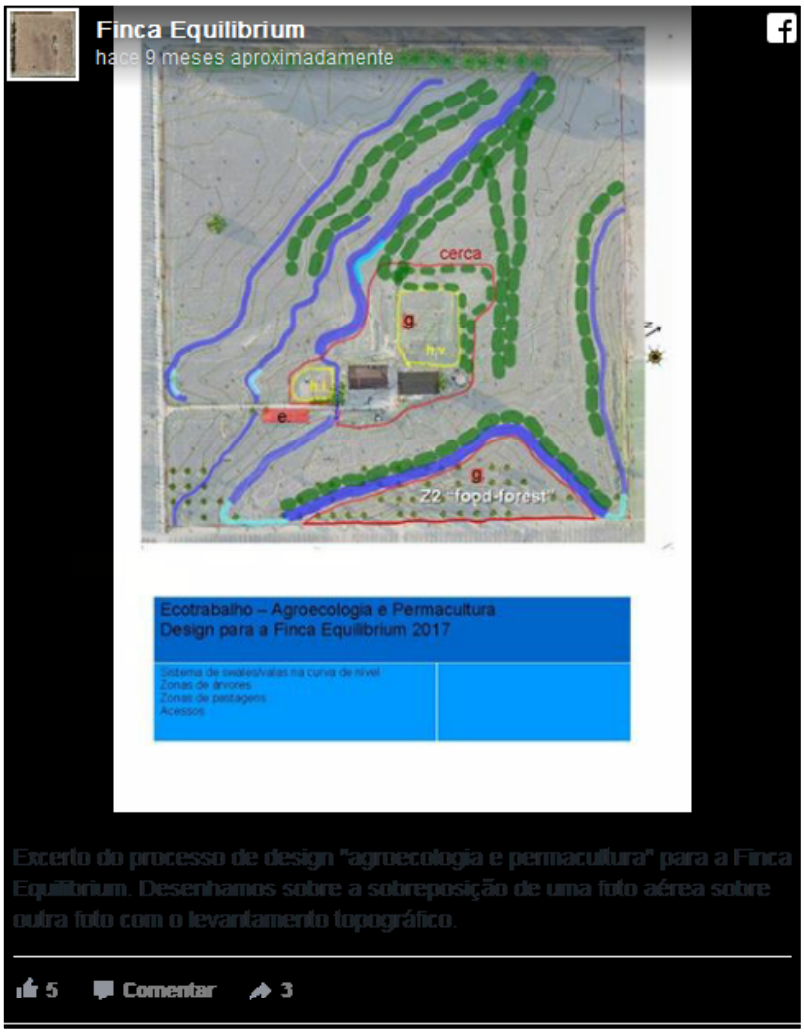
This project has received funding from the European Union's HOrizon 2020 research and innovation programme under grant agreenment Nº. 727872

Water retention in semi-arid environments with sandy soils

Source: Ana Tomás (ISA-UL), Josep Crous-Duran (ISA-UL), João Pedro Gonçalves (Finca Equilibrium)

The Finca Equilibrium is a six hectares farm that started its activities in January 2017, in Poceirão, located 55km inland from Lisbon in Central Portugal (38.717048, -8.756364). The region is characterized by a flat topography with hot and dry weather, sandy soils with very low organic matter values and pools of water ("pegões") over heavy clay layers. The main long term objective of the Finca Equilibrium, of the land owner and João and Mónica (the current developers), is to grow a food-forest kind of agroforestry system that will produce enough food to sustain the farm inhabitants (2 or 3 families), livestock, plus a surplus for occasional clients. For this they are gathering knowledge from several sources including local elderly people wisdom but also from international speakers like Allan Savory, Geoff Lawton, Ernst Gotsch and Akira Miyawaki.



For the implementation they considered different production methods, like biointensive organic gardening, permaculture and syntropic agroforestry, creating a green patch mosaic and tree belts that contrasts with the neighboring parcels dedicated to monoculture crops, wine production or livestock grazing.

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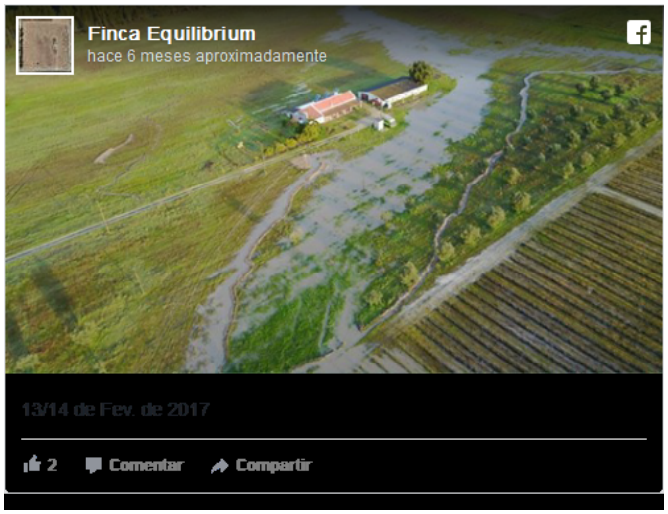
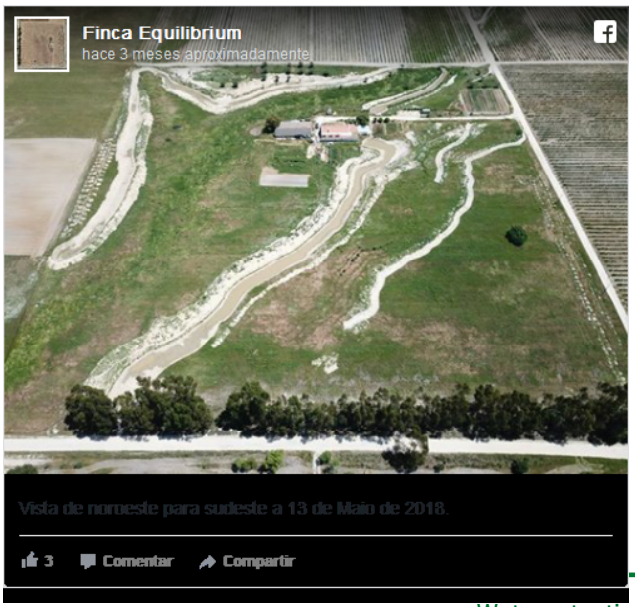
One of the first challenges addressed when they started working the land was related to the water management, particularly on how to promote rain infiltration within the parcel. The region received for the past three years an average of 300 mm of rain per year but concentrated in short-term rain events, during one wet week, or only one wet month. Even considering that the property includes a temporary water line going through it from its south corner all the way to the other end, during strong precipitation events, this water line rapidly fills with storm water coming from the soaked valleys and dirt roads, sending the available water by natural runoff out of their land, leaving no time for infiltration.



