Soil Organic C, SON and SOP of Sandy Soils As Affected by Intensive Loblolly Pine Management in SE U.S.

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Importance of Southern Pine Ecosystems for SOC Storage

- More than 12 and 5.3 million ha in loblolly and slash pine respectively (Neary et al 1990).
- 5.8 million hectares of Spodosols in the southeastern U.S.
- 70 Mg C y^{-1} accumulated in secondary forests of SE U.S. (Richter et al. 1995).

Storage and Protection Mechanisms of SOC

- Total Storage – Increase in total SOC
- Long-term storage – Increase in protected SOC

- Protection mechanisms
  - Chemical: Sorption onto clay
  - Physical: Macro and micro-aggregates
  - Bio-chemical: Chemical recalcitrance

Sandy Soils of the Southeast and SOC Storage

- Chemical protection
  - Low clay; 2-5%
- Physical protection
  - Macroaggregation is weak
  - Microaggregation is unknown

Sandy Soils of the Southeast and SOC Storage

- Biochemical protection
  - Litter-fall of pine is acidic and high in polyphenols

- High accumulation of forest floor C (Johnson and Todd, 1992) and slow accumulation of soil C (Schlesinger 1990, 1991)

Carbon Accumulation in Pine Ecosystem

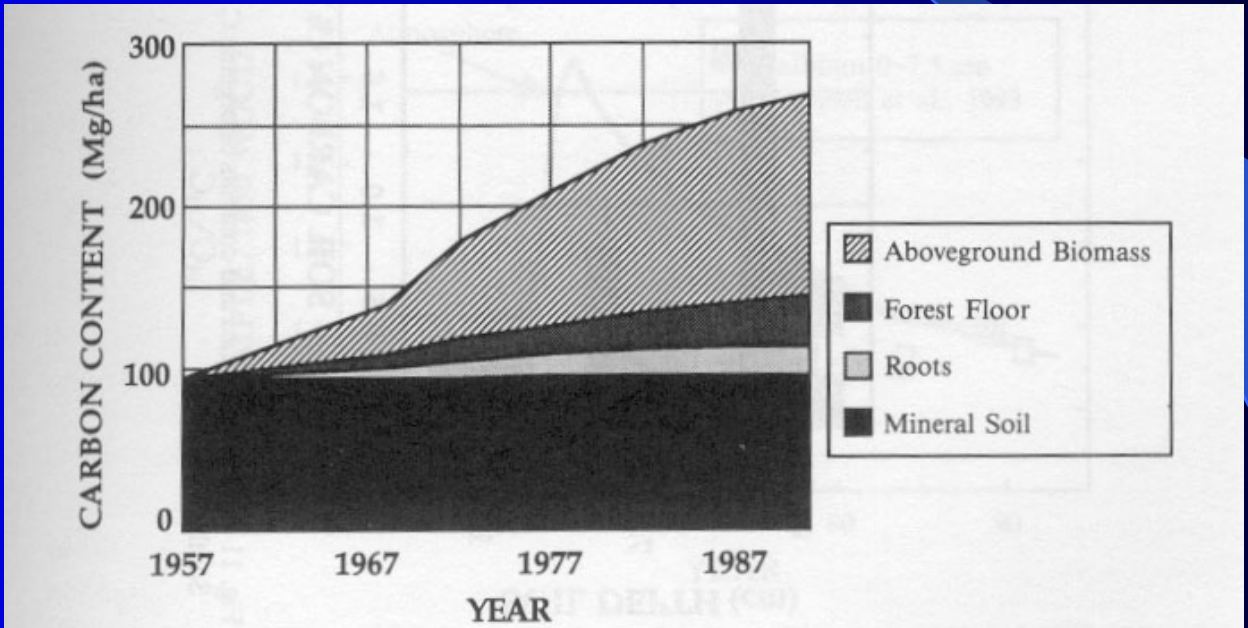


Fig. 11–2. Accumulation of C over 28 yr in a loblolly pine ecosystem in the Calhoun Experimental Forest, South Carolina.

