

Hay Production in Sicily: A Case Study on Environmental Impact Across Two Seasonal Yields

Prestigiacommo Simona¹, Auteri Monica¹, Traverso Marzia², Mankaa Rose², Pedalà Maria Concetta³, Di Miceli Giuseppe¹

¹Department of Agricultural, Food and Forest Sciences, University of Palermo, Viale delle Scienze, Building 4, 90128 Palermo, PA, Italy;

²Institute of Sustainability in Civil Engineering in RWTH Aachen, 52074 Aachen, Germany;

³Circular S.R.L., Via Libertà 34, 90141 Palermo, Italy.

Hay production is essential for livestock farming with Italian forage crops covered approximately 6 million hectares in 2023. However, forage production is highly sensitive to climatic variation, which can significantly affect yields, increasing the environmental pressure per unit of product.

This study employs Life Cycle Assessment (LCA) to assess the environmental impacts of mixed hay production from different mediterranean forage species. Data were collected from a farm located in Cammarata (AG), Sicily, over two growing seasons: a high-yield (HY) season in 2021-2022 and a low-yield (LY) season in 2023-2024.

A "cradle-to-gate" system boundary was defined, covering the production and transport of inputs and field operations up to hay bale transport to the barn. Two distinct functional units (FUs) were employed: yield-scaled (ton of hay) and area-scaled (hectares of cultivated land).

The LCA, conducted using SimaPro 9.5.0.2 and the CML-IA baseline V3.09 / EU25 method, revealed that FU selection greatly influenced environmental performance interpretation. In the LY season, impacts per ton of hay were about 70% higher than in the HY season due to lower yields. However, when assessed per hectare, the difference was around 20%, suggesting that agronomic practices remained consistent, and environmental pressure per unit area did not change significantly.

Marine Aquatic Ecotoxicity per yield-scaled FU increased from 2.66E+05 (HY) to 1.02E+06 (LY) kg 1,4-DB eq. Similarly, GWP100a increased 3.3-fold, from 1.55E+02 (HY) to 5.12E+02 (LY) kg CO₂ eq, reflecting higher input requirements and increased emissions per unit of biomass.

Normalization of results showed the previous categories as the most affected, representing the primary areas of concern. Adaptive strategies will be essential for ensuring sustainable hay production while maintaining productivity.