

Greenhouse gas emissions from orchard agroecosystems in Spain. A comparison between organic and conventional farming.

Eduardo Aguilera, Gloria Guzmán, Antonio Alonso, Juan Infante-Amate, and Manuel González de Molina
Agro-ecosystems History Laboratory, Universidad Pablo de Olavide, Spain (emagufer@upo.es)

Orchard agroecosystems are widespread in the Mediterranean area, accumulating large amounts of carbon in their living biomass. Organic farming could increase this carbon storage through soil carbon sequestration, which is enhanced with techniques such as cover cropping, residue incorporation and the application of organic amendments. An increase in energy efficiency could also contribute to the improvement of the greenhouse gas emission (GHGe) budget of woody perennial agroecosystems. However, full assessments comparing GHGe under organic and conventional management are scarce.

A cradle to farm gate, attributional life cycle assessment (LCA) of organic and conventional perennial woody cropping systems in selected growing areas in Spain was performed. Activity data of management practices was obtained from interviews to 42 pairs of organic and conventional growers of six types of crops: citrus, subtropical fruits, other fruits, treenuts, vineyards and olives. This information was linked to emission factors from LCA databases, IPCC guidelines and the scientific literature to calculate the total GHGe budget. Emissions associated to the production and of all industrial inputs were estimated, as well as direct and indirect emissions in the form of CO₂ from fuel combustion, N₂O from fertilizer application (using specific Mediterranean emission factors), and CH₄ and N₂O from biomass burning. Unproductive periods of the cropping cycle of perennial crops, as well as soil carbon sequestration were also taken into account. Coproduction of residual biomass, used as fuel wood, was accounted for through economic allocation. Results obtained with other allocation methods and system expansion are also shown.

Our results underline the dominance of fossil energy related emissions in Mediterranean cropping systems. Fuel combustion is the major contributor to GHGe from rainfed systems, while in irrigated systems the importance of other factors increase: N₂O emissions, irrigation energy and, in the case of conventional management, fertilizer production. Significant differences between organic and conventional management were found. Energy-related emissions were lower under organic management, but the major differences were due to increased carbon sequestration in organic farms. In some cases, the magnitude of carbon sequestration was larger than the sum of all other GHGe, in terms of CO₂ equivalents. This means that some organic orchard growers are obtaining carbon neutrality in their production process. The better performance of organic management is due to a high biomass recirculation in the systems, with large quantities of organic matter being applied to the soil in the form of cover crop aboveground and belowground biomass, pruning residues, composted agro-industry residues and animal manures.