



Fire-Resilient Agroforestry & Regenerative Hydrology

Strategies for large private estates, holm oak & pine mosaics, and silvopastoral systems in the Garrotxa

The Garrotxa (and in particular the Alta Garrotxa's nearly 33,000 hectares of protected natural landscape) faces a paradox common across the Mediterranean: the very beauty and ecological richness of its forests make them vulnerable to catastrophic wildfire. Dense *Quercus ilex* woodland mixed with flammable pine stands, steep and often inaccessible terrain, and decades of rural depopulation have created a landscape where fuel loads accumulate unchecked.

In February 2026, the Consorci de l'Alta Garrotxa participated in the technical session "Quan cremara la Garrotxa?" (When will the Garrotxa burn?), convened by the Fundació Pau Costa and the Federació ADFs de la Garrotxa. The session brought together firefighters (GRAF), rural agents, and land managers to define strategic management zones. The message was clear: the question is not *if* the Garrotxa will face a major fire, but *when*, and whether the landscape and its communities will be ready.

This document presents AGECO's approach for private landowners of 20+ hectare properties in the Garrotxa: practical, site-adapted strategies that combine agroforestry, regenerative hydrology, and silvopastoralism to reduce fire risk, generate economic value, and contribute to the collective resilience of the territory.

"The only constant is change. In a landscape shaped by fire, drought, and centuries of human use, our role is not to control nature. It is to design systems that dance with her rhythms while protecting what we value."



The Alta Garrotxa: steep forested valleys, mosaic fields, stone masias, and morning mist.

1. The Garrotxa Fire Landscape

The Garrotxa's terrain presents specific challenges for fire management. Steep, forested valleys with limited road access mean that once fire takes hold, suppression is extremely difficult. The Alta Garrotxa already has a strategic fire prevention infrastructure plan (approved 2023) identifying priority zones (Sant Aniol, la Muga), but the plan's effectiveness depends on active landscape management, not just emergency response.

The fuel problem

- **Quercus ilex (holm oak) forest:** moderate fire resistance if managed, but dangerous when the understory is dense with accumulated litter and scrub.
- **Pine stands (P. halepensis, P. nigra, P. sylvestris):** highly flammable in the resinous canopy. Unmanaged pine forest is the highest-risk element in the landscape.
- **Mosaic fields and abandoned terraces:** historically kept open by grazing and cultivation, now reverting to scrubland, creating fuel continuity where there was once discontinuity.
- **Traditional orchards and small vineyards:** potentially excellent firebreaks if maintained, but often neglected.

The opportunity

For large private landowners, the opportunity lies in **converting a fire liability into an ecological and economic asset**. Strategic thinning of pine stands, restoration of open mosaic landscapes, integration of silvopastoralism, and enrichment planting with fire-resistant species can turn a property from a fire risk into a fire-resilient, productive system, with support from existing institutional frameworks.



Left: unmanaged pine forest with accumulated fuel. Right: managed agroforestry mosaic with open canopy and water retention.

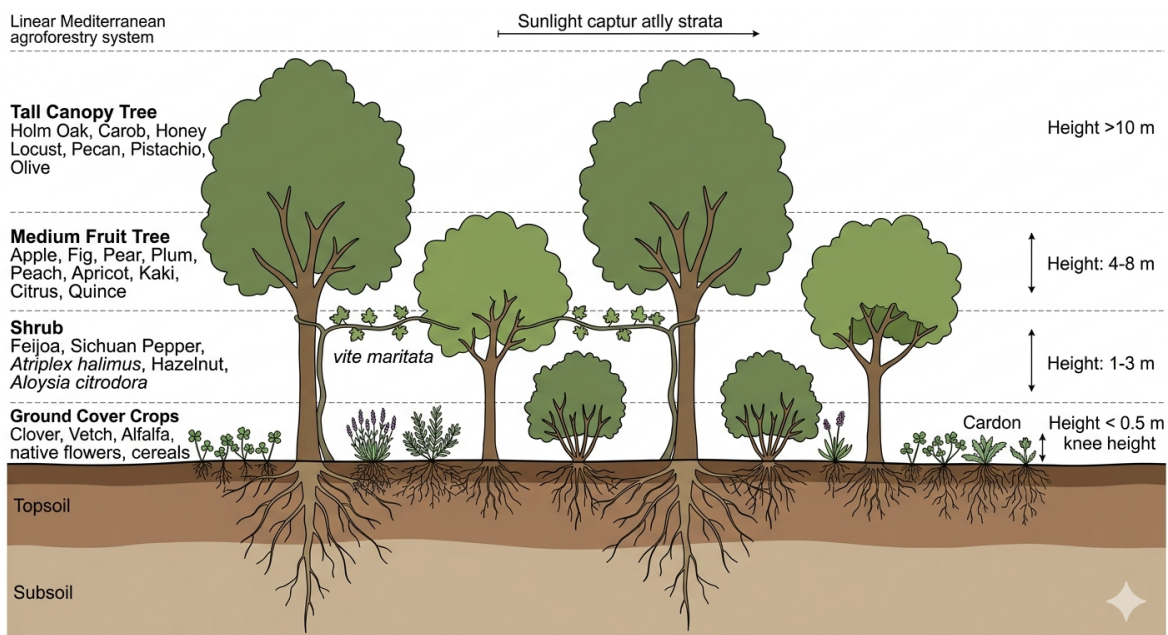
2. Vitiforestry: Fire-Resilient Vineyard Design

