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Agronomic strategies in response to changes in agricultural and cropping systems

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Agroecological approaches in Mediterranean cropping systems: experimental evidence from a real on-farm comparison

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Mediterranean cropping systems are increasingly affected by multidimensional pressures, including climate instability, soil fertility degradation, and market volatility. These challenges call for a systemic reconfiguration of production models. In this context, agroecology, conceived as an integrated, systemic, and place-based paradigm, offers a viable pathway to improve resource use efficiency, agroecosystem resilience, and socioeconomic sustainability. This contribution presents the results of a two-year field trial (2022–2024) conducted in Basilicata (Southern Italy), comparing a simplified conventional system with an agroecological system specifically designed in accordance with seven selected principles of agroecology. The experimental design, implemented under real on-farm conditions, was structured around four strategic components: (i) crop diversification, through three-year rotations including cereals (*Triticum durum* – durum wheat), legumes (*Vicia sativa* – common vetch, *Lens culinaris* – lentil, *Cicer arietinum* – chickpea), and oilseeds (*Brassica napus* – canola), combined with intercropping practices and multi-cultivar strategies to enhance temporal, spatial, and genetic diversity; (ii) input optimization, through site-specific nitrogen and phosphorus fertilization based on VRT (Variable Rate Technology); (iii) integration of microbial biotechnologies, via foliar application of *Methylobacterium symbioticum* SB23; (iv) functional comparison between simplified and complex agronomic strategies. The agroecological system achieved grain yields and protein content comparable to or higher than those of the conventional system, while significantly improving input efficiency. VRT-based fertilization led to an average reduction of nitrogen and phosphorus inputs by –39% and –30%, respectively, without compromising yield or quality. In unfertilized plots, the application of *M. symbioticum* resulted in an average yield increase of 17% compared to the control, with grain protein content reaching up to 13.5%

and total nitrogen accumulation comparable to that of conventionally fertilized plots. These findings highlight the contribution of foliar biological nitrogen fixation in low-input systems. In addition, under no-input management, the durum wheat-vetch intercropping system exhibited clear agronomic advantages, including an average increase of 2 percentage points in grain protein content, enhanced nitrogen uptake, and Land Equivalent Ratio (LER) values consistently above 1, indicating improved land-use efficiency. The entire protocol was co-designed with farmers and local stakeholders within the Living Labs of the AgriEcoMed and TECH4YOU projects, ensuring territorial adaptation, replicability, and scalability. The integration of crop diversification, site-specific input management, microbial biostimulants, and participatory co-design constitutes a robust and transferable model for the agroecological transition of Mediterranean cereal systems.