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Influence of biochar production conditions on its structure, properties and stability

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Introduction

The main objective of this work has been to relate the biochar production process and operating conditions to the yield, and the resulting structure and properties of biochar that determine its long-term stability. Such knowledge is very important from the point of view of designing a biochar production system with optimal energy balance that would produce high yields of biochar of suitable quality.

To achieve this, we used our lab-scale pyrolysis facilities to produce biochar from sugarcane bagasse under closely defined, controlled and monitored conditions. Initial tests were performed in a batch system on a scale of approximately 100g (see Fig. 1), before scaling up to a continuous pyrolysis unit capable of producing up to 2kg of biochar per hour. In our experiments we varied operating conditions including the temperature, residence time and the heating rate. Biochar samples obtained in these experiments were then characterised. The biochar from the lab-scale pyrolysis units and its properties were compared with biochar produced from the same starting material in an industrial slow pyrolysis unit (Pacific Pyrolysis).

Results and Discussions

To assess the impact of production conditions on the stability of biochar we subjected the different biochar samples to a series of tests that are a part of a biochar characterisation toolkit, under development at the UK Biochar Research Centre. These tests consist of different aging and degradation procedures that aim to simulate natural processes occurring in soils, i.e. processes to which biochar would be exposed during its long-term storage in the environment. The results provided information on the expected short-term release of labile carbon from biochar in soil, and the presence of labile nutrients within the biochar matrix. Even though this information does not yet provide us with a quantitative predictive capability for long-term biochar stability, it allows us to do comparative analysis of the stability of biochar produced under different conditions. This then allows us to assess which combinations of feedstock and operating conditions are best suited for production of biochar with different proportions of stable carbon.

Figure 1. Batch lab-scale pyrolysis unit for biochar production at the UKBRC pyrolysis lab.

Conclusions

The information on stability of biochar is very important for the assessment of the climate change mitigation potential of biochar, as it has not yet been clearly defined what proportion of biochar actually remains "permanently" sequestered and how much is quickly released back to the atmosphere, potentially altering patterns of short-term biological activity in soil. Our results show how and to what degree the selection of operating conditions influences the yield and stability of biochar.