A simple and accurate method for estimating soil carbon sequestration using biochar based on proximate analysis

Procurement | Demonstration

Item: Bamboo, Unutilized woody biomass

GHG emission reduction
Biomass utilization

Outline

Biochar has gained increasing attention due to its potential mitigating climate change and improving soil quality, and it is also being used to generate carbon credits. Estimating soil carbon sequestration with biochar typically requires time-consuming and costly methods, such as elemental analysis. However, our newly developed method simplifies this process by applying proximate analysis based on the Japanese Industrial Standard (JIS) M 8812, which is commonly used in coal quality assessment. This approach allows for more straightforward and accurate estimation of soil carbon sequestration using biochar.

Background/effect/note

Biochar is produced from biomass through pyrolysis at temperatures in excess of 350˚C under low-oxygen conditions (Fig. 1, left). When applied to agricultural land (Fig. 1, right), biochar improves the physical, chemical, and biological properties of soil, thereby fostering an improved soil environment. Globally, biochar is recognized as an effective and low-cost solution for carbon dioxide removal (CDR) and soil carbon sequestration. Estimating soil carbon sequestration according to the IPCC 2019 Refinement (Equation 1) involves determining the organic carbon content (F_c) and the carbon remaining after 100 years (F_{perm}). However, this process typically requires time-consuming and costly elemental analysis and other measurements, imposing a burden on biochar carbon credit project developers. To address this issue, we developed a new method that uses proximate analysis instead of elemental analysis. This method estimates the pyrolysis temperature and soil carbon sequestration based on biochar's volatile matter (*VM*) and fixed carbon (*FC*) contents. Using this method illustrated here by the example of bamboo and unutilized woody biomass, research institutions can develop and share estimation formulas tailored to different feedstocks, thereby enhancing the efficiency of quality assessment processes. In countries with existing proximate analysis standards for charcoal, this method allows the back-calculation of biochar's pyrolysis temperature (Fig. 2), F_c (Fig. 3a), F_{perm} (Fig. 3b), and $F_c \times F_{perm}$ (Fig. 4) from standard proximate analysis data. In countries without such standards, adopting this method based on JIS M 8812 provides simplified yet reasonably accurate quality verification, facilitating the broader use of biochar for CDR with the co-benefit of soil improvement.

Equation 1. Biochar carbon sequestration (ton-CO_2) = Biochar mass (ton, drymatter) $\times F_c \times F_{perm} \times 44/12$

Fig. 1. Biochar (bamboo) produced using a flame-curtain kiln (left), and biochar mixed with manure for application to farmland (right).

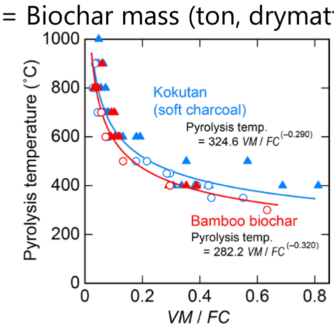

Fig. 2. Estimation of pyrolysis temperature from JIS M 8812 data on bamboo and woody biochar.

Technical details:

https://doi.org/10.34556/gars-e.4

Contact
rbrc@st.ritsumei.ac.jp

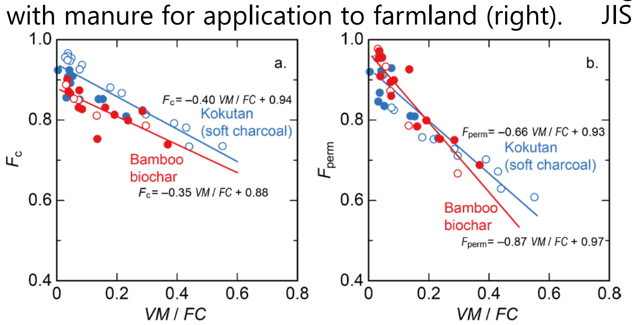

Fig. 3. (a) Estimation of organic carbon content F_c and (b) carbon remaining after 100 years F_{perm} from JIS M 8812 data on bamboo and woody biochar.

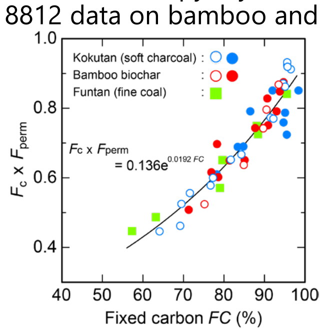

Fig. 4. Relationship between FC (JIS M 8812) and $F_c \times F_{perm}$.

RITSUMEIKAN UNIVERSITY

Institute of Wood Technology, Akita Prefectural University