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Editorial: Can the trees save the crops? Predicting the services provided by traditional and novel agroforests in changing Mediterranean landscapes

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Editorial on the Research Topic
Can the trees save the crops? Predicting the services provided by traditional and novel agroforests in changing Mediterranean landscapes

Agroforestry is a land use system that combines trees and/or shrubs (woody perennials) for timber or fruit with crops and/or animal husbandry, based on agroecology principles (Nair, 1991). Agroforestry systems have a long tradition in Mediterranean-type ecosystems where they are diverse and comprise five main practices: silvoarable systems, silvopastoral systems, forest farming, riparian buffer strips and windbreaks/hedgerows (Mosquera-Losada et al., 2022). Intensification, mechanization and depopulation of marginal areas have rendered traditional Mediterranean agroforestry practices to be considered obsolete by decision-makers, and in many situations these systems are abandoned or converted to intensive agriculture, pastures or forests (Varela et al., 2022). On the other hand, present agricultural, animal husbandry and forestry systems, mostly monocultures, are highly specialized productions, subjected to economic pressures and responsible for many local and regional environmental impacts (Tilman, 1999). Recent findings highlight the regulating and supporting services provided by agroforestry that may be especially important facing highly erratic economic scenarios and dynamic environmental conditions predicted for the near future in Mediterranean-type areas (Castle et al., 2022). In fact, planted trees among "crops" (silvoarable or alley cropping) contribute to carbon sequestration, functional biodiversity, reduce soil erosion, control microclimates (radiation, temperature, humidity, wind), increase soil fertility, retain agrochemicals and are able to recycle water and nutrients from deeper

layers (Scott et al., 2022). The development of novel woody perennial "crop" combinations in Mediterranean-type ecosystems and the sustainable management of existing ones is only possible if we are able to understand and predict the functioning of agroforestry, link practices with ecosystem services and prove that these systems are a viable option for rural areas, namely facing uncertain and evolving forecasted environmental conditions (Blaser et al., 2018). Considering their future ecological and economic relevance, the investments and conservation of agroforestry practices require the understanding of their capacity to withstand and recover from disturbances imposed by natural and anthropogenic factors (e.g., climate change) (Viñals et al., 2023). Ecological modeling provides useful tools to study these complex systems by predicting the outcome of alternative scenarios and may help guide the management options from projected future outcomes (Bakiş et al., 2021). Models linked and parametrized with real data studies could support resilient agroforestry while mitigating climate change and even increase productivity following the climate smart agriculture principles provided by the Food and Agriculture Organization (Arosa et al., 2017). Simulation of trade-offs between provisioning (i.e., productions), regulating (e.g., nutrient retention, mitigating greenhouse gas emission) and supporting (e.g., soil structure, water regulation and functional biodiversity support) services are especially important for estimating the interest of practitioners, possibilities and sustainability of investing in agroforestry (Rolo et al., 2021). Moreover, as models can be used in the understanding of complex ecological processes, by incorporating variables that are difficult tackle and integrate otherwise, might support assertive policies to promote resilient agroforestry systems (Wilson and Lovell, 2016).

In this scope, this Research Topic presents a collection of works linking models with agroforestry systems, with a special emphasis on Mediterranean ecosystems, their associated services and sustainability facing environmental change, without disregarding policy issues. Ivezić et al. have synthesized published information on crop yields in European agroforestry systems using meta-analysis. The results obtained from diverse eco-regions and types of systems show divergent results, apparently with more competition between the crop and the tree in northern Europe and within novel agroforestry systems. The authors finish calling attention to the need for more research to support winning agroforestry systems and agroforestry management. Ferreiro-Domínguez et al. present a biophysical model to predict long-term production according to light and water availability of a forest, a pasture and an agroforest in Galicia (Northern Spain) using the same species within present and future predicted environmental conditions. The results of the model show that tree growth was enhanced in agroforestry systems while climate conditions apparently did not produce significant differences. Santos et al. extend the recently developed Habitat Amount Hypothesis to landscapes dominated (or co-dominated) by crops or trees, which were compared by a cellular based spatial model. The results obtained show that agroforestry systems substantially increase functional diversity and overall biodiversity within landscapes. The authors conclude that underpinning agroforestry through European Agri-environmental funding schemes is relevant to biodiversity conservation in agricultural landscapes. Gonçalves et al. discuss ecological and physiological interactions between trees and crops in Mediterranean agroforestry systems and models to simulate these interactions, including a comparison with monocultural systems. They conclude that the most suitable combination of tree/crop species should include complementary traits, crucial to boost productivity, ecosystem services, and environmental sustainability. To finish, Mosquera-Losada et al. review the types of agroforestry systems and associated spatio-temporal scales, discuss the most assertive policies and the barriers to its implementation. Technical, economical, educational and policy development issues were identified hindering agroforestry implementation in Europe, as well as policy recommendations to overcome the identified problems.

