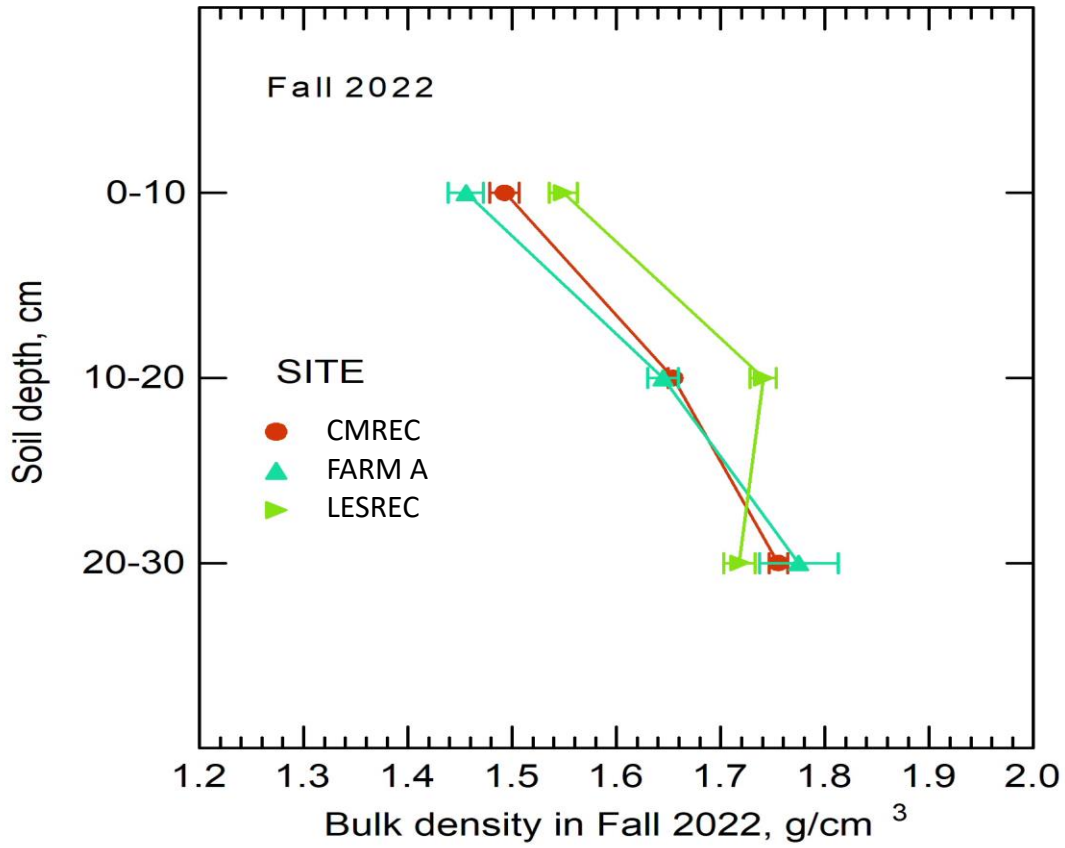


- ✓ No significant difference between treatments at any depth except 0-10 cm at CMREC.
- ✓ Significant difference in bulk density between the depths.

