

Does Soil Structure Matter? Aggregation Effects on Nutrient Fate Across Costa Rican Land Uses

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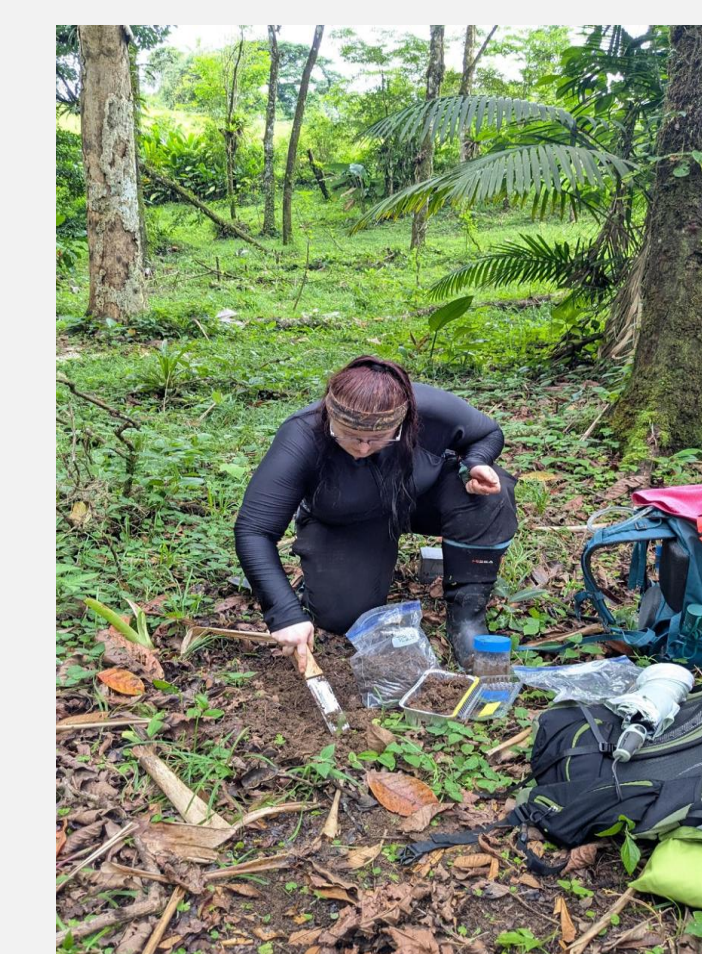
Introduction

- Aggregate structure plays a major role in water infiltration and percolation in soils
- Agricultural disturbance can destabilize aggregate, potential increasing nutrient leaching
- Tropical systems receive intense precipitation and are sensitive to management

Objective: Determine if aggregation in a tropical environment affects nutrient leaching under three sites with different land uses (native forest, PES forest (paid for ecosystem services), and papaya farm).