(Richter et al. 1995)

Intensive Management

- Site preparation and bedding
- Application of complete fertilizer
- Sustained weed control

Effects of Intensive Management

- Increase in litter input
- Decrease in weed biomass
- Decrease in root mortality and fine root biomass?

Effects of Intensive Management

- Increase in mineralization potential
  - Fertilization decreased litter polyphenols by 17% (Polglase et al 1992)
  - Weed control increased polyphenol content of foliage by 48%

Effects of Intensive Management

- Changes in SOC of -30 % to +100% have been reported

  (Laiho et al 2003, Johnson and Curtis 2001, Shan et al 2001, Harding and Jokela 1994)

- Initial investigations have shown a 9% to 69% increase in the 0-5 and 5-10 cm depths in the >2mm fraction

SOM Fractionation

- Size fractionation
  - Sand size OM (Macro OM)
  - Silt and clay size OM
- Density fractionation
  - Light fraction
  - heavy fraction

Active Fractions

- Higher contents of C and N
- Lower protection
- Higher mineralization rates (Romkens 1999, Gregorich et al. 1994)
- Important for nutrient supply
- e.g Light fraction, Macro OM

Passive Fractions

- Higher recalcitrance
- Longer turnover periods
- Important for long term storage of carbon in the ecosystem
- e.g. Heavy fraction and silt size fraction

Importance of Organic N and P

- Forested Spodosols are generally deficient in both N and P
- The bioavailability of N and P in surface soils is controlled by mineralization
- Intensive management can alter mineralization by influencing the distribution of N and P in different fractions (Polglase et al. 1992; Grierson et al. 1997)

Objectives

- Adapt methods for characterization of SOC, SON and SOP in sandy soils using size-density fractionation and mineralization

- Investigate the SOC, SON and SOP changes due to intensive management
  - Low vs. high intensity fertilization and weed control
  - Genotype influences
  - Planting density

Hypotheses

- Carbon size-density characteristics
  - **H1:** The light density fraction of all size classes is the active fraction, with higher N, P concentrations and greater mineralizability
  - **H2:** The > 150 micron light fraction is most active

Hypotheses II

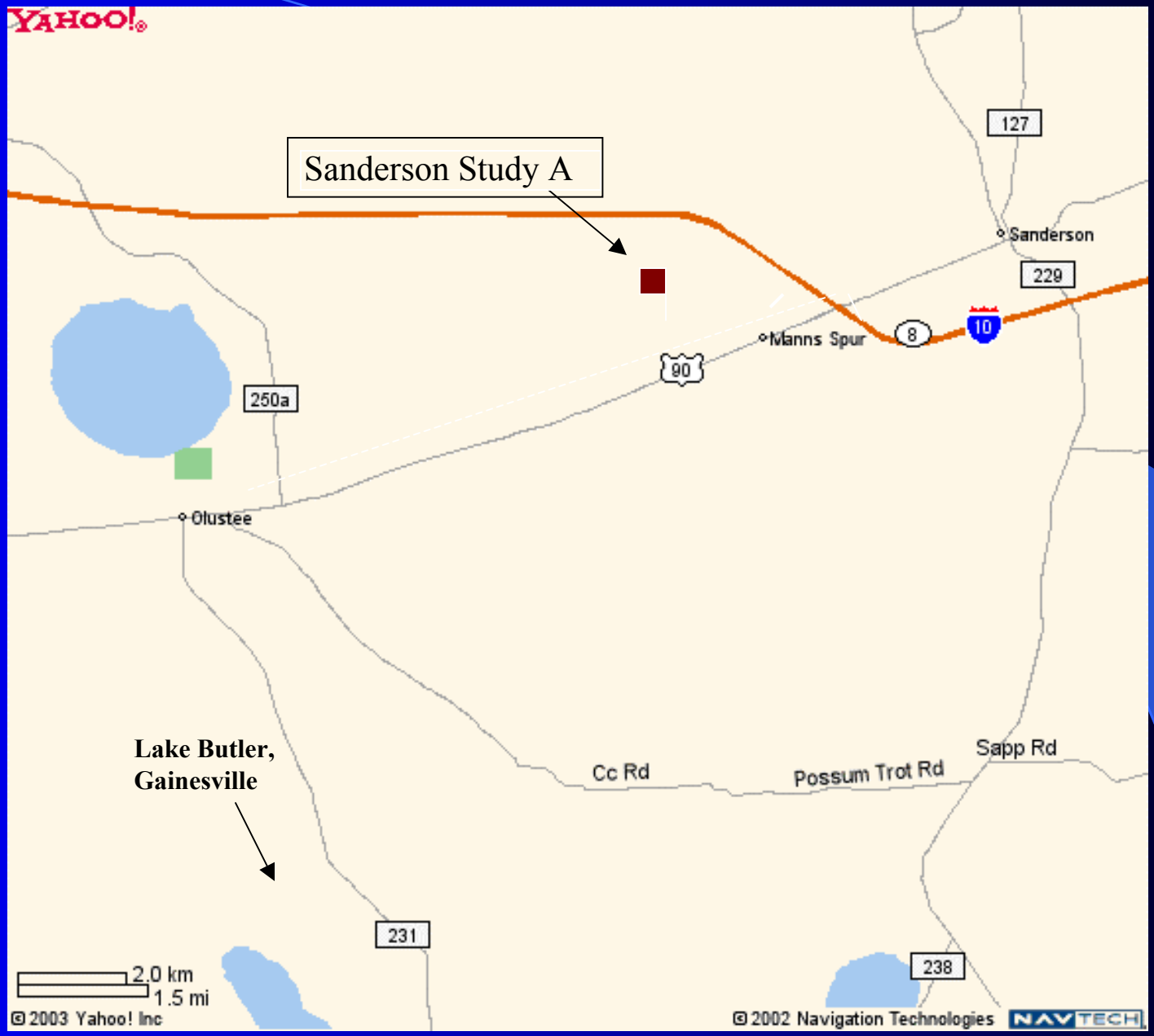
- Carbon changes with management intensity

