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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

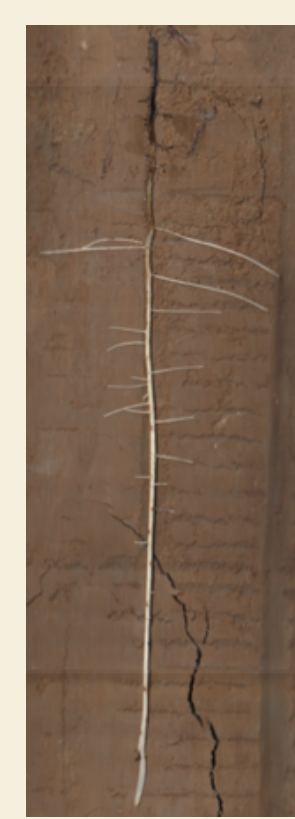
- Silty and carbonated Fluvisol
- Hybrid walnuts (*Juglans regia* × *nigra*) planted in 1995. Current density is 110 trees ha⁻¹
- Durum wheat (*Triticum turgidum* L. subsp. *Durum*) sown in the inter rows and in the agricultural control plot



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



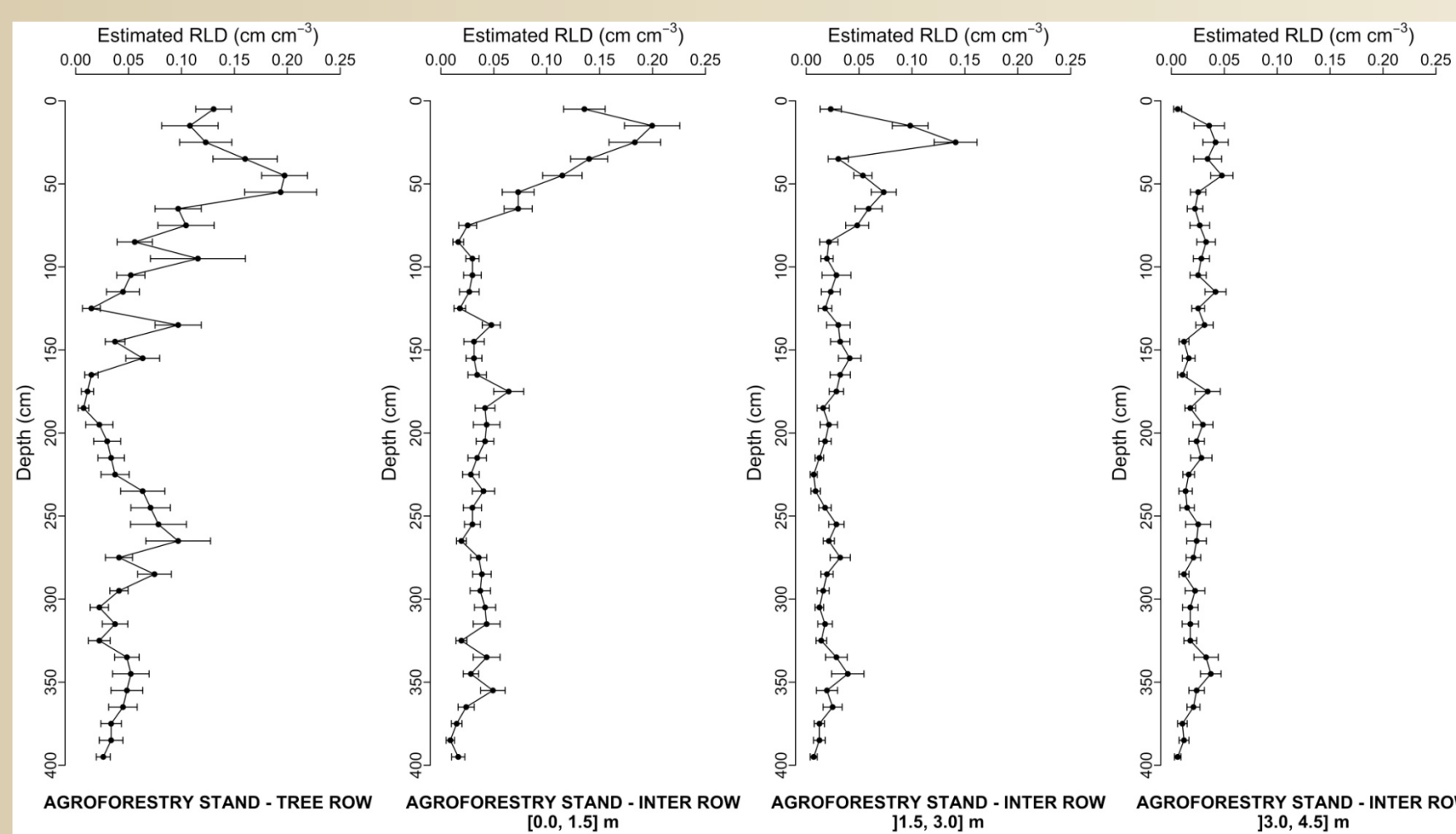
SOC fractions

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



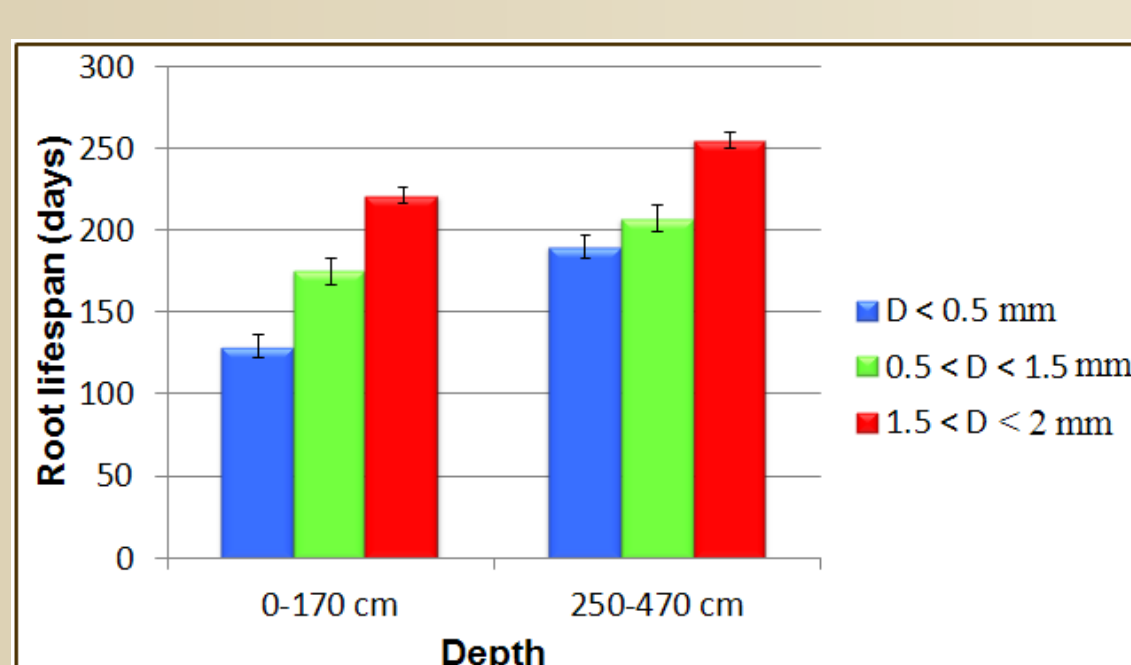
Results

- Tree fine root density: tree row > inter-row
➡ with increasing distance from the tree



Tree root length density in the agroforestry.

