

A green roadmap for vietnam's agriculture and forestry: From carbon farming to Comprehensive circular bioeconomy governance

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Abstract

In the era of the 2050 Net-Zero commitment, Vietnam's agriculture and forestry sectors are standing at a historic crossroads: transitioning from a paradigm of chemical-intensive extractive farming to ecological governance and proactive carbon farming. Decades of intensive chemical inputs and aggressive mechanization have severely depleted soil organic matter (SOM) across tropical agricultural zones, causing soils to lose between 25% and 75% of their original carbon stocks. This has transformed vital land resources from natural carbon sinks into primary sources of greenhouse gas (GHG) emissions. This strategic paper proposes a comprehensive, localized green roadmap to restructure Vietnam's circular bioeconomy by synthesizing empirical successes and addressing systemic technological and institutional bottlenecks.

Practically, this roadmap highlights two landmark, nationally scalable Nature-based Solutions (NbS): the Forest Emission Reductions Payment Agreement (ERPA) in the North Central region, and the 1-Million-Hectare High-Quality, Low-Emission Rice Project in the Mekong Delta. Technologically, the roadmap emphasizes governing microbial and organic flows in soil, prioritizing carbon accumulation in stable Mineral-Associated Organic Matter (MAOM) rather than volatile Particulate Organic Matter (POM). We raise a critical technical warning regarding the over-promotion of raw biochar: as biologically inert 'dead carbon,' it can cause short-term Nitrogen and Phosphorus deficiencies unless co-composted; furthermore, its pyrolysis must be strictly regulated to mitigate carcinogenic Polycyclic Aromatic Hydrocarbons (PAHs) and prevent overall carbon leakage. Restructuring landscapes by ecological regions is vital: protecting peatland pockets in the Mekong Delta via rewetting and paludiculture prevents catastrophic emissions of up to 30 tons of CO₂/ha/year, while multi-strata Agroforestry in the Highlands can sequester carbon equivalent to half of the entire agricultural sector's

emissions if applied to just 9% of land. To democratize carbon markets for smallholders, we advocate integrating low-cost, digital MRV technologies (remote sensing, IoT, and AI).

Institutionally, this paper seeks to invert the 'reverse pyramid' characterized by a top-heavy focus on voluntary markets but a weak baseline of mandatory soil protection standards. We propose rapidly passing the draft Decree on forest carbon sequestration (amending Decree 06/2022/ND-CP) before June 2025 to clarify private property rights; instituting 'corresponding adjustments' under Article 6 of the Paris Agreement to resolve double-counting; restructuring new-style cooperatives as centralized carbon risk managers; and institutionalizing a legislative five-tier biomass utilization hierarchy (Food → Feed → Nutrient Return → Biomaterials → Bioenergy). Once resolved, this green transition is estimated to contribute an additional 0.43% to Vietnam's GDP annually during the 2025-2030 period, establishing a highly competitive, self-reliant, and ecologically resilient bioeconomy.

Keywords: Carbon farming; Circular bioeconomy; Carbon credits; MRV system; Ecological governance; Carbon institutions; Nature-based Solutions (NbS); 1-Million-Hectare Rice Project.