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The potential of biochar to increase soil fertility, crop productivity and carbon sequestration: ensuring there are no negative environmental effects

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This research is being carried out at the National Trust Wallington estate in Northumberland, NE England, an agricultural estate where land-management options are being considered in an attempt to enhance current land carbon stocks and reduce carbon emissions. In an ideal situation short rotation coppice will be grown and used as a substitute for fossil fuels, thereby reducing carbon emissions. Biochar will be created as a by-product of biofuel production and applied to the soils on the estate where it will potentially remain locked up for thousands of years due to its high stability. If this process of char production from biomass can be carried out and applied to soils on a yearly basis there is the potential for biochar to provide a perpetual carbon sink. The potential does not stop there however, as it has been suggested that applying char produced from biomass to soils low in organic matter can improve soil fertility and nutrient retention, thereby increasing plant productivity. This increase in plant productivity will increase photosynthetic drawdown of CO_2 and further contribute to the carbon sequestration benefits of biochar application.

As this is a relatively new area of research these are all just potentialities, and the aim of this study is to ensure there are no negative environmental impacts associated with applying biochar to the arable and forestry soils on the estate, with the initial aim of increasing the estates soil organic carbon sink. In order for the estate to become carbon neutral through biochar application alone it was calculated that 3312 Kg/ha/year of biochar would need to be applied to the current area of arable land. This however is based on the assumption that all of the biochar added is stable and will remain in the soil, and assumes that addition does not lead to increased CO_2 emissions from the organic matter already present.

This study presents the results of plant productivity, leachate and weekly soil respiration measurements from 24 lysimeters filled with arable and forestry soils and 4 levels of charcoal treatment in order to identify any negative implications involved with the use of biochar. Levels of treatment were chosen to assess the impact of application on a yearly basis, and any negative impacts which may result from very high eventual concentrations. The following levels of charcoal were applied: 0 Kg/hectare, 6250 Kg/hectare, 62500 Kg/hectare, 87 500 Kg/hectare. The lysimeters containing 0 Kg/ha act as a control, the lysimeters containing 6250 Kg/hectare allow assessment of the impacts of 2 years of addition, 62 500Kg/ha the impact of 18 years of addition, and 87 500kg/ha the impact of 26 years of addition. The results from the plant productivity and leachate trial will indicate the levels of biochar which can be applied to increase productivity, without causing any negative environmental effects. The soil respiration measurements will identify any carbon losses which may result from adding biochar to gain benefits in terms of plant productivity.