Methods & Experimental Design

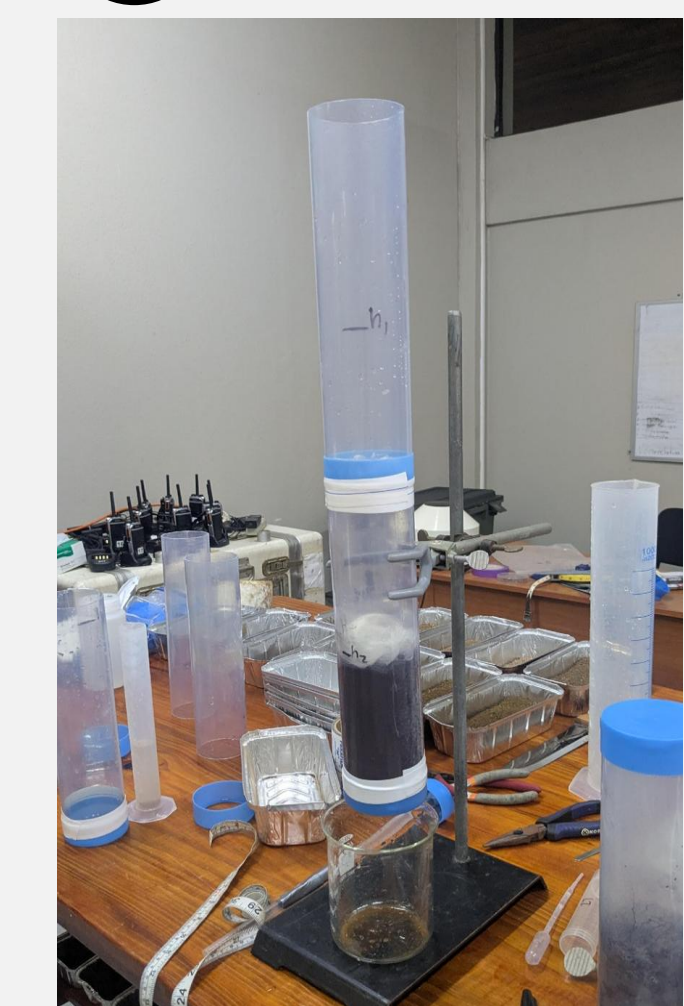
1 Collected Core Samples & Grab Bags



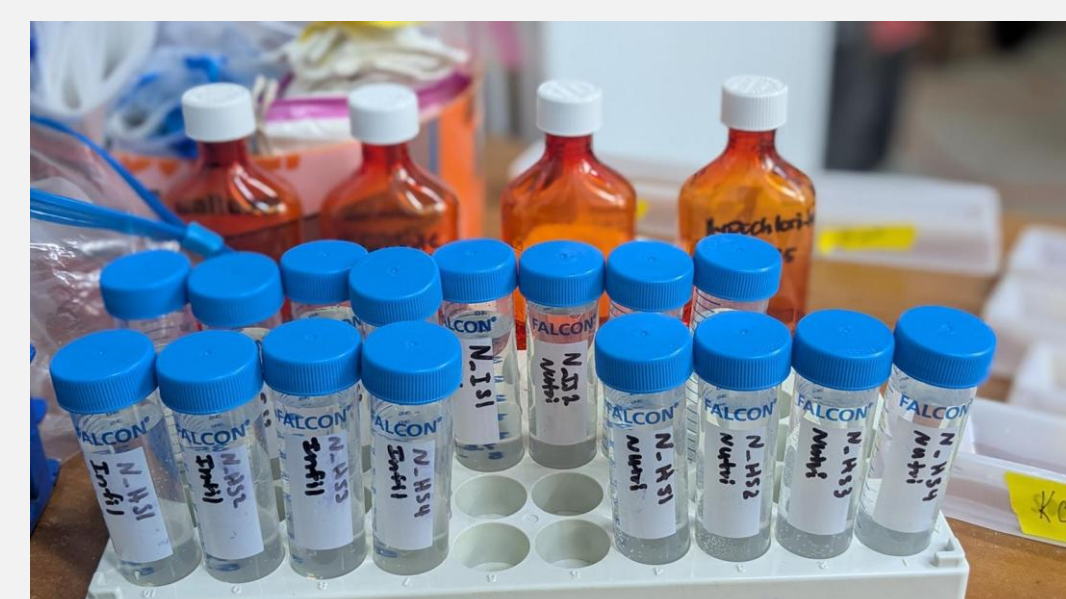
- Randomized sample locations at each site
- 4 intact cores collected in liners.
- 4 grab bags of soil.
- Dried & sieved the grab bags to 2 mm then returned equivalent dry weight of intact cores into core liners.