Author contributions

MS wrote the first draft. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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References

Arosa, M. L., Bastos, R., Cabral, J. A., Freitas, H., Costa, S. R., and Santos, M. (2017). Long-term sustainability of cork oak agro-forests in the Iberian Peninsula: a model-based approach aimed at supporting the best management options for the montado conservation. *Ecol. Modell.* 343, 68–79. doi: 10.1016/j.ecolmodel.2016.10.008

Bakiş, A. L. P., Macovei, I., Barros, P., Gomes, C., Carvalho, D., Cabral, J. A., et al. (2021). Is biodiversity linked with farm management options in vineyard landscapes? A case study combining ecological indicators within a hybrid modelling framework. *Ecol. Indic.* 121, 107012. doi: 10.1016/j.ecolind.2020.107012

Blaser, W. J., Oppong, J., Hart, S. P., Landolt, J., Yeboah, E., Six, J., et al. (2018). Climate-smart sustainable agriculture in low-to-intermediate shade agroforests. *Nat. Sustain.* 1, 234–239. doi: 10.1038/s41893-018-0062-8

Castle, S. E., Miller, D. C., Merten, N., Ordonez, P. J., and Baylis, K. (2022). Evidence for the impacts of agroforestry on ecosystem services and human well-being in high-income countries: a systematic map. *Environ. Evid.* 11, 1–27. doi: 10.1186/s13750-022-00260-4

Mosquera-Losada, M. R., Rodríguez-Rigueiro, F. J., Santiago-Freijanes, J. J., Rigueiro-Rodríguez, A., Silva-Losada, P., Pantera, A., et al. (2022). European agroforestry policy promotion in arable Mediterranean areas. *Land Use Policy* 120, 106274. doi: 10.1016/j.landusepol.2022.106274

Nair, P. K. R. (1991). State-of-the-art of agroforestry systems. *For. Ecol. Manage.* 45, 5–29. doi: 10.1016/0378-1127(91)90203-8

Rolo, V., Roces-Diaz, J. V., Torralba, M., Kay, S., Fagerholm, N., Aviron, S., et al. (2021). Mixtures of forest and agroforestry alleviate trade-offs between ecosystem services in European rural landscapes. *Ecosyst. Serv.* 50, 101318. doi: 10.1016/j.ecoser.2021.101318

Scott, E. I., Toensmeier, E., Iutzi, F., Rosenberg, N., Lovell, S., Jordan, N. R., et al. (2022). Policy pathways for perennial agriculture. *Front. Sustain. Food Syst.* 616, 983398. doi: 10.3389/fsufs.2022.983398

Tilman, D. (1999). Global environmental impacts of agricultural expansion: the need for sustainable and efficient practices. *Proc. Nat. Acad. Sci.* 96, 5995–6000. doi: 10.1073/pnas.96.11.5995

Varela, E., Olaizola, A. M., Blasco, I., Capdevila, C., Lecegui, A., Casasús, I., et al. (2022). Unravelling opportunities, synergies, and barriers for enhancing silvopastoralism in the Mediterranean. *Land Use Policy*, 118, 106140. doi: 10.1016/j.landusepol.2022.106140

Viñals, E., Maneja, R., Rufí, M., Martí, M., and Puy, N. (2023). Reviewing social-ecological resilience for agroforestry systems under climate change conditions. *Sci. Total Environ.* 869, 161763. doi: 10.1016/j.scitotenv.2023.161763

Wilson, M. H., and Lovell, S. T. (2016). Agroforestry—the next step in sustainable and resilient agriculture. *Sustainability* 8, 574. doi: 10.3390/su8060574