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Carbon markets and food system climate change mitigation: Evidence from the clean development mechanism

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Abstract

While carbon market mechanisms like the Clean Development Mechanism (CDM) offer a promising pathway to measurable mitigation outcomes, their contribution to food system emissions has not yet been systematically studied. The study applied a quantitative, retrospective analysis using the CDM pipeline dataset, covering projects from 2002 to 2023. A stepwise filtering approach reduced 12,896 projects to 483 food system–related projects related to Article 6, followed by classification across food system stages, project types, and regions. GHG emission reductions were analysed using annual values reported by the projects and modeled with a Gamma-based GLM, while SDG co-benefits were identified through keyword-based text analysis of project documents. Our results show that CDM projects contributed approximately 606,555 ktCO e in emission reductions across the food system. Food waste management related projects alone account for 562,951 ktCO e of total mitigation, while production (17,929 ktCO e), consumption (16,457 ktCO e), processing (4,759 ktCO e), pre-production (786 ktCO e) and projects contributing to more than one food system stage remain marginal. Similarly, mitigation outcomes are dominated by a narrow set of technologies, with landfill gas (66 %), methane avoidance (17.3 %), and biomass energy (13.6 %) accounting for over 96.9 % of total reductions. Regionally, the Americas (49.8 %) and Asia (41.7 %) together contribute more than 90 % of total emission reductions, while Africa accounts for only 8.1 %, highlighting persistent structural inequalities in carbon market participation. Regression results indicate that mitigation performance is primarily driven by project type and duration rather than food system stage or geography. Projects using high-performing technologies and longer implementation periods consistently achieve greater emission reductions. Beyond mitigation, the contribution to sustainable development is uneven. SDG6 (clean water and sanitation) and SDG7 (affordable and clean energy) account for 39.3 % and 22.8 % of project co-benefits, respectively, while 19.5 % of projects report no SDG contribution. Although CDM has demonstrated its ability to mobilise mitigation at scale, it falls short of enabling a balanced, system-wide transformation. These findings highlight the need for more inclusive, flexible, and context-sensitive carbon market mechanisms under Article 6 to unlock the full mitigation potential of food systems.

Keywords: Carbon markets and clean development mechanism, climate finance, food system, greenhouse gas emissions

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