Results and Discussion

1. Bulk density

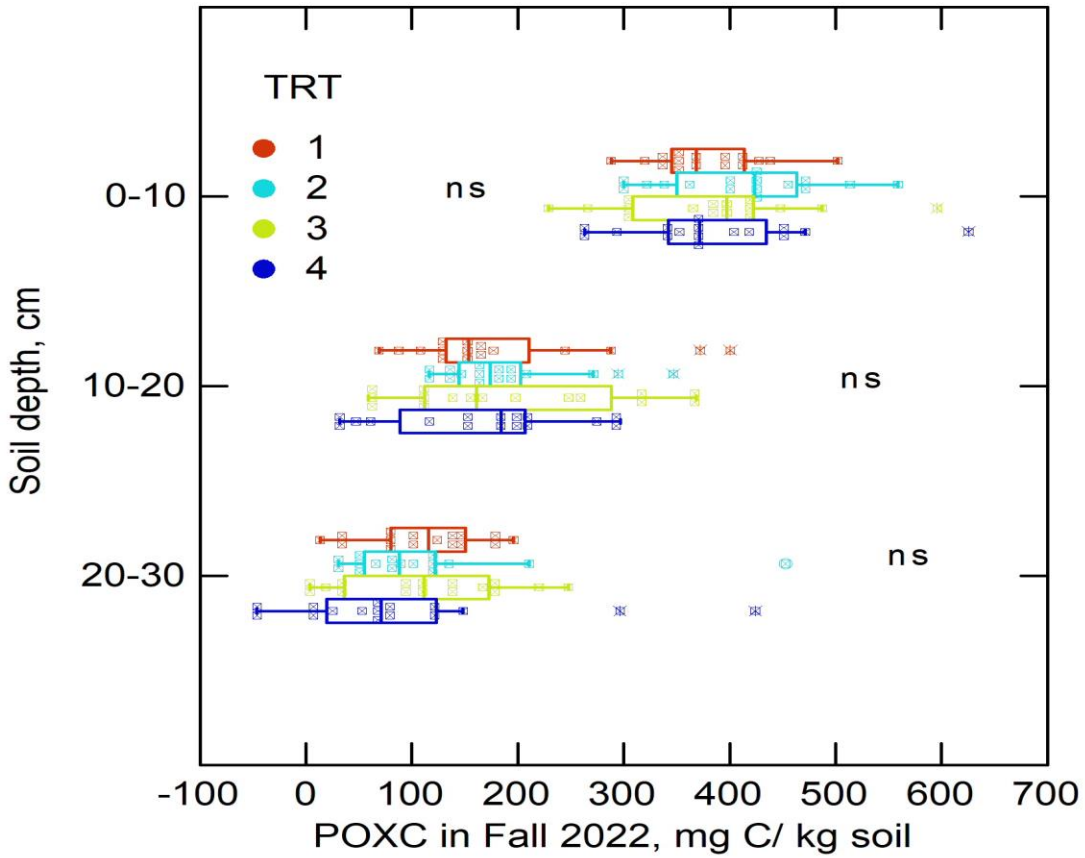
Bulk density vs. soil depth at various sites



✓ Significant difference in