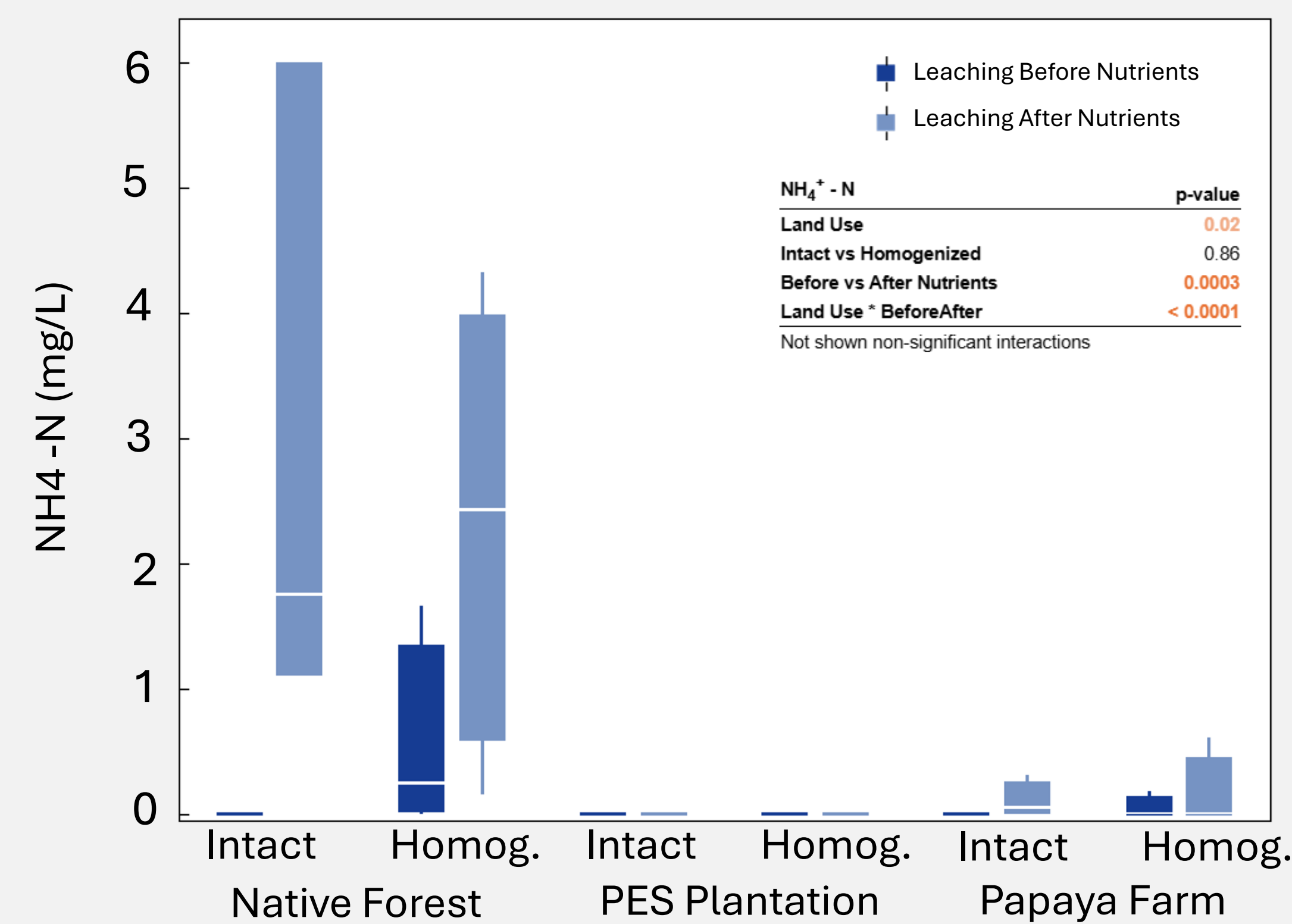
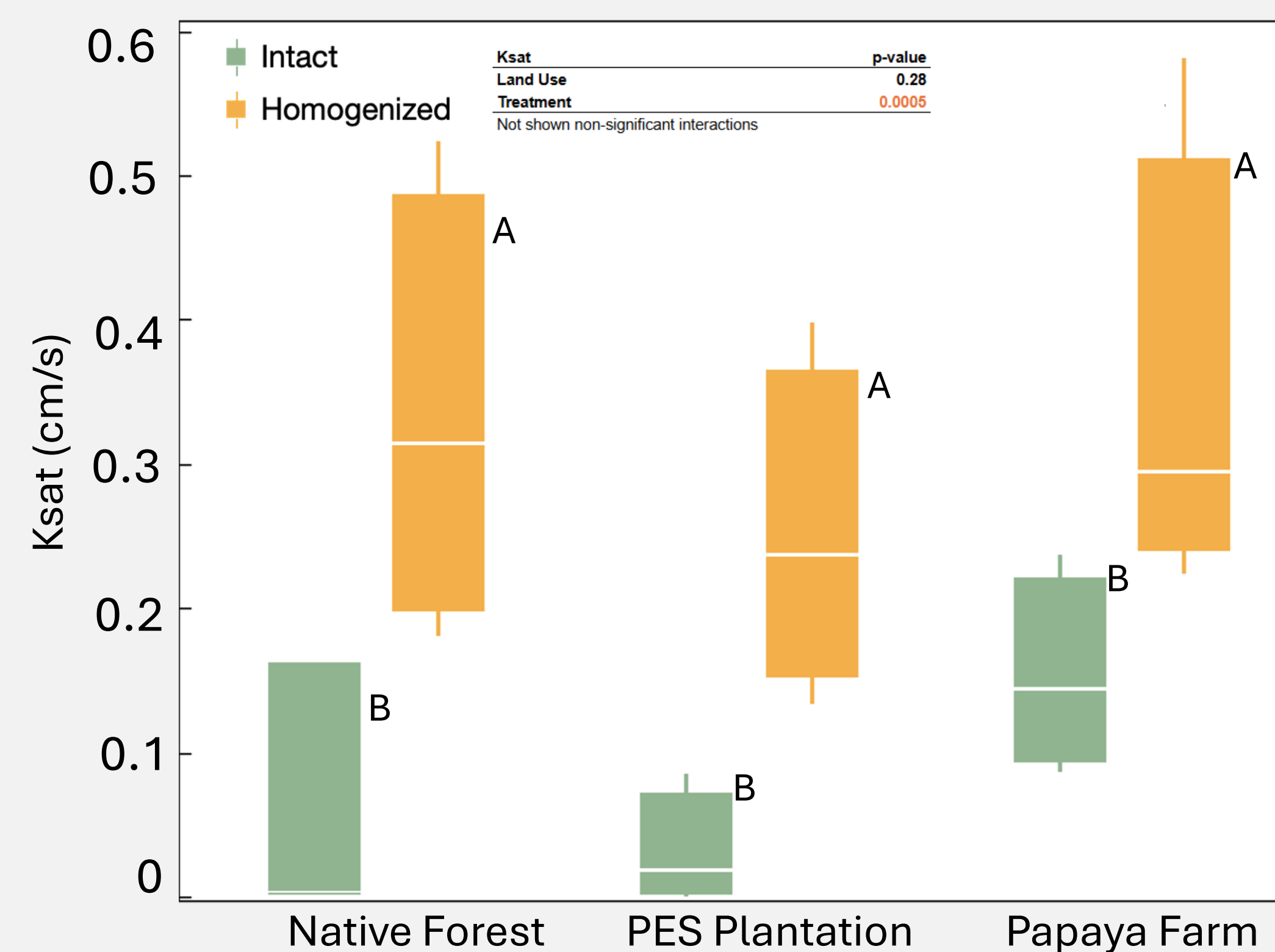
