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# **Session: 1. Agronomic strategies and transformations**



# LONG-TERM TILLAGE AND COVER CROPS INFLUENCE SOIL CO<sub>2</sub> EMISSIONS, COMPACTION, AND BIOMASS YIELD IN A MAIZE-SORGHUM ROTATION

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Sustainable agricultural production requires optimizing of soil physical conditions and minimizing greenhouse gas (GHG) emissions, particularly in intensively managed cropping systems. This study evaluated the combined effects of tillage systems and cover crops on soil CO<sub>2</sub> emissions, compaction, moisture, and biomass yields in a maize-sorghum rotation. The field trial started in 2017 at the Fondazione per l'Agricoltura "F.lli Navarra" (Ferrara) with the aim to compare three soil management systems [conventional tillage (CT), minimum tillage (MT), and no-tillage (NT)]. In addition, tillage radish (*Raphanus sativus* L. var. *longipinnatus*) and Phacelia (*Phacelia tanacetifolia* Benth.) were cultivated as cover crops during the winter period. Data were collected over two cropping seasons and included soil CO<sub>2</sub> flux and soil moisture at 15-days intervals, in addition soil compaction assessment in the 0-30 soil profile was measured at maize sowing (April), at cover crop sowing (September), and at sorghum planting (April). Biomass yield of both main crops and cover crops was recorded to evaluate carbon content and productivity. Statistical analyses were used to investigate the relationship between soil compaction, CO<sub>2</sub> emissions, and biomass production. Results showed that soil CO<sub>2</sub> emissions were highest in the conventional tillage system indicating increased microbial respiration due to organic matter input from cover crop mixture and greater soil disturbance. In contrast, no-tillage systems maintained lower emission rates but also exhibited higher compaction, especially at maize sowing, which negatively correlated with early crop establishment and biomass accumulation. Cover crops significantly affected soil properties contributing to a significant reduction in soil compaction. Soil moisture content was generally higher in NT and MT treatments compare to conventional soil management, likely due to improved residue cover and reduced evaporation. However, excessive compaction in NT also limited crop root exploration, which in some cases reduced biomass accumulation of both maize and sorghum crops. Across both

years, positive correlations were observed between lower compaction, reduced CO<sub>2</sub> emissions during critical growth stages, and higher biomass yield in both maize and sorghum. Overall, the integration of cover crops into conservation tillage systems demonstrated potential to improve soil physical conditions, reduce CO<sub>2</sub> emissions, and maintain biomass productivity, especially in minimum tillage system. Indeed, the reduction of soil compaction due to the mixture of cover crops was particularly effective under minimum tillage, where it balanced soil aeration and moisture retention. These findings highlight the importance of cover crop species to tillage systems to optimize agroecological benefits and mitigate climate impacts in Mediterranean cropping systems.

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