THE ROLE OF BIOCHAR IN MANAGEMENT OF SUGARCANE

By

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Abstract

THE SUGARCANE industry in many parts of the world produces food and energy (stationary and fuel). The industry is well positioned to offer greenhouse gas abatement and climate change mitigation. The thermal conversion, via a slow pyrolysis process, of cane residues such as green harvest trash and bagasse can produce additional thermal or electrical energy as well as biochar. Studies have shown that a commercial slow pyrolysis unit could generate over 2MWh of electricity from every four tonnes of dry trash, as well as 1.3 tonnes of biochar per hