QUANTIFYING SOIL CARBON DYNAMICS: A COMPARATIVE ASSESSMENT OF CARBON FARMING VS. CONVENTIONAL SYSTEMS IN CORN AND SUNFLOWER CULTIVATION IN NORTH MACEDONIA

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Precise carbon determination transforms carbon farming from an empirical concept into a scientifically-driven, economically viable, and policy-relevant practice. It enables farmers and researchers to quantify soil health improvements and climate benefits, unlock new revenue via carbon markets, and foster adaptive management and sound policymaking rooted in hard data. In doing so, it advances the broader goal of sustainable, climate-smart agriculture—anchoring the study's comparative findings in real-world impact and long-term viability.

This study presents a comparative evaluation of carbon farming and conventional agricultural systems in the cultivation of corn (*Zea mays L.*) and sunflower (*Helianthus annuus L.*), focusing on their effects on soil carbon, nitrogen dynamics and other soil characteristics over a two-year period (2024-2025). Soil samples were collected at the beginning, midpoint, and end of the study to assess total organic carbon (TOC) and total nitrogen (TN) under each management system. The results demonstrated a consistent and significant increase in both carbon and nitrogen content in soils managed under carbon farming practices compared to those under conventional management. In corn plots, carbon farming led to a progressive accumulation of TOC and TN, attributed to organic matter inputs, minimal soil disturbance, and enhanced microbial activity. Sunflower plots also showed increased TOC and TN, although with a delayed response, likely due to the crop's higher nutrient demand and biomass turnover. In contrast, conventional systems showed stagnant or declining trends in TOC and TN, underscoring the limitations of intensive tillage and synthetic input dependence in maintaining long-term soil fertility. The findings highlight the potential of carbon farming as a viable strategy for enhancing soil health, increasing nutrient retention, and contributing to climate-smart agricultural practices in cereal and oilseed production systems.

Key words: carbon farming, conventional agriculture, soil organic carbon, total nitrogen, corn, sunflower, agroecological practices, soil fertility, climate-smart agriculture, sustainable soil management