Managing Soil Health for Pasture Sustainability

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1. PROJECT OVERVIEW

The concept of soil health has been receiving much attention in the United States, and ways of defining and describing soil health have been developed in different agricultural and natural systems. Although a number of commercial laboratories (mainly in the Midwestern US) are currently offering soil health assessments, selection and interpretation of indicators of soil health (measurable soil attributes) should be done at a local scale. Research is needed to evaluate, select, and implement a suite of soil health indicators that are relevant to Florida environmental conditions and soils. Although soil health assessments are gaining in popularity and are currently being promoted as tools to guide management of many types of agricultural production systems, science-based information is needed to develop and validate a soil quality framework for guiding pasture management decisions and monitoring their outcomes. Currently, limited information exists on how soil health can be used to increase productivity and resilience of perennial pasture systems in Florida. The main objectives of this project were to: 1) develop and validate a soil health tool for perennial pastures in Florida, 2) evaluate the impacts of pasture management on soil health, and 3) create educational tools to explain and disseminate information regarding the benefits of soil health in the context of sustainable pasture management. *This proposal addresses the* ***FCA Priority # 6 "Ranching Activities Impacts on the Environment)*****.**

2. PROJECT ACTIVITIES (JANUARY – AUGUST 2017)

Producer Survey

A survey tool was developed to examine management practices associated with the participant sites. Participant sites were identified and collection of data began in May 2017. A total of 32 forage and soil samples were collected in central and south Florida during the period of May through August, 2017 (Table 1). Participant sites ranged from small scale (<50 acres) cow/calf commercial operations to relative large scale ranches (>3,000 acres). Size of the fields where samples were collected from ranged from < 10 acres to > 40 acres. Forage species included bahiagrass, bermudagrass, limpograss, perennial peanut, pearl millet, and stargrass use for hay production, haylage, green chopped, or grazed. Fertilization strategies ranged from no fertilization to multiple fertilizer applications throughout the growing season. Participants were also asked to rank their pastures into 2 categories: bad vs. good. Photos of selected sites are provided in Appendix 1.

Soil and Tissue Sampling and Analyzes

At each location, composited soil samples (0-6" deep) were collected and associated pasture management history (past 5 yr) was recorded. A minimum of 15 soil cores was collected from each area and combined into a composite sample for chemical, physical, and biological characterization. Additional undisturbed cores (3 per location) were collected for bulk density and root biomass determinations. Soil analysis included pH, Mehlich-3 extractable P, K, Ca, and Mg, total organic C, total N, and labile organic C, soil respiration, and bulk density.

Forage height was measure at 10 random locations in each pasture. Forage mass was estimated at locations that exhibited samples were collected and analyzed for total P, K, Mg, Ca, S, B, Zn, Mn, Fe, and Cu.

3. RESULTS SUMMARY

Soil

The predominant soil series were Myakka, Candler, Immokalee, Okeechobee, Smyrna, Wauchula, Pomona, and Bradenton fine sand (Table 1).

Soil pH ranged from 4.3 to 6.8. The majority of the samples (~65%) had soil pH below the recommended level of 5.5 for warm-season grasses (Table 2). Soil P levels were low (< 26 ppm) in approximately 80% of the samples. However, tissue P concentrations were generally (87% of the samples) above the critical level of 0.15 established for grazed bahiagrass pastures (Table 3). Approximately 50% of the samples had low soil K levels (< 26 ppm). Soil Ca, Mg, Zn, and Cu were within the typical expected concentrations for most soils in Florida. Cation exchange capacity (CEC) and bulk density were also typical of sandy soils.

Total C and N concentrations varied significantly among the various sites (0.42 to 8.9% for C and 0 to 0.62% for N). Preliminary analysis suggested that soil C and N were mainly influenced by soil type rather than pasture management. Additional laboratory characterization of selected soil C fractions (i.e., labile light C) and collection of a large number of soil samples from various soil types and management conditions are expected to elucidate whether soil C can potentially be a reliable indicator of soil health in pasture soils.

Plant Tissue

Forage height was affected by the pasture management (i.e., grazed at the time of the sample collection, mowing, etc.). Crude protein levels ranged from 3.9% (stockpiled limpograss) to 18.5% (grazed bahiagrass pasture) (Table 3). Tissue P levels were generally above the critical limit of 0.15% established for grazed bahiagrass pastures. Smallest tissue P (0.04%) and K (0.56%) levels were associated with the stockpiled limpograss. Calcium, Mg, S, and micronutrient concentrations were typical of warm-season grasses in Florida.

