Final Technical Report

FCEB Project #8

FINAL REPORT FINAL REPORT - FLORIDA CATTLE ENHANCEMENT GRANT

Project Title: Evaluating the effectiveness and economic viability of pasture management strategies to increase soil carbon sequestration and greenhouse gas mitigation

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Project Overview: Although the U.S. beef industry plays a major role on the national and global agricultural system and economy, issues related to the overall sustainability of beef have become increasingly contentious both nationally and internationally. Estimates suggest the beef cattle industry in the U.S. accounts for 52% of greenhouse gas (GHG) emissions from animal agriculture and 25% of all agricultural emissions. Among the different sectors, the greatest GHG contributions are associated with cow-calf operations, mainly due to methane emissions via livestock enteric fermentation. Opportunities to improve the overall environmental footprint of beef production should emphasize the adoption of management practices that optimize productivity while also providing environmental benefits. This project is evaluating the benefits and trade-offs associated with "climate-smart" practices, here defined as pasture management strategies that can potentially reduce GHG emissions or sequester more carbon. The specific objectives are to: 1. quantify important environmental benefits associated with perennial pasture systems in Florida, 2. evaluate potential tradeoff associated with the adoption of "climate-smart" management strategies on pasture productivity, soil carbon sequestration, GHG emissions, and global warming mitigation potential, and 3. examine the economic returns of different management strategies. For the purposes of this project, "climate-smart" practices are defined as a pasture management strategy that can potentially reduce greenhouse gas emissions or sequester more carbon. Treatments include the use of annual and perennial legumes overseeded into bahiagrass pastures, nutrient management (unfertilized vs. pastures fertilized with organic or inorganic amendments), and introduction of native species on soil health, greenhouse gas emissions, soil carbon sequestration, pasture productivity, and economic returns. This project addresses the following FCA research priorities: 'Ecosystem services of grazing lands', 'Pasture and Forage Management', and 'Societal Benefits of Ranching'.

Experimental Approach: A new field study was established on a bahiagrass (Paspalum notatum) pasture at the UF-IFAS Range Cattle Research and Educational Center in Ona, FL (27°23'12.0"N, 81°56'12.8"W). Predominant soil was a Smyrna sand (Sandy, siliceous, hyperthermic Aeric Alaquods). The experimental area has been fertilized or limes during the past 15 years but the vegetation has been occasionally mowed. No livestock grazing has occurred during the past 15 years.

Treatments consist of a combination of cover crop and nutrient management strategies. The following treatments were evaluated:
Treatments will consist of:

1) Bahiagrass monoculture
2) Bahiagrass overseeded with a mix of annual legumes (sunn hemp - *Crotalaria juncea* and aeschynomene - *Aeschynomene americana*)
3) Bahiagrass overseeded with perennial legume (perennial peanut - *Arachis glabrata*)
4) Bahiagrass fertilized with Inorganic N (ammonium nitrate at 200 lb N/A)
5) Bahiagrass fertilized with organic N (biosolids at 200 lb plant available N/A)
6) Bahiagrass amended with biochar (20 Mg ha^{-1}).
7) Bahiagrass amended with basaltic rock (10 and 20 Mg ha^{-1})

Treatments were arranged in a randomized complete block design, with four replicates. Each experimental unit was 15 x 20 ft with a 7.5 ft isle between plots. Plant available N in biosolids was calculated using a mineralization factor of 1.5 and an application rate of 200 kg plant available N ha^{-1}.

Plots were overseeded in June 2023 and reseeded again in September 2023 and July 2024 due to poor germination. Inorganic fertilizer and biosolids were land applied in September 2023 and July 2024. Biochar was applied in December 2023 and July 2024. Basaltic rock was applied in March and July 2024.

Forage evaluation was conducted in September 2023 and June 2024. Measurements included herbage mass, ground cover, and frequency of the desirable grass species.

