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# Offsetting Emissions through On-site Carbon Accounting in Agroforestry: the Case of Carbon Neutral Certified Coffee

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**Abstract**

Today farmers suffer from multiple social-ecological and economic pressures and accelerated changes in production conditions. Agroforestry systems are recognised as a promising approach as it has the ability to address a wide range of these challenges. Particularly the high potential of agroforestry systems for climate change mitigation through carbon sequestration becomes increasingly important. Agriculture is not only affected by climate change but also contributing significantly to it; 19–24 % of greenhouse gas emissions originate from the agri-food sector. Carbon related standards and certifications such as the Publically Available Specification (PAS) 2060 for carbon neutrality are on the rise. However, the biogenic carbon sequestration by agroforestry systems is not accounted for in such Life Cycle Assessment based certifications so far. Therefore, compensation of GHG emissions remains subject to offsetting by obtaining international carbon credits. Carbon offsetting has been often criticised for its lacking transparency and sustainability. Whereas, accounting for on-site carbon sequestration could incentivize agroforestry production systems and address consumers demand for low-carbon and sustainable agri-food products.

This study investigated the Costa Rican case of the world's first coffee that is certified as carbon neutral in compliance with PAS 2060 since 2011. The objective was to analyse the carbon sequestration potential of coffee-agroforestry-systems in Costa Rica and estimate to which extent it could compensate the coffee's carbon footprint. We developed a carbon sequestration model, with a time horizon of 20 years, based on a detailed carbon stock assessment in selected transects.

Carbon sequestration on average reached $1.71 \pm 2.64$ t C $ha^{-1}$ $yr^{-1}$, which corresponds to findings from existing literature on coffee-agroforestry-systems in Central America. This on-site carbon sequestration rate would compensate the coffee carbon footprint of 2.79 kg $CO_2$eq $kg^{-1}$ green coffee by 160 %. Factors, determining the potential of emission offsetting are: carbon sequestration $ha^{-1}$ (most influential), yield $ha^{-1}$ and carbon footprint of the product (least influential). The study shows the high potential that accounting for on-

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site carbon sequestration has to replace unsustainable carbon credits. By this, it can promote agroforestry systems as a management option for farmers to tackle the multifaceted challenges today and in future.

**Keywords:** Carbon neutral, carbon sequestration, coffee agroforestry, Costa Rica