

Abstract

Greenhouse gas (GHG) emissions from the agricultural sector play a significant role in global warming and climate change. Soils act as both sources and sinks of greenhouse gases (GHGs), including nitrous oxide (N_2O), carbon dioxide (CO_2) and methane (CH_4). While previous studies have largely examined the contribution of agriculture and land-use change to anthropogenic GHG emissions, the contribution of specific soil properties to GHG emissions remains less clear. Therefore, this review synthesizes previous studies not only on broader soil properties but also highlights specific soil variables and their interactions within these broader categories that contribute to individual GHGs and regulate their production and emissions. We conclude that soil physical, biological, and chemical properties are important drivers of GHG emissions. Physical properties include soil temperature, bulk density, water content, soil structure, texture and porosity. Biological properties, particularly biological processes and chemical properties, including soil pH, organic matter, soil carbon, cation exchange capacity (CEC) and micronutrient availability, interact to regulate GHG production, consumption and emissions. Understanding these soil-specific controls is therefore essential for developing effective and context-specific strategies for reducing GHG emissions and enhancing the mitigation potential of agricultural soils.