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AGREACH AN ILLINOIS PROGRAM FOR SMALLHOLDER EXTENSION +

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

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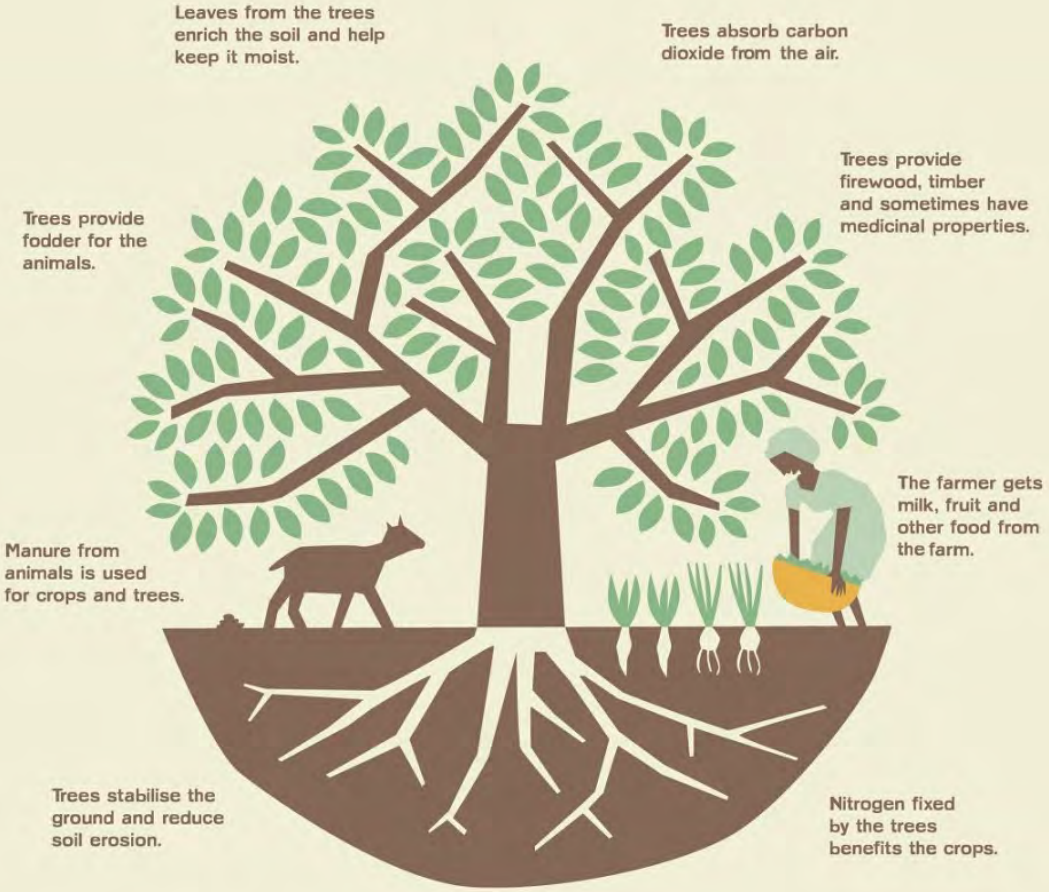
Paying small farmers to plant and maintain trees

mitigates CO_2 emissions by encouraging
carbon sequestration
and facilitates the transition to more
productive climate-resilient agroecosystems

Trees provide a multitude of benefits



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).

Provisioning Services	Regulatory Services	Cultural Services
food	climate	spiritual & religious
fresh water	diseases	recreation & ecotourism
biological raw materials	pests	aesthetic
biochemicals	water	inspirational
medicines	air	educational
genetic resources	soil	sense of place
biomass & fuel		cultural heritage
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 $\leq$ 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

University of Texas Libraries: http://www.lib.utexas.edu/maps/americas/haiti_rel99.pdf

2013
tree
nurseries
established

2014
trees
planted

Kajou peyi (*Swietenia mahogani*)

Sèd (Cedrela odorata)

Mango (*Mangifera indica)*

Measured survival and growth of 4 species for 5 years (2014-2019)

Kafe (*Coffea arabica)*

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 cross 50 farms

We compared estimates from 3 equations:

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

Y_{total} (kg) = EXP(-2.187+0.916*LN(p* dbh^2*H (Chave et al. 2005)

