Carbon sequestration in traditional, high-density, and super high-density fig (*Ficus carica* L.) production systems in Extremadura (Spain).

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INTRODUCTION

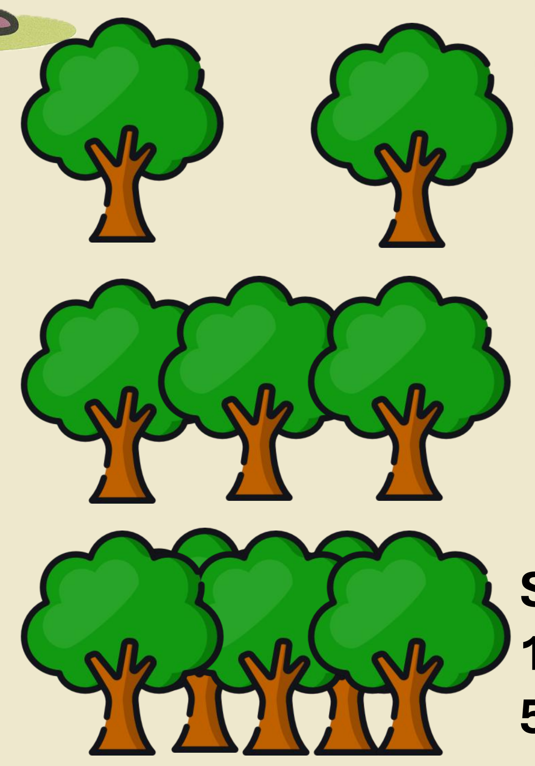
In the context of climate change and rising greenhouse gas emissions, Mediterranean agriculture plays a key role as a carbon sink, with perennial woody crops storing CO_2 in their biomass. Among them, the fig tree (*Ficus carica* L.), traditionally cultivated in the region, stands out not only for its economic and cultural relevance but also for its capacity to sequester carbon. Extremadura (Spain), one of the European Union's leading fig-producing areas, features diverse orchard systems ranging from traditional low-density plantations to modern high- and super-high-density models.

OBJECTIVE

To evaluate the carbon sequestration potential of fig orchards in Extremadura (Spain) under different management systems (traditional, high-density, and super-high-density)

MATERIALS AND METHODS

3 FIG ORCHARDS



Traditional 204 trees/ha 13 years

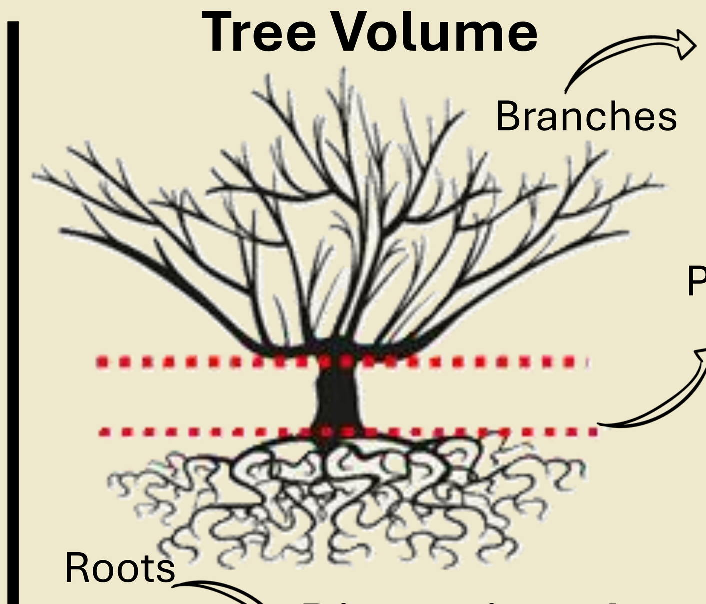
High density 400 trees/ha 7 years

Super high density 1200 trees/ha 5 years

In each plot, three areas were sampled depending on the vigour of the fig trees: Optimal, Medium, Low X 3