4. SUMMARY AND CONCLUSIONS

Results suggested that pastures and hayfields in Florida exhibited a wide range of soil chemical, physical, and biological properties. Additional laboratory analyses are currently being conducted to fully characterize the impacts of various soil types and pasture management strategies on selected soil properties. Although some characteristics are inherent of a particular soil type, we anticipate that the results from this study will provide the first critical steps to define soil health for pastures in Florida. Although full implementation of soil health framework will require coordination with local and national groups, we anticipate this study will provide

the basis to develop locally-based tools to assist land managers in the development of management strategies that sustain forage production and sustainability. We hope that funds will continue to be available through the Florida Cattlemen's Beef Enhancement program to support our current efforts that address research priority # 6 "Ranching Activities Impacts on the Environment).

ACKNOLEDGEMENTS

We sincerely thank the producers for their willingness to participate in this study. We also want to extend our appreciation to county extension personnel (Bridget Stice, Ed Jennings, Lauren Butler) who facilitated the site visits and sampling. Thanks to the FCA for providing the funds to support this project.

5. PERCENTAGE COMPLETION OF PROJECT DELIVERABLES: 100%

Table 1. Detailed information about the study sites.

[1]Pasture condition was based on producer's assessment of overall pasture health (yield, persistence, presence of weeds, etc).

Sample ID	County	Species	Pasture condition[1]	Soil Series
1	Hardee 1	Jiggs bermudagrass	good	Myakka fine sand (40%); Valkaria fine sand (60%)
2	Levy 1	Bahiagrass	bad	Candler fine sand (100%)
3	Levy 2	Bahiagrass	good	Candler fine sand (100%)
4	Levy 3	Tifton 85 bermudagrass	good	Candler fine sand (100%)
5	Levy 4	Pearl millet	medium	Candler fine sand (100%)
6	Levy 5	Bahiagrass	good	Candler fine sand (27.5%); Candler-Apopka complex (34.4%); Candler fine sand (38.1%)
7	Okeechobee 1	Bahiagrass	good	Oldsmar fine sand (100%)
8	Okeechobee 2	Bahiagrass	bad	Winder sand (88%); Chobee muck (11%)
9	Okeechobee 3	Bahiagrass	bad	Floridana, Placid and Okeelanta (100%)
10	Okeechobee 4	Bahiagrass + common bermudagrass	good	Floridana, Placid and Okeelanta (100%)
11	Okeechobee 5	Limpograss	good	Samsula muck (100%)
12	Okeechobee 6	Stargrass	good	Immokalee fine sand (98.3%); Valkaria fine sand (1.7%)
13	Okeechobee 7	Bahiagrass	bad	Salerno sand (71.5%); Duette fine sand (28.5%)
14	Polk 1	Bahiagrass	medium	Wabasso fine sand (76.5%); Bradenton fine sand (20.0%); Floridana mucky fine sand (3%)
15	Polk 2	Bahiagrass	good	Bradenton fine sand (100%)
16	Polk 3	Bahiagrass	bad	Bradenton fine sand (100%)
17	Polk 4	Bahiagrass + common bermudagrass	bad	Udorthents (100%)
18	Polk 5	Bahiagrass	good	Smyrna and Myakka fine (95.6%); Huntoon muck (3.3%)
19	Polk 6	Bahiagrass	medium	Satellite sand (36.7%); Pompano fine sand (31.3%); Smyrna and Myakka fine sands (31.1%)
20	Polk 7	Bahiagrass	good	Satellite sand (47.7%); Immokalee sand (13.6%); Smyrna and Myakka fine sands (38.7%)
21	Polk 8	Bahiagrass	bad	Satellite sand (71.3%); Immokalee sand (24.1%); Smyrna and Myakka fine sands (4.6%)
22	Polk 9	Jiggs bermudagrass	good	Immokalee sand (100%)
23	Polk 10	Bahiagrass	medium	Hontoon muck (3.9%); Immokalee sand (78.5%); Smyrna and Myakka fine sands (17.6%)
24	Polk 11	Bahiagrass	bad	Pomona fine sand (75.5%); Smyrna and Myakka fine sands (21.2%)
25	Polk 12	Bahiagrass	good	Smyrna fine sand (42.0%); Myakka fine sand (38.7%); Adamsville sand (11.8%); Narcoossee
26	Polk 13	Bahiagrass	good	Myakka fine sand (72.1%); Narcoossee fine sand (27.9%)
27	Polk 14	Bahiagrass	Medium	Myakka fine sand (95%); Narcoossee fine sand (5%)
28	Polk 15	Bahiagrass	good	Smyrna and Myakka fine sand (57.1%); Zolfo fine sand (42.9%)
29	Polk 16	Bahiagrass	bad	Smyrna and Myakka fine sand (97.9%); Zolfo fine sand (2.1%)
30	Osceola 1	Bahiagrass	good	Wauchula fine sand (100%)
31	Osceola 2	Bahiagrass	bad	Wauchula fine sand (60.5%); Smyrna and Myakka fine sand (21.4%); Immokalee sand (17.9
32	Osceola 3	Limpograss	Newly established	Candler sand (47.9%); Smyrna and Myakka fine sands (7.4%); Adamsville fine sand (5.4%)

