



Landscape around Gorafe on the bank of the Gor River, Spain © Ventura Carmona /Getty Images

Granada Foodscape

Ensure climate resilience by promoting return to traditionally used practices



LOCATION: Andalusia, Spain
SIZE: 1.5 million ha

SPAIN

SYNOPSIS

For millennia, the varied terrain of southern Spain's Granada foodscape had primarily supported subsistence production. Extensive mountainous areas, with shallow soils, were cultivated with tree crops, including almonds and olives. When global markets began opening up in the 1980s, the highest-yielding agricultural areas transitioned from inherited traditional practices to highly mechanized systems intended to maximize production. Rainfed almond plantations and olive groves of the Granada foodscape, where production is constrained by the elements, had a harder time competing in global markets.

Now, less than half a century later, the mechanized approach has degraded soils, jeopardizing the long-term viability of regional olive production and compromising the profitability of almonds. More severe weather is also threatening the vulnerable yields of regional rainfed tree crops, for which economic margins are already narrow.

Protecting long-term production and profitability of crops within the Granada foodscape may require a large-scale shift

GRANADA

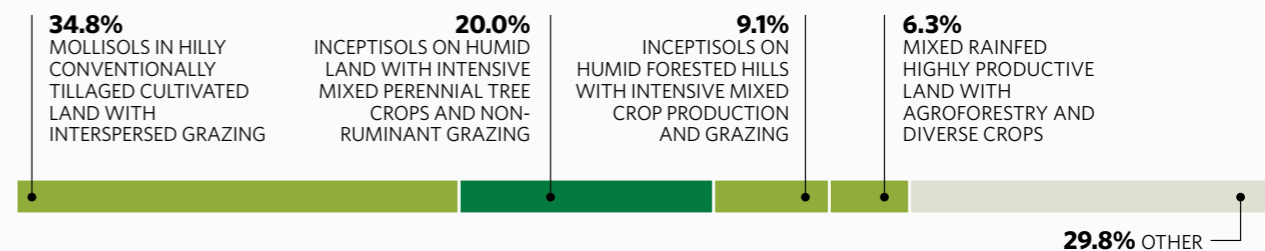


FIGURE 1. Map of Granada foodscape. The bars represent the most extensive foodscape classes within the foodscape. The color of bars indicates the intensity groups corresponding to those classes: intensive production dominant (dark green) and mixed mosaic food cultivation (light green). The other category includes the classes that each made up <5% of the foodscape area.

back to traditional practices. The need to adapt to increasing climatic irregularity makes change even more urgent. The legacy of traditional practices that are well suited to a climate-resilient future creates a promising path forward, bolstered by available public subsidies to mitigate the expense of transition across the foodscape. In the case of almonds grown in the Granada foodscape, one of the biggest factors pushing almond producers here to grow nuts organically is that they are not able to compete with the relatively cheap, irrigated almonds from the San Joaquin Valley (United States).

DESCRIPTION OF FOODSCAPE

Andalusia, the southern-most region in Spain, touches both the Atlantic and Mediterranean coastlines. The land surrounding the Atlantic river basins in the north is characterized by fertile soils and suitable for irrigation. Toward the southeast, both the mountainous terrain and more seasonally dependent Mediterranean-feeding rivers create challenging conditions for cultivation with limited water access. The patchwork of land use and land cover here, including urban centers, row crops, pasture, and tree crops, has been strongly shaped by the climate and water resources.



Olives growing on a tree, Granada, Spain
 © Rafael Santos Rodriguez / EyeEm/Getty Images

Spain's access to the European Economic Community beginning in 1985 marked a shift in the cultivation practices toward water efficiency, as growing industries such as tourism put greater strain on regional water supplies. The connection to larger markets also presented the potential for a globalized economy centered around Andalusia's growing agricultural commodity: olive oil. Where irrigation was installed, management practices were adjusted to accommodate machinery and the promise of higher productivity as a result.

Despite its long history of human occupation with densely populated and intensely cultivated pockets, Andalusia has protected terrestrial and marine areas that support migratory birds and emblematic vertebrates, such as the Iberian lynx, among many other species. The rich biodiversity native to the region is not, however, isolated from agricultural land use. In fact, 11% of Andalusia's agricultural land cover is part of the Natura 2000's European network of conservation areas, including 135,000 ha of olive groves, making the case for land sharing practices within groves.

