Historical Changes in Total and Recalcitrant Soil C of Wheat Cropping Systems in Pendleton, OR

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Background

- Carbon sequestration in soil
  - SOC pool 3.3x larger than atmosphere, 4.5x larger than biotic pool (Lal 2004)
- Organic carbon declined when soil was cultivated with conventional tillage, even with additions of manure (Rothamstead, Pendleton, Champaign, Columbia) (Reicosky et al. 1995)
  - If OC vulnerable to climate change and management, how are recalcitrant-C pools reacting? (Tubiello et al. 2007, Rusmussen et al. 1980, Buyanovsky et al. 1996)

- Soils reach an equilibrium after 60 years of cultivation (Jenny 1941)
  - Can long-term experiment (LTE) stations help to navigate and gain knowledge on carbon dynamics in soil?
  - Are models correctly depicting real-world data?

Background

Questions/Hypothesis

Recalcitrant-C

- How much recalcitrant-C (non-hydrolyzable C) is in the soil of a till-based wheat cropping system?

C-sequestering amendment

- Over time, does manure and pea-vine amendments increase %NHC in soil?

Hypothesis:

If manure is applied, there will be an increase and more %NHC in the soil than the control and pea-vine treatment.

Impacts of Research

Gain knowledge of site data on long-term experiments (LTE) at Columbia Basin Agricultural Research Center (CBARC) to calculate effects of climate change and management

Future Goals:

- Compare data to CROPSYS model
- Producer's expectations for long-term C storage

Soil/Plots

- Site: Pendleton, OR
- Climate: Semi-arid
- Precipitation: <18in/yr
- Soil: Walla Walla silt loam
- Management: W/F system, conventional tillage

Table 1. Treatment identification and field plot designation.

Treatment No.	Field Plot	Organic-N Addition	Residue/Nitrogen Treatment
8	*1508* *1518*	Manure[1]	No burn, No nitro.
9	*1509* *1519*	Pea Vines[2]	No burn, No nitro.
10	*1510* *1511* *1520*	---	No burn, No nitro.

[1]Manure= 10 tons/acre crop [2]Pea Vines= 1 ton/acre crop
Note: All management strategies have been continuous since 1931.

Methodology

Methodology

Acid Hydrolysis

- 1g soil
- 6M HCl
- Digest for 16hrs
- Pour off supernatant
- Diluted and dried

%NHC= non-hydrolyzable carbon

- Resistant-C
- Ranges 30-70% of SOC (Paul et al. 2001)
- ~1400 years older than total SOC

Soil loss

- %NHC skewed with loss of soil particles (Plante et al. 2006)

$$\%NHC = \frac{\left(\frac{gC}{kg\ sample}\right)_{after} \times \frac{mass_{after}}{mass_{before}}}{\left(\frac{gC}{kg\ sample}\right)_{before}}$$

Methodology

<u>Organic C &N</u>

- .2-.3g dry soil
- %C and %N calculated using a CHN dry combustion analyzer

Carbonates had to be identified as they can misinterpret C data (Paul et al. 2000)

