Secondary, we proceeded to an executive scale and to material circulation research with pyrolysis. One achievement research was carried out at south island, Japan namely Miyako-Island, Okinawa. There, two types of pyrolysis plants were installed whose main feeding materials were bagasse (sugarcane squeezed residue) and cattle sludge. Bio-char from bagasse can be used to sustain agriculture. We found that application of biochar from bagasse enables 1) to increase sugarcane production and 2) to reduce nitrate nitrogen concentration which is a dominant ground water contamination cause, there. Therefore, farmland application of biochar from bagasse can attribute sustainable agriculture taking into consideration of both crop production and environment. In addition, we tried to make an optimal biomass refinery systems at the island including pyrolysis and to achieve it. Optimal allocation of the biomass and plant operation conditioned were studied with LCA (Life Cycle Assessment).

Thirdly, there is an ongoing research project with pyrolysis at Miyako-Island, also. We hope to make an application manuals for farmland of the converted biomass such as biochar, anaerobic digestive slurry and compost etc.

These kinds of research were fully funded by Ministry of Agricultural, Forestry and Fisheries, Japan.

These kinds of research can be applicable to other materials and sites, hopefully.

A16: Biomass availability, energy consumption, and opportunities for biochar use in rural household of Western Kenya

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Wood burning is the primary source of cooking energy in rural households throughout Africa. Yet, population growth and expansion of cultivated lands have led to scarcity of fuel wood and the exploitation of the remaining forests poses a threat to global biodiversity that should be reduced rather than promoted. An alternate fuel source is the use of biomass residues. However, their removal from the farm can lead to decreasing levels of soil organic matter and nutrient availability, decreasing agricultural productivity. An alternative is the pyrolyzation of biomass residue while cooking, which can provide syn-gas as a source of fuel energy and biochar as a soil amendment. This return of biochar to soil may improve soil productivity by conversion of crop residues to a longer-lasting biochar amendment.

Our objective is to determine the feasibility of producing biochar and syn-gas through the process of cooking in African small holder farms. In this study a biomass and energy survey is used to establish household cooking activities, use of cooking stoves, fuel use and estimation of biomass in rural households in South Nandi, Kenya. Data will be presented on the types and quantities of biomass available as potential feedstocks for the production of syn-gas and biochar. In addition, stove efficiency and specific fuel consumption rates are presented identifying the cooking energy needs of the household.

In the future these findings will be used to establish the initial design of an improved cooking stove which can be used for the production of syn-gas and the resulting by-product, biochar as a soil amendment.

Technical Session 2: Biochar Characterisation

Oral Presentations

Biochar and it's Characterisations

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I, like many others in the past, considered that the black colour of soils in mid-western states of the USA and of Alberta was attributable to organic matter. We were correct, but the colour could not be attributed to the conventional dark coloured components of soil organic matter (SOM). Before former student Andre Simpson departed for the USA and Canada, we set out to fractionate the humic acids (HAs) from the Mollisol Soil Standard of IHSS. We had been intrigued with the characteristic NMR spectrum in the aromaticity resonances of the Mollisol HA standard. We achieved a fractionation. One fraction gave a symmetrical peak in the aromatic resonance, and the spectrum for the second fraction was characteristic of HA components with origins in altered lignins. It became clear subsequently that the symmetrical aromatic peak was from fused aromatic structures. The spectrum showed a strong resonance for carboxyl functionality and that suggested that some oxidation of peripheral components of the fused aromatic structures had taken place.

Other circumstances brought me into contact with the Brazilian Chapter of IHSS, and the subsequent introduction of Brazilian post-doctorals and students to my laboratory in Limerick. Inevitably that introduced me to the Terra Preta de Indio initiatives, and the involvement of colleague Etelvino Novotny in studies of the Terra Pretas. I regretted that, during my communications with Wim Sombroek at meetings of the International Society of Soil Science, I had not taken more interest in his pioneering work in the Amazon Region.

I still maintain, of course, interests in the Chemistry of SOM, but our involvements with Second Generation Biorefining and in the Pyrolysis and Gasification of biomass has caused members of my Group to take a strong interest in Biochar. NMR spectra of Biorefinery residues from lignocellulose substrates show that the carbohydrate components are transformed to platform chemicals, and the residues are rich in altered lignins and resistant SOM components such as suberins and suberans. When subjected to pyrolysis processes these residues give rise to gases, bio-oils, and chars.

The properties of the chars depend on the substrates and on the temperature and air regimes used. In our recent studies we have seen some amazing plant growth promoting effects from biochars, and these results could not be attributed to fungal colonies but to growth stimulators sorbed in the biochar. Interestingly there were significant differences in growth stimulations between chars of C3 and C4 plants.

NMR provides a powerful tool for studies of compositions of Biochars. However, the usual NMR procedures used for humic and SOM studies do not meet specific requirements for Biochars because pyrogenic materials present strong local magnetic susceptibility heterogeneities. Our data show that uses of CSA-filter and TOSS techniques make the pulse sequences very sensitive to imperfections in the πpulses. We will show how we have used Variable Amplitude CP - (VACP)/MAS spectra and composite πpulses in the CSA-filter and TOSS pulse sequences. In that way the component functionalities in a humic acid (HA) from a Terra Preta soil were successfully determined. Other techniques will be discussed.