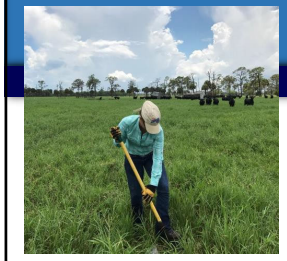

Agronomic and Environmental Impacts of Land Application of Biosolids to Bahiagrass Pastures in Florida

Ona Webinar
March 10, 2020

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Soil & Water Science, Univ. Florida/IFAS Range Cattle REC

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What are "Biosolids"?

- Biosolids are the solid, semisolid or liquid material produced during the treatment of domestic wastewater
- Sewage sludge undergoes pathogen control treatment that meet regulatory requirements
- Sewage sludge that is disposed of by landfill or incineration is NOT considered biosolids
- Disposal options include landfill, distribution and marketing, incineration, land application

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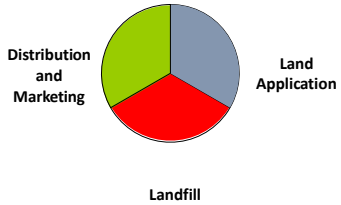
Biosolids Management in Florida

- **Total Production → 340,000 dry tons/year (10,000 - 20,000 imported)**
- **~ 2/3 is beneficially used and 1/3 third is landfilled**



- **30% of FL population is onsite sewage treatment**

Source: Maurice Barker, Biosolids Coordinator, FL-DEP

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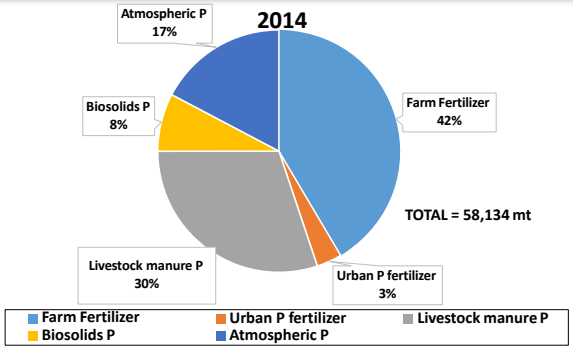
Phosphorus Imports from Various Sources



- 30% reduction in ag fertilizer P (1999 to 2014)

M. Silveira, Soil & Water Science, University of Florida

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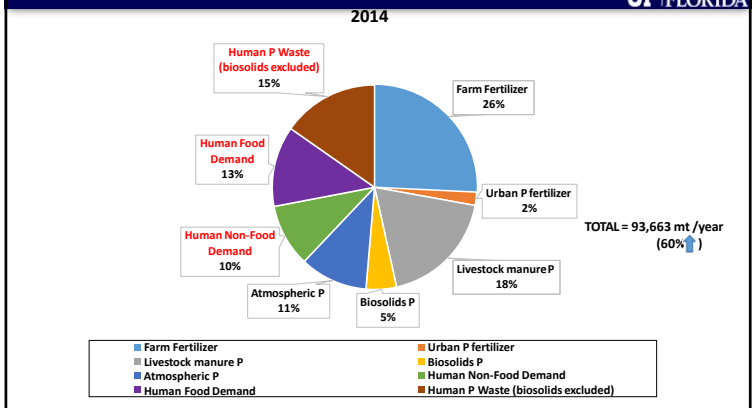
Phosphorus Imports from Various Sources



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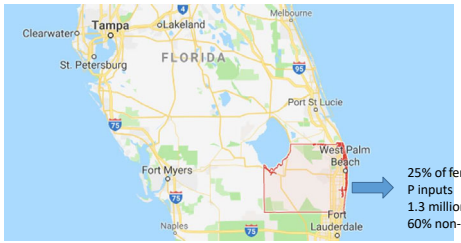

25% of fertilizer P inputs
1.3 million acres; 60% non-ag use

M. Silveira, Soil & Water Science, University of Florida

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Popular Press

Blue Cypress Lake erupts with pollution-eating algae linked to municipal sewage treatment

Turns Out That Using Human Poop to Fertilize Crops Isn't Such a Great Idea

Tons Of South Florida Sewage Finds Its Way Into St. Johns River To 'Devastating Effect'

Class B biosolids: DEP discusses water pollution from human waste spread on farmland

Florida House committee amends biosolids bill to strengthen state biosolid regulations

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Land Application of Biosolids

Benefits:

- Perennial pastures are good candidates for receiving biosolids because of extended growing season, extensive root systems, and relatively high nutrient requirements
- Land application of biosolids improves soil chemical, physical, and biological properties and promotes forage production
- "Slow release" fertilizer source