bulk density between the depths at all sites.

2. Labile Carbon

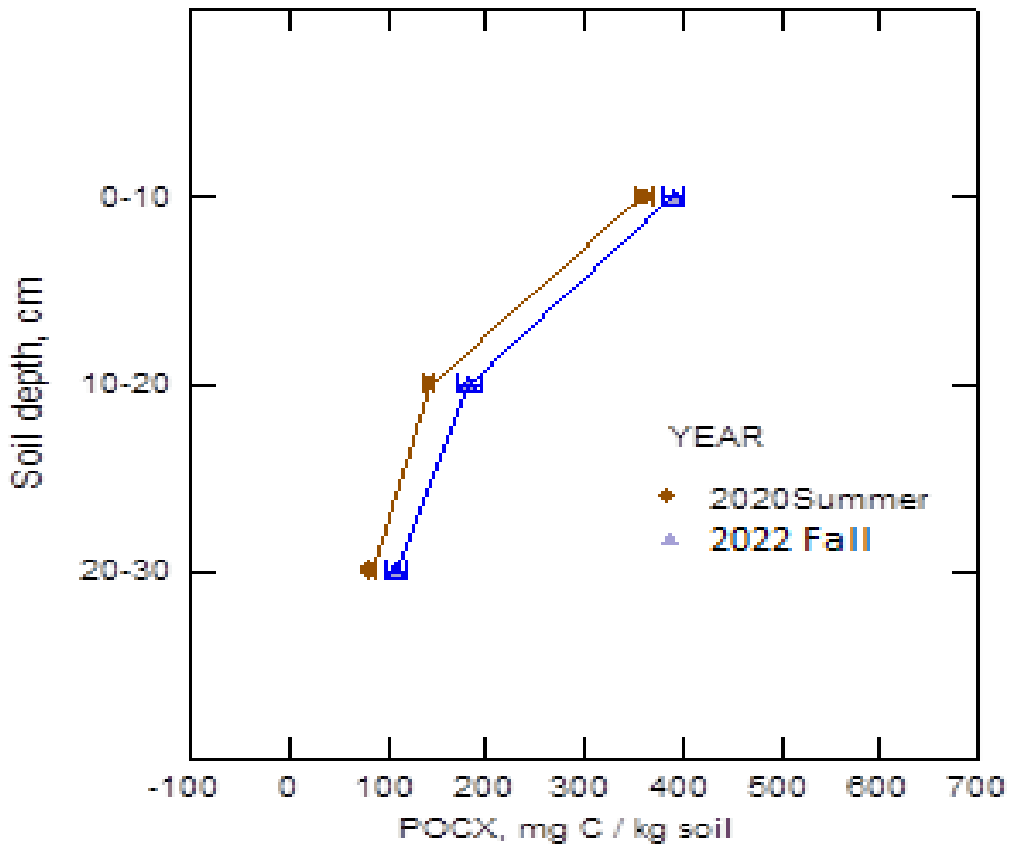
POXC vs soil depth at four treatments (Fall 2022)