- HCl-test

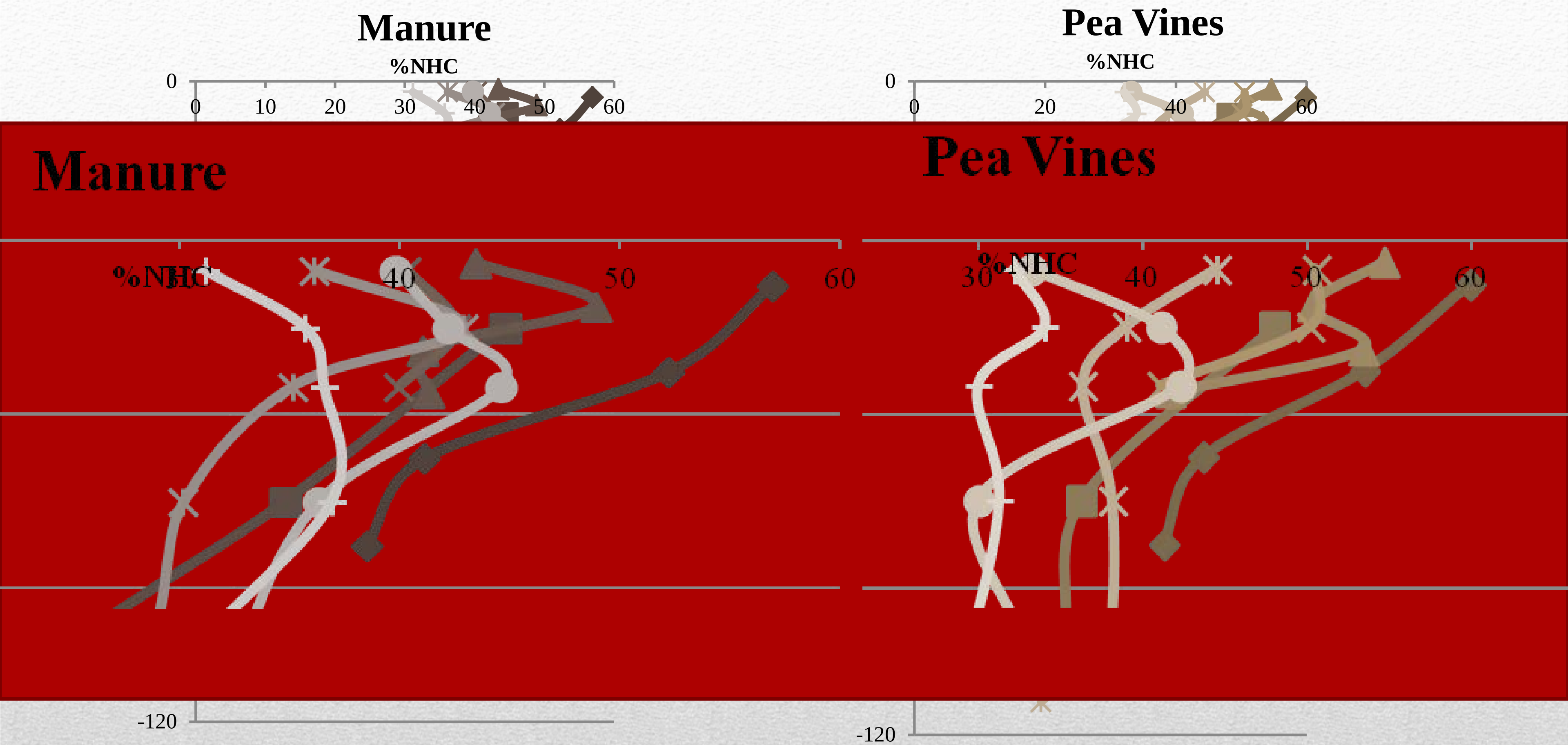
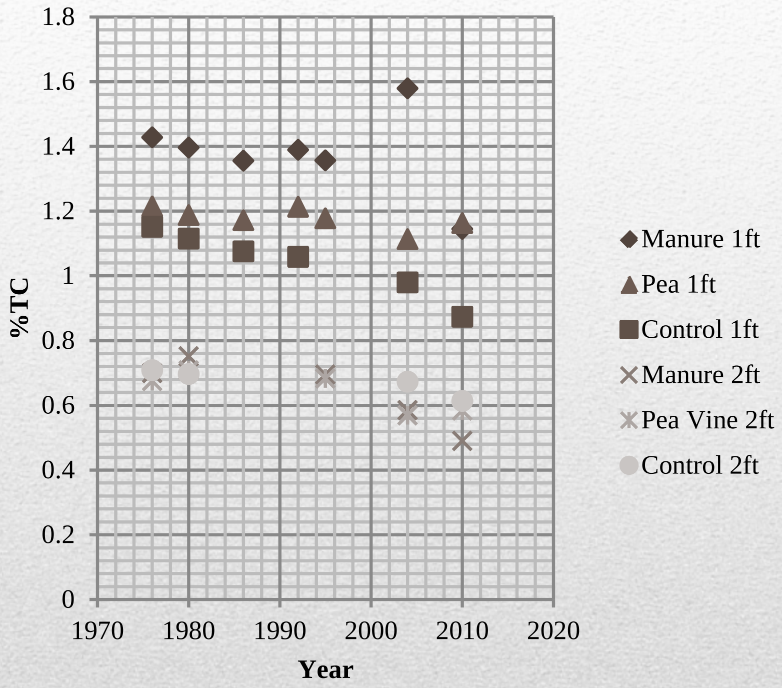


Figure 1. %NHC compared to depth through time in manure and pea plots. All available depth measurements were applied on graph.