Measurements

Tree Volume



Modelling as cylindrical sections

Dimensioned according to: Galan et al., 2025

Wood density
- Oven-drying
- Weighing
- Water displacement by volume

Thermo Finnigan 1112 EA elemental analyser

% Carbon in wood

CARBON x 3,67 → CO_2 equivalent

RESULTS

Tree development (optimal, medium, low) strongly influenced structural and carbon-related parameters within each production system (Table 1). In the traditional system, tree volume ranged from 0.137 m³ in optimally developed trees to 0.075 m³ in low-vigour trees, with corresponding differences in dry wood weight (91.49 and 54.90 kg). Similar decreasing trends with lower vigour were observed in the high- and super-high density orchards.

Table 1. Carbon storage in fig orchards under different planting systems.

System	Development	Tree volume (m3)	Dry wood density (kg/m3)	Dry wood weight (kg)	Carbon content (kg C tree^{-1})	CO_2 equivalent per Tree (kg CO_2e)	CO_2 equivalent per Hectare (t CO_2e ha^{-1})
Traditional (204 trees/ha)	Optimal	0.137	667.3	91.49	37.019	135.86	27.7
	Medium	0.108	705.7	76.19	30.826	113.13	23.1
	Low	0.075	733.0	54.90	22.213	81.52	16.6
	Average	***0.107***	***702.0***	***74.87***	***30.294***	***111.18***	***22.7***
High density (400 trees/ha)	Optimal	0.069	735.5	50.88	20.587	75.55	30.2
	Medium	0.040	718.0	28.91	11.696	42.93	17.2
	Low	0.033	692.8	23.14	9.362	34.36	13.7
	Average	***0.048***	***715.4***	***34.06***	***13.783***	***50.58***	***20.2***
Super high density (1200 trees/ha)	Optimal	0.015	658.1	10.20	4.126	15.14	18.2
	Medium	0.009	666.2	6.25	2.529	9.28	11.1
	Low	0.007	685.9	4.73	1.913	7.02	8.4
	Average	**0.011**	**670.1**	**7.10**	**2.871**	**10.54**	**12.6**

Wood density remained relatively stable among systems, ranging from 670.1 kg/m³ in the super-high density orchard to 715.4 kg/m³ in the high-density system. The average carbon concentration in fig wood was 40.46%.

Carbon storage per tree varied according to vigour, with optimally developed traditional trees storing 37.0 kg C tree^{-1} (135.9 kg CO_2eq tree^{-1}), compared with only 22.2 kg C tree^{-1} (81.5 kg CO_2eq tree^{-1}) in low-vigour trees.