No significant difference in POXC between treatments at any depth.
Significant difference between 3 depths at all treatments

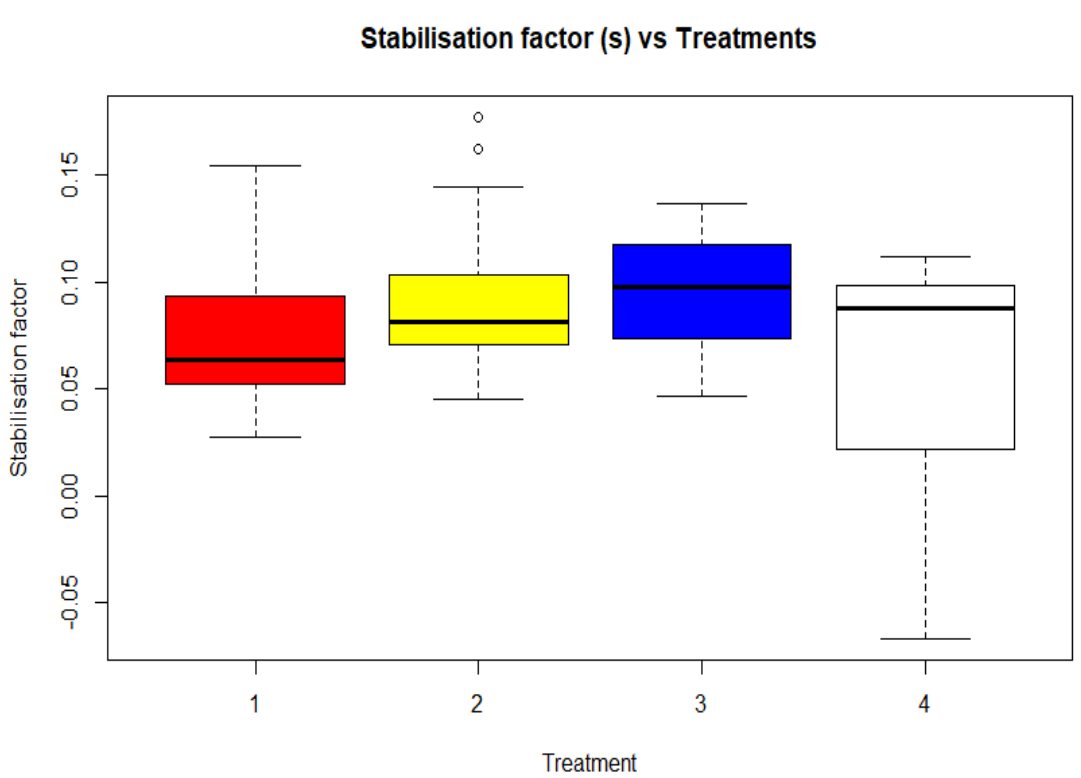
2. Labile Carbon

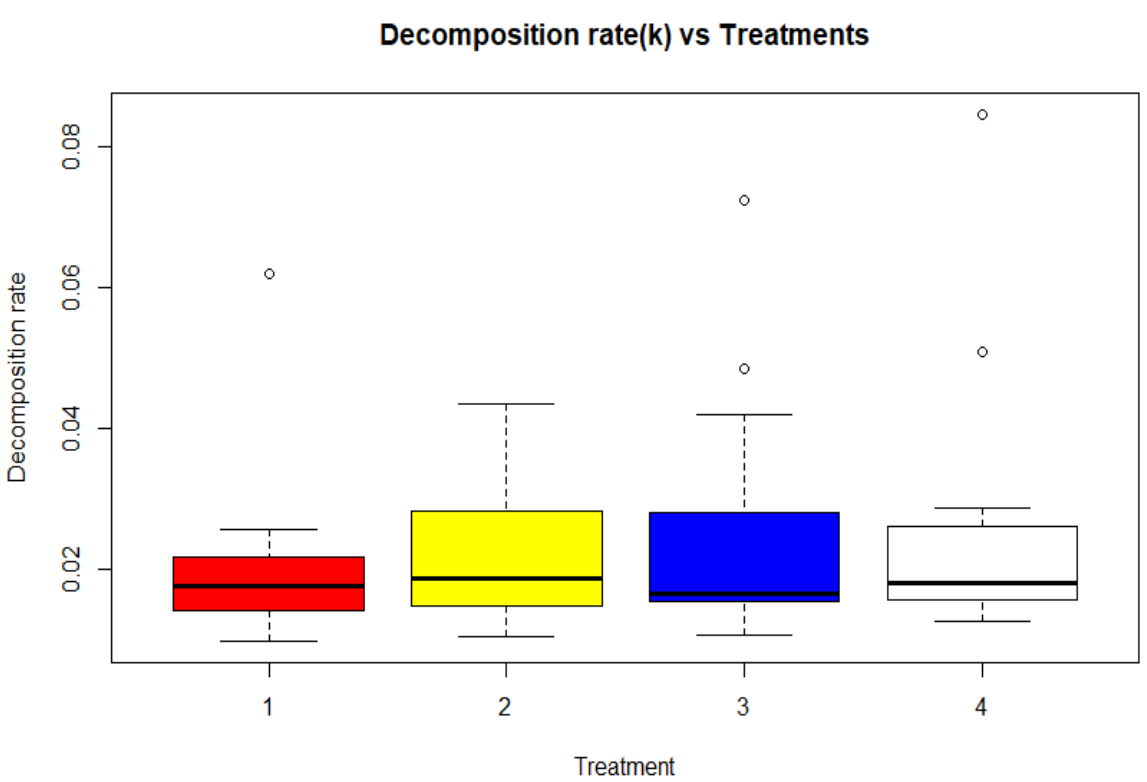
POXC vs soil depth at year 2020 and 2022