Y_{total} (lbs) = 0.25 (dbh^2H) (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 *

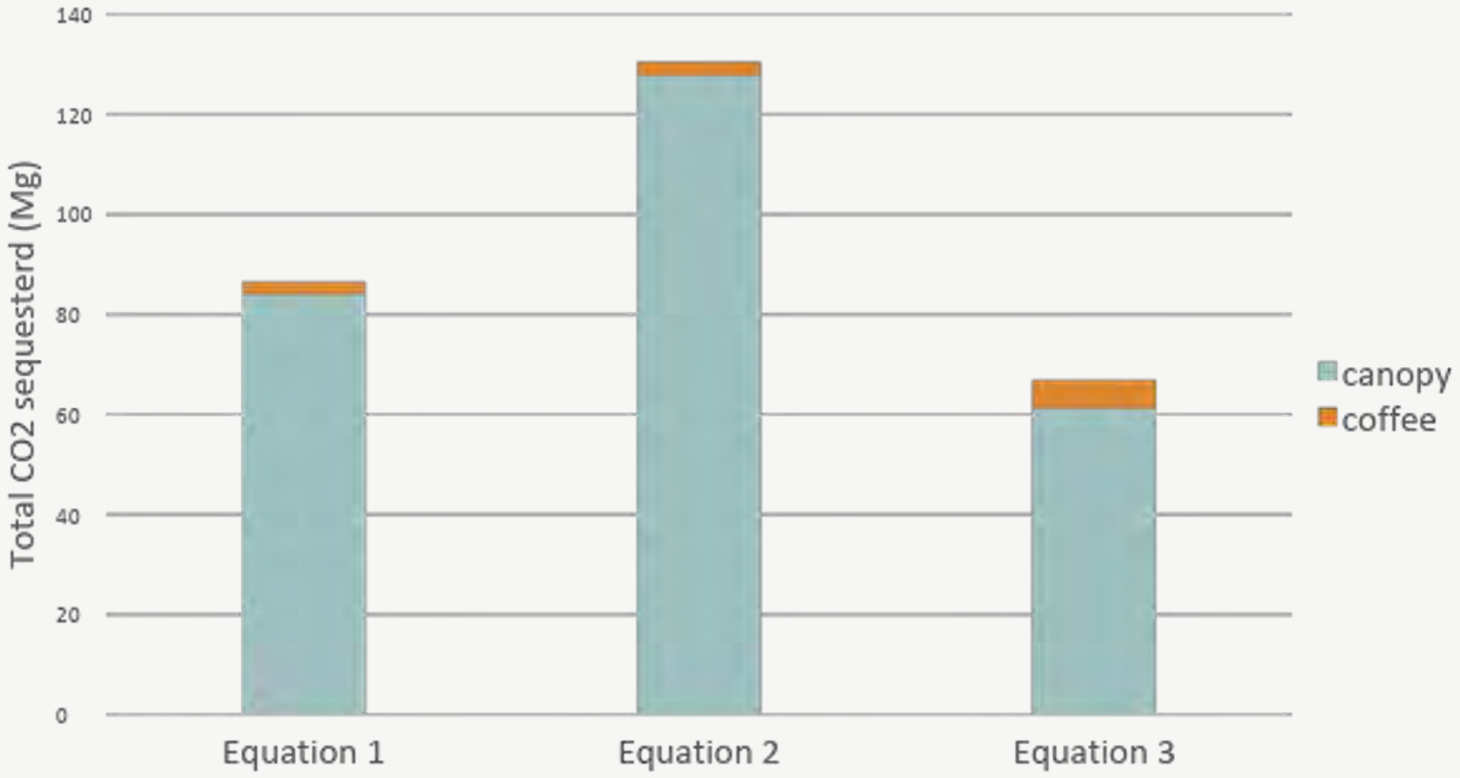


Fig. 4. Estimates of total CO2 sequestered across 50 farms (<0.5 ha each) using tree 5-year tree height and diameter data in three equations. Equation 1 estimate based upon wood density of 0.43 g/cm.

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

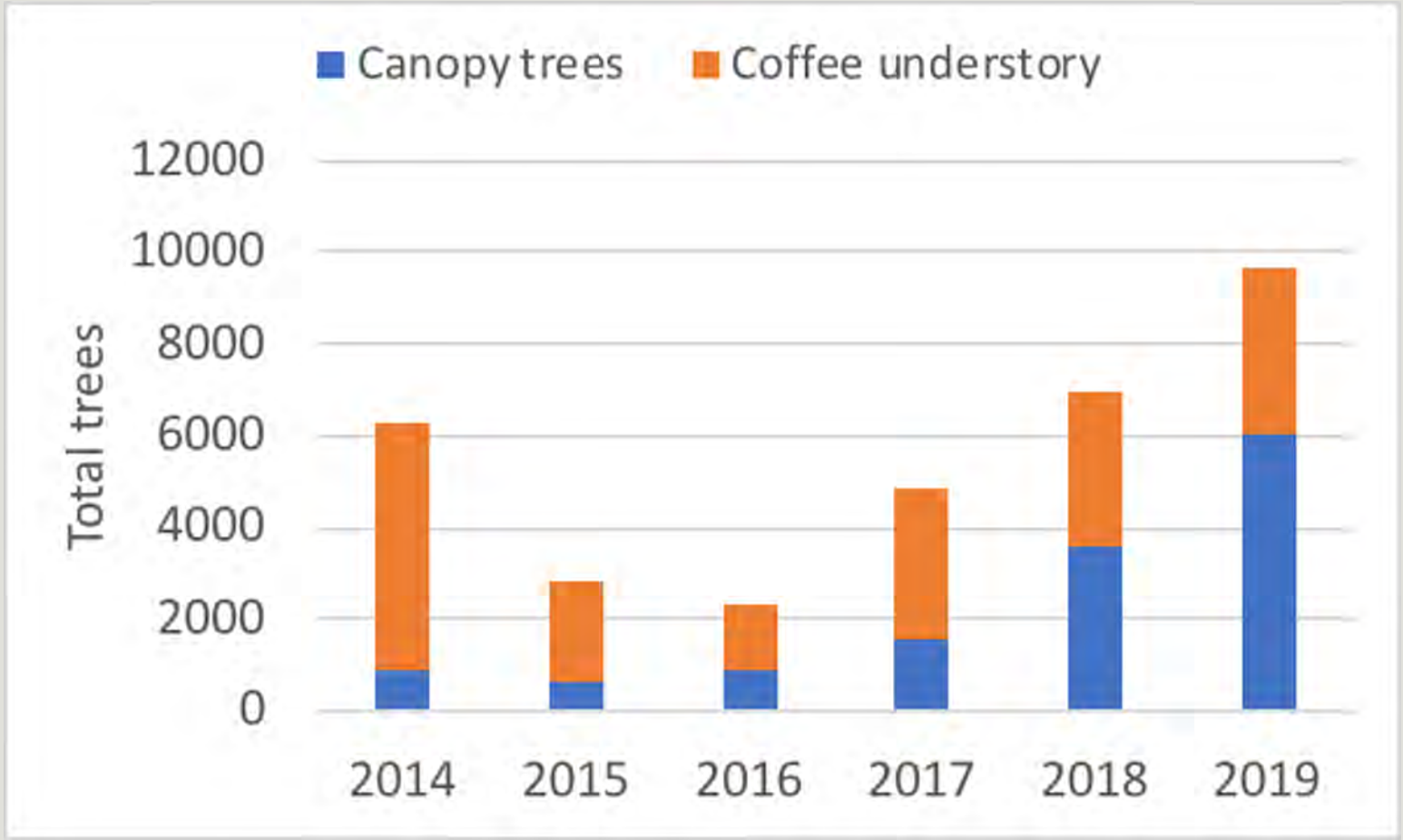
Young trees rapidly sequester carbon (~200 Mg/year)