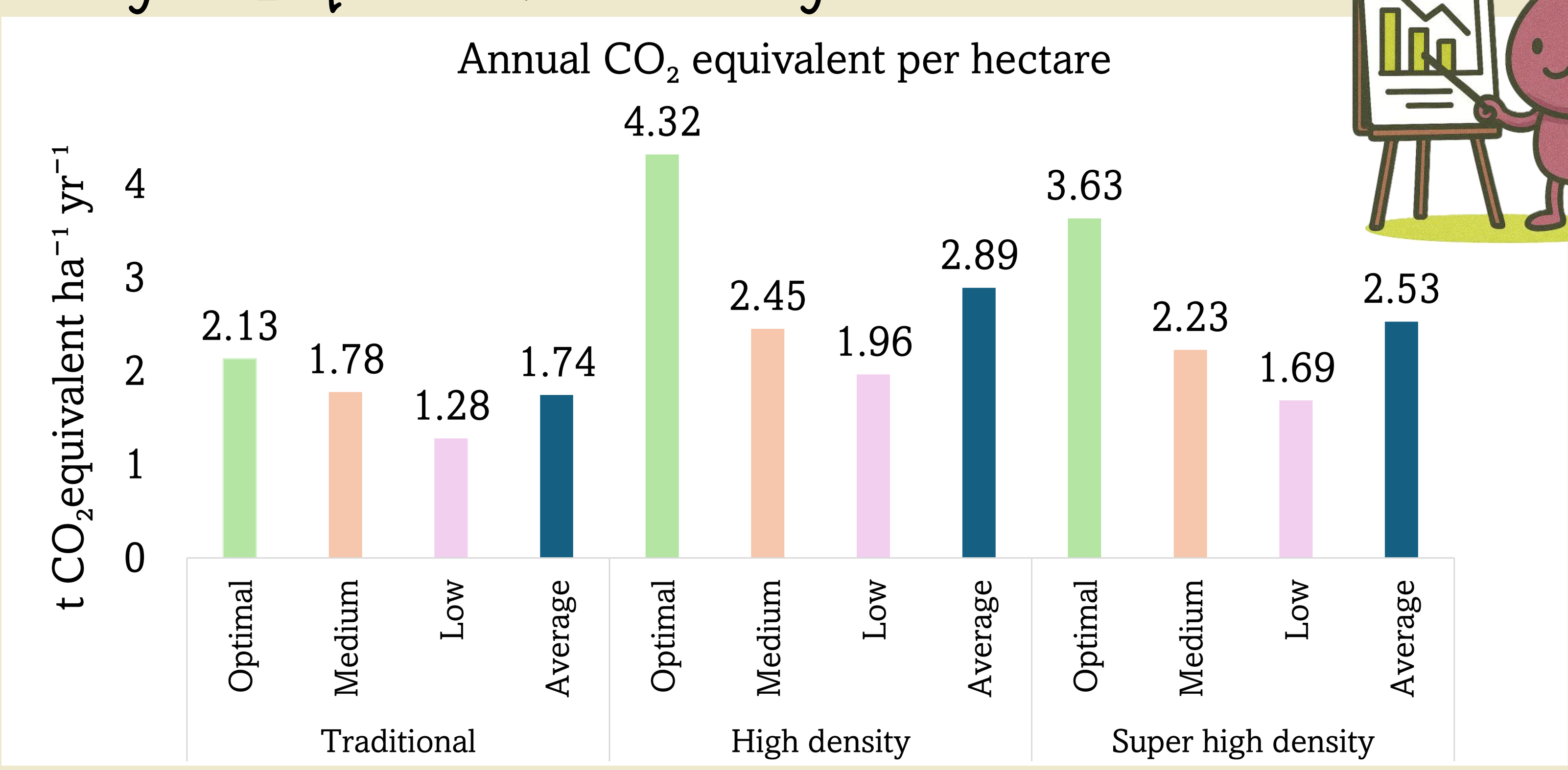


Figure 1. Annual CO_2 sequestration per hectare in fig orchards.

The high-density system showed the highest average annual CO_2 storage rate, with 2.89 t CO_2eq ha^{-1} yr^{-1}, followed by the super-high density system with 2.53 t CO_2eq ha^{-1} yr^{-1}, and the traditional system with 1.74 t CO_2eq ha^{-1} yr^{-1}. At the extremes, optimal trees in the high-density orchard reached 4.32 t CO_2eq ha^{-1} yr^{-1}, while low-vigour trees in the traditional system stored only 1.28 t CO_2eq ha^{-1} yr^{-1}.

CONCLUSIONS

Considering the different levels of tree development within each system is essential when evaluating carbon sequestration. Planting density also influences sequestration per hectare, although not in a strictly linear way, since super high density orchards stored less than high density ones. Overall, fig orchards contribute to climate change mitigation and add environmental value to Mediterranean fruit crops.

Galán, A. J., Marques da Silva, J. R., & López Corrales, M. (2025, 9–12 de junio). *Póster: Absorción de CO_2 por el cultivo de la higuera* [Póster]. XVIII Congreso Nacional de la Sociedad Española de Ciencias Hortícolas (SECH 2025), Valencia, España. Sociedad Española de Ciencias Hortícolas.

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