Agroforestry for a climate-smart agriculture – a case study in France

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Introduction

- Agroforestry systems are agroecosystems associating trees with farming practices. They provide a variety ecosystem services whilst maintaining a high agricultural production
- Trees store carbon into their biomass but also produce an important amount of fresh organic matter that could enhance soil organic carbon (SOC) stocks
- Rarely been studied in Mediterranean climate and mainly in topsoil layers

Objectives of the study

➢ Quantify all organic inputs (leaf litter, fine roots, etc.) to soil

➢ Quantify and spatialize SOC stocks plot to 2 m soil depth

➢ Assess effect of agroforestry on SOC fractions

Study site

- Silty and carbonated Fluvisol
- Hybrid walnuts (*Juglans regia* × *nigra*) planted in 1995. Current density is 110 trees ha^{-1}
- Durum wheat (*Triticum turgidum* L. subsp. *Durum*) sown in the inter rows and in the agricultural control plot

Materials and methods

Organic inputs

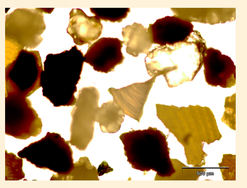
- Two pits 150 cm deep + 1pit 400 cm deep pit in the agroforestry plot
- Fine root densities: mapping
- Fine root turnover: 16 minirhizotrons installed 0, 100, 250 and 400 cm deep
- Leaf litter: four walnut trees packed with a net
- Natural vegetation in the tree rows: sampling of aboveground and belowground biomass

SOC stocks

- ≈ 100 soil cores sampled in both plots to 2 m soil depth
- SOC contents estimated using field visible and near infrared spectroscopy
- Bulk densities measured for each soil core
- SOC carbon stocks calculated on an equivalent soil mass basis
- Spatial distribution of SOC stocks studied using geostatistical methods

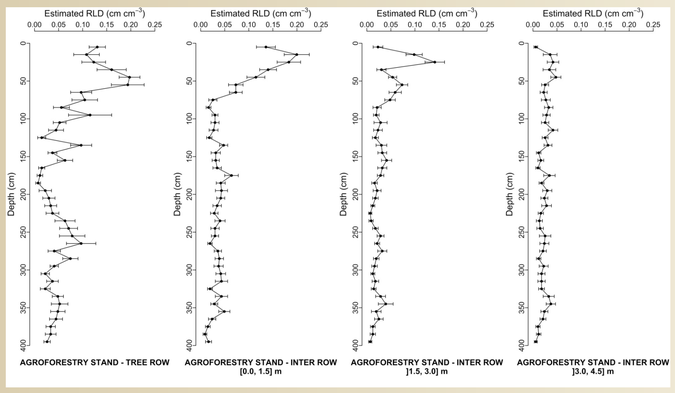
SOC fractions

- Particle-size fractionation performed at four depths: 0-10, 10-30, 70-100 and 160-180 cm



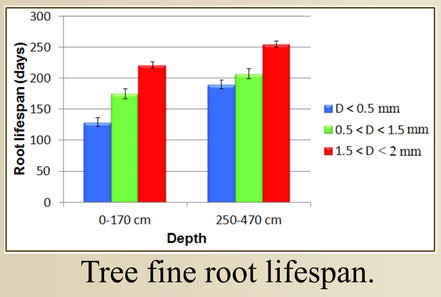
Results

- Tree fine root density: tree row > inter-row
  ➘with incresing distance from the tree



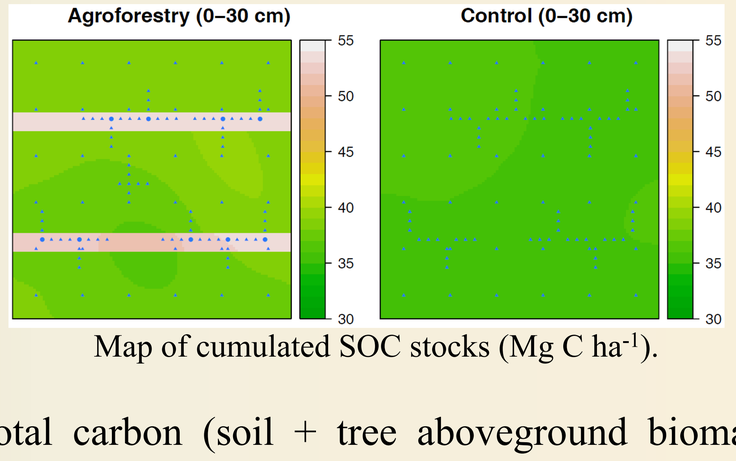
Tree root length density in the agroforestry.

- Root **lifespan** ↗ with increasing **depth** and fine root diameter



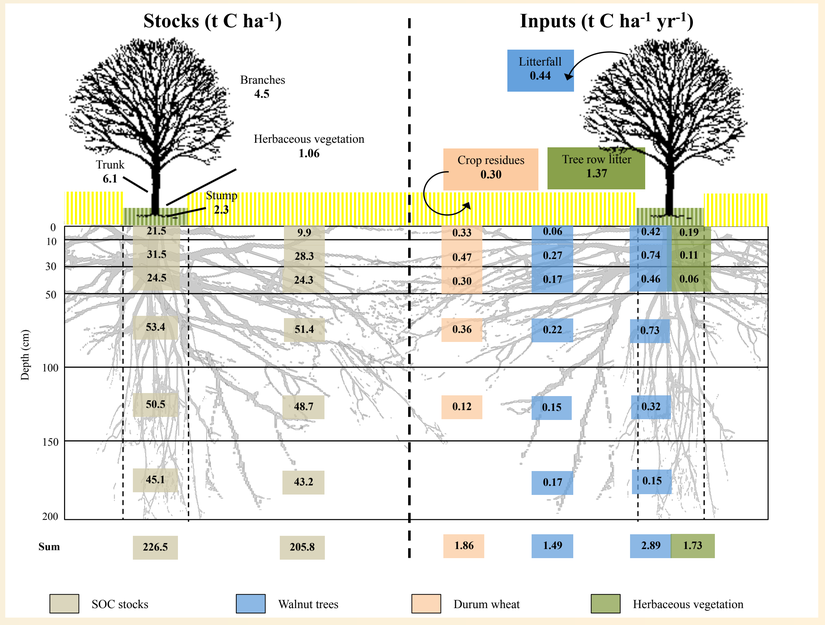
Tree fine root lifespan.

- Additional SOC storage rate was **350 ± 88 kg C ha^{-1} yr^{-1}** at 0-100 cm
- ≈ 75% of additional SOC was located at 0-30 cm
- **Tree rows** > 50% of additional SOC storage



Map of cumulated SOC stocks (Mg C ha^{-1}).

- Total carbon (soil + tree aboveground biomass) storage rate was **1.11 ± 0.16 Mg C ha^{-1} yr^{-1}**
- Most additional SOC was made of **particulate organic matter** (>50 µm)



SOC stocks and organic carbon inputs in an agroforestry system.

- Organic C inputs to the soil **increased by 30%** in the agroforestry plot compared to the control plot in 0-200 cm

Conclusion

Agroforestry systems are an efficient practice to enhance SOC stocks in agricultural lands and contribute to climate change mitigation

References

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