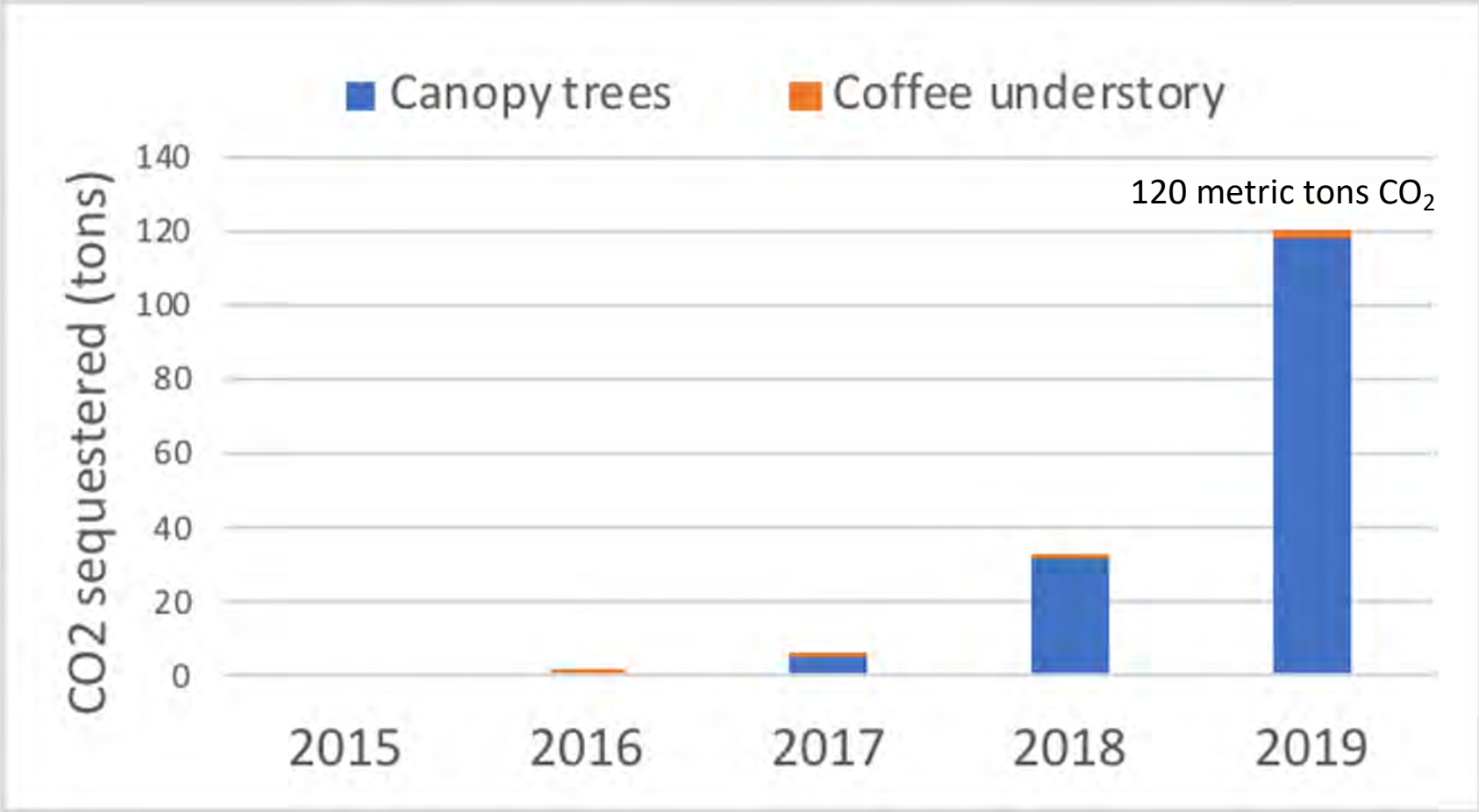
Farmers are harvesting coffee

Farmers avoided deforestation

Soils are protected & enriched

More families are joining


Canopy trees
Coffee understory
Total trees
12000
10000
8000
6000
4000
2000
0
2014
2015
2016
2017
2018
2019


Canopy trees
Coffee understory
CO2 sequestered (tons)
140
120
100
80
60
40
20
0
2015
2016
2017
2018
2019
120 metric tons CO_2

