

**Greenhouse gas emissions of Spanish sheep farming systems: allocating between meat production and ecosystem services**

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Sheep farming systems (SFS) in Spain are considered pasture-based and low-input, but large differences in input utilization, land use and intensification level exist, and their environmental impacts, therefore, are expected to differ. We used life cycle assessment (LCA) to evaluate and compare greenhouse gas (GHG) emissions of three contrasting SFS: (1) grazing (G): located in alpine mountains, with 1 lambing per year and free ranging; (2) mixed sheep-cereal (M): located in mid-altitude ranges, with 3 lambings in 2 years and guided grazing; (3) zero-grazing (Z): located in low altitude semi-arid conditions, with 5 lambings in 3 years and no grazing. The functional unit (FU) was 1 kg of lamb live-weight leaving the farm. Emissions of GHGs from on-farm processes and farm inputs were computed according to IPCC guidelines (Tier 2 level). Per FU, GHG emissions were highest for G (28.4 CO<sub>2</sub>-eq), intermediate for M (24.3 CO<sub>2</sub>-eq) and lowest for Z (19.5 CO<sub>2</sub>-eq). Besides meat, however, these, SFS also provide ecosystem services to society (e.g. biodiversity and landscape conservation). We valued these services for each SFS based on agri-environmental subsidies of the EU, and used economic allocation to distinguish GHG emissions of SFS between meat and ecosystem services. Correcting for multifunctionality of SFS, GHG emission per kg live-weight changed, i.e. lowest for G (15.2 CO<sub>2</sub>-eq), intermediate for M (18.0 CO<sub>2</sub>-eq) and highest for Z (19.5 CO<sub>2</sub>-eq). A comparison of GHG emissions among SFS should account for the multifunctionality of these systems.