Soil samples (0-4, 4-8, and 8-12 inches) were collected in June 2023 and were thoroughly characterized. Analyzes included bulk density, soil C, N, and Mehlich-3 extractable nutrients and soil health using the comprehensive Assessment of Soil Health (CASH) framework.

Greenhouse gas emissions have been constantly monitored using the static chamber technique. Gas samples have been collected by-weekly since the beginning of the experiment in June. Soil moisture sensor were deployed in July 2024.

Result – Treatment intended to evaluate the impacts of native species failed due to poor seed germination. In December 2023, this treatment was replaced with biochar. Two additional treatments (basaltic rock applied at 10 and 20 Mg ha^{-1}) were imposed in March 2024

Nitrogen addition via either inorganic fertilizer or biosolids increased bahiagrass herbage mass relative to control but no differences were observed among the other treatments (Table 1). The proportion of legume in the mix was relatively small because of the short period between plot establishment and forage evaluation.

Initial soil chemical characteristics are typical of unfertilized/native soils (Table 2). Total and labile soil C and N decreased with increased soil depth.

Greenhouse gas fluxes recorded in the current study were within the range reported in previously published studies. Larger daily fluxes were associated with periods of greater rainfall

and temperature. Mean daily CO_2, CH_4, and N_2O fluxes were not affected by treatment (Fig. 1); however, a significant effect of treatment was observed on cumulative annual fluxes (Table 3). Annual CO_2, CH_4, and N_2O fluxes generally increased with addition of N. Increased annual CH_4 fluxes associated with sunn hemp and peanut treatments was likely due to soil physical disturbance caused during legume overseeding/planting.

Conclusions – results of the 1-yr study demonstrated that management practices such as N addition can increase pasture productivity; however, our preliminary data also demonstrated some potential negative effects on GHG balance. Additional years of data collection are necessary to understand the role of pasture management on C sequestration and climate change mitigation. Our data also demonstrated that adoption of certain conservation practices such as the use of native grass species and overseeding legumes into established pastures may be impractical/uneconomical for commercial ranchers.

Table 1. Bahiagrass herbage mass and legume ground cover

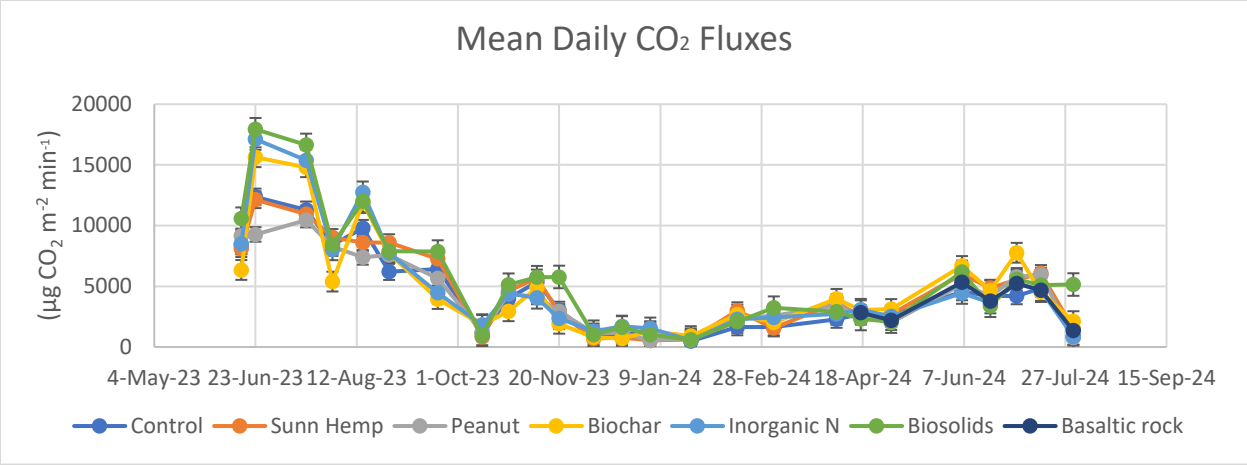
Treatment	Bahiagrass herbage mass (lb/A)	Legume ground cover (%)
Control	3293b	---
Sunn hemp	3961b	3
Peanut	2800b	4
Inorganic N	6761a	---
Biosolids	6727a	---
Biochar	3398	
Basaltic Rock	---	
P value	<.0001	