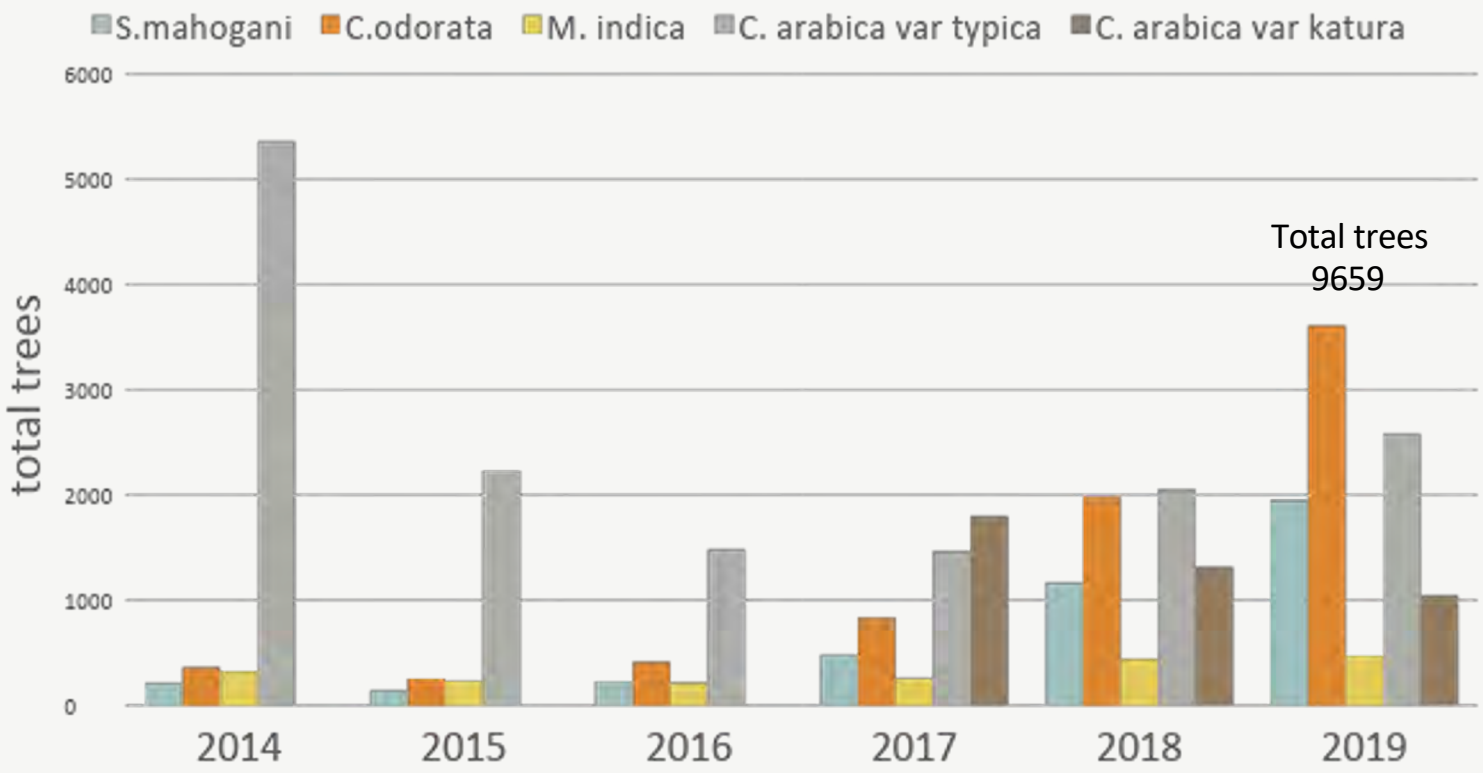


Fig. 1. Total number of trees growing on farms in the zone of Bois Jolie, Central Plateau Haiti by year and species across 50 farms. Canopy trees increase over time as farmers receive carbon payments.