Small-scale vineyards are an important part of the Garrotxa's mosaic landscape. While modest in area compared to the Emporda, they play an outsized role in fire prevention: well-managed vine rows create low-fuel corridors that break vegetation continuity. Adding companion trees and aromatic buffers into and around these vineyards strengthens their protective function while generating additional income.

The Garrotxa's cooler, more humid microclimate and volcanic soils call for a different species palette than the coastal Emporda. Here, deciduous fruit trees thrive alongside the vines, and the higher rainfall supports a denser companion system.

Recommended design elements

| Layer | Species (Garrotxa-adapted) | Function |
|------------------|--|---|
| Canopy trees | Apple, pear, cherry, plum | Windbreak, shade, diversified harvest, deciduous canopy = low summer fuel |
| High-value trees | Quince, kaki, sweet acorn oak (<i>Q. ilex ballota</i>) | Drought tolerance (kaki), fire resistance (oak), high-value fruit, mast for silvopastoral |
| Aromatic buffer | Thyme, lavender, rosemary, sage, comfrey, <i>Phlomis</i> | Fire-resistant barrier, pollinator habitat, comfrey as dynamic accumulator |
| Ground cover | Sainfoin, vetch, alfalfa, sulla, cereals | Living mulch, nitrogen fixation, soil protection, grazing resource |
| Fire barrier | Mediterranean cypress, holm oak | Proven fire-resistant windbreak; high leaf moisture |



Agroforestry layers: tall canopy, medium fruit trees, shrubs, aromatics, ground cover, and vine.

Turnkey budget: Vitiforestry system (per hectare)

Based on 2025/2026 nursery prices (Girona province). Includes access surcharge for difficult terrain typical of Garrotxa properties.

| Item | Detail | Cost (EUR) |
|---------------------------------------|--|--------------|
| PLANT MATERIAL | | |
| Companion trees (100) | Apple, pear, cherry, plum @ EUR10-15 | 1,250 |
| High-value trees (30) | Quince @ EUR10-14, kaki @ EUR12-18 Sweet acorn oak @ EUR8-12 | 390 |
| Aromatic plants (600) | Lavender, rosemary, thyme, sage, comfrey @ EUR1.50-2.50 | 1,200 |
| Cover crop seed | Sainfoin, vetch, alfalfa mix | 80 |
| Perimeter cypress (50) | Cupressus sempervirens @ EUR8-12 | 500 |
| Subtotal plant material | | 3,420 |
| INFRASTRUCTURE & MATERIALS | | |
| Chestnut stakes (180) | 1.5m round @ EUR2.50-3.50 | 540 |
| Tree protectors (180) | Spiral or mesh @ EUR2.50-3.00 | 495 |
| Mycorrhizal inoculant | 130 trees @ EUR0.50 | 65 |
| Basalt rock dust | 500 kg @ EUR0.12/kg | 60 |
| Electric fencing (400 m) | Posts, wire, solar energiser | 1,400 |
| Subtotal infrastructure | | 2,560 |
| SOIL & MULCHING | | |

| | | |
|-------------------------------------|-------------------------------------|---------------|
| Wood chip mulch (BRF) | 20 tonnes @ EUR60-80/t | 1,400 |
| Keyline subsoiling | Tractor + Yeomans ripper | 350 |
| Subtotal soil & mulching | | 1,750 |
| LABOUR & DESIGN | | |
| AGECO design & site audit | Topographic analysis, species plan | 960 |
| Planting labour | 2 people x 4 days @ EUR120/day | 960 |
| Fencing installation | 1 person x 2 days | 240 |
| Access surcharge | Difficult terrain logistics | 300 |
| Subtotal labour & design | | 2,460 |
| TOTAL: TURNKEY (per hectare) | All inclusive, ready to grow | 10,190 |

3. Fire-Resilient Diversified Orchard

The Garrotxa has a long tradition of mixed orchards (apple, pear, cherry, plum, quince) often found on the more accessible terraces and valley floors. These orchards, when maintained, are among the most fire-resistant elements in the landscape: deciduous canopy, managed understory, regular human presence. When abandoned, they become a fire risk.

