Florida Pine Flatwoods: Sustainability in the Context of Long-Term Agroecosystem Research (LTAR)

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Abstract Text:

Pine flatwood ecosystem is often used as a feed source in cow-calf production systems while also providing habitat for many plants and wildlife species and representing an important carbon sink. However, this ecosystem is increasingly threatened by urbanization pressure. Species composition in this ecosystem may be shifted through natural or anthropogenic events, among which fire occurrence is one of the most relevant. Fire may occur naturally at an average frequency of three years, but fire suppression strategies can reduce this frequency to five to 10 and, in some locations, to as little as 50 years. From a production standpoint, more frequent fire may result in shifts in botanical composition towards more desirable grass species and grassland-associated wildlife, especially when fire has been suppressed for many years. Fire management regimen can also influence other ecosystem services, including greenhouse gas mitigation, water quality preservation, nutrient cycling, soil carbon sequestration, and above and below-ground biomass production. These changes have rarely been evaluated over a period longer than three years in the Florida pine flatwood ecosystem, which limits our ability to effectively understand the multifaceted impacts and interactions of fire and grazing on ecosystem responses. The USDA, Long-Term Agroecosystem Research (LTAR) network creates valuable opportunities to cooperate in multi-disciplinary long-term research that addresses conservation and production challenges associated with agricultural sustainable intensification.

SUGARCANE RESPONSE TO NITROGEN APPLICATION: COMPARING BRAZIL AND FLORIDA SITES

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Abstract:

Nearly 22% of sugarcane grown in South Florida, equaling 90,000 acres is grown on mineral soils, which have low levels of organic matter, silt, and clay, providing little nitrogen (N) mineralization, low capacity of retention, and highly leachable. The same occurs in a large part of the Brazilian territory, responsible for the biggest sugar production in the world (38.85 million tons), where N use efficiency can potentially be reduced by 19% and 5.6% as a result of volatilization and leaching, respectively. Consequently, studies related to response to N in Florida and Brazil has being revised for improving sugarcane production and reducing environmental impacts. The objectives of this study were to compare recent developments in N management in both countries to evaluate the response of sugarcane for N rates in mineral soils, creating strategies to reduce N losses. In Florida, four small-plot trials were established in representative soils of grower fields with low organic matter, comparing N rates through 60 and 300 lb N/acre/year and three to five split applications. The new recommendation, based on this study, and previously reported work is about 200-220 lb N/acre split application in 5 and 4 applications to plant and ratoon cane, respectively. From two sites in Brazil, developed in main productive area, sugarcane has not shown response to higher doses and/or split applications, resulting in lowering the standard application rate from 2,4 lb N/tons to 2 lb N/tons of sugarcane produced.

Coupling Ethanol Extraction with Anaerobic Digestion to Remove As from As-hyperaccumulator *Pteris vittata*

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Improper disposal of arsenic-rich biomass and the lack of efficient methods to treat it may cause contamination in the environment. We developed an efficient method for As extraction from As-rich biomass of As-hyperaccumulator *Pteris vittata* by coupling an ethanol extraction procedure with anaerobic digestion. This study assessed As partitioning among three phases (gas, liquid and solid) during anaerobic digestion of *P. vittata* biomass. The biomass was first extracted with ethanol. Then, extracted biomass with and without As was digested at 35°C under anaerobic conditions for 35 d. Coupling ethanol extraction with anaerobic digestion decreased As concentration in *P. vittata* biomass from 2,665 to 60 mg kg^{-1} or by 98%. While the biomass was reduced by 64-71%, volatile solids were decreased from 94 to 15-18%. Methane production was 145 and 160 $L_N CH_4$/kg VS (volatile solids basis) after 35 d for As-rich and control biomass. As a final step, 51% of As in anaerobic digestate was recovered by As–Mg precipitation. At this level, *P. vittata* biomass can be considered safe by USEPA regulation. Effective As removal from *P. vittata* biomass prior to disposal improves phytoremediation process and lower biomass transportation and landfill disposal costs.

WASTEWATER TREATMENT PLANT PHOSPHORUS MASS BALANCE USING STELLA MODEL

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Much of the struvite literature focuses on either struvite production or mitigation and the effect P removal as struvite has on external systems, such as wastewater effluent and biosolids. A P mass balance model, based on activated sludge WWTPs with aerobic digestion, was developed to determine the effect P removal as struvite may have on internal system waste stream P dynamics. A system dynamics model, STELLA V9.0 (STELLA, isee systems Inc., Lebanon, NH, US), was used to generate P mass balances using stocks, flows and transforming variables (converters) with data collected from four representative WWTPs in north Florida. The treatment capacities of the WWTPs ranged from 371-2,650 m^3 wastewater d^{-1}. The incoming P load to these WWTPs ranged from 2.0-17.6 kg d^{-1}, and the treated effluent P load ranged from 0.6-4.9 kg d^{-1}. The P content of the biosolids generated by the WWTPs ranged from 1.4–5.8%. The individual physical components of the activated sludge process were replicated in STELLA for the P mass balance. Phosphorus removal through struvite crystallization was included in the model, using the experimentally determined struvite-P production rate or converter. Model results demonstrated that the major effect of struvite production on internal P stocks within WWTPs was a reduction in biosolids-P. Simple, system dynamics models may be useful tools for helping to determine the feasibility of implementing struvite-P removal as a means of reducing regulated P outflows in small WWTPs.