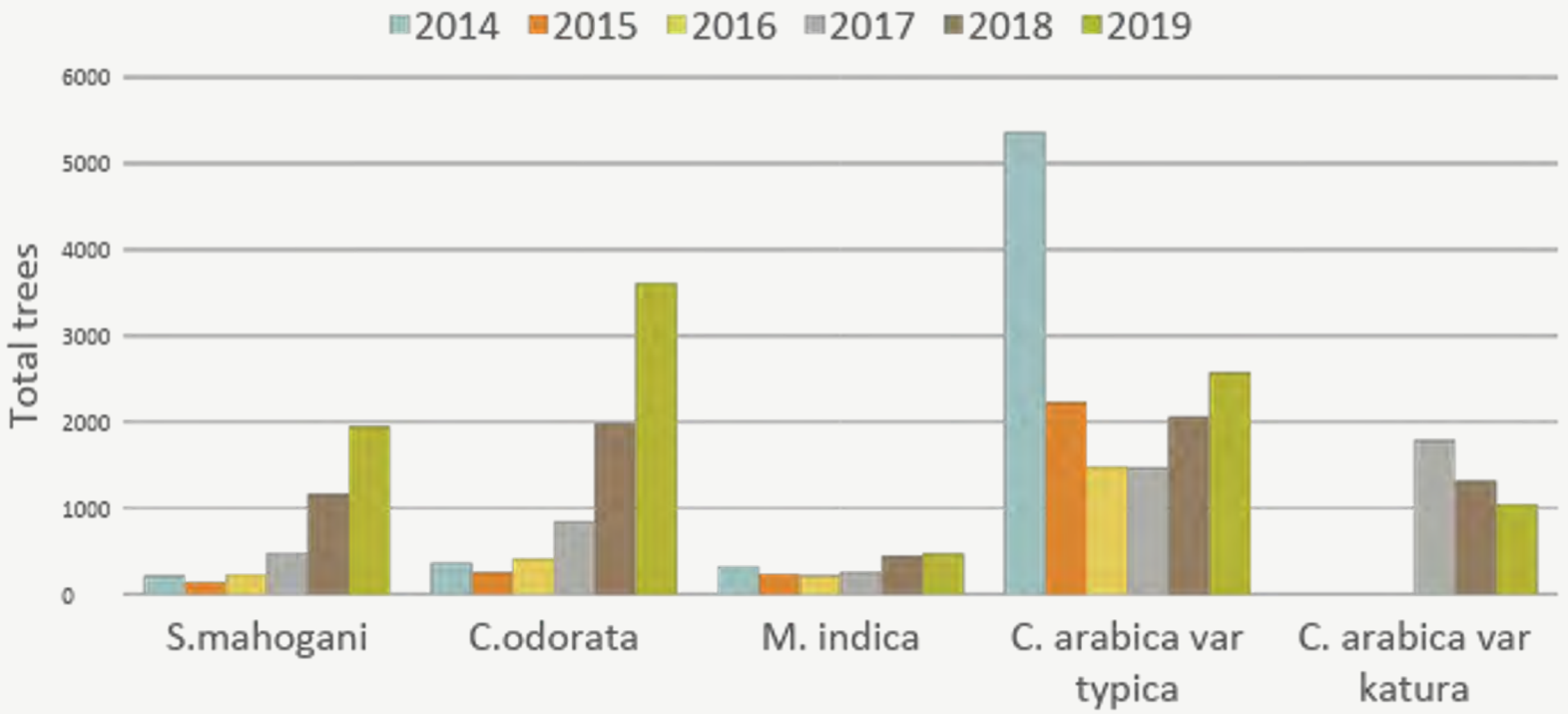


Fig. 2. Total number of trees growing on farms in the zone of Bois Jolie, Central Plateau Haiti by species and year (50 farms). Non-coffee canopy trees increase over time as farmers receive carbon payments

