

Silvoarable system in Puig-Reig (Barcelona): diversifying cereal production with valuable broadleaves.

Silvoarable Systems.



Figure 1. Aerial image of silvoarable system in Can Pallot (Puig-Reig, Barcelona province)
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Figure 2. Rows of valuable broadleaves (Hybrid walnut and Common ash) intercropped with cereals in Can Pallot (Puig Reig).
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/// Context ///

Agroforestry systems are the deliberate combination of woody vegetation with agricultural or livestock production to obtain benefits from their interactions. Among them, silvoarable systems combine crops with woody vegetation, which can be arranged in the field perimeter, in rows (alley-cropping), in groups or dispersed, and can serve multiple yet compatible purposes:

- Production (timber, fruit, forage, mushrooms)
- Protection (biodiversity, soil, water, animal welfare, windbreak)
- Landscape improvement

Silvoarable systems offer many benefits compared to conventional cropping:

- Increase in overall productivity, thanks to the complementarity in using light, water and nutrients in time

- (different phenology) and space (vertical overlapping)
- Soil protection against erosion, and water protection thanks to leachates filtering
- Improved biodiversity: system diversification, ecotones creation, restoration of trophic chains
- Improvement of the crop microclimate: buffered temperatures, less wind exposure
- Increased C fixation in soil and in timber

The silvoarable demonstration system at Can Pallot farm was implemented in 2014 under LIFE Farms for the Future (futuragrari.cat/16) and is currently being monitored under LIFE AgroForAdapt (agroforadapt.eu). It combines winter cereals with rainfed walnut and ash for valuable timber production. Overall tree mortality is 24%, with average diameter growth of 0.5 cm/year. No relevant interactions between trees and crops have been observed so far.

/// Solution for a Resilient Future ///

The Can Pallot farm in the municipality of Puig-Reig (Barcelona province) is located at the coordinates: 41.981309, 1.917696, with an area of 1.5 hectares. This system consists of an alley cropping system, with 3 rows composed of various arrangements of hybrid walnut and Common ash, intercropped with winter cereals (rotation of wheat, barley and oat), in a 18 x 4 m or 18 x 2.5 m frame (Figures 1 and 2). We are using two different frames to assess their effect on various ecosystem services, including production, leachates filtration and improvement of the microclimate.

The main physical and climatic features are:

- Mean altitude: 470 m
- Average slope: 9%
- Aspect: southeast
- Physiographic position: valley floor – lower slope
- Classification of climate (Papadakis): Mediterranean temperate

- Average annual temperature [coolest month; hottest month]: 12.7°C [3.5°C; 21.5°C].
- Annual [summer] rainfall: 675 mm [190 mm].

Soil characterisation:

- Soil classification (WRB): Eutrophic Leptosol (LP-eu) on sandstone and shale (W7a).
- Base geology: Marls, siltstones and gravels with intercalated conglomerates
- Texture (USDA): Loamy-sandy (19% clay, 24% silt, 57% sand)
- pH: 8.3
- Organic matter: 2.0%
- Other relevant soil data: 31% carbonates; 19% stoniness.

Before tree planting, the land was cultivated with rainfed winter cereals (wheat, barley and oat).

The tree plant material, both aimed for valuable timber production, is:

- Hybrid walnut (*Juglans x intermedia* Mj-209xRa) sized 40-60 cm bare rooted.
- Common ash (*Fraxinus excelsior*) in a 300 cm³ container.

The soil preparation method was mechanised pit digging (40 x 40 x 40 cm). Right after planting, we installed a black polyethylene mulch sized 100 x 100 cm and individual 150 cm high mesh-wall tree shelter. The tending of the trees consist of an annual pruning between the years 1-15.

The main results so far are:

- Common ash: 26% mortality.
- Average diameter at breast height (1.3 m): 4.6 ± 0.2 cm (average growth: 0.5 cm/year).
- Average height: 4.1 ± 0.1 m (average growth: 43 cm/year)



Figure 3. Soil preparation with a backhoe excavator in Can Pallot site.
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- Hybrid walnut: 22% mortality
- Average diameter at breast height (1.3 m): 4.8 ± 0.3 cm (average growth: 0,5 cm/year)
- Average height: $3,3 \pm 0,2$ m (average growth: 31 cm/year)
- Cereal: average production: 2,200-2,800 kg/ha grain; 1,800-2,200 kg/ha straw.

For the moment, we have perceived no clear impact of the trees on crop yield, although the severe drought of the last 3 seasons (2021-23), with long periods of high temperatures and uneven precipitation distribution have reduced tree growth and have made it difficult to extract meaningful conclusions with regard to the crop-tree interactions. We are using two different frames to assess their impact on different ecosystem services, including production, leachate filtration and microclimate improvement.



Figure 4. Common ash with a mesh-walled individual tree shelter in Can Pallot site.
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/// Always Moving Forward ///

Agroforestry systems are identified in the EU Green Deal (and in the Strategies developing it) as an eco-intensification practice to be promoted in order to address simultaneously climate change adaptation and mitigation, biodiversity conservation and diversifying farm income. These systems are attracting major interest because of their versatility and compatibility with other agroecology practices (regenerative and conservation agriculture, organic farming...).

However, the shift from monoculture crop farming to silvoarable systems comes at a cost: adding trees to a field requires thorough planning (choice of species, tree

arrangement, planting techniques), an initial investment and a dynamic long-term management, of each component individually and of their interactions, which will evolve over time.

When designing an alley cropping system, an important decision to be taken is the distance between the rows of trees, which must be chosen so that they do not interfere with mechanisation and do not require additional passes; the width of the machinery must therefore be taken into account. A management challenge is to control spontaneous vegetation in the space between two successive trees in a row.

Further information

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Acknowledgment / Contribution

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Authors: Guillem Llena; Jaime Coello – CTFC | **Partner:** CTFC – Forest Science and Technology Centre of Catalonia