Analysis

% Total Carbon



% Non-hydrolyzable carbon

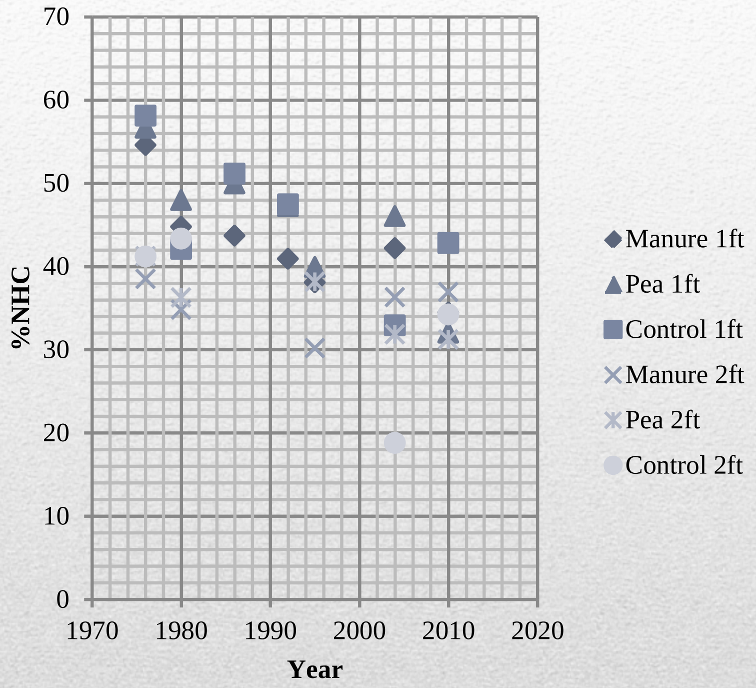


Figure 2. Total C and NHC through time. All depth measurements were averaged to the 1st and 2nd foot.