The AGECO approach restores and enriches these traditional orchards into **multi-functional, fire-resilient systems**: productive (diversified fruit across seasons), protective (fuel discontinuity, windbreak, soil moisture), and regenerative (soil building, carbon sequestration, biodiversity). Adding kaki, quince, and sweet acorn oak creates a layered canopy with harvest windows from June (cherry) through December (kaki, quince).

Key design principles

- **Diversified canopy:** apple, pear, cherry, plum as the productive backbone. Quince and kaki for autumn/winter harvest and drought resilience. Sweet acorn oak for mast and silvopastoral integration.
- **Managed understory:** aromatic plants (rosemary, thyme, sage, comfrey), leguminous cover crops, seasonal vegetables.
- **Silvopastoral integration:** sheep and goat grazing during strategic periods, aligned with the Ramats de Foc model.
- **Boundary buffers:** cypress, holm oak, elderberry, hawthorn, blackthorn hedgerows where the orchard borders forest.



Garrotxa diversified orchard: mature apple and pear trees with young kaki, quince, aromatic understory, wood chip mulch.

Turnkey budget: Diversified orchard (per hectare)

For new orchard establishment or enrichment of an existing traditional orchard. 100-150 trees/ha.

| Item | Detail | Cost (EUR) |
|---------------------------------------|--|--------------|
| PLANT MATERIAL | | |
| Main fruit trees (80) | Apple, pear, cherry, plum @ EUR10-15 | 1,000 |
| Extended season trees (30) | Quince @ EUR10-14, kaki @ EUR12-18 | 420 |
| Structural trees (20) | Sweet acorn oak @ EUR8-12 Service tree @ EUR10-14 | 240 |
| Boundary hedgerow (120) | Elderberry, hawthorn, blackthorn, hazelnut, dogwood @ EUR3-5 | 480 |
| Aromatic understory (400) | Rosemary, thyme, sage, comfrey @ EUR1.50-2.50 | 800 |
| Cover crop seed | Sainfoin, vetch, alfalfa, clover | 80 |
| Subtotal plant material | | 3,020 |
| INFRASTRUCTURE & MATERIALS | | |
| Chestnut stakes (130) | For fruit + structural trees | 390 |
| Tree protectors (130) | Spiral or mesh @ EUR2.50-3.00 | 365 |
| Mycorrhizal inoculant | 130 trees @ EUR0.50 | 65 |
| Basalt rock dust (500 kg) | @ EUR0.12/kg | 60 |
| Electric fencing (400 m) | For silvopastoral rotation | 1,400 |
| Subtotal infrastructure | | 2,280 |
| SOIL & MULCHING | | |

| | | |
|-------------------------------------|--|--------------|
| Wood chip mulch (BRF) | 15 tonnes @ EUR60-80/t | 1,050 |
| Keyline subsoiling | Contractor, 1 ha | 350 |
| Subtotal soil & mulching | | 1,400 |
| LABOUR & DESIGN | | |
| AGECO design & site audit | Landscape reading, fire risk map, species plan, layout | 960 |
| Planting labour | 2 people x 4 days @ EUR120/day | 960 |
| Fencing installation | 1 person x 2 days | 240 |
| Access surcharge | Difficult terrain logistics | 300 |
| Subtotal labour & design | | 2,460 |
| TOTAL: TURNKEY (per hectare) | | 9,160 |
| All inclusive, ready to grow | | |

Enrichment vs. new planting: For existing orchards where main trees are in place, the budget drops to approx. **EUR5,500-6,500/ha**. Bulk nursery orders for 5+ ha reduce plant costs by 15-20%.

4. Silvopastoralism: The Cornerstone Strategy

Silvopastoralism (the integration of managed grazing with forest and tree systems) is the single most effective and historically proven strategy for maintaining fire-resistant landscapes in the Garrotxa. The Ramats de Foc (Fire Flocks) initiative, founded in 2016 by the Fundacio Pau Costa, has demonstrated this at scale: currently 18 shepherds manage approximately 500 hectares of strategic fire management zones in the Province of Girona through prescribed silvopasture.

How Ramats de Foc works, and how you can participate

The initiative brings together public and private stakeholders to maintain strategic forest areas through targeted grazing. Bombers de la Generalitat (GRAF unit) identifies zones where vegetation management is critical. Herds of sheep, goats, and donkeys are deployed following prescribed silvopasture plans.

- **For landowners:** participating means your property benefits from professional grazing management at strategic points. The Fundacio Pau Costa supports agreements with herders, subsidy applications, and grazing plan development.
- **For producers:** products carry the "Ramats de Foc" label, connecting fire prevention with local gastronomy. In June 2025, nearly 20 restaurants in the Alta Garrotxa served dishes from fire-prevention herds.
- **The broader vision:** Ramats de Foc supports rural economic viability, prevents depopulation, strengthens short food supply chains, and maintains biodiverse landscapes.