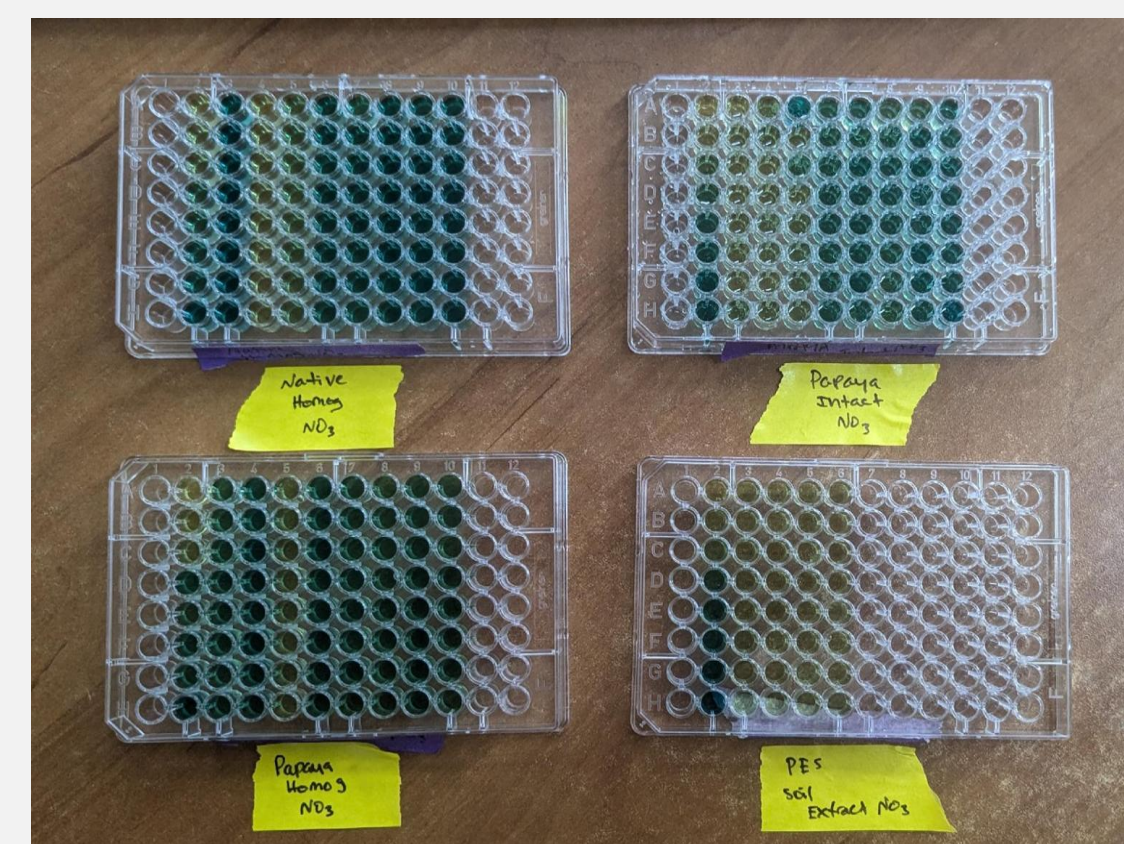