[255 words]

Effects of Hurricane Irma on water quality and dissolved organic carbon concentrations across Pellicer Creek

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Dissolved organic carbon (DOC) influences biogeochemical cycling and water quality in wetland systems. When disturbance events occur, and increase the influx of DOC into waterways, these biogeochemical cycles are altered and may take several months to return to normal. The disturbance created by Hurricane Irma caused salinity and DOC fluctuations throughout Pellicer Creek that caused a large spike in concentrations that flowed downstream and out into the Intracoastal waterway. Through water sampling and data sonde deployment, it is apparent that the influx of DOC off the landscape affected many water quality parameters during and for several weeks after the hurricane. The large DOC input into Pellicer Creek from upland systems created a nutrient and salinity gradient that varied from pre-disturbance conditions, potentially effecting long-term nutrient cycling.

Water Balance Variation across North America - the Long-Term Agroecosystems Research Network

A knowledge of water availability underpins agriculture, land and water management. Quantifying the components of the water balance at a site (ie. precipitation, evaporation, runoff, net groundwater recharge/discharge) enables understanding how water availability varies with season and year. This poster describes the development of a water budget of a subtropical grassland/ranchland at Buck Island Ranch, a part of the Archbold Biological Station-University of Florida LTAR network site. This is part of a wider ongoing cooperative study developing water balances at the watershed (> 400 ha) and/or field (< 100 ha) scales at eighteen USDA Long-Term Agroecosystems Research (LTAR) network sites across North America. The poster also summarizes results across the LTAR network. While precipitation and evapotranspiration (ET) ranged from around 250 mm in the Southwest to > 1000 mm in the Southeast, the ET coefficient (ET/[precipitation+irrigation]) was fairly constant for fields with similar land cover within the same climatic region: 0.73 on crop sites with humid climate, and 1.05 for grassland in semi-arid regions. The Budyko framework is used to show how sites lie along gradients of water and energy limitation – the factors that govern ET, typically the biggest loss of water from agroecosystems. The knowledge on water balances for different agroecosystems provides the baseline information to assess potential changes in water availability caused by climate or land use change.

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The Characteristics of Biofuel Residues and their Potential Impacts on Soil Properties

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Biofuel production process results in vast amount of bioenergy residue that needs to be utilized, considering that these residues can be the most beneficial as a soil amendment. The main objective of this study was to characterize the physico-chemical properties of wetcake- second generation bioenergy residue that is described as a "non-fermentable lignin" component of the lignocellulosic crop residues.

We have applied various drying pretreatments to the moist-fresh wetcake samples to evaluate its impact on carbon (C) content and quality. Air dried, oven dried, freeze dried and centrifuged-- residue freeze-dried samples have been analyzed using sequential fractionations method for operationally defined C pools. ^{13}C solid state NMR analysis was conducted on pretreated wetcake samples to identify organic C functional groups. We hypothesized that ^{13}C NMR spectra will indicate that the acid hydrolysis removes primarily more labile carbon components and the residue left after the chemical treatment will be composed of more chemically resistant compounds.

Our results suggests that much of the C in wetcake is present in stable pool. The acid hydrolysable fraction is largely comprised of proteins, nucleic acids, polysaccharides and carboxyl C while non-hydrolysable residue typically contains mainly lignin, fats, waxes and resins. Air-dried, freeze-dried and centrifuged freeze-dried wetcake samples showed no significant difference from each other, while oven-dried wetcake sample had significantly higher O-alkyl/aryl ratio of 4.2, as compared to 1.9-2.3 in other pretreated samples. We assume that during the oven drying some part of the aryl-C, which consists of the aromatic lignins, phenols and ethers were converted to more labile O-alkyl groups, specifically to methoxyl C, carbohydrate and cellulose.

Our recommendation is to proceed with air-dried treatment which has the minimum disturbance effect on samples.

Biochar and P Fertilizer Amendments Affect As Tolerance and Uptake by Rice

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Biochar affects As uptake by plants but its effectiveness is affected by P and Fe content. However, little information is available on the interactions of biochar, As, P and Fe in rice plants. In this study, the effects of maize straw-derived biochar on As accumulation in paddy soil were evaluated. An As-contaminated soil was amended with 0 or 1% biochar and 0 or 90 mg kg^{-1} P and rice plant was grown for 70 days. Biochar application increased rice plant biomass by 5.1% with no P, but its biomass was reduced by 182% at 90 mg kg^{-1} P. Besides, biochar addition reduced As accumulation in the roots and shoots by 57 and 47% with no P, but As uptake was increased by 12% and 56% for the roots and shoots at 90 mg kg^{-1} P. P concentration was increased in the roots but reduced in the shoots with no P. Moreover, with no P, biochar affected root cell wall composition and increased Fe plaque formation, thereby reducing As uptake. Besides, it increased crystalline Fe concentration while exchangeable Fe was decreased at both P levels. Therefore, biochar application inhibited As stress by enhancing root growth, promoting Fe plaque stability and increasing Fe plaque quality.