- Root lifespan ➡ with increasing depth and fine root diameter

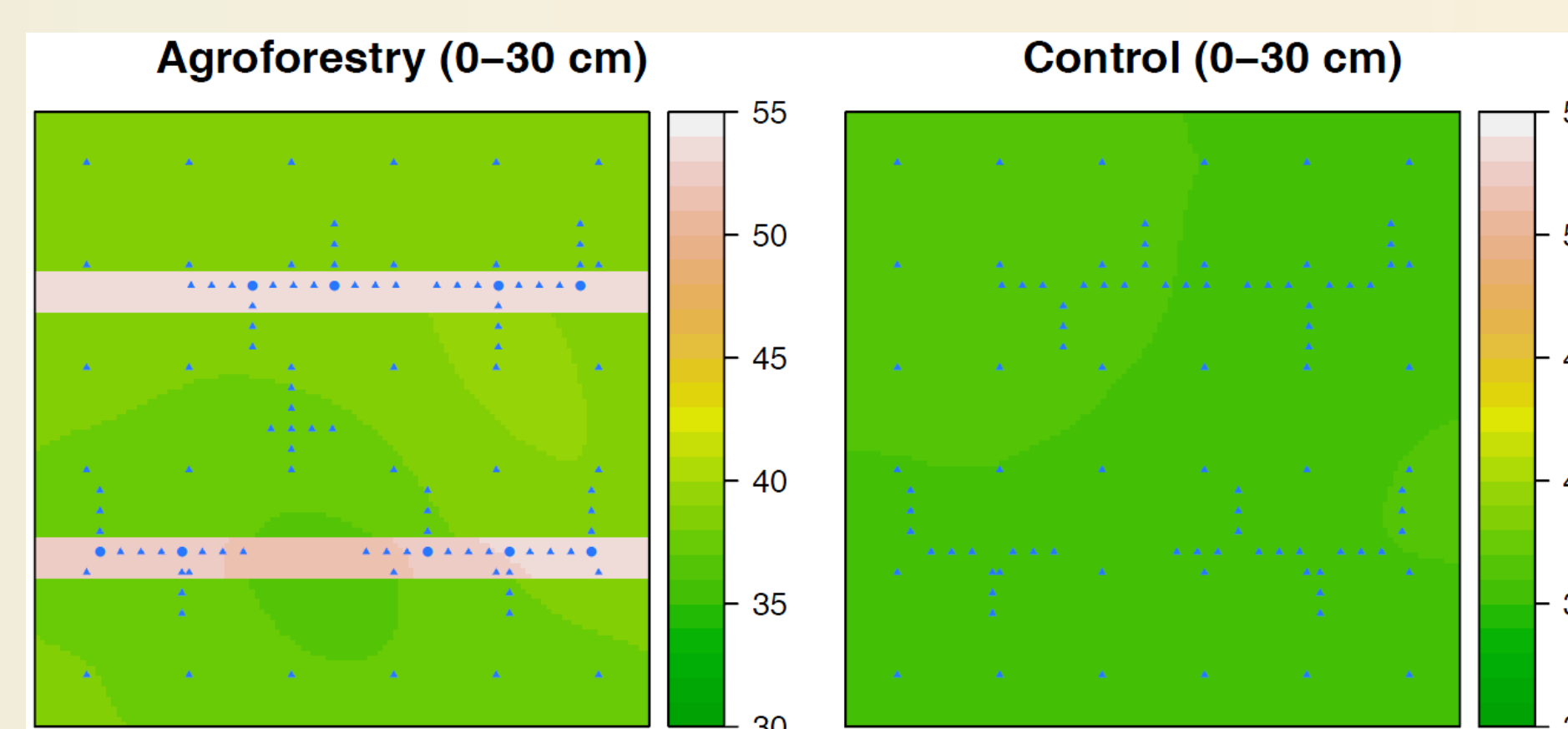


Tree fine root lifespan.

- Additional SOC storage rate was $350 \pm 88 \text{ kg C ha}^{-1} \text{ yr}^{-1}$ at 0-100 cm

