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Payment for Ecosystem Services in Haiti’s Central Plateau: Carbon, Coffee and Community Collaboration

Deborah McGrath\(^1\), Reginald Cean\(^2\) and Keri Watson\(^3\)

Departments of Biology\(^1\) and Earth and Environmental Systems\(^3\),
The University of the South, Sewanee, TN USA

\(^2\)Association Zanmi Agricol, Corporant, Haiti

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Paying small farmers to plant and maintain trees

mitigates CO₂ emissions by encouraging carbon sequestration and facilitates the transition to more productive climate-resilient agroecosystems
Trees provide a multitude of benefits

- Leaves from the trees enrich the soil and help keep it moist.
- Trees absorb carbon dioxide from the air.
- Trees provide firewood, timber and sometimes have medicinal properties.
- Trees stabilise the ground and reduce soil erosion.
- Nitrogen fixed by the trees benefits the crops.
- Manure from animals is used for crops and trees.
- The farmer gets milk, fruit and other food from the farm.
Small farmers face high opportunity costs for maintaining trees, despite the severe consequences of deforestation.

Limited land is cleared to grow annual subsistence crops.

Charcoal, the most commonly used fuel, sells for a high price.

Charcoal sells for $30-40 per sack.

Watershed protection has no market value.
Table 1. Examples of ecosystem services (from McGrath and Greenwalt 2013).

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<th>Provisioning Services</th>
<th>Regulatory Services</th>
<th>Cultural Services</th>
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<tr>
<td>food</td>
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<td>spiritual &amp; religious</td>
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<td>fresh water</td>
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<td>recreation &amp; ecotourism</td>
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<td>biomass &amp; fuel</td>
<td></td>
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Supporting Services
- habitat provision & stabilization, soil formation, nutrient cycling, primary production, oxygen production
- Waste assimilation, detoxification & purification

Adapted from Ecosystem and Human Wellbeing A Framework for Assessment (Millennium Ecosystem Assessment) and Measuring Nature’s Benefits: A Preliminary Roadmap for Improving Ecosystem Service Indicators (Layke 2009)
Payment for ecosystem services (PES) may help offset high opportunity costs by adding value to other environmental services.

Ecosystem services are benefits that people derive from nature.

People alter ecosystems in pursuit of services that pass through a market exchange often to the detriment of services whose value is external to financial markets.

Payment for ecosystem services are voluntary transactions in which land stewards are paid for management practices that result in continued or improved ecosystem service provision.
Agroforestry systems offer a “bundle of services” that PES programs can support

**Ecological** - Carbon sequestration, watershed protection, biodiversity conservation, soil conservation (thereby generating more supporting services)

**Socioeconomic** - Augment farmer incomes during tree establishment, encouraging adoption of diverse, asset-building agroforests that raise farm productivity, increase resiliency and improve livelihoods, thereby **meeting** multiple Millennium Development Goals

Can PES offer a meaningful tool for restoring ecosystem health and transferring income to the rural poor? (Milder et al. 2010)
Can PES work in Haiti to restore degraded land and raise household incomes?
Zanmi Kafe
Pilot PES program in Haiti’s Central Plateau

Partnership among farmers, Association Zanmi Agrikol (AZA) and the University of the South (UoS)

Shade coffee-based agroforestry system initiated in 2013 in the Central Plateau community of Bois Jolie (n= 50 farms ≤ 2 hectares each)

Ecosystem service payments to farmers funded by a “Green Fee” paid by UoS students that also promotes sustainability education on campus

Students verify and monitor environmental service provision (carbon sequestration, biodiversity, soil restoration) and conduct on-farm research
2013
Tree nurseries established

2014
Trees planted
Measured survival and growth of 4 species for 5 years (2014-2019)
Students monitor seedling survival, growth and health while they conduct verification surveys.
Payments made in 2015 - 2019 based upon surveys of survival and growth on every farm
Tree survey data was used to estimate total CO$_2$ sequestration across 50 farms