Silvopastoral fire prevention: sheep grazing under oaks with clean understory. Young trees with protective guards.

Turnkey budget: Silvopastoral system (per hectare)

| Item | Detail | Cost (EUR) |
|---------------------------------------|--|--------------|
| PLANT MATERIAL | | |
| Canopy trees (100) | Sweet acorn oak, apple, pear, cherry @ EUR8-12 | 1,000 |
| Shrub layer (50) | Hazelnut @ EUR5-8 | 325 |
| Cover crop seed | Pasture mix: sainfoin, vetch, clover | 80 |
| Subtotal plant material | | 1,405 |
| INFRASTRUCTURE & MATERIALS | | |
| Chestnut stakes (100) | @ EUR2.50-3.50 | 300 |
| Tree protectors (100) | Heavy-duty mesh @ EUR3.50 | 350 |
| Mycorrhizal inoculant | 100 trees @ EUR0.50 | 50 |
| Basalt rock dust (300 kg) | | 36 |
| Electric fencing (400 m) | Rotational paddock system | 1,400 |
| Subtotal infrastructure | | 2,136 |
| SOIL & MULCHING | | |
| Wood chip mulch (BRF) | 12 tonnes @ EUR60-80/t | 840 |
| Keyline subsoiling | Contractor, 1 ha | 350 |
| Subtotal soil & mulching | | 1,190 |
| LABOUR & DESIGN | | |
| AGECO design & site audit | Silvopastoral plan, fire risk map | 720 |
| Planting labour | 2 people x 3 days @ EUR120/day | 720 |
| Fencing installation | 1 person x 2 days | 240 |
| Access surcharge | Difficult terrain | 300 |
| Subtotal labour & design | | 1,980 |
| TOTAL: TURNKEY (per hectare) | All inclusive, ready to grow | 6,711 |

5. Transitioning Pine Stands to Fire-Resilient Woodland

For many Garrotxa properties, the most impactful long-term intervention is the progressive replacement of flammable pine monocultures with mixed, fire-resilient woodland. This is not clearfelling; it is a gradual, strategic transition that works with the existing forest structure.



Pine-to-resilient-woodland transition: thinned pines with young cypress, cherry, and deciduous species.

Turnkey budget: Woodland transition (per hectare)

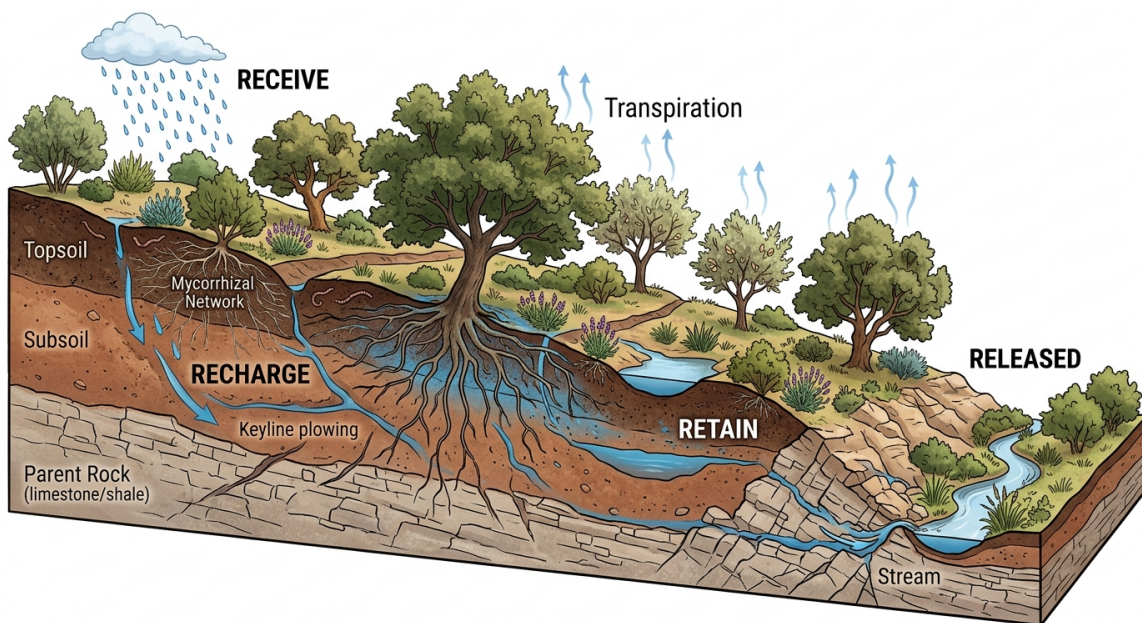
Lower density planting (250 trees/ha) for underplanting within existing thinned pine forest.

