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Restoring woody agroecosystems in Mediterranean drylands through regenerative agriculture

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Regenerative agriculture (RA) is gaining increasing recognition as a plausible solution to restore degraded agroecosystems. In Mediterranean drylands, RA has been limitedly adopted by farmers due to its initial state of development and lack of empirical evidence on its impacts. To support its large-scale adoption, we carried out a participatory monitoring and evaluation project in the high steppe plateau of Southeast Spain, involving local farmers applying RA in their almond farms. To assess the effect of RA, we studied 9 farms and selected in each farm one field with regenerative management and one nearby field with conventional management based on frequent tillage (CT). We clustered fields under regenerative management based on the different RA practices being applied and distinguished 4 types of RA treatments: 1) reduced tillage with green manure (GM), 2) reduced tillage with organic amendments (OA), 3) reduced tillage with green manure and organic amendments (GM&OA), and 4) no tillage with permanent natural covers and organic amendments (NT&OA). We used physical (bulk density and aggregate stability), chemical (pH, salinity, total N, P, K, available P, and exchangeable cations) and biological (SOC, POC, PON, microbial activity) soil propertoes and the nutritional status of almond trees (leaf N, P and K) to evaluate the impacts of RA compared to CT. We found that GM treatment improved physical soil properties, presenting regenerative fields higher soil aggregate stability. Our results showed that OA improved most soil chemical and biological soil properties, however physical properties remained similar. RA treatments combining ground covers and organic amendments (GM&OA and NT&OA) exhibited greater overall soil quality restoration than individual practices, improving physical, chemical and biological soil properties. NT&OA stood out for presenting the highest soil quality improvements. All RA treatments maintained similar crop nutritional status compared to CT. We conclude that RA has strong potential to restore the physical, chemical and biological quality of soils of woody agroecosystems in Mediterranean drylands without compromising their nutritional status, thereby enhancing their resilience to climate change and long term sustainability.