A INNOVATIVE LIFE CYCLE ANALYSIS METHODOLOGY TO ASSESS THE IMPACT OF THE VALORIZATION OF AGRICULTURAL WASTE PRODUCTS: THE CASE OF THE CONDENSE COMPOST

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EXECUTIVE SUMMARY

In Mediterranean areas, olive mill wastes constitute a significant environmental problem. The olive oil production system generates solid residues (olive cake) and aqueous effluents (OMWW) that can become phytotoxic due to their high phenol, lipid and organic acid concentrations. Due to the high cost of the various physico-chemical or biological treatments proposed, OMWW often remains untreated and it is directly discharged to the environment causing considerable pollution to both surface and ground waters. In many areas, olive mill wastes environmental impact is combined with pollution caused by animal manure and its management, with most common environmental problems being those of global warming, acidification and aquatic and terrestrial eutrophication. On the other hand, both OMWW and animal manure contain significant quantities of nutrients and organic matter that could be reused if properly treated.

The CONDENSE method addresses the need for a management option that minimizes the environmental impacts of both animal manure and OMWW while valorizing their valuable resources (organic matter, nutrients) in a cost effective way. The product of this method is a soil amendment that could considerably minimize the need for NPK inorganic fertilizers while also providing a solution to the environmental impacts of such wastes. The CONDENSE system is a set of processes that can be analyzed with Life Cycle Analysis (LCA) to quantify environmental impacts of all the stages included in the process from the production of the animal manure and OMWW to their treatment and the generation of the compost. However, existing impact categories in LCA do not allow the quantification of the benefits from the use of compost as soil amendment and thus adopt a cradle to gate approach.

While conducting LCA on compost products, the consequent interpretation is not able to incorporate the effects of organic amendments to soil functions (food and fibre production; filtering, buffering and transformation of water, nutrients and contaminants; storage of carbon and nutrients; and biological habitat provider as well as gene pool).

In this work, we propose a comprehensive LCA methodology where we combine the traditional LCA assessment with the use of the 1D - Integrated Critical Zone (1D-ICZ) model in order to account for the impacts of organic amendments to soil functions. The 1D-ICZ is an one dimensional model that links the development and loss of soil structure to nutrient dynamics and biodiversity by combining various submodels (Flow and transport model (Hydrus 1D); bioturbation; chemical equilibrium, weathering (SAFE); C/N/P dynamics and aggregate formation (CAST); and vegetation dynamics (PROSUM). The 1D-ICZ model simulates and quantifies the dynamics of C, N and P sequestration in soils in relation to soil structure and protection of organic matter; above- and below-ground C stocks including microorganisms, fungi and consumers; and solutes transformation and water filtration in soils. In this work, the 1D-ICZ model was used to simulate field data of a tomato cultivation experiment, to assess the impact of inorganic fertilization and the compost developed in the CONDENSE project, on soil functions. We compared soil function improvements due to compost addition that include biomass production, carbon and nutrient sequestration, soil biodiversity and water filtration and transformation compared to inorganic fertilization.

The proposed methodology compliments the LCA analysis by incorporating the impact on soil functions. This comprehensive LCA assessment can be used to evaluate tradeoffs of agro-ecological practices for sustainable land management. The innovative aspect of the proposed methodology is that it can be also used for product redesign in order to minimize the impacts to the environment. Finally, the enhanced LCA procedure can be used as a tool to design the application rates for optimum soil functions and minimize product emissions.

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