Trends through time

C Content in Soil

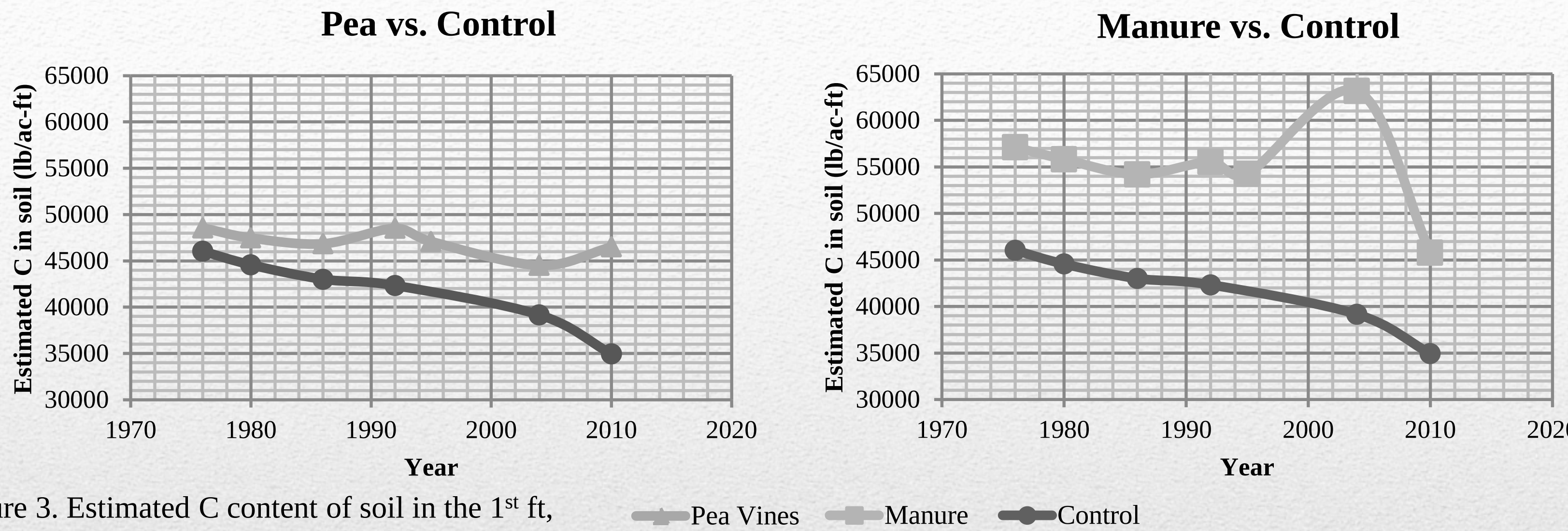


Figure 3. Estimated C content of soil in the 1st ft, using averaged data.

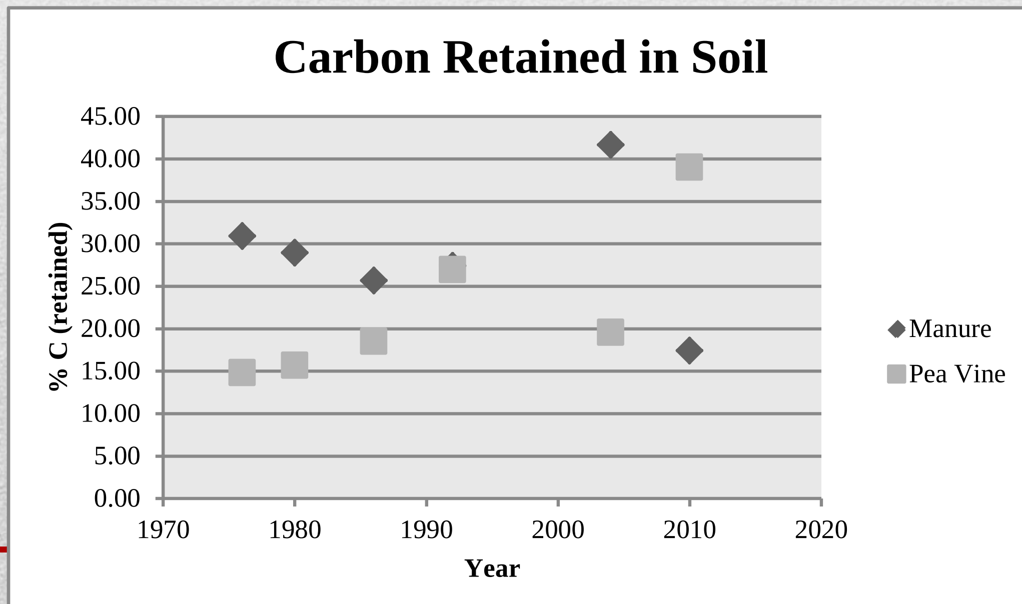


Figure 4. %C retained in soil (1st ft.) by estimating amount of C applied vs. actual soil tests. Averaged 1st ft data used.

Conclusion

- %TC constant in manure/pea
- Carbon retained in pea treatment, not manure
  - C:N ratio of manure smaller than pea vines (Rasmussen et al. 1980)
- %NHC decrease through time
  - NHC being lost/utilized in soil top foot
  - Attempt no-till system, where manure show largest pool of NHC (Lorenz et al. 2006)
  - Age of NHC create difficulty determining fluctuation
- Modify hydrolysis procedure to account for lost C

Limitation

- Soil loss during procedure
  - NHC is 30-70% SOC, so change may only be determined in **size** of pool (Paul et al. 2001)
  - Greater %NHC in silt-size fraction (Plante et al. 2006)

Climate change and carbon sequestration in soil

- Is it worth time and effort?
- Are producer’s going to benefit?

Ethical Implications/Issues

Thank you for your time!

Acknowledgements

Dr. Bill Pan, Dr. Dave Huggins, Lauren Young, Tabitha Brown & the NCRE Lab!

Questions?

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