Significant difference in POXC at all depths between 2020 and 2022

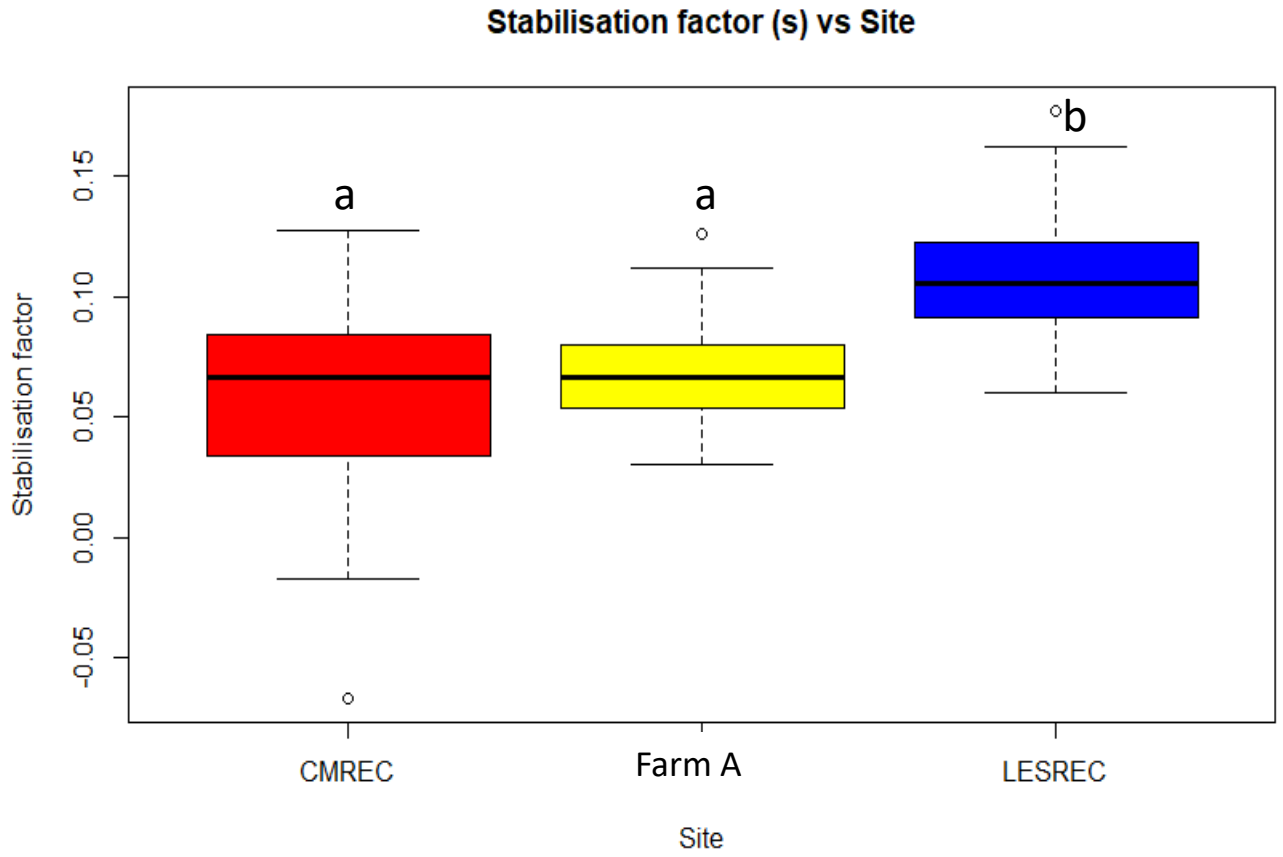
3. Tea bag study





No significant difference between treatments on stabilization factor (S) and decomposition rate (k)

