Agricultural Greenhouse Gases Program (AGGP2)

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# Enhancement Planting and Soil Amendment Enhance C Sequestration in Agroforestry Systems

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## Introduction

Planting failure, tree damage by field equipment, or intentional and unintentional removal of trees can create gaps in agroforestry systems. Gaps in the treed component of agroforestry systems can impair the ecological function of those systems to trap snow (in regions with snowfall), reduce wind speed, and decrease soil carbon (C) sequestration. Those gaps can be filled by planting trees (enhancement or in-fill planting). Soil amendments such as inorganic fertilizers and manure are added to the cropland component of agroforestry systems to increase soil productivity and sustainability. The type of amendments used can affect the ability of agroforestry systems to sequester C and the emission of greenhouse gases (GHGs). We reviewed the literature to provide a synthesis of existing knowledge on the effect of enrichment planting and soil amendments on C sequestration and GHG Emissions in agroforestry systems

## Methods

A literature search was conducted using Google Scholar and ISI Web of Science with the following keywords: “agroforestry”, “carbon sequestration”, “biochar”, “composting”, “enrichment planting”, “environmental service”, “greenhouse gas emission”, “manure”, “manure pellet”, and “secondary forest”. The search resulted in more than 200 publications. Those publications were screened for their content on soil C sequestration and GHG emissions in agroforestry systems, resulting in more than 80 publications that were used for this review.

## The Result

Only a few studies have examined the effect of enrichment planting in agroforestry systems; those studies show that enrichment planting increases C storage in plant biomass, particularly in shelterbelts or silvopastoral systems. Greater tree species richness and density benefit soil C sequestration; broadleaf tree species perform better in increasing soil C storage.

Application of biochar to cropland soils has been shown to increase soil organic C content, reduce $CO_2$ and $N_2O$ emissions, and increase $CH_4$ uptake. Biochar addition can reduce $N_2O$ emissions by 3-84%, depending on the feedstock type used for producing the biochar. Less $CO_2$ and $N_2O$ are emitted when compost is applied to soil instead of manure, while more $N_2O$ is emitted when pelleted manure is applied instead of raw manure.

Fig. 1. An example of agroforest establishment. Proper management of weed competition and prevention of damage by wildlife browsing is essential.

## Implications

Planting of trees into gaps of forested areas within agroforestry systems helps to improve the ecological function of the system. Enhancement or in-fill planting should be encouraged to improve the ecological goods and services of agroforestry systems. Application of organic amendments such as compost and biochar should be favored instead of raw manure for enhancing C sequestration and reducing GHG emissions in the cropland component of agroforestry systems.

## Further Reading

Shrestha, B.M., Chang, S.X., Bork, E.W., Carlyle, C.N. 2018. Enrichment planting and soil amendments enhance carbon sequestration and reduce greenhouse gas emissions in agroforestry systems: A review. Forests 9, 369; doi:10.3390/f9060369.

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