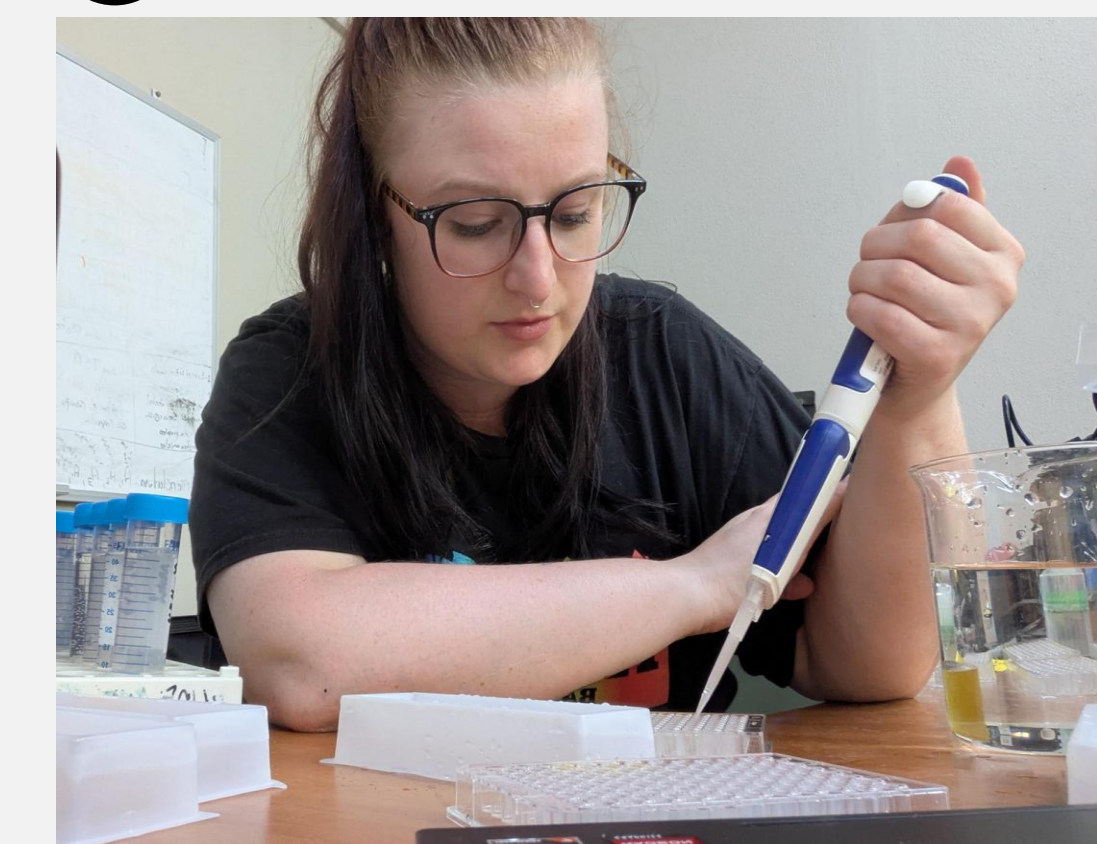
2 Infiltration of homogenized and intact cores