| Item | Detail | Cost (EUR) |
|---------------------------------------|---|--------------|
| PLANT MATERIAL | | |
| Native trees, bulk (250) | Service tree, wild cherry, maple, cypress, rowan @ EUR4-8 | 1,000 |
| Shrub layer (150) | Viburnum, privet, elderberry, hazelnut, blackthorn @ EUR3-5 | 600 |
| Subtotal plant material | | 1,600 |
| INFRASTRUCTURE | | |
| Chestnut stakes (250) | @ EUR2.50-3.50 | 750 |
| Tree protectors (250) | @ EUR2.50-3.00 | 690 |
| Mycorrhizal inoculant | 250 trees @ EUR0.50 | 125 |
| Basalt rock dust (400 kg) | | 48 |
| Subtotal infrastructure | | 1,613 |
| SOIL & MULCHING (optional) | | |
| Wood chip mulch (BRF) | 20t (or use on-site pine slash) | 1,400 |
| Subtotal soil & mulching | | 1,400 |
| LABOUR & DESIGN | | |
| AGECO design | Forest assessment, thinning plan | 720 |
| Planting labour | 2 people x 5 days (forest terrain) | 1,200 |

| | | |
|--|-----------------------|--------------|
| Access surcharge | Difficult terrain | 400 |
| Subtotal labour & design | | 2,320 |
| TOTAL: with BRF mulch | | 6,933 |
| TOTAL: without BRF (pine slash) | Reduced option | 5,533 |

6. Regenerative Hydrology for Steep, Forested Terrain

"In a Mediterranean climate, the single most impactful thing you can do to reduce fire risk is to keep water in the landscape longer."

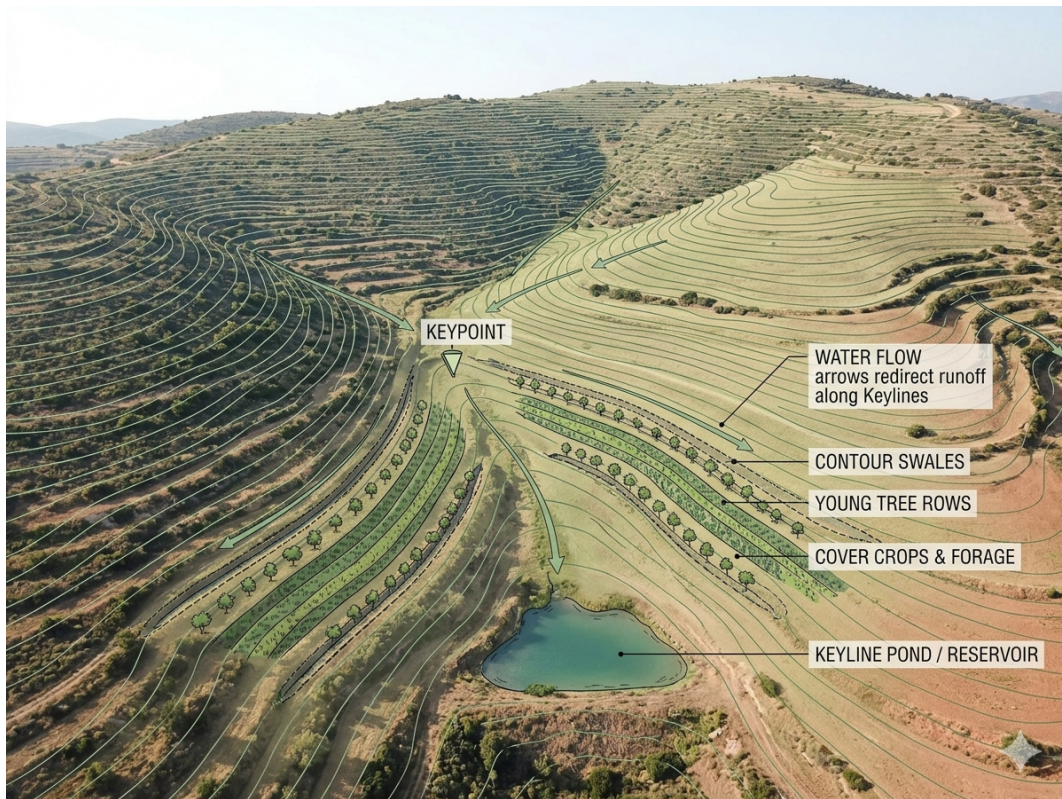


The four stages of regenerative hydrology: receive, recharge, retain, release.

Regenerative hydrology applies four principles (**receive, recharge, retain, and release**) to change how water moves through your property. On steep, forested Garrotxa terrain, the tools are adapted: selective keyline work on accessible fields, contour log terraces on slopes, and small water-harvesting basins at valley bottoms.