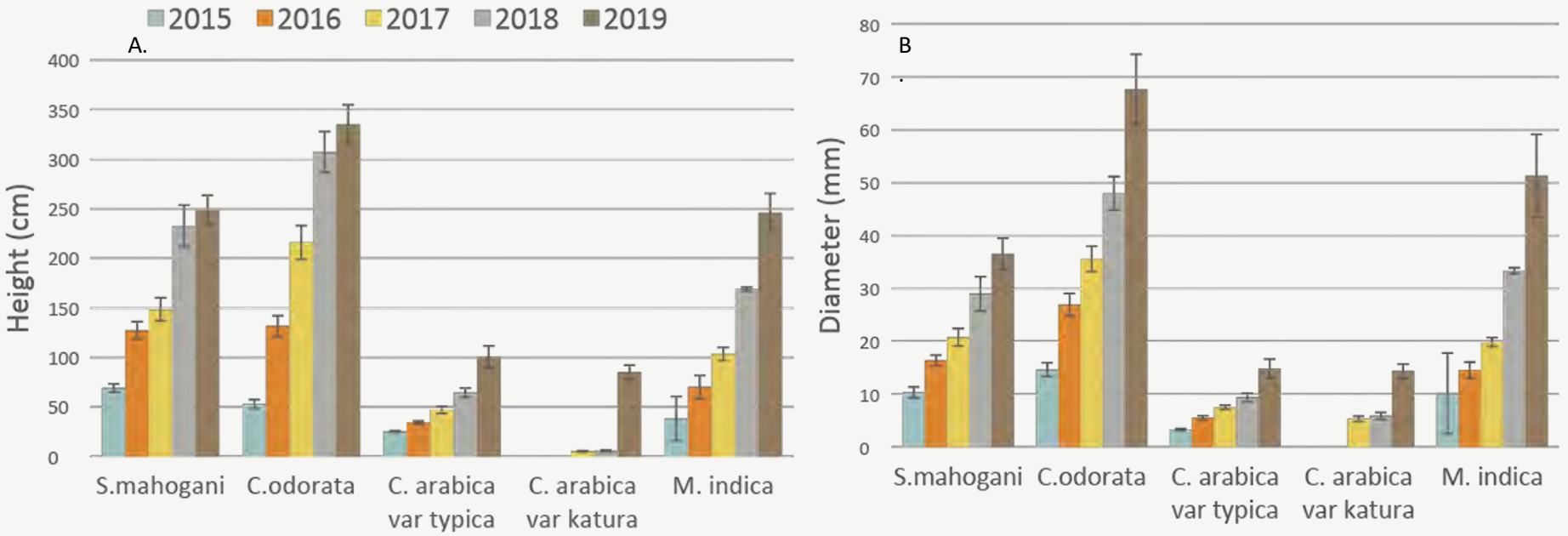
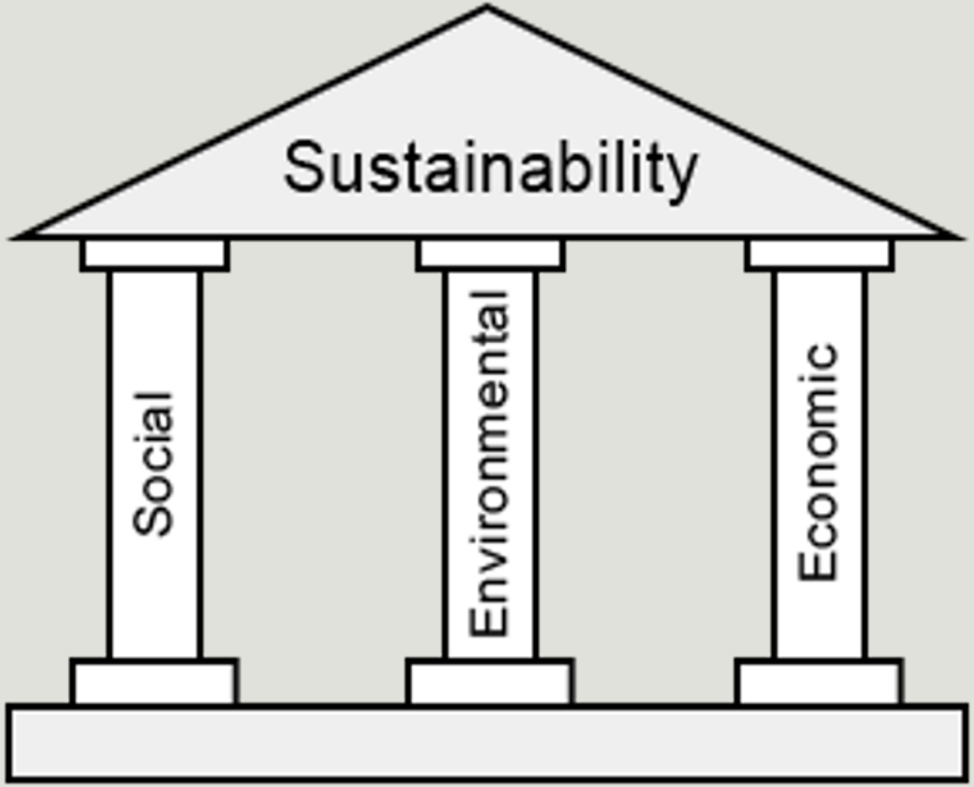


Fig. 3 A and B. Mean (± one std err) height (cm) and diameter (mm) growth of *Swietenia mahogani*, *Cedrela odorata, Coffea Arabica typica*, *Coffea Arabica katura and Mangifera indica* growing on farms in the zone of Bois Jolie, Central Plateau Haiti (n=50 farms).

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.**
- CO_2 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 CO_2 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 to 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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American Colleges of the South
Sommer-Speck Fund for Environmental Internships