Table 2. Selected soil chemical and physical properties.

Sample ID	Soil pH	Mehlich-3						CEC	Bulk Density	Total N	Total C
		P	K	Mg	Ca	Zn	Cu				
		ppm						meq/100g	g/cm3	%	
1	5.6	35	19	41	318	5	4	3	1.2	0.00	0.55
2	5.8	52	87	22	256	2	0	4	1.3	0.04	0.94
3	5.3	55	45	37	174	2	0	4	1.4	0.06	1.15
4	6.2	33	25	93	411	2	0	4	1.4	0.05	0.94
5	6.6	42	29	51	514	4	4	4	1.4	0.00	0.58
6	5.6	13	8	12	209	2	1	3	1.3	0.00	0.43
7	5	8	43	87	1929	1	0	18	0.4	0.62	8.95
8	5.6	6	18	59	973	3	0	8	1.0	0.14	2.15
9	6.2	21	53	204	2075	2	0	15	0.8	0.24	2.89
10	6.2	13	116	67	2948	3	0	19	0.8	0.33	3.83
11	5.4	13	147	153	1923	4	0	17	0.6	0.22	4.24
12	5.2	7	68	68	1314	2	0	13	0.9	0.17	3.46
13	4.9	11	67	169	1357	2	0	15	0.9	0.17	3.51
14	5.2	2	24	79	954	2	0	10	1.0	0.08	2.58
15	5.2	2	32	63	877	2	0	9	0.9	0.07	2.11
16	5.1	3	30	76	846	2	0	9	0.7	0.10	2.65
17	6.8	76	19	82	2468	55	7	15	1.1	0.07	2.14
18	4.6	4	43	86	409	4	0	9	1.0	0.06	2.52
19	4.7	2	14	36	183	3	0	4	1.1	0.01	1.27
20	4.9	2	14	33	177	2	0	3	1.0	0.00	0.85
21	5.3	44	11	28	583	17	2	6	1.2	0.04	1.48
22	5.8	26	19	53	692	5	0	6	1.0	0.04	1.27
23	5.2	5	49	57	518	3	0	6	0.8	0.04	1.57
24	5.2	4	33	28	386	2	0	6	0.9	0.02	1.36
25	5.3	7	64	109	453	4	0	7	0.8	0.08	2.12
26	6.1	9	21	190	813	2	0	8	1.0	0.08	2.26
27	4.7	2	17	40	232	3	0	5	1.1	0.03	1.55
28	4.9	4	11	34	196	5	1	4	1.3	0.01	0.96
29	4.7	2	14	29	232	2	0	5	1.2	0.02	1.35
30	4.6	3	27	44	523	2	0	9	0.9	0.13	3.16
31	4.4	2	24	35	328	1	0	7	1.1	0.09	2.49
32	4.3	4	18	34	195	1	0	6	1.0	0.11	2.93

Table 3. Plant tissue characterization.