Keyline principles adapted to the Garrotxa

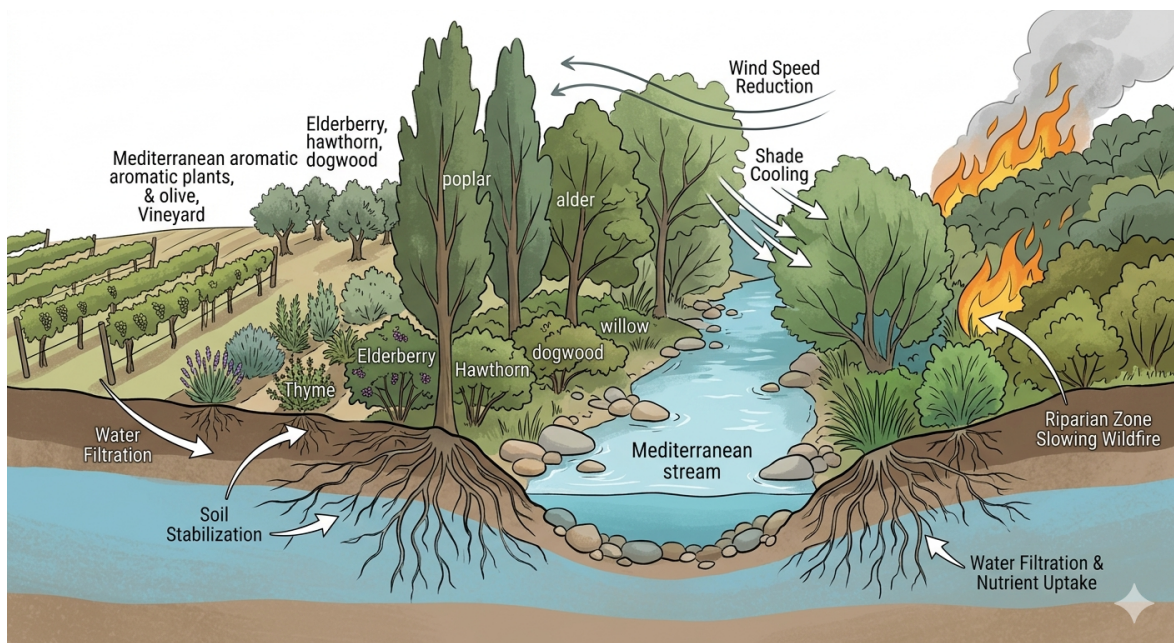
- **On accessible mosaic fields and orchards:** full keyline subsoiling to redistribute water from wet valleys to drier slopes.
- **On forested slopes:** contour-aligned log terraces ("leaky dams") and strategic rock placements that slow runoff without heavy machinery.
- **At keypoints and valley bottoms:** small water-harvesting basins that capture seasonal runoff and recharge the water table.



Keyline design: contour swales, tree rows, cover crops, and a water-harvesting pond.

Riparian agroforestry strips

The Garrotxa's network of streams (the Fluvia, the Muga, and their tributaries) offers a natural framework for fire-resilient design. Riparian buffers of native species create linear firebreaks that also protect water quality and provide habitat corridors.

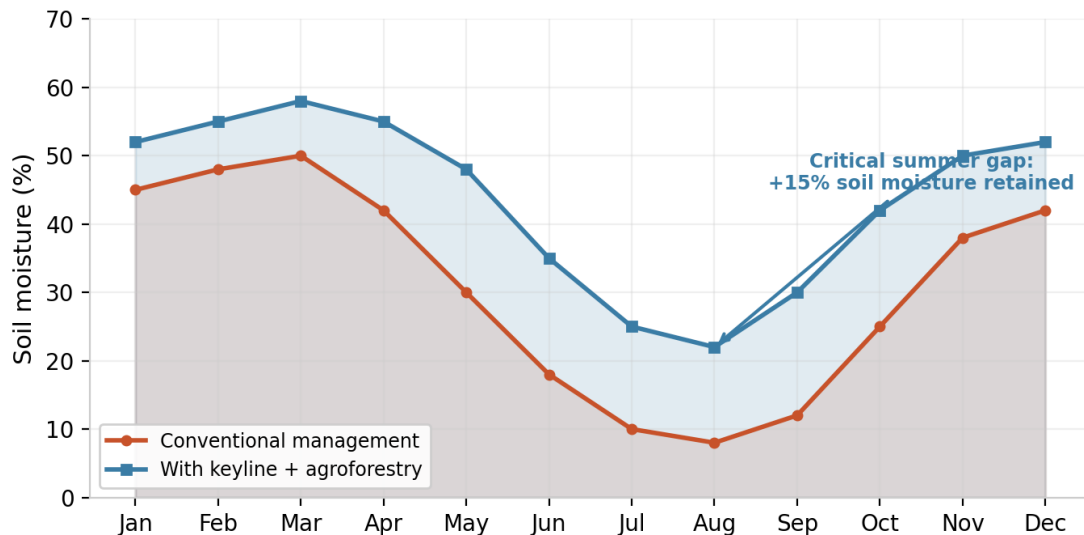


Riparian buffer: poplar, alder, elderberry, hawthorn protecting a stream. Fire slowed by the moist green corridor.