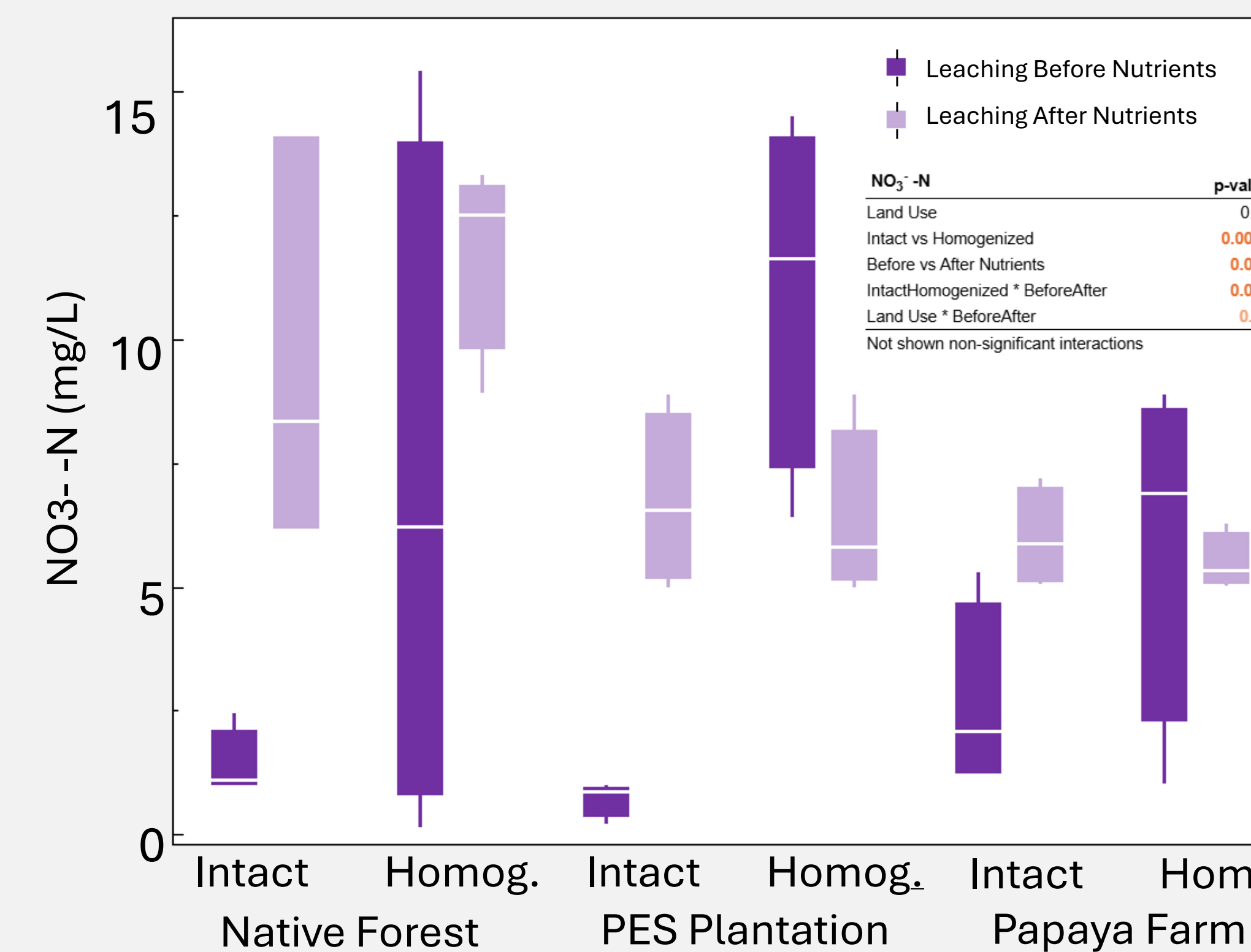
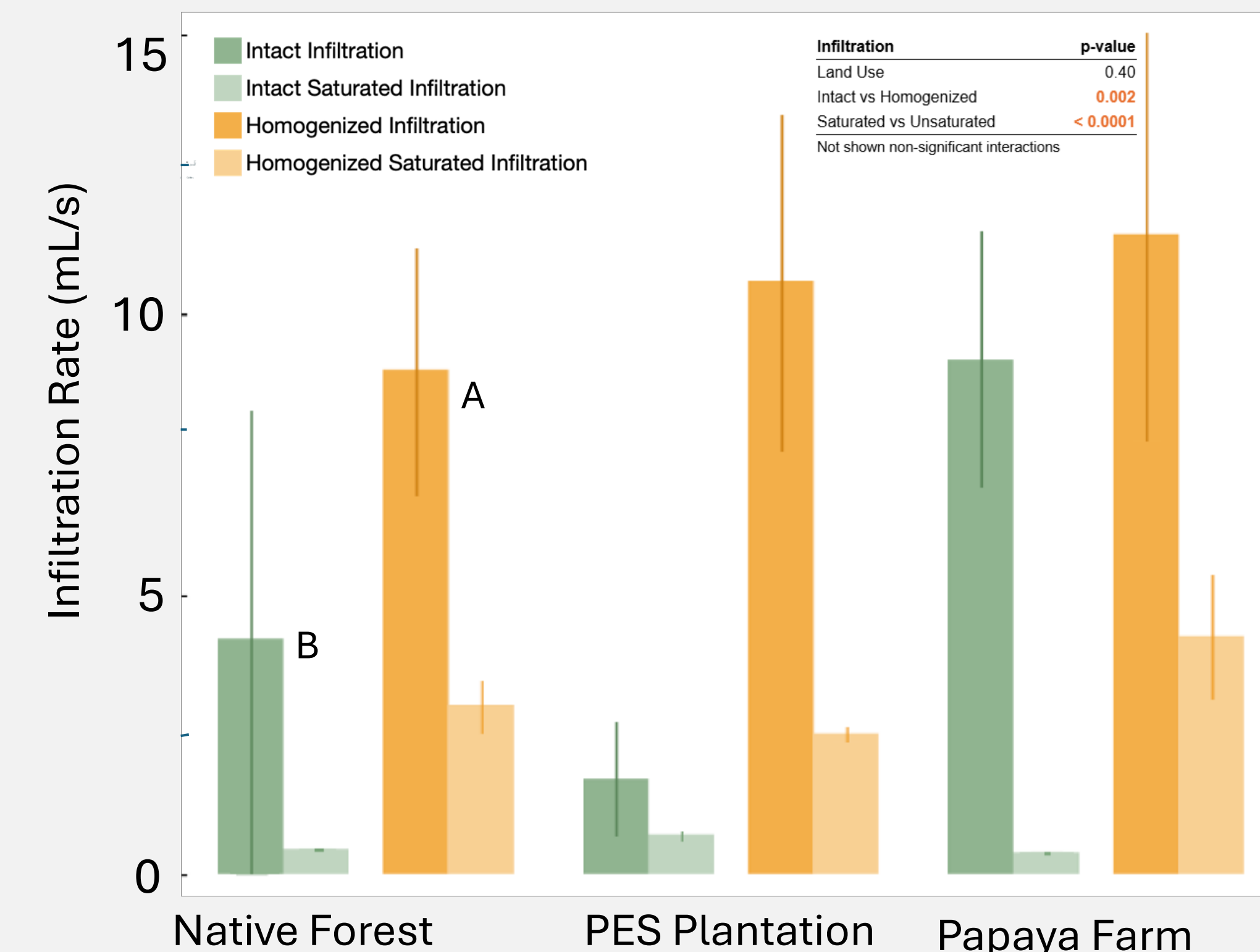
- Leachate collected from Initial Infiltration before adding nutrients to establish baseline
- Second sample of leachate collected after the addition of NH₄, NO₃ nutrient solution.