Challenges:

- Public perception regarding the potential trace metals and pathogen contamination risks, odor and other nuisance issues,
- Variable chemical composition and nutrient availability, cost of transport and spreading, grazing restrictions, and environmental regulations
- Unbalanced N: P ratio (3:1-3:4 in biosolids vs. 6:1-8:1 requirement for crops)

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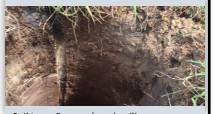
Agronomic and Environmental Impacts of Biosolids Application to Bahiagrass Pastures Pastures in Florida (FL Cattle Enhancement Funds)

UF UNIVERSITY of FLORIDA

Objectives

1. To establish a long-term, instrumented field trial designed to evaluate the agronomic benefits and potential environmental impacts of biosolids application to pastures.
2. To evaluate the effects of biosolids application on soil chemical (C, N, and P dynamics), physical (water holding capacity, aggregate stability), and biological properties (microbial diversity).
3. To monitor N and P losses via leaching and greenhouse gas emissions.
4. To evaluate the impacts of co-application biosolids with biochar on nutrient use efficiency and nutrient losses

Experimental area: established bahiagrass pasture at the University of Florida-Range Cattle Research and Education Center in Ona, FL



Soil type: Smyrna (sandy, siliceous, hyperthermic Aeric Alaquods)

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Land Application of Biosolids

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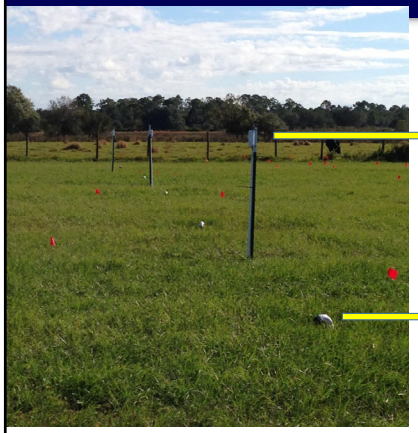

Soil moisture sensors (4 and 12") and data logger

Lysimeter

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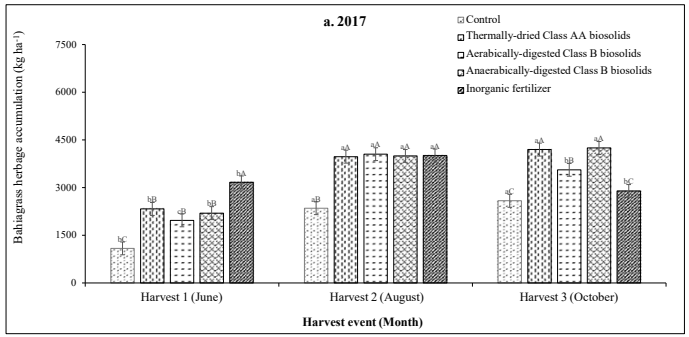
Forage Responses



Lu. Yet al. 2020. Biosolids and biochar application effects on bahiagrass herbage accumulation and nutritive value. *Agron. J.* (In Press).

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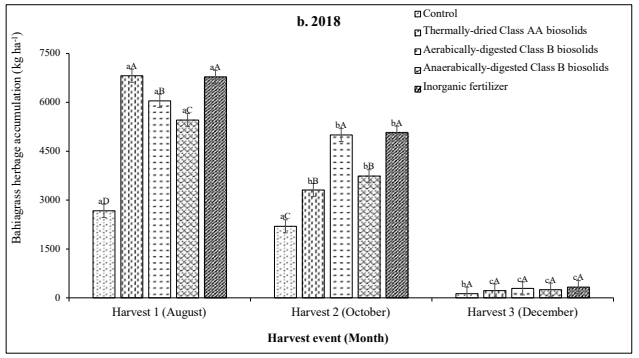
Forage Responses



Lu. Yet al. 2020. Biosolids and biochar application effects on bahiagrass herbage accumulation and nutritive value. *Agron. J.* (In Press).

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Forage Responses

Fertilizer source	Year 2017	2018
	kg ha^{-1}	
Control	6022 b	4995 d
Thermally-dried Class AA biosolids	10500 a	10347 bc
Aerobically-digested Class B biosolids	9580 a	11335 ab
Anaerobically-digested Class B biosolids	10443 a	9441 c
Inorganic fertilizer	10070 a	12178 a

Lu. Yet al. 2020. Biosolids and biochar application effects on bahiagrass herbage accumulation and nutritive value. *Agron. J.* (In Press).