Granada, a province within southeast Andalusia and the focus of this foodscape, is dominated by mountainous terrain with a stretch of Mediterranean coastline (FIGURE 1).

The northern part of Granada contains high-yielding olive groves supported by decades-old irrigation infrastructure. Along the coast, more abundant access to fresh water supports greenhouses and other horticultural crops important for Europe's winter produce supply.

The remainder of agriculture in the Granada foodscape is concentrated in lower rainfall areas with no irrigation, thus constraining productivity. The valleys are used primarily for cereal production while the inclined areas with poorer soils are cultivated with marginal olive groves and almond plantations. The areas in between support livestock and hunted wildlife.

CHALLENGES

Since adopting more globalized practices in the 1980s, both irrigated and rainfed agricultural systems in Granada are now approaching environmental and economic limits created by soil degradation and drought events.

Though the initial transition away from more traditional practices boosted yield and established the region as top producer of olive oil, the mechanized model is now damaging production. As water is the region's primary constraint, the soils between tree rows are often left bare (through a combination of tillage and herbicide application) to limit competition for water. Exposed soils, combined with steeper sloped terrain and the region's drier climate, cause average soil losses of 5.9 t/ha per year, and higher than 25 t/ha per year in some areas.

Erosion has been steadily degrading soils that were already shallow, placing the ultimate sustainability of the mechanized model of farming into question. For irrigated, high-production areas, this issue

Groves of tree crops near the town of Alhama de Granada, Granada, Spain
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is jeopardizing the region's position in the global olive oil market, which would have implications for both the local economy and the region's cultural identity.

For rainfed olives, degradation is made more problematic by increasing rainfall extremes. During low rainfall periods, soils become drier with no alternative source of water. Come winter, the torrential rains heavily erode the tilled soils. These challenges are eating into the productivity of already low-yielding groves.

Though almonds are less water intensive, the water constraints on rainfed production are preventing almond farmers from competing with high-producing irrigated almond regions such as California's San Joaquin Valley foodscape. With anticipation of growing demand on water supply and greater climate irregularity, without a change in agricultural methods, such as a transition to organic agricultural practices that can command a higher price in the global market, almond producers in the Granada foodscape will continue to be strained to compete successfully against cheaper, irrigated crops in global markets.

BENEFITS AND VALUE OF NATURE-BASED SOLUTIONS IN THE GRANADA FOODSCAPE

The importance of agricultural exports to both culture and economy here has helped foster an appetite for regenerative solutions in the Granada foodscape. Sustaining this foodscape requires improved water management combined with an assisted transition back to some of the region's traditional practices. In general, traditional agricultural practices within the foodscape are centered around creating a more resilient water supply and anchoring soils to minimize erosion. Many of these solutions have always been based in the benefits nature provides to agriculture.

Planting cover crops in exposed soils between tree crop rows protects soil from erosion, helps accumulate soil organic carbon, and, over time, improves soil structure. In addition to between-row cover, planting native hedges around field edges helps capture soil, improves water infiltration into soil, and provides habitat for diverse native species, especially birds. Swales dug into field boundaries contribute to the resilience of water resources by collecting excess rainwater to buffer times of water scarcity.

Though these more traditional practices tend to generate marginal net economic gains for irrigated and rainfed olive growers (Supplementary Material, Archetype A and Archetype B, respectively),¹ the potential reduction in soil loss is a significant benefit. In addition, cover crops and hedges give farmers the opportunity to rent fields out for hunting and grazing for supplementary income. Integrating livestock, preferably sheep or horses, would require careful management to protect tree crops. However, additional income from these uses of marginal groves, in particular, could help buffer farmers' income from highly variable rainfall-dependent yields.

Realizing this regenerative transition for rainfed almond plantations (Supplementary Material,¹ Archetype C) in the Granada foodscape requires strategic public sector support to help farmers link soil health and water management improvements to lucrative market access.

For example, given the known resource constraints limiting almond production, the regional government is bolstering subsidies to help capture the organic market for almond exports. The subsidies help farmers through the transition to organic production and continue to give them a bump beyond conventional almond subsidies once they are certified.





