

## Integrated crop-livestock farming systems

Integration of livestock and crops as a viable alternative to specialized systems that can improve resource efficiency and ecosystem services. A case study from Lemnos, Greece.



Farmer Field School on livestock management.  
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Alliance for Mediterranean Nature and Culture (AMNC)  
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### /// Context ///

Mediterranean agriculture faces a multitude of challenges, including loss of biodiversity, overexploitation of freshwater resources, disruption of nutrient cycles, soil degradation, and altered fire patterns. These problems are exacerbated by factors such as water scarcity, heavy reliance on energy imports, and the prevalence of highly specialized agroecosystems with low diversity. Against this backdrop, the adoption of integrated forms of agriculture, such as the Mandra system in Lemnos (Greece), emerges as a promising avenue for reinvigorating the sustainability of agricultural landscapes and strengthening resilience against the impacts of climate change.

Integrated farming systems involve the simultaneous

cultivation of different crops (which include cash crops, food crops and energy crops) along with a variety of livestock, while implementing comprehensive methods to recycle animal waste. The overall goal is to optimize resource utilization, particularly with regard to nutrients, reduce dependence on external inputs such as fertilizers, pesticides and concentrated feed, and sustain favorable environmental outcomes.

Through the adoption of complementary agricultural practices between crops and livestock, several key ecosystem services are realized. These include erosion control, biological regulation (including pollination) and maintenance of soil fertility, which includes both soil structure and nutrient cycling.

### /// Solution for a Resilient Future ///

The Mediterranean region has long been admired for its unique agricultural practices, deeply rooted in tradition and sustainability. Among these practices, the mandra system stands out as a testament to the resilience and adaptability of Mediterranean agriculture. Characterized by its mixed crop-livestock land use, the mandra system embodies the principles of diversification and complementarity, contributing to both ecological sustainability and community livelihoods.

At the heart of the mandra system lies the 'mandra' itself, a traditional farming structure found predominantly on the island of Lemnos. The mandra serves as a multifunctional area enclosed by dry-stone walls, housing essential components such as animal sheds, shepherd huts, and barns. Surrounding the mandra are pastures and arable lands cultivated with cereals and leguminous crops.

Diversification is best represented by the close co-existence of crop fields and pastures. Crop rotation, intercropping, and fallow practices enhance soil fertility and minimize the risk of nutrient depletion, contributing to sustainable land management (MedINA, 2018; MedINA, 2020).

Livestock harmonious integration with crop cultivation epitomizes resource use efficiency. Photosynthesis carried out by grasses promotes the conversion of carbon dioxide, water, and minerals into biomass. Legume species act as an alternative to mineral fertilization by fixing nitrogen, resulting in synergies that benefit biomass production. Crop residue management further enhances farm sustainability, as straw and stubble remaining on fields can serve as fodder for grazing livestock. Finally, manure improves soil fertility and water retention, mitigating the impact of drought-

induced soil degradation and increasing long-term productivity. Therefore, grazing animals help close the nutrient cycle and control weeds, reducing the need for mechanical interventions such as tillage and ploughing, which result in soil disturbance (Bonaudo et al, 2013).

Integrated crop-livestock systems also play a crucial role in the Mediterranean as they contribute to conserving a wide biodiversity of species and breeds of domestic animals. These breeds often exhibit adaptability to marginal areas that might otherwise be abandoned due to agricultural limitations. Furthermore, their ability to withstand increasing temperatures and reduced water availability underscores their importance in the face of

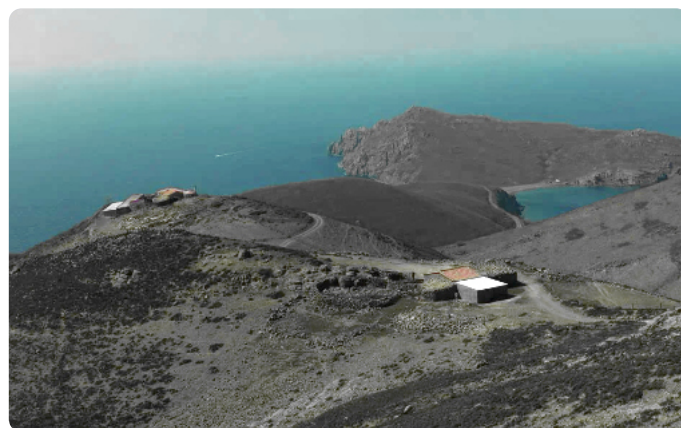


Typical mandra of Lemnos Island.  
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climate change challenges (Bernués et al, 2011).

In light of the increasing incidence forest fires in the Mediterranean, livestock grazing is acknowledged as a valuable tool in fire prevention as it helps reduce the build-up of combustible vegetation, such as grasses and shrubs, and create firebreaks (Bernués et al, 2011).

In conclusion, integrated systems provide ecosystem services such as soil conservation, biodiversity conservation, and carbon sequestration, contributing to environmental resilience and climate change mitigation. Agroecological practices, such as rotational grazing and cover cropping, enhance ecosystem functions and reduce vulnerability to droughts.



Typical mandra of Lemnos Island.  
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### /// Always Moving Forward ///

The ecological and heritage importance of crop-livestock systems is threatened by the intensification and modernization trends that changed the agricultural landscape in the second half of the 20th century. These same trends are behind the increasing abandonment of rural areas and the decline of animal husbandry, leading to the rapid standardization and homogenization of agricultural landscapes (Martin et al., 2016). In addition, the investment and know-how required to switch to integrated systems is often a major obstacle to sustaining the practice on small farms.

To revitalize this practice and reverse the deterioration of

key ecosystem services, such as soil and water quality conservation, caused by specialized farming systems, it is paramount to strike an effective and sustainable balance between environmental and socioeconomic goals. Farmers must be adequately rewarded for their contribution to maintaining cultural landscapes and biodiversity. A key step would be to assess the positive externalities generated by these systems that help to tackle droughts and fires. Measuring the benefits of this practice in economic terms would help promote the creation of agricultural and environmental policies that compensate farmers for their provision of public goods.

#### Further information

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