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Bahiagrass Crude Protein and Digestibility

Year	Control	Thermally-dried Class AA biosolids	Aerobically-digested Class B biosolids	Anaerobically-digested Class B biosolids	Inorganic fertilizer
	CP† (%)				
2017	8.8 c	10.1 b	10.6 ab	10.7 a	10.2 ab
2018	8.2 d	9.8 c	11.4 a	10.3 bc	10.4 b
P value	0.005				
	IVDOM (%)				
2017	38.2 a	38.2 a	37.2 a	37.1 a	37.9 a
2018	34.0 c	37.5 a	37.8 a	36.7 ab	35.3 bc
P value	<0.0001				

†Means represent the average across biochar treatments (with or without biochar) and 3 harvest events each year (n= 24). Same lowercase letters within rows are not different ($P > 0.05$).

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N recovery as affected by fertilizer source and year

Fertilizer source	Annual PAN load		Herbage N accumulation	
	2017	2018	2017	2018
	kg N ha^{-1}			
Control	0	0	77 bA†	56 cA
Thermally-dried Class AA biosolids	160	160	160 aA	136 bB
Aerobically-digested Class B biosolids	160	160	151 aB	185 aA
Anaerobically-digested Class B biosolids	160	160	167 aA	136 bB
Inorganic fertilizer	160	160	163 aA	180 aA
P value			<0.0001	

†Means represent the average across biochar treatments (with or without biochar) and 4 replicates (n= 8). Same lowercase letters within columns and uppercase letters within rows are not different ($P > 0.05$).

- 85 to 116% of applied PAN accumulated in bahiagrass above-ground tissue
- No differences between biosolids and inorganic fertilizer

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P recovery as affected by fertilizer source and year

Fertilizer source	Annual total P load		Herbage P accumulation	
	2017	2018	2017	2018
	kg P ha^{-1}			
Control	0	0	13 bA	8 dB
Thermally-dried Class AA biosolids	70	70	32 aA	31 bcA
Aerobically-digested Class B biosolids	165	74	30 aB	34 abA
Anaerobically-digested Class B biosolids	82	107	32 aA	29 cA
Inorganic fertilizer	165	74	31 aB	36 aA
P value			0.004	

†Means represent the average across biochar treatments (with or without biochar) and 4 replicates (n= 8). Same lowercase letters within columns and uppercase letters within rows are not different ($P > 0.05$).

- 18 to 46% of applied P accumulated in bahiagrass above-ground biomass
- No differences between biosolids and inorganic fertilizer

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Conclusions – water quality study

- ❖ Repeated application of biosolids at levels based on crop N requirement showed no impacts on N and P leaching compared with control treatments
- ❖ Biochar showed no benefit in mitigating N and P leaching
- ❖ Fluctuating water table favored N and P leaching.
- ❖ Soils in this study exhibited high P-sorption capacity that prevent significant P leaching

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Greenhouse gas CO_2, CH_4, N_2O emissions as affected by biosolids and biochar application

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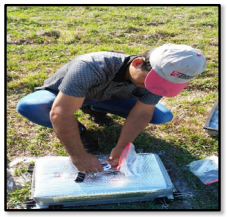


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Conclusions – Greenhouse Gas Emissions

- Climatic factors (i.e. soil moisture, temperature) played a greater role on GHG emissions than fertilizer treatments
- Biosolids led to higher N_2O emissions relative to inorganic fertilizer, probably caused by higher total N application rate associated with biosolids treatment (240 kg ha^{-1} yr^{-1} for biosolids vs. 160 kg ha^{-1} yr^{-1} for inorganic fertilizer)
- Biochar addition suppressed CO_2 emissions but limited effect was observed on N_2O and CH_4 fluxes

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Conclusions

- ❑ Results demonstrated that biosolids applied at N-base rate is a viable alternative for sustainable bahiagrass production while reducing the dependence on inorganic fertilizer
- ❑ Repeated application of either biosolids or inorganic fertilizer based on crop N requirement showed no impacts on water quality or GHG emissions
- ❑ Total N mass leached accounted for 11% of applied PAN for inorganic fertilizer vs. 2% for biosolids. Leachate P for inorganic fertilizer and biosolids were less than 1% of applied P.
- ❑ Climatic conditions (rainfall, water table level) had a greater impact on greenhouse gas emissions than fertilizer management
- ❑ Although biochar may increase soil carbon levels, it showed no agronomic or environmental benefits

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Acknowledgments

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THANK YOU!

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