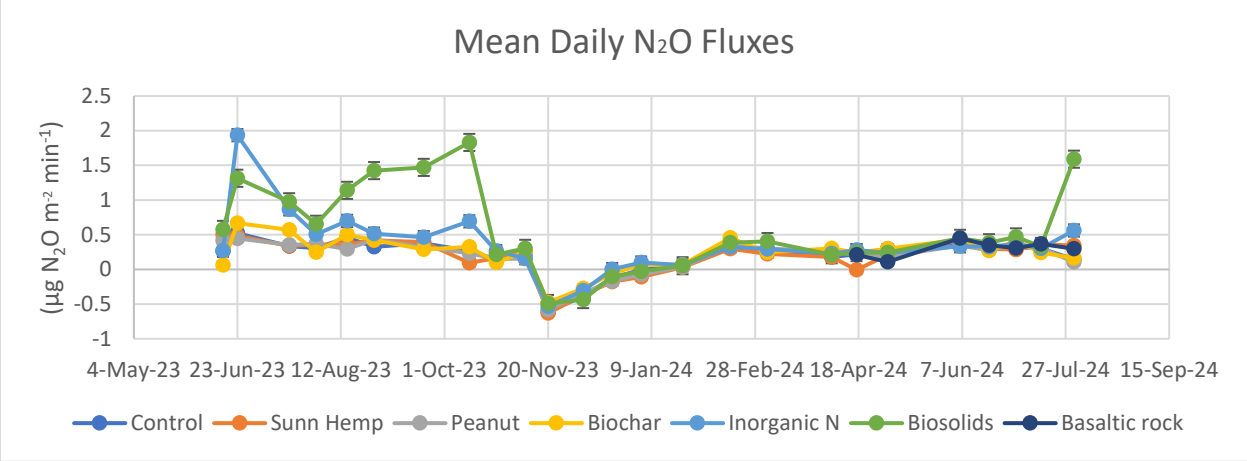
Table 2. Soil health indicators.

Soil Depth	pH	Total C	Total N	Active C	Soil respiration	Aggregate stability	Soil Protein	Water 0.1 bar	Water 151 bar	water capacity	Mehlich-3 P	Mehlich-3 K	Mehlich-3 Al	Mehlich-3 Fe
in		_____% _____		mg kg^{-1}	µg CO2 /g soil day	%	mg g^{-1}	_____ g water g $soil^{-1}$_____			_____mg kg^{-1}_____			
0-4	4.6	1.7	0.10	550	44	59	12	0.12	0.05	0.06	5	15	49	94
4-8	4.8	0.8	0.04	380	16	36	6	0.07	0.02	0.06	5	9	54	147
8-16	5.0	0.5	0.02	341	19	39	5	0.10	0.02	0.08	8	8	113	123

Table 3. Cumulative annual greenhouse gas fluxes as affected by treatments.

Treatments	CO_2	CH_4	N_2O
	Mg ha^{-1} yr^{-1}	_____ kg ha^{-1} yr^{-1} _____	
Control	24.9b	-0.06bc	1.2bc
Sunn Hemp	27.3b	0.76a	1.1c
Peanut	24.8b	1.07a	1.2c
Inorganic N	28.2ab	0.51ab	2.1ab
Biosolids	31.9a	0.36ab	3.2a
Biochar	28.4b	-0.60c	1.5bc
SE	2	0.33	0.40
P value	<.0001	0.0028	0.02