Sample ID	Forage height	Crude Protein	P	K	Mg	Ca	S	B	Zn	Mn	Fe	Cu
	inches	%						ppm				
1	11	10.4	0.22	0.79	0.17	0.43	0.17	6.3	119	63.2	47.7	8.5
2	4	15.1	0.26	1.96	0.19	0.38	0.36	6.0	43.4	203.6	138.1	8.3
3	3	18.5	0.37	2.15	0.29	0.34	0.31	5.5	33.9	215.9	104.8	10.3
4	6	15.5	0.37	2.01	0.24	0.51	0.42	4.8	32.4	49.5	102.7	9.9
5	16	16.3	0.7	4.44	0.36	0.53	0.22	5.5	43.1	84.8	440.5	10.8
6	10	14.9	0.33	2.1	0.24	0.46	0.25	4.8	45.5	137.5	118.9	10.8
7	6	13.9	0.39	1.23	0.26	0.36	0.39	6.4	40.8	121.9	83.5	7.8
8	5	13.4	0.33	0.7	0.59	0.63	0.35	6.2	35.9	46.4	74.9	9.4
9	4	11.9	0.19	1.22	0.24	0.51	0.41	9.9	29.9	64.5	74.5	5.5
10	10	10.8	0.18	2	0.17	0.55	0.38	9.8	26.7	41.1	60.8	7.2
11	18	10.5	0.23	2.79	0.21	0.25	0.36	7.6	31.6	16.6	56.4	10.4
12	17	11.1	0.3	2.48	0.12	0.3	0.22	3.9	37.8	31.3	40.2	8.2
13	12	9.9	0.27	1.54	0.35	0.34	0.18	3.8	22.0	58.1	46.4	5.5
14	13	7.8	0.13	0.84	0.4	0.43	0.16	3.6	18.0	23.7	53.3	4.2
15	9	9.6	0.17	1.66	0.32	0.41	0.2	4.2	18.1	28.2	56.2	5.7
16	13	7.7	0.39	1.78	0.19	0.51	0.35	7.4	89.8	16.3	79.0	11.1
17	3	13.8	0.14	1.04	0.28	0.37	0.15	3.4	13.2	20.5	39.4	3.9
18	3	14.9	0.3	1.66	0.39	0.31	0.32	4.7	38.1	144.3	65.8	8.6
19	3	10.9	0.24	1	0.47	0.35	0.24	4.1	40.6	204.9	59.9	7.4
20	4	10.9	0.22	1.01	0.3	0.4	0.21	4.5	33.6	178.3	136.2	7.1
21	2	10.9	0.44	0.81	0.51	0.69	0.27	5.0	80.5	47.7	70.5	8.6
22	9	11.0	0.26	1.01	0.23	0.49	0.35	4.7	41.3	17.5	64.1	7.7
23	6	9.7	0.31	1.47	0.32	0.38	0.21	4.5	37.6	40.3	49.2	6.4
24	6	8.4	0.31	1.36	0.34	0.51	0.2	4.3	22.4	26.4	50.4	5.0
25	14	8.1	0.18	1.64	0.32	0.3	0.2	4.9	19.6	74.1	38.3	4.5
26	13	7.7	0.18	1.22	0.38	0.3	0.2	5.1	12.8	24.3	37.0	4.3
27	7	6.7	0.15	0.99	0.26	0.35	0.11	4.5	16.3	86	52.5	3.7
28	4	9.1	0.31	1	0.58	0.43	0.24	5.0	39.8	155.1	62.7	7.1
29	5	9.1	0.27	0.83	0.6	0.39	0.23	3.9	38.8	201.6	61.7	6.4
30	6	7.7	0.18	1.21	0.31	0.28	0.2	4.0	19.0	79.9	64.6	5.3
31	8	6.9	0.12	1.04	0.36	0.25	0.12	3.5	13.9	46.9	42.5	4.5
32	43	3.9	0.04	0.56	0.14	0.1	0.1	2.2	17.3	9.7	30.6	4.0

Appendix 1 – Photos of selected participant sites

BUDGET JUSTIFICATION

BUDGET FOR FLORIDA CATTLE ENHANCEMENT FUND - BUDGET JUSTIFICATION					
PROJECT TITLE: Managing Soil Health for Pasture Sustainability (# P0037824)					
DETAILED LINE ITEM DESCRIPTION	QTY	% Complete	TOTAL	EXPLANATION/JUSTIFICATION OF DELIVERABLE	COMPLETION DATE
Collection of soil, forage, and management data	N/A	100%	$ 8,550.7	soil collection and management practices survey. Items include (but not limited to): paper bags, soil cores cylinders, flags, forage clippers, auger	9/01/2017
Soil Analyses	N/A	100%	$16,217.9	laboratory supplies (reagents, filter paper, instrument consumables, gas cylinder), soil chemical, physical and biological characterization, shipping of samples for analyses	9/01/2017
Forage Analyses	N/A	100%	$3,517.4	forage analyses, shipping of samples for analyses	9/01/2017
Final Research Project Report	1			Project report detailing research, which may include, findings, future needs, results, conclusions, issues, risks, assessments and all other pertinent information.	9/01/2017
GRAND TOTAL: (equal to percentage of completion)			**$28,286.00**		9/01/2017