  - **H3:** High intensity management results in higher proportion of active SOC (whole soil basis)
  - **H4:** The passive fractions are not affected by management intensity
  - **H5:** The genotype 756 produces more litterfall of better quality
  - **H6:** The soil under 756 contains higher C, N and P concentrations, hence more active SOC

Experimental Site

- A loblolly pine study owned by International Paper Company and managed by the Forest Biology Research Cooperative; a part of SFRC.

- The variables are management intensity, planting density and genotypes.



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Methods

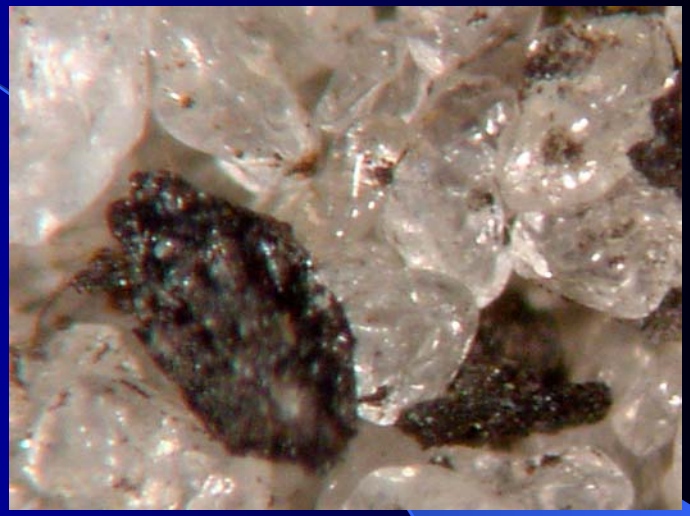
- Size-Density Fractionation
  - Sieving, sonication and density separation (Meijboom et al, 1995; Cambardella and Elliot, 1993)
- Chemical Characterization
  - C, N, P
  - Polyphenols
- Mineralization potential of fractions
  - Lab incubation (Zibilske 1994)
  - Permanganate oxidation (Blair et al, 1995)

Interpretation

- Physically protected SOC
  - Size fractionation; sonication
- Chemically protected SOC
  - Size and Density fractionation
- Biochemically protected SOC
  - Size-density fractionation; polyphenol content, mineralization potential