We compared estimates from 3 equations:

\[ Y_{\text{total}} \text{ (kg)} = 1.163 + 0.017 \text{dbh}^2 \text{H} \text{ (Cole and Ewel 2006)} \]

\[ Y_{\text{total}} \text{ (kg)} = \exp(-2.187 + 0.916 \ln(p \times \text{dbh}^2 \text{H}) \text{ (Chave et al. 2005)} \]

\[ Y_{\text{total}} \text{ (lbs)} = 0.25 (\text{dbh}^2 \text{H}) \text{ (Trees For the Future)} \]

Y = above ground mass; dbh = diameter at breast height; H = height
P = wood density (0.42); Mass * 1.2 = above + belowground per tree;
Kg C/tree = 50% dry mass; sequestered CO$_2$ = carbon mass *
Fig. 4. Estimates of total CO2 sequestered across 50 farms (<0.5 ha each) using tree 5-year tree height and diameter data in three equations. Equation 1 estimate based upon wood density of 0.43 g/cm.
Results

Over 5 years, the total number of trees planted increased by > 40% despite 50% survival of *C. Arabica typica* during the first year.

Canopy trees *Swietenia* and *Cedrela* increased nearly 10-fold.

This coincided with increasing payments to farmers.

Canopy trees had relatively high growth rates despite site limitations (dry microclimate, rocky nutrient-poor soils).

In 2018 some farms started to harvest and sell coffee.

Between 80-120 Mg CO$_2$ was stored (average 2.2 Mg/farm).

These trees are projected to sequester 140-250 Mg CO$_2$ per year.
Tree cover tripled over 5 years
Canopy trees increased 10-fold
Young trees rapidly sequester carbon (~200 Mg/year)
Farmers are harvesting coffee
Farmers avoided deforestation
Soils are protected & enriched
More families are joining
The graph shows the CO2 sequestered (tons) from 2015 to 2019. The categories are Canopy trees and Coffee understory. In 2019, the graph indicates a significant increase in CO2 sequestered, reaching 120 metric tons CO2.
Fig. 1. Total number of trees growing on farms in the zone of Bois Jolie, Central Plateau Haiti by year and species across 50 farms. Canopy trees increase over time as farmers receive carbon payments.
Fig. 2. Total number of trees growing on farms in the zone of Bois Jolie, Central Plateau Haiti by species and year (50 farms). Non-coffee canopy trees increase over time as farmers receive carbon payments.
Fig. 3 A and B. Mean (± one std err) height (cm) and diameter (mm) growth of *Swietenia mahogani, Cedrela odorata, Coffea Arabica typica, Coffea Arabica katura* and *Mangifera indica* growing on farms in the zone of Bois Jolie, Central Plateau Haiti (n=50 farms).
Payments for ecosystem services can work for small farmers in the poorest of countries

- Payments for carbon sequestration had an incentivizing effect on tree planting and maintenance.

- CO₂ sequestered in Haiti is **highly additional**

- **Payments avoided deforestation.** Half the households surveyed used carbon payments to purchase items that would normally be paid for by cutting trees and making charcoal for sale

- **Families are selling products** from their agroforestry systems (which encourages more tree planting)
PES linked to agroforestry meets Millennium Development Goals
Partnerships with academic institutions help remove barriers to implementing PES programs

These services are highly valued by academic institutions concerned with sustainability

Getting the price right matters. We recommend paying farmers $20-50/Mg CO₂ for the bundle of services provided by agroforests (~bag of charcoal)

Costs of monitoring and verification can be significantly reduced by academic researchers and teams of students (who seek these experiences)
Ongoing work

- Refine estimates of CO$_2$ sequestration and compare with CO$_2$ emitted to calculate true carbon offsets
- Expand pilot project to more communities in Haiti - seek new partnerships
- Diversify agroforestry systems with more tree crops
- Continue ecological and ecosystem service studies (diversity indicators, nutrient cycling, other watershed benefits)
Appreciation for Our Collaborators and Supporters

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