Moving towards manure phosphorus mass balance in watersheds through pyrolysis to biochar

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There are sometimes more manure nutrients produced than local crops need, with approximately 10% of all counties in the USA producing more phosphorous (P) in manure than is taken up by crops (Maguire et al., 2007). This excess manure P has historically been land applied locally and increased soil test P above agronomic optimum which increases P losses to surface waters. However, as only 10% of all counties in the USA produce more P than is harvested in crops, this also means that 90% of counties do not have sufficient manure P to meet crop needs and must use commercial P fertilizer. Therefore problems with excess manure P are heavily related to distribution, and a cost effective method to redistribute manure P could help alleviate environmental concerns. Pyrolysis of manure into biochar is one possible solution. Pyrolysis is thermal conversion of organic materials, such as manure, in an oxygen-free environment into liquids, gases and solids. There are several forms of pyrolysis, such as fast, slow and vacuum. The fast and vacuum pyrolysis processes emphasize bio-oil production with biochar and gases as byproducts, while slow pyrolysis favors biochar production at the expense of bio-oil and gases. Biochar is substantially lighter than manure because of moisture loss and volatilization of the organic compounds. However, most of the inorganic compounds and P originally in the manure are retained in the biochar residue after the pyrolysis. "Terra preta" soils amended with material similar to biochar in the Amazon hundreds of years ago show improved productivity relative to native soils. This is primarily due to increased water holding capacity, cation exchange capacity and nutrient use efficiency. The fact that Terra preta soils have elevated carbon hundreds of years after biochar application has also raised interest in biochar for carbon sequestration. If pyrolysis can produce bio-oil and the biochar is a value added product that contains all the manure P, then it may be a cost effective solution for regional surpluses of manure P. We produced biochar from broiler litter using fast pyrolysis and then evaluated it as a value added product in two greenhouse trials using two soils. Salt toxicity of biochar was investigated using lettuce seeds germinated at 15 rates of biochar application to soils ranging from 100% soil to 100% biochar by weight. Results showed that litter biochar addition at and above approximately 5% caused salt toxicity. In humid regions the salts would leach throughout the growing season, so the salt in the biochar limits annual applications, but not total application rates over several years. Staying below this 5% by weight upper application rate, peppers were grown with five rates of biochar application. We will pepper harvest and quality and total plant biomass. We will also report soil properties, including Mehlich 1 extractable nutrients, pH, cation exchange capacity, soluble salts, and water holding capacity. We will also discuss the implications for large scale pyrolysis of manure.

Maguire, R.O., D.A., Crouse, and S.C. Hodges. 2007. Diet modification to reduce phosphorus surpluses: A mass balance approach. J. Environ. Qual. 36:1235-1240.