Turnkey budget: Regenerative hydrology (per hectare)

| Item | Detail | Cost (EUR) |
|---------------------------------|-----------------------------------|--------------|
| Keyline subsoiling | Tractor + Yeomans ripper | 350 |
| Swale construction (200 m) | Excavator 1/2 day + operator | 600 |
| Water harvesting pond (50 m3) | Excavation + lining | 2,200 |
| Riparian buffer (100 m) | 50 native trees/shrubs + stakes | 650 |
| AGECO hydrology design | Contour mapping, water flow plan | 640 |
| Earthworks supervision | AGECO on-site | 640 |
| Access surcharge | Heavy machinery, Garrotxa terrain | 400 |
| TOTAL: HYDROLOGY PACKAGE | Per hectare | 5,480 |

Soil moisture through the year: conventional vs. regenerative



7. Institutional Collaboration & Available Subsidies

Consorci de l'Alta Garrotxa

The Consorci (11 municipalities, three county councils, the Diputacio de Girona, and the Generalitat) manages the protected natural area and coordinates fire prevention. In March 2026, it celebrated its 25th anniversary. For landowners, the Consorci is the primary contact for coordinating on-property management with landscape-scale fire prevention.

Available subsidies

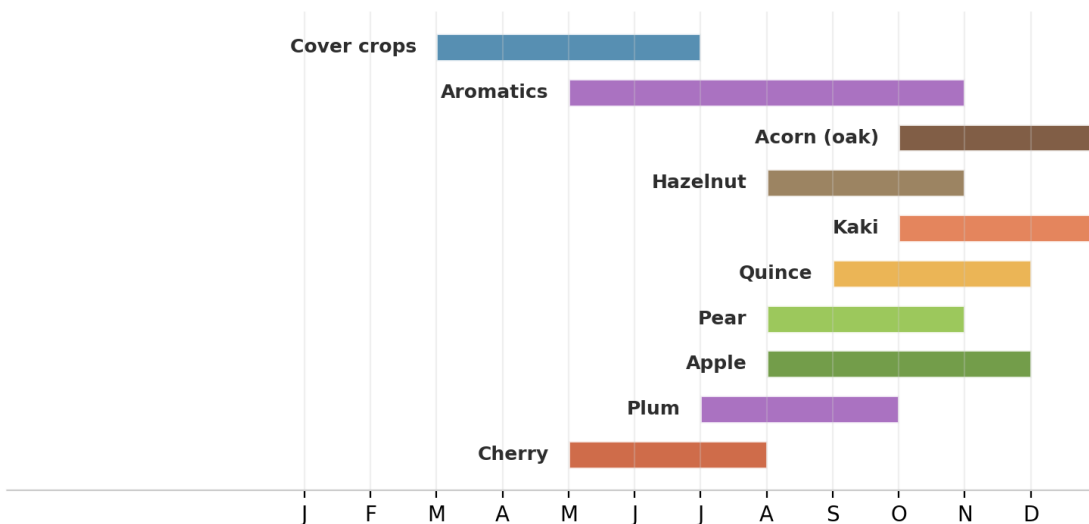
- **CPF ecosystem services subsidies (2026):** up to EUR10,000/beneficiary for silvicultural practices; up to EUR25,000 for forest reserves. Properties need a current forest management plan.
- **Generalitat forestry subsidies:** support for prescribed grazing in strategic management zones.

- **EU agri-environmental schemes:** for farms integrating agroforestry, organic management, or landscape stewardship.
- **AGECO subsidy scouting:** as part of ongoing packages, we proactively identify and help you apply for relevant funding.



Garrotxa harvest: apples, pears, quinces, kaki, plums, cherries, hazelnuts, local cheese and honey.

