# Carbon and Nitrogen Storage in Biosolids Amended Soils

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**Background**

Application of biosolids from municipal solid waste facilities to farmland in Washington State has been practiced since the 1980s. Research done at these sites has shown that applications of biosolids are able to provide necessary fertility for broad acre crops, and lead to an increase in soil carbon and nitrogen (Cogger et al., 2014).

**Question**

The objective of our study was to identify the changes in acid resistant and light carbon and nitrogen fractions as a part of overall C and N gains in the system, and use those values to estimate the emission storage value of the biosolids system.

## Method

- Conventionally tilled WW-fallow rotation
- Biosolids applied every 4 years beginning in 1994
  - Rates of 2.0, 3.0, and 4.5 dry tons/acre
- Two non-biosolids comparisons
  - Anhydrous ammonia, every 2 years
  - No nitrogen fertilizer
- 0-4 inch soil depth hand sampled postharvest
- Total C, N analysis
  - ~0.25 g air dried, ground soil weighed for Leco analysis.
- Acid resistant fraction determined by acid hydrolysis of 1g of air dried, ground sample (Plante et. al., 2006).
- Light fraction determined by agitating 25g of soil in NaI solution with density of 1.7 g $cm^{-3}$ as in Gollany et al., 2012.

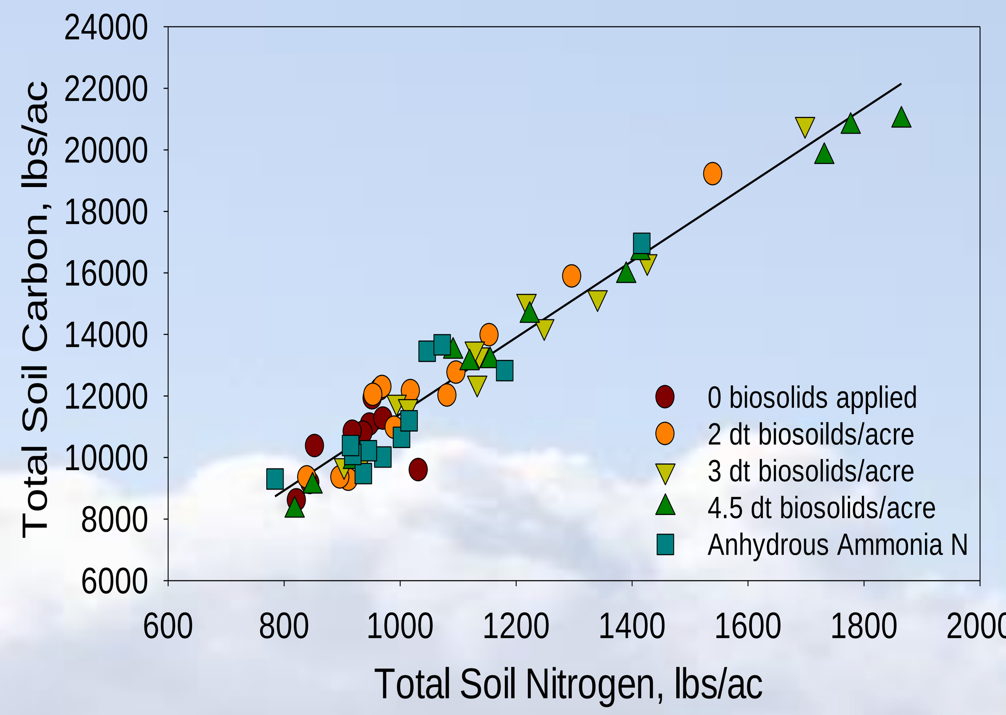


**Figure 1:** Soil carbon as a function of soil nitrogen.

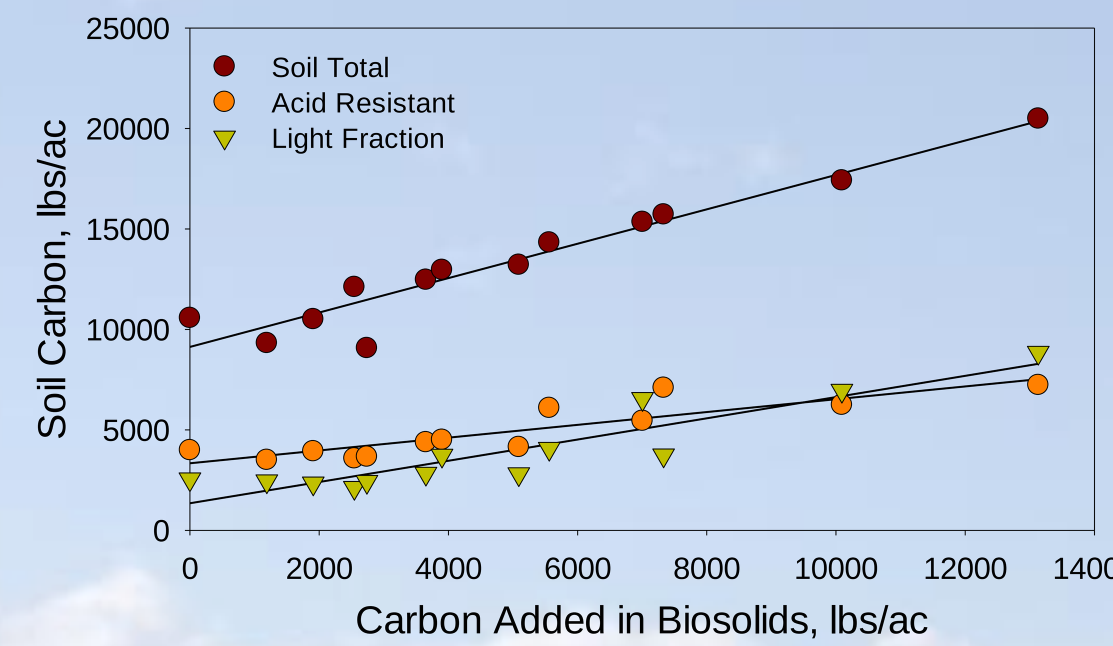


**Figure 2:** Soil carbon gains as a function of pounds of carbon added in applied biosolids.

| | C Accumulation | | N Accumulation | |
|---|---|---|---|---|
| | Slope | $r^2$ | Slope | $r^2$ |
| Total | 0.773 | *0.776* | 0.357 | *0.819* |
| Acid Resistant | 0.282 | *0.573* | 0.040 | *0.262* |
| Light Fraction | 0.461 | *0.606* | 0.184 | *0.655* |

**Figure 3:** Slope and $r^2$ of least squares lines for carbon and nitrogen accumulation data. Slope can be interpreted as retention, as it represents pounds of C or N stored per pound of C or N applied.

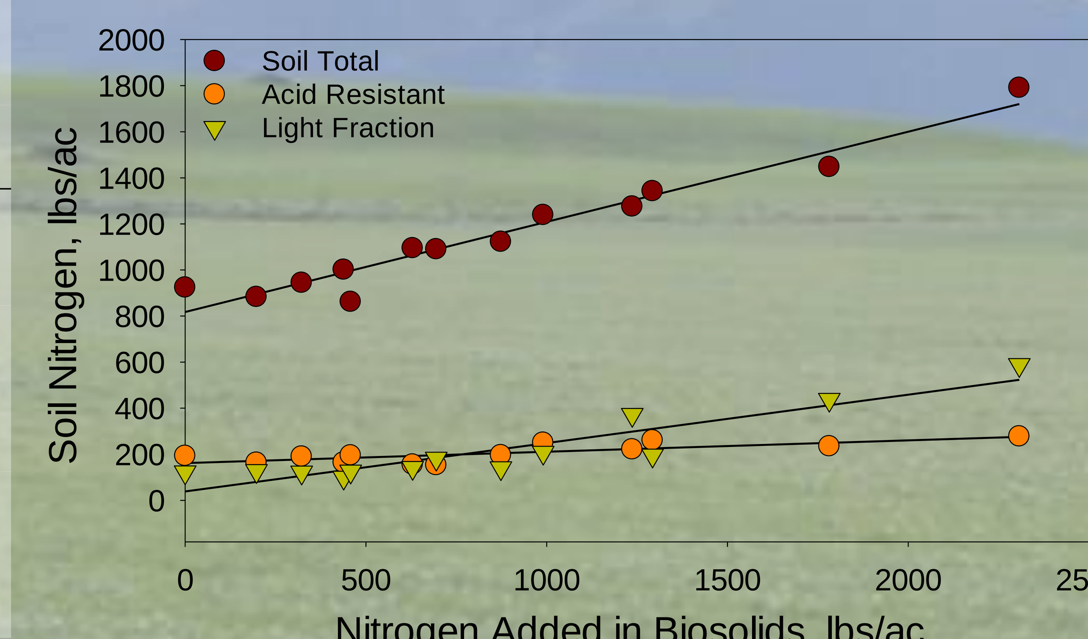


**Figure 4:** Soil nitrogen gains as a function of Mg N added in biosolids.

**Results and Discussion**

Carbon and nitrogen levels in the soil have been positively influenced by the application of biosolids. The greater the application rate, the greater the carbon and nitrogen storage.

When soil C is evaluated as a function of soil N, the relationship is linear with a slope of 12.4 lbs C/lb N, demonstrating that soil carbon pools will not increase unless soil nitrogen pools increase (Figure 1).

***Carbon Fractionation***

The light fraction is generally regarded as a highly labile pool that is sensitive to management, and the acid resistant fraction is thought to be much more stable and less sensitive to management practices. As total carbon increases, carbon in the light and resistant fractions also increase (Figure 2). The accumulation rate for each fraction can be evaluated as the slope of the line through a set of points for amount of nutrient added vs. amount of nutrient stored (Figure 3).

***Nitrogen Fractionation***

Soil nitrogen can be fractionated just as soil carbon is (Figure 4), and illustrates many of the same trends—definite increases in total soil N, and light fraction N, while the recalcitrant pool experiences a much lower rate of increase.

**Conclusion**

Soil C and N accumulation due to application of biosolids in a wheat-fallow system is extremely high, approximately 77% of the C and 35% of N added. Lower soil accumulation of N than C is due to crop N uptake and grain N removal from the system. The light fraction more readily stores new C and N, while the acid resistant fraction is slower to change.

There are unavoidable emissions associated with transporting biosolids 200 miles (400 roundtrip) from Renton to Mansfield, WA. Using EPA values for lifecycle analysis, trucking 1 ton of biosolids emits 262 lbs $CO_2$equivalents ($CO_2$e). In comparison, based on biosolids with a carbon content of 33% and a soil retention rate of 77%, 1863 lbs $CO_2$e are stored in soil carbon for each ton of biosolids applied.

Applying these transport and storage values, along with an additional decrease in emissions when synthetic N fertilizer is replaced by biosolids N, the 50,000 tons of biosolids applied to WW-F land each year have the potential to sequester tens of thousands of tons of $CO_2$e as soil carbon.

**References**

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**The authors thank USDA NIFA Award #2011-68002-30191 (REACCH) for support of this research.**

*Soil analysis done by Yaoyi Xiao as a REACCH intern in summer 2013.*