Ripe oranges, Granada, Spain.
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Though implementation costs are higher compared to olive groves (Supplementary Material,¹ Granada – Archetypes A and B), incorporating organic certification into the regenerative transition for almond plantations provides a net gain of \$44,000 annually for a 35 ha plantation. Access to premium pricing in organic markets drives the drastic change in profit. Adopting nature-based regenerative solutions is a small step for farmers on the path to organic certification, with costs mitigated by the substantial subsidies.

However, public-private schemes are not the only enabling factors for a successful transition to a nature-based regenerative agricultural future in the Granada foodscape. The globalization of practices within the Granada foodscape are recent enough that there is still a strong cultural memory of generational farming. Fortunately, regenerative solutions build on traditional practices handed down through generations, so adoption by producers within the Granada foodscape may be met with less resistance compared to untested practices.

Scaling such nature-based regenerative practices across a total of 300,000 ha within the Granada foodscape could bring as much as \$128 million per year in additional revenue (FIGURE 2). Coupling modernized water management infrastructure with traditional regional practices could set this foodscape on a path to regenerating their soils while sustaining and improving their extensive tree plant economy.

AGGREGATION OF ARCHETYPES TO THE FOODSCAPE LEVEL

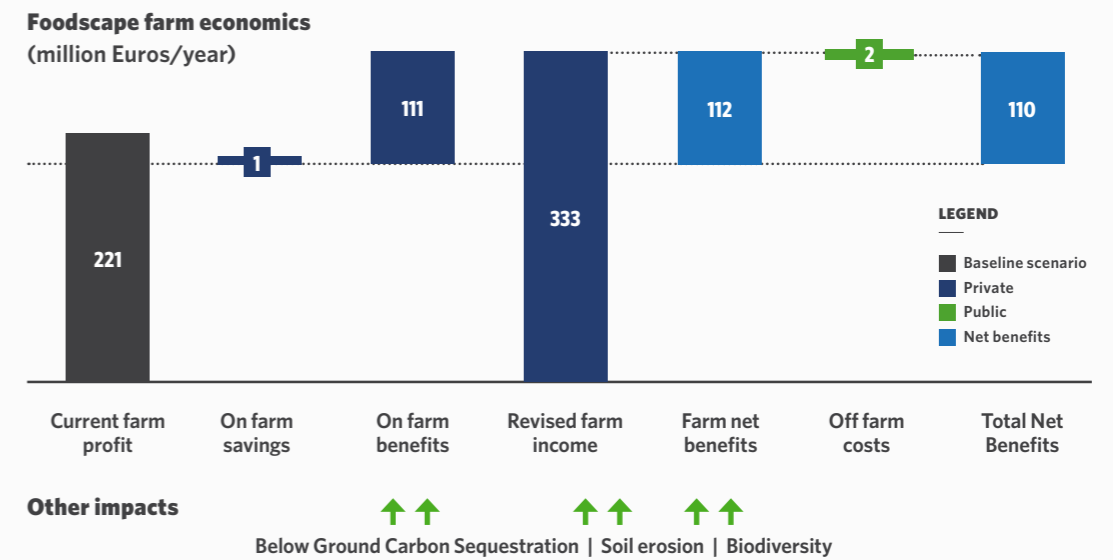


FIGURE 2. Summary of economic analysis of nature-based solutions in the Granada foodscape. Disaggregated costs & benefits toward \$[110 million Euro conversion] million net benefits from several farm archetypes: Starting with baseline current farm profits (grey, far left), the diagram shows proposed future on farm benefits and costs (dark blue), totaling farm net benefits of [112 million Euro conversion] (light blue, middle). Additional public off farm benefits and costs (light green) added to and subtracted from farm net benefits equals [110 million Euro conversion] total net benefits (light blue, far right). Other impacts are qualitative assessments of other ecosystem service benefits. The proposed nature-based solutions associated with the farm archetypes are represented in the boxes. See Supplementary Material for a description of methods.¹

This is a case study excerpted from the report *Foodscapes: Toward Food System Transition*. Please access the entire global report at [nature.org/foodscapes](https://www.nature.org/foodscapes).

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