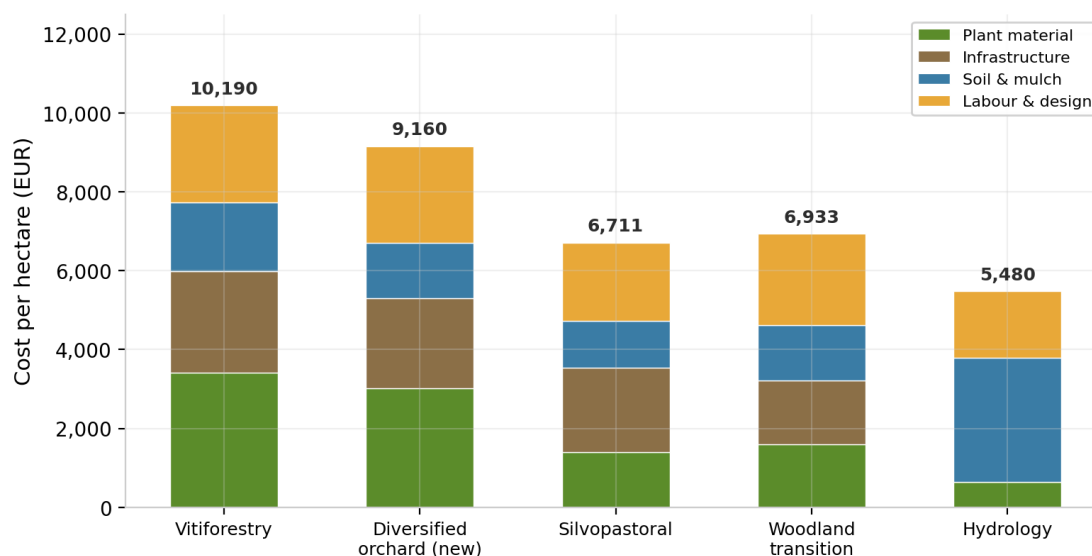
Harvest calendar: Garrotxa diversified orchard + vitiforestry



8. Budget Summary & Next Steps

| System | Turnkey cost/ha | Includes |
|---|--------------------|--|
| Vitiforestry (small vineyard integration) | ~EUR10,200/ha | 130 companion trees, 600 aromatics, 50 cypress, cover crops, fencing, BRF, keyline, design + labour + access |
| Diversified orchard (new) | ~EUR9,200/ha | 130 fruit/structural trees, 120 hedgerow, 400 aromatics, fencing, BRF, keyline, design + labour + access |
| Diversified orchard (enrichment) | ~EUR5,500-6,500/ha | Hedgerow, aromatics, cover crops, fencing, BRF, keyline, design + labour (trees already in place) |
| Silvopastoral system | ~EUR6,700/ha | 100 trees, 50 hazelnut, cover crop, fencing, BRF, keyline, design + labour + access |
| Woodland transition | ~EUR5,500-6,900/ha | 250 native trees, 150 shrubs, stakes, guards, BRF (optional), design + labour + access |
| Regenerative hydrology | ~EUR5,500/ha | Keyline, swales, 50 m3 pond, riparian planting, design + supervision + access |

Turnkey budget breakdown per system (Garrotxa)



All budgets are turnkey: plants, materials, soil amendments, mulch, earthworks, design, and planting labour included. Prices based on 2025/2026 supplier rates. **Actual costs may vary up to +/-30%** depending on the specific context of each property (terrain difficulty, accessibility, soil conditions, and labour availability). Material and plant prices are subject to seasonal and market fluctuations. A precise quote is established after the on-site consultation. Discounts apply for multi-hectare implementations and implementations.

Phased approach for large properties (20+ ha)

| Phase | Timeline | Actions |
|---------------------------------|-------------|--|
| 1. Immersion & Audit | Months 1-3 | Full site analysis: topography, water flows, soil, vegetation, fire exposure. Map using Scale of Permanence. Identify strategic zones. Assess access. |
| 2. First interventions | Months 3-12 | Thin highest-risk pine zones. Establish silvopastoral grazing (Ramats de Foc). Plant boundary buffers. Riparian strips. Keyline on accessible fields. Enrich existing orchard. |
| 3. System development | Years 1-3 | Progressive woodland transition. Expand silvopastoral zones. Water harvesting. Vitiforestry companion planting. Monitor, adjust, refine. |
| 4. Legacy | Years 3+ | Complete master plan. Annual impact reporting. Team training. Property as demonstration site. |

| Step | What happens | Investment |
|--------------------------------|--|---|
| 1. Discovery call | 30-min complimentary conversation to understand your property and define priorities. | Free |
| 2. On-site consultation | Full-day site immersion (access constraints typical of Garrotxa): landscape reading, fire risk mapping, water flow analysis, initial design. | EUR80/hour (min. 4-6 hours) |
| 3. Ongoing partnership | Monthly strategy sessions, professional design, soil interpretation, on-site days, subsidy scouting, coordination with Consorci and Ramats de Foc. | From EUR350/month (Professional) From EUR890/month (Legacy) |

Contact

Pierre Muller, AGECO

pierre@ecoag.org | +33 7 68 52 67 52 | www.ecoag.org

Instagram & Facebook: @ag_eco

AGECO designs are grounded in systemic observation, ecological science, and the specific reality of your land and your context. We do not sell utopias. We design working systems that leave the soil, the landscape, and the community better than we found them.