3 Plated leachate in microplates for nitrate and ammonium determination



Results



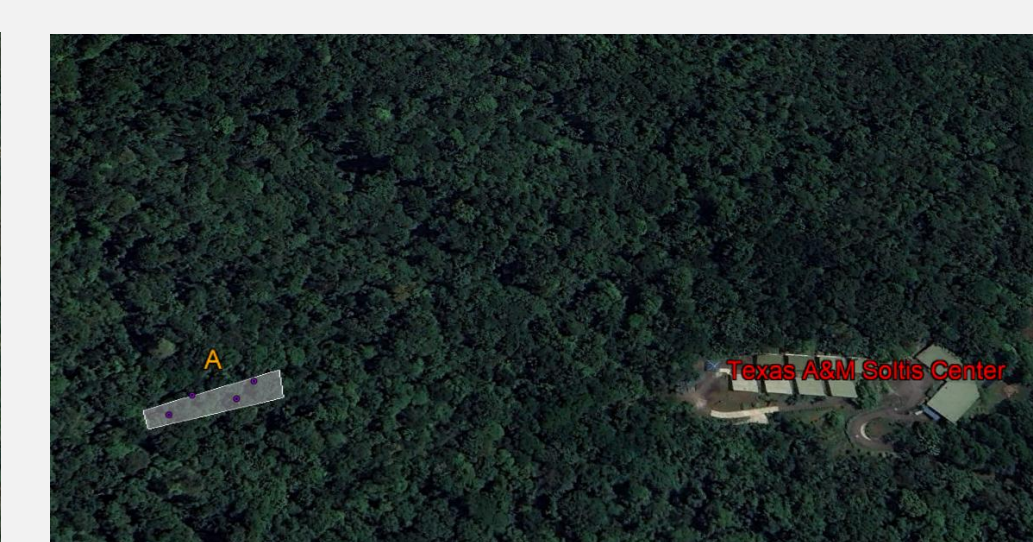
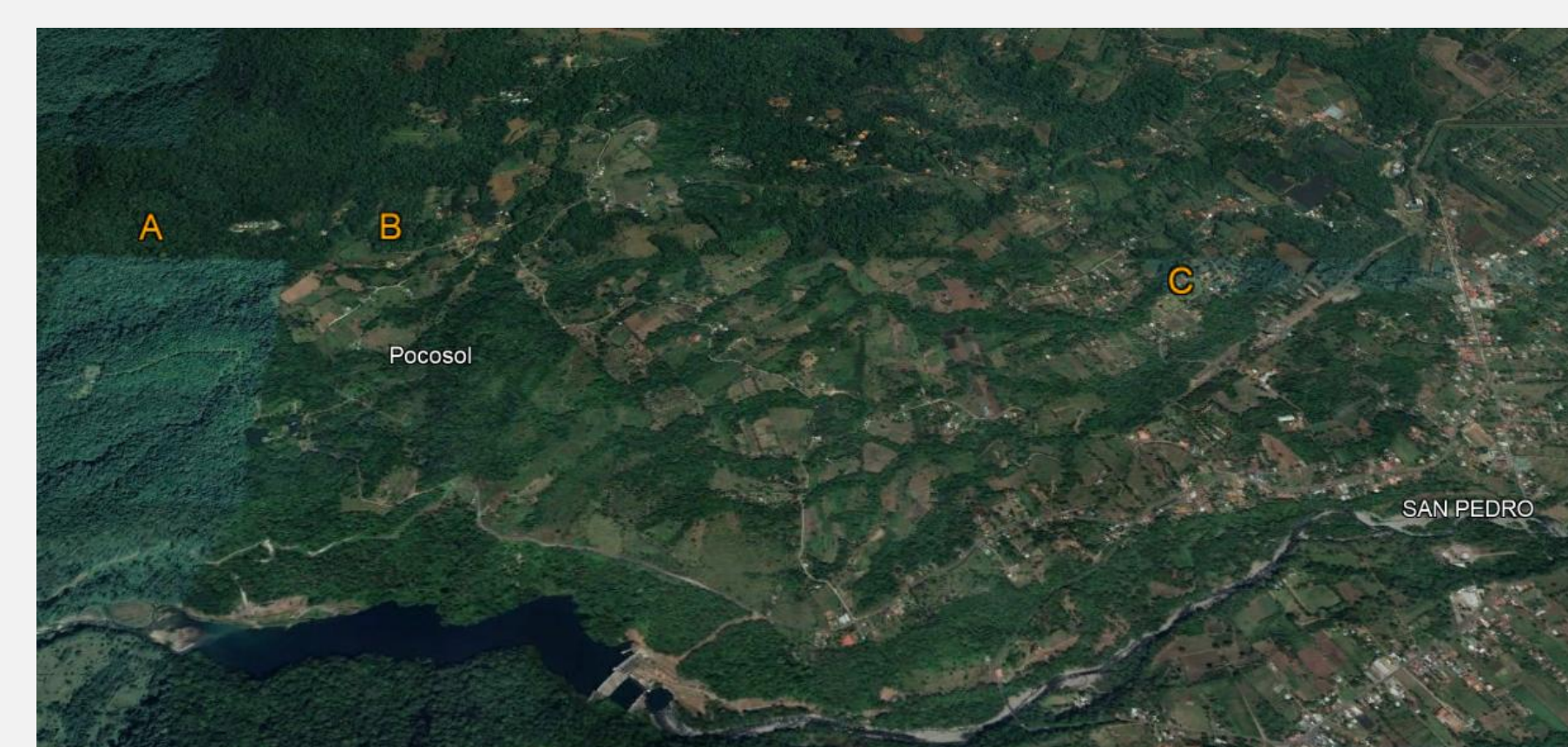
	Native Forest	PES Plantation	Papaya Farm
Clay (%)	70 ± 6 b	86 ± 2 a	51 ± 3 c
Sand (%)	5 ± 1 b	6 ± 1 b	28 ± 3 a
SOC (%)	4.8 ± 0.7 b	7.3 ± 0.3 a	2.4 ± 0.1 c
N (%)	0.39 ± 0.05 b	0.66 ± 0.03 a	0.29 ± 0.01 b