In order to promote infiltration over a much broader area and to increase the fast-flood buffer effect, they decided to start by installing "key-line on-contour and off-contour ditches" or "swales" - at the same time they infiltrate, hold and spread water since the top of the ditch is on-contour but the bottom is off-contour. In March 2018, and with a budget of 3000 euros, it took around 60 hours of work, using a power shovel, for excavating 1 km of ditch with 0,5-1,5 meter depth. As a test to severe weather, on May 20th 2018, two months after the building of the ditches, there was a heavy rain event, when some 30 l m-2 of water poured in a single hour.

The muddy water spread all along the main ditch 750 meters long bottom and the water remained in the parcel for about a month until most of it infiltrated, while attracting an extra number of birds and insects.



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In the long run, it is expected that the infiltration of this extra water available due to the presence of the ditches will help to raise the groundwater table that, considering some local people reports and the fact that several local spring water fountains have dried up, has been decreasing during the recent decades. This water rise would also allow an easier and less expensive access to water and would avoid the need of over-using the existent water pumps or the acquisition of more powerful ones.

While the water infiltration is improving, it's in progress the implementation of several agroforestry systems with multiple trees and crops. For this purpose they created their own plant nursery, where they grow more than twenty different tree species including ***Araucaria*** sp. and ***Morus*** sp. that are used later in their own parcels. In the future, young elements of these tree species could be sold offering an extra income for the farm.

Joao showing us the nursery in the farm

Another problem to be faced in the farm is the presence of low organic matter soils. Harvest and chopping residues of the old eucalyptus elements, already present in the farm, are used as input of organic matter for the soil: large eucalyptus big dry trunks are buried in the farm roads and in the vegetable garden beds berms and paths, for the slow decomposition of organic matter, while medium trunks are used for fencing and leaves and small branches are used as mulching for protecting soil biota, retention of soil humidity and soil temperature stability.

In addition and in order to create microclimate effects via windbreak, night dew condensation and dripping, shading, rising air humidity levels and prepare the stage for fruit and fodder trees establishment, some sun loving fast growing tree species adapted to local conditions were planted, including several species of eucalyptus. Casuarinas, plus other trees and shrubs that also have nitrogen-fixing abilities (e.g. ***Ceratonia siliqua, Albizzia*** sp.), are being tested. These first tree belts of fast biomass plantations are located mainly in the bottom margin of the established ditches so they can benefit from the extra infiltration of water.

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The criteria followed for the selection of these tree elements include: 1) adaptation to local low water table conditions by fast development of a deep root system, 2) canopy adapted to a long sunny summer, wind and air dryness, 3) the tolerance to poor, free draining sandy and waterlogged heavy clay soils and 4) the acceptance of intense, heavy or light, pruning regimes.

P re-existing eucalyptus windbreak that now also provides input of organic matter for the soil

New tree plantations of eucalyptus (on the back), casuarina (in front) and mulberry (on the right) trees

Closer to the house, there are two areas of around 400 m2 dedicated to vegetable gardens and staple crops like potatoes and sweet potatoes. These where organized in different strata and different species consociations, to fill the horizontal space, to outcompete weeds, and the vertical space, mingling tree lines with tall vegetable plants, ground plants and tubers. This area also supplies for a few veggies boxes delivered in Lisbon, when Mónica leaves for her job there – a multi-functional car ride.

Tree and sweet potatoes lines within the vegetable garden

Mónica working in their vegetable garden. In the foreground is visible the multiple vegetable strata and species

Currently the farm is also working on the establishment of living fences to surround pasture areas in different parts of the property, where they could work some sort of rotational grazing plan. In a first phase by collaborating with their neighbor shepherd (with around 400 sheep), that could graze on these areas and in return taking advantage of the trampling of standing straw and excrements left by the animals, that will help to increase soil organic matter.

On a more social point of view, João and Mónica are working with the local parish and agroecology network and welcome anyone who wants to know more about the project and are open to work in its development. Hitchhikers are organized on facebook and several gatherings are happening on Saturdays. Helping hands are never too much!