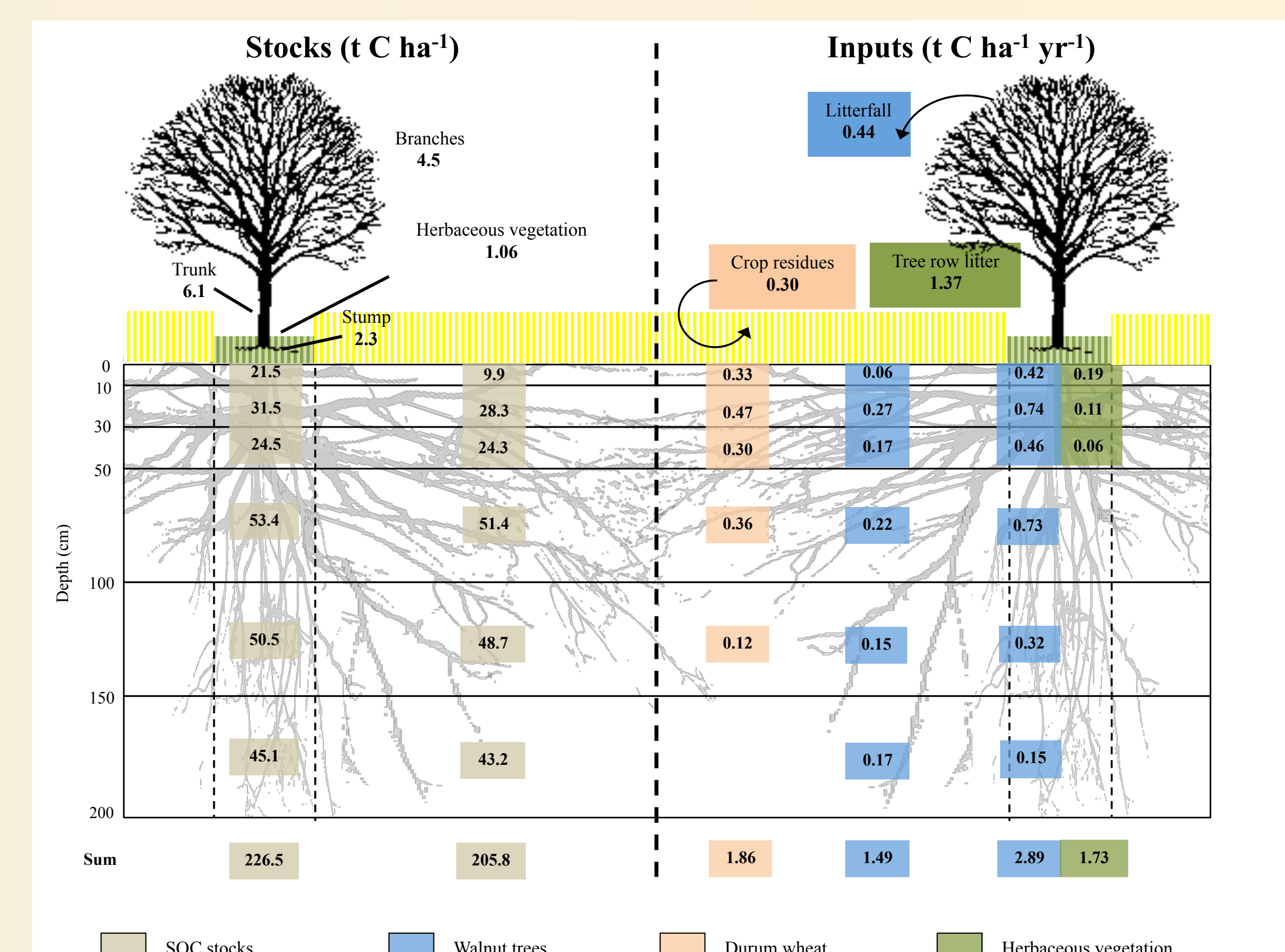
- ≈ 75% of additional SOC was located at 0-30 cm

- 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 $1.11 \pm 0.16 \text{ Mg C ha}^{-1} \text{ yr}^{-1}$
- 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

Cardinael R, Mao Z, Prieto I, Stokes A, Dupraz C, Kim JH, Jourdan C, 2015. Competition with winter crops induces deeper rooting of walnut trees in a Mediterranean alley cropping agroforestry system. Plant & Soil (in press)

Cardinael R, Chevallier T, Barthès BG, Saby NPA, Parent T, Dupraz C, Bernoux M, Chenu C. Impact of agroforestry on stocks, forms and spatial distribution of soil organic carbon. Geoderma (submitted)