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Accounting for Carbon Offsets in Agriculture: Enhancing Sustainability through Soil Organic Carbon (SOC) Sequestration

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As the third-largest driver of climate change, the agricultural industry accounts for at least 22% of global greenhouse gas (GHG) emissions, making it a major source of carbon emissions. Since soils in agriculture represent the largest terrestrial carbon reservoir that can be enhanced through improved land management practices, these practices have the potential to alter the balance of soil organic carbon (SOC). By adopting climate-smart carbon farming practices (e.g. conservation tillage, organic farming, cover cropping, crop rotations), farmers can mitigate or potentially reverse the loss of carbon from their fields. One approach to facilitate the trading of environmental commodities that represent SOC sequestration in agriculture is through a carbon market, which typically denotes an economic instrument designed to mitigate agricultural emissions by providing financial compensation for each metric ton of CO_2 emissions avoided. Agricultural land managers can receive direct compensation for the removal and storage of CO_2 in the form of SOC as carbon offsets. As carbon offsets possess monetary value and can be traded as instruments within carbon markets, this mechanism creates a potential mutually beneficial opportunity, where farmers are compensated for SOC sequestration, while other sectors gain the ability to mitigate their CO_2 emissions.

Since there is a current lack of focus on specific mitigation techniques and outcomes of carbon offsets in SOC sequestration, the research *aims* to propose comprehensive methodologies for accounting for carbon offsets in agriculture, with a specific focus on both sustainability and simplified Measurement/Monitoring, Reporting, Verification (MRV) processes that enable farmers to actively observe their carbon footprints while contributing to emission reduction efforts. To address this question, the research explores the existing MRV methods and approaches by employing systematic, scoping and critical literature review along with an analysis of current regulatory protocols, guidelines, standards and MRV initiatives for SOC sequestration. As a result, the research outlines a conceptual methodology for an integrated MRV processes designed for agriculture that could facilitate the quantification, monitoring, reporting and verification of carbon offsets and SOC changes.

The *findings* indicate that MRV methodologies for measurement/monitoring part refer to tracking changes in emissions or sequestration levels over time. Reporting involves the structured processes for communicating these findings, while verification plays a crucial role by requiring project administrators or independent auditors to thoroughly assess and

confirm the accuracy, completeness, and credibility of the reported results, thereby ensuring compliance with established standards and maintaining the integrity of the carbon offset program. Firstly, accurate accounting of SOC changes in agriculture should utilize established measurement and monitoring approaches (measurement/monitoring part), including field-based direct measurements, modelling techniques, remote sensing or lookup tables. The chosen approach should be simple to implement, considering local conditions, to minimize costs for both administrators and farmers. Once data collection is completed, all relevant information should be compiled and reported (reporting part). For reporting SOC changes, carbon project developers should select the earliest reliable data point available. Reporting periods can range from 1 to 5 years for soil carbon projects. Additionally, when registering a soil carbon project, developers must choose a permanence period of either 25 or 100 years, during which the carbon sequestered in the soil must be preserved. To register a soil enrichment carbon project, developers are required to submit several reports: a re-implementation report, an initial report, bi-annual reports, and a final report. Finally, to ensure compliance with the established requirements, an external auditor should review the measurement and monitoring results and verify the amount of greenhouse gas benefits achieved and documented by the carbon project (verification part). Upon successful verification, carbon credits can be issued using different payment models including action-based, results-based and hybrid payment approaches.