Valorization of farm pond biomass as fertilizer for economically recycling phosphorus

Sanjay Shukla[1], Asmita Shukla[2], and Alan W. Hodges[3]

1- Department of Agricultural and Biological Engineering, University of Florida, sshukla@ufl.edu, 2 – Consolidated Safety Services, Fairfax, VA, USA, ashukla@ufl.edu, 3- Department of Food and Resource Economics, University of Florida, awhodges@ufl.edu

Long-term fertilizer phosphorus (P) inputs are causing phosphorous saturation of agricultural soils globally. This saturation is spreading to the edge-of-the-farm stormwater detention systems (SDSs). Surface soils in some SDSs were found to be P saturated in the Everglades Basin. Legacy P can be released to surface waters making SDSs a P source rather than their designed sink function. The P release is common after large storms due to dilution and resulting desorption of soil bound P. Management options to revert their sink functions are needed to reduce downstream P discharges. We evaluate sustainable options to revert their role to P sink by extracting the excess soil P. We evaluated the water quality and economic aspects of biomass-harvesting to extract excess P from ponded systems. We conducted a 20-year net present worth analysis to evaluate the economic feasibility of biomass harvesting for reducing downstream P losses. Furthermore, the economic and environmental benefits of on-farm use of harvested biomass waste as an organic amendment were also evaluated. Coupled actions of harvesting-composting would help close the P movement loop between the farm and the downstream surface waterbody thus, making it a sustainable and more profitable alternative of managing SDSs as P sinks.

We use baseline biogeochemical and economic data for P-saturated SDSs that are releasing legacy P to downstream environments, to develop and evaluate a P recycling program for low (LIC) and high intensity cropping (HIC) systems in the iconic Everglades basin of Florida, USA. Results showed that harvesting-composting can conservatively increase the P retention from 50% to 75%. Compost use can increase retention of water and P, and yield while improving soil health. Cost incurred in harvesting and composting can easily be offset by the economic value of the resulting compost and the reduction in State's expenditure on regional P treatment systems. Treatment costs were $26/kg of P for HIC and $42/kg for LIC, more than 10 times the current state expenditure of $355-$909/kg P using constructed wetlands. Recycling provides a better price to performance ratio for the HIC because of high water and P inputs. The SDSs located in LIC systems are saturated to a lesser degree compared to HIC given low water and P inputs.

We propose an incentivized, payment for environmental services (PES) program, where producers are paid for P recycling. The PES program considers the intensity of cropping systems and their location along the drainage network, to achieve basin-scale P load reduction. The estimated, potential basin-scale P retention with the PES was 854 metric tons, 5 times the P that entered the Everglades Protection Area in 2018, at 93% less cost than the current state-operated treatment systems. There are additional benefits of the harvesting-composting – application of compost also increases a farm's water- and nutrient-holding capacity to reduce fertilizer inputs and reduce phosphorus losses. Harvesting biomass on an annual basis may also reduce the carbon footprint which can become another potential benefit. Harvesting-composting followed by on-farm application of compost would return the lost phosphorus to the farm in an economic fashion without any additional financial burden to the farmers.