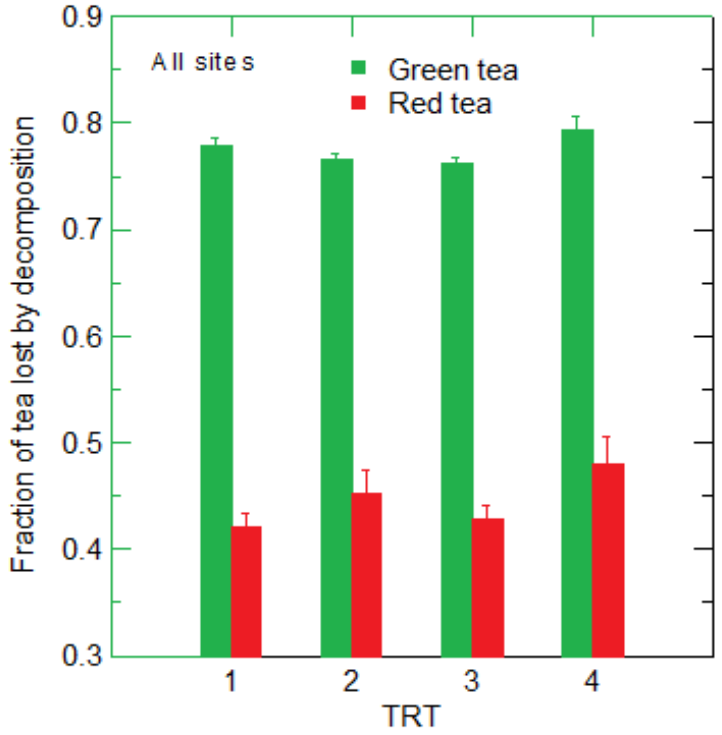
3. Tea bag study



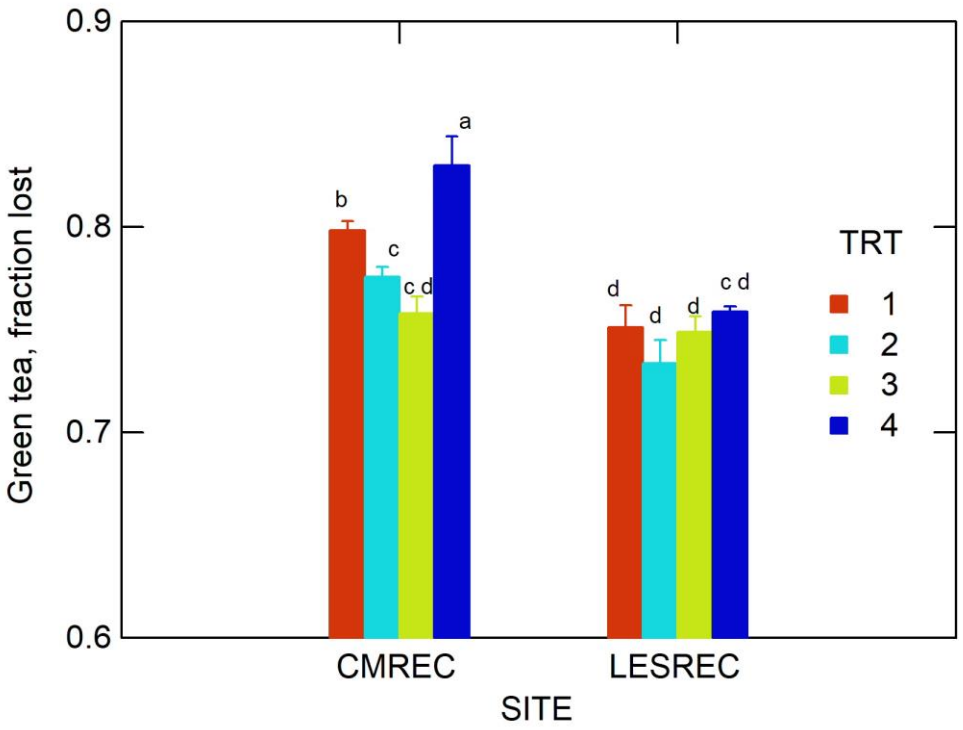
Stabilization factor (s) significantly higher at LESREC compared to the other two sites.

3. Tea bag study

Fraction of tea (green and red) lost by decomposition



Fraction of green tea lost by decomposition



No significant difference in fraction lost by decomposition between treatments except for green tea at CMREC

Future work

- Other soil physical, chemical, and biological properties, Soil Health Index
- Crop productivity
- Farm profitability

Acknowledgement

- USDA/NIFA Award 301326-00001
- NESARE Award GNE2125535383
- Soil quality lab team, ENST, University of Maryland-College Park
- UMD extension, Collaborating research stations and farmers

☺ Thank You! ☺