Mean ± Std Error. Letters represent Tukey's Posthoc Mean Comparison

Discussion

In this research we found that poor aggregation increased Ksat, with no effect from land use. Soil texture and organic carbon varied considerably across sites, with the papaya farm having the sandiest and least organically rich soils. Homogenization of the soil increased infiltration in the PES plantation and saturated infiltration in both PES plantation and papaya farm. Initial leaching of ammonium was relatively minimal across all land uses. The addition of nutrients did increase leaching in the native forest, but PES plantation and papaya forest held onto nitrate. Before nutrients were applied, leaching of nitrate was minimal for native and PES plantation soils, though homogenized soils were generally greater or more highly variable. The addition of nitrate increased leaching in the intact soils, while homogeneous soils did not differ. Overall, aggregation retained nutrients better, and while land use did not affect nutrient leaching, it did affect the infiltration of water, suggesting that over time it may be significant.

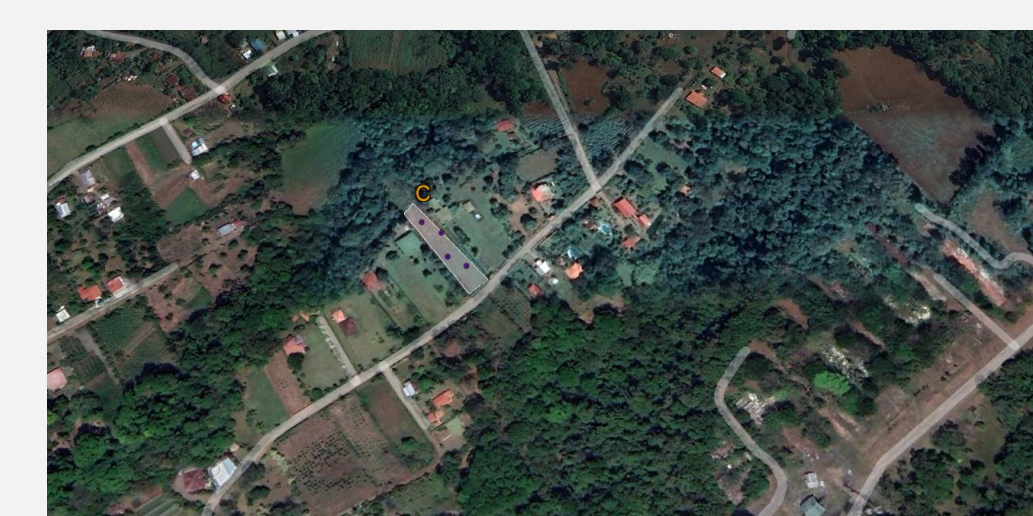
Sampling Sites



Native Forest (A)



PES Plantation (B)



Papaya Farm (C)

Implications

Due to the greater initial infiltration rate and ammonium leaching of the intact papaya farm soils, results suggest management may affect nutrient distribution. The increase in nutrient leaching when aggregates are destroyed emphasizes the importance of programs like PES managed forests that offer monetary incentives to landowners for efforts towards conservation of natural environments.

References

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- Basche, A.D., & DeLonge, M.S. (2019). *Comparing infiltration rates in soils managed with conventional and alternative farming methods: A meta-analysis.*
- Bronick, C.J., & Lal, R. (2005). *Soil structure and management: A review.*

Acknowledgements

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