Abstract

This study measures methane fluxes in tropical agroforestry soils with relation to rainfall and temperature to determine agroforestry’s use as a potential methane sink within the Reducing Emissions from Deforestation and Forest Degradation (REDD+) program. Agroforestry is a sustainable agriculture method which uses the intercropping of crops and trees for economic benefit, known to provide carbon sequestration benefits and food security to small communities while maximizing soil health. Efficiency, productivity, and profitability benefits are brought about by agroforestry in Belize, a country participating in the REDD+ program. The role of methane is currently unclear within the REDD+ program, but the inclusion of agroforestry for carbon sequestration purposes is gaining traction. Methane fluxes were measured several times per week during two key months: April for the dry season and July for the wet season. Samples were collected using six static soil chambers and analyzed with GC-FID. Temperature, rainfall, barometric pressure, and soil volumetric water content were also measured alongside methane fluxes. Average methane flux for the dry season campaign was 0.05 mg CH₄ m⁻² h⁻¹ and 0.03 mg CH₄ m⁻² h⁻¹ for both seasons. There was a strong negative correlation between methane flux and rainfall in the dry season, and a weak positive correlation in the wet season. With acknowledgment of uncertainties, no significant flux values were seen, and thus this rigorous study of agroforestry soils must be completed to solidify its status as a methane sink, if only seasonally. By understanding methane fluxes in tropical agroforestry soils, agroforestry can be utilized as a tool for climate change mitigation as part of the REDD+ program.

Introduction

Agroforestry is the practice of planting crops within silviculture plantations, also called alley cropping. Intermingling food crops and cocoa with rubber trees promotes soil fertility and increases productivity. Traditional agroforestry systems have acceptable productive and economic performance, as well as high social acceptability. Agricultural lands potentially can remove large quantities of carbon from the atmosphere over time; the integration of trees and plants throughout these same agricultural lands may contribute to larger reductions of carbon over this same period. It is possible to draw inspiration from the above factors pertaining to carbon and apply them to methane. An important greenhouse gas, methane potential atmospheric warming effects when compared to carbon dioxide’s high-volume release by cattle, industry, and human-caused events could lead to significant comparison studies and sequestration solutions to greenhouse gas build-ups in the atmosphere.

This study aims to evaluate the behavior of methane at the soil-atmosphere interface in agroforestry systems with regard to environmental variables. Methane has shown patterns of efflux from soil during rainfall events. Because Belize has a distinct wet and dry season, methane uptake is likely to differ with rainfall. Therefore, rainfall, soil and ambient temperature, and soil volumetric water content was measured during sample collection. Although it is unlikely that agroforestry systems will be as efficient at greenhouse gas sequestration as native forests, they can be used as a substitute for conventional farming practices such as slash-and-burn farming for smallholder farmers.

REDD+ is a climate change mitigation strategy from the United Nations Framework Convention on Climate Change (UNFCCC), which offers results-based payments to reduce or remove forest carbon emissions. This project assessed agroforestry’s potential in the REDD+ Program in 2015 under support to REDD+ projects that enhance forest carbon.

Currently, REDD+ does not contain language or mechanisms that are specific to methane. However, it is possible to draw inspiration from those pertaining to carbon and apply them to methane. Restricting REDD+ to carbon only strategy deprives the community and potential benefits from those projects. In May of 2019, Belize’s Ministry of Agriculture officially launched the REDD+ Preparedness Project, with Eduardo Reyes as the REDD+ Coordinator. Belize does not yet have a REDD+ strategy and remains in the planning and consultation stages.

Methods

➢ Sampling: 3x per week or more through April and July 2019
➢ BD syringes, Labco Exetainer vials, and 6 HDPE chambers (soil collar and gas tight lid)
➢ Chambers sampled every 20 minutes for total closure time. Of 40 minutes, vials flushed with sample and overfilled to prevent contamination.
➢ Soil temperature and ambient temperature measured prior to chamber closure.
➢ Soil volumetric water content measured through dielectric permittivity with Vemco soil moisture sensor.
➢ Flux measured daily rainfall.

➢ Flux calculated through slope of linear regression and chamber-volume/surface area in Excel.

Results

This study found that there may be trends of uptake in agroforestry soils both in the dry season and the wet season, but these trends were not statistically significant (alpha=0.05).

➢ Rejected hypothesis that agroforestry soils significantly uptake methane gas.
➢ Rejected hypothesis that environmental variables have a significant impact on methane fluxes.

Environmental Variables

➢ Methane uptake in agroforestry soils depends on the flux, rainfall, and ambient temperature, weak correlation between flux/soil temperature and flux/solil VWC.

➢ Wet season: Moderate correlation between flux/ambient temperature, little to no correlation between flux/soil temperature or soil VWC, weak correlation between flux/rainfall.

Conclusions

This study may have trends of uptake in agroforestry soils both in the dry season and the wet season, but these trends were not statistically significant (alpha=0.05).

➢ Rejected hypothesis that agroforestry soils significantly uptake methane gas.
➢ Rejected hypothesis that environmental variables have a significant impact on methane fluxes.

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References


Table 1. Average methane flux statistics for dry season and wet season.

<table>
<thead>
<tr>
<th>Campname</th>
<th>R² Adj R²</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry season (Apr)</td>
<td>0.43</td>
<td>-0.19</td>
</tr>
<tr>
<td>Wet season (Jul)</td>
<td>0.87</td>
<td>0.74</td>
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</tbody>
</table>

Determine Methane Uptake in Tropical Agroforestry Soils: A Case for Inclusion in REDD+

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