The Role of Alfalfa in Carbon Farming
A Case Study in Emilia-Romagna

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Keywords: *alfalfa, life cycle assessment, soil organic carbon*

Alfalfa represents the most important forage crop in Italy, with a recognized role in environmental and climate protection. Alfalfa is a multi-annual leguminous plant that can cover the soil for 3-5 years, preserving it from erosion, does not require nitrogen fertilisation and, thanks to its expansive root system, improves infiltration and water supply in the soil (Guo et al., 2019). Due to these elements, fields in rotation with Alfalfa have higher soil organic carbon (SOC) than fields in monocultures (Sainju and Lenssen, 2011). The objective of this study is to assess the SOC in fields and the carbon footprint (CF) of alfalfa dry forage grown in hilly and flat areas in the Emilia- Romagna region (Italy) in order to evaluate carbon emission and removal associated to this crop.

Soil sampling in 0-30 cm layer was done in 88 sites, SOC and texture were evaluated by near infrared reflectance spectroscopy (NIRS) and Carbon stock (CS - Mg/ha) calculated (Dal Prà et al., in press). Dry Matter (DM) productions of aboveground biomass for all sites and for three years (2019, 2020 and 2021) were collected. CF was calculated both for cultivation and drying processes, according to ISO 14040-44:2006 and ISO 14067:2018.

The hilly area was characterised by silty-clay-loam soil while flat area by clay-loam soil. SOC was higher in flat (1.34%) than hilly (1.27%) areas and CS was 55.5 and 53.0 Mg/ha respectively. The average aboveground biomass was 10.03 Mg/ha (DM), 11.03 Mg/ha (DM) and 7.26 Mg/ha (DM) for 2019, 2020 and 2021 respectively. The flat area produced an average of 9.19 Mg/ha (DM), while the hilly area 9.06 Mg/ha (DM). CF for a ton of Alfalfa DM related to cultivation process was higher in 2021 (95.9 kg CO2 eq/t) than in 2019 and 2020 (78.5 and 77.4 kg CO2 eq/t respectively), as well as higher in flat (99.2 kg CO2 eq/t) than in hilly (72.8 kg CO2 eq/t) area.

CF for a ton of Alfalfa DM (cultivation + drying process) was 138 (kg CO2 eq/t), 139 (kg CO2 eq/t) and 146 (kg CO2 eq/t) for 2019, 2020 and 2021 respectively. The higher CF registered in 2021 is due to the dry season that reduced severely DM production. CF cultivation represent 68% of the total CO2 emission in 2021 while it was 57% and 56% for 2019 and 2020 respectively.

The survey made in this study on Alfalfa cultivated fields shows CS average value higher than the ones reported by Emilia-Romagna region Environmental service for plain (52 Mg/ha) and hilly (45 Mg/ha) areas. The results of the study indicate that even in the eastern areas of Emilia-Romagna region alfalfa can increase the soil CS compared to the territorial average values . At the same time, it is a crop with low levels of carbon emissions.

The presented study was carried out with the support of the operational group for agricultural productivity and sustainability mediCArbonio, RDP 2014-2020 EMILIA-ROMAGNA Region.

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