Methods Evaluation

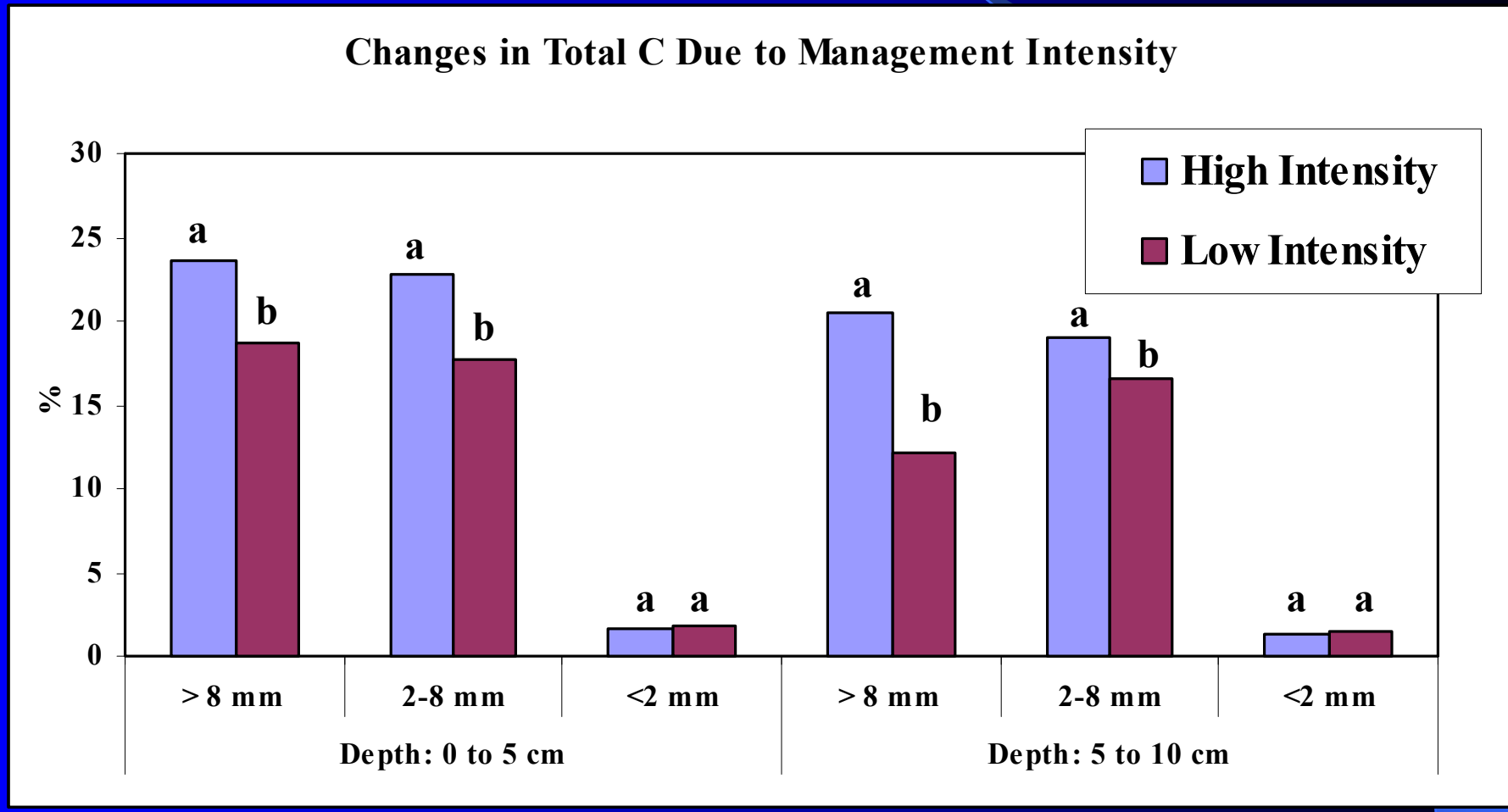
Dry Sieving



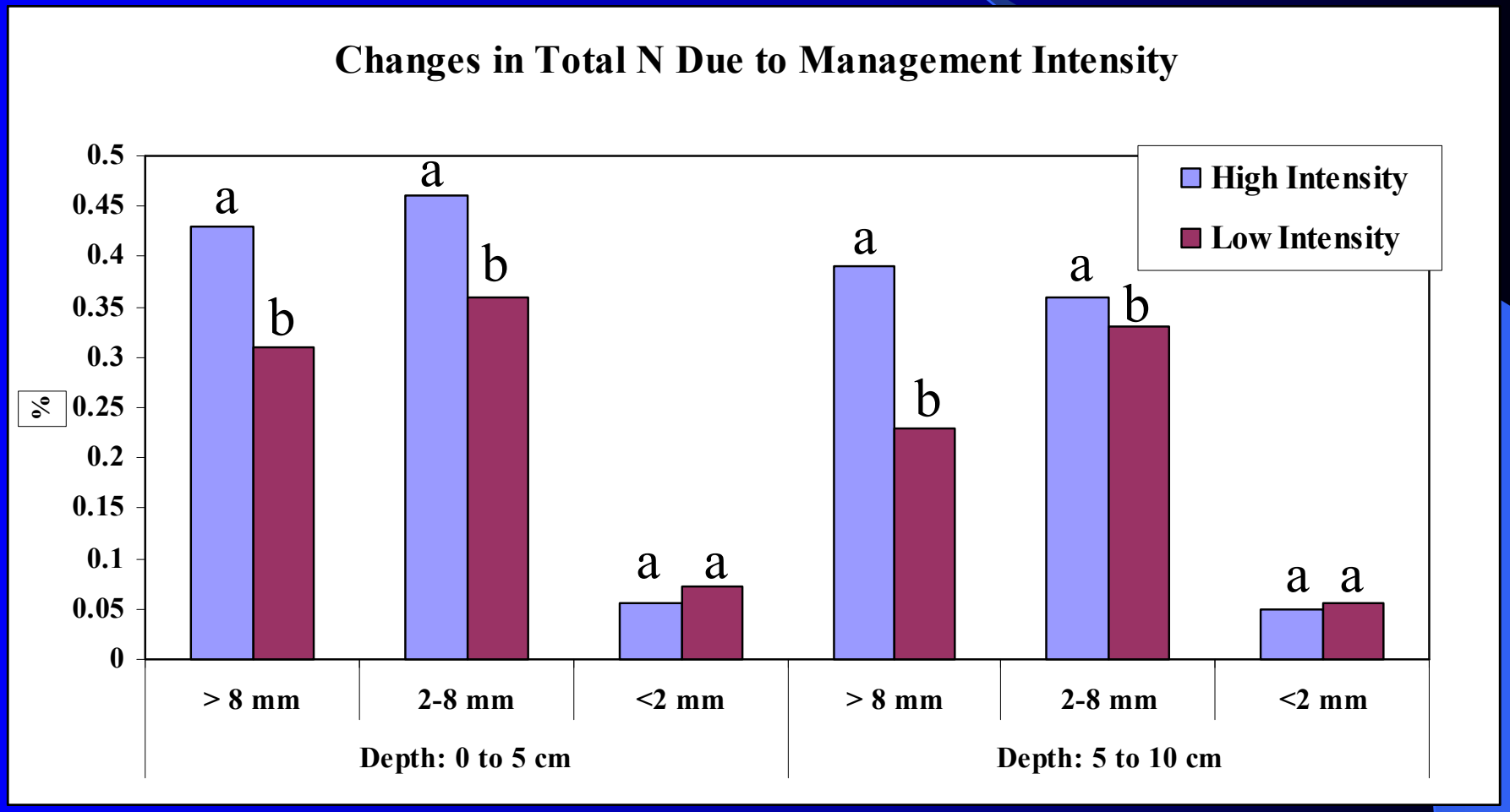
Wet Sieving

Sonication

Effect of Management Intensity I



Effect of Management Intensity II



To Summarize..

- Profile of SOM with associated N and P
- Effect of management on SOM quality in terms of
  - Nutrient supply
  - Long term C storage

Thank you!