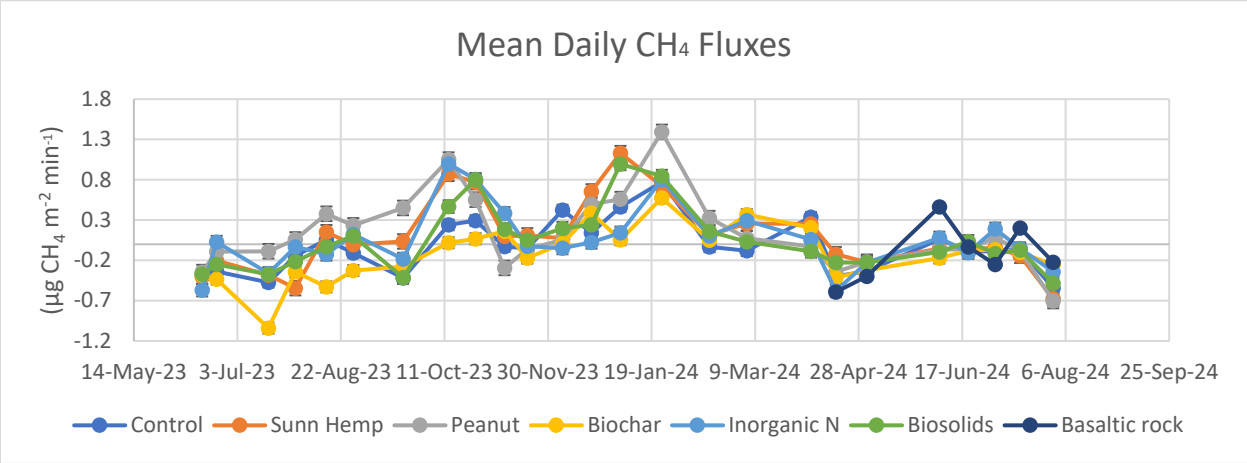


Fig. 1. Mean daily CO2, N2O and CH4 fluxes as affected by treatment.

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Invoice Date:	08/09/2024
Invoice Period:	03/01/2024 - 07/31/2024
Principal Investigator:	Silveira,Maria Lucia
Award Begin Date:	10/30/2023
Award End Date:	07/31/2024
UF FEIN:	59-6002052

Sponsor Award ID:	8
Award Title:	Evaluating the effectiveness and economic viability of pasture management strategies to increase soil carbon sequestration and greenhouse gas mitigation
Award Amount:	$45,592.00

Invoice #	I000130162
UF Award #	AWD15790
Primary Project #	P0324559
Primary Department:	60780000
Current Invoice Amount:	$25,039.61

Description	Current	Cumulative
Personnel - Salary	$6,473.55	$10,789.25
Personnel - Fringe Benefits	$763.82	$1,273.05
Tuition	$2,168.26	$8,673.01
Materials and Supplies	$8,536.23	$15,519.27
Contractual Services	$456.00	$456.00
Other Expenses	$3,958.93	$3,958.93
Direct Cost	$22,356.79	$40,669.51
Facilities and Administrative Costs	$2,682.82	$4,880.34
Total	$25,039.61	$45,549.85

For billing questions, please call 352.392.1235
Brown,Katrina Adel brownk3@ufl.edu
Please reference the UF Award Number and Invoice Number in all correspondence

By signing this report, I certify to the best of my knowledge and belief that the report is true, complete, and accurate, and the expenditures, disbursements and cash receipts are for the purposes and objectives set forth in the terms and conditions of the federal award. I am aware that any false, fictitious, or fraudulent information, or the omission of any material fact, may subject me to criminal, civil, or administrative penalties for fraud, false statements, false claims or otherwise. (U.S Code Title 18, Section 1001 and Title 31, Sections 3729-3730 and 3801-3812).

Katrina Brown

Certifying Official

Payment History	
Cumulative Invoices:	$45,549.85
Payments Received:	$20,510.24
Outstanding Balance:	$25,039.61
Note: Outstanding balance includes current invoice amount	

FOR UF USE ONLY Additional Projects: N

Project ID	Deptid	Department Name	Current	Cumulative

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P0324559	60780000	AG-RCREC-ONA	$25,039.61	$45,507.86