Soil Organic Matter from Southern Pine Biofuel Feedstocks Under Different Soil Types and Management Systems

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Background & Motivation

- Managed Loblolly pine stands mature in 25-35 yrs., compared to unmanaged stands which can take 50 yrs. to mature[1,2]
- Fertilization, competition control, and thinning are the most beneficial management operations for overall forest yield[2,3]
- Pre-commercial thinning releases over-crowded stands, increases growth of remaining trees, decreases risk of insects and disease[1,4]
- Using pre-commercial thinnings from Loblolly plantations has the potential to deliver sustainable biofuels by reducing our dependence on fossil fuels and lowering CO_2 emissions.

How does this maximized management, i.e. higher thinning and fertilizer and herbicide inputs, affect soil carbon stocks?

Experimental Design

Used a pre-existing experimental research study (Western Gulf Culture Density Study) established in 2000-2003 and managed by the Plantation Management Research Cooperative in Athens, GA

12 sites sampled, representing 4 soil types:

- Poorly-drained vs. well-drained
- Shallow vs. deep restrictive layer

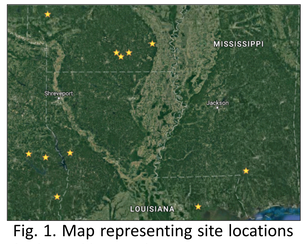


Fig. 1. Map representing site locations (indicated by stars)

6 Treatments at each site:

2 Silvicultural Regimes

- Intensive (standard management)
- Maximum: ↑ fertilization, + competition control

3 Thinning Intensities

- 700 trees/acre (TPA, no thin) ; 450 TPA and 200 TPA

4 Replicate cores taken per treatment

Soil Sampling

- **1m deep soil cores** (separated by depths 0-15cm, 15-30cm, 30-50cm, 50-100cm) taken per plot
- **Bulk soil (0-15cm) separated into DOM and primary soil organic matter fractions**

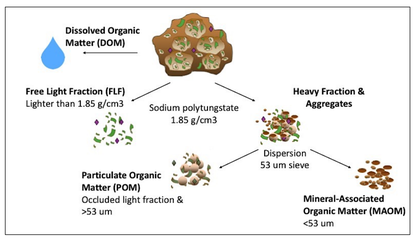
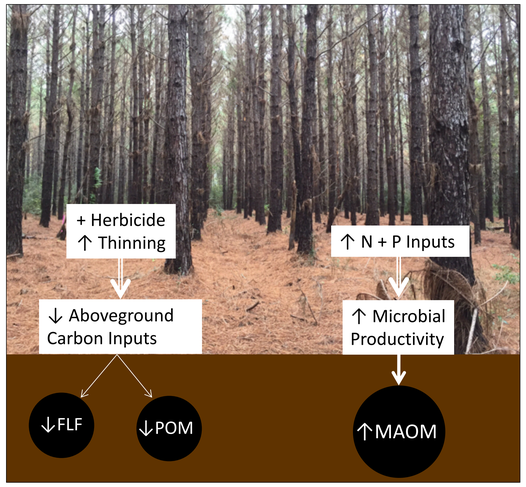


Fig. 2. Soil fractionation scheme

Fig. 3. Pictures of soil coring and processing in the field

Hypotheses

Plantations with maximized management will have lower soil C stocks than plantations with less intensive overall management,



in well-drained soils compared to poorly-drained soils,

in soil fractions that are not mineral-associated.

MAOM will increase as a result of higher nutrient availability

Fig. 4. Conceptual diagram of hypothesized effect of maximized management on soil C stocks and SOM fractions

Results

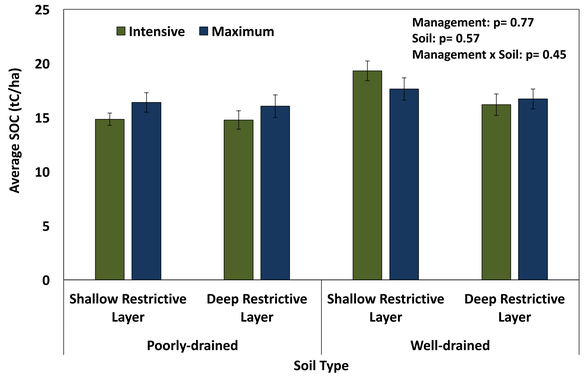


Fig. 5. Average total soil carbon stocks (tC/ha), comparing soil types and silvicultural regimes, averaged across thinning intensities.

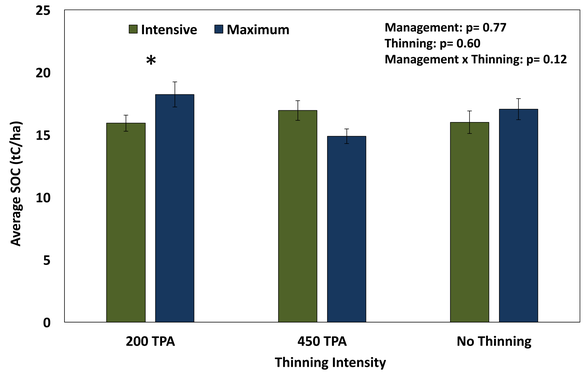


Fig. 6. Average total soil carbon stocks (tC/ha), comparing thinning intensities and silvicultural regimes, averaged across soil types. Asterisk denotes significant increase in SOC in the maximum management compared to the intensive management in the 200 TPA thinning treatment.

Results

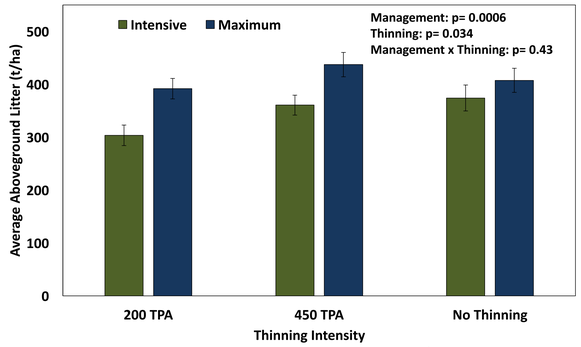


Fig. 7. Average aboveground litter dry weight (tons/ha) comparing silvicultural regimes and thinning intensities, averaged over soil types.

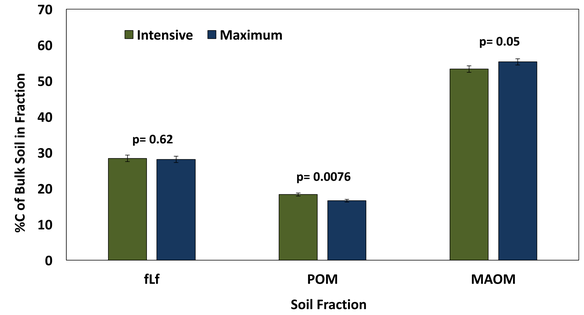


Fig. 8. Average proportion of C in each fraction, comparing silvicultural regimes, averaged across thinning intensities and soil types.

Conclusions

- **Increased management shows trends in increased bulk soil C stocks, however not significantly so far (Figs. 5 and 6)**
- **Fertilization/herbicide management :**
  - **Increased aboveground litter production (Fig. 7)**
  - **Increased the proportion of C in the MAOM fraction (Fig. 8)**
  - **Decreased the proportion of C in the POM fraction (Fig. 8)**

These poor quality soils are most productive with high fertilizer inputs, which may also increase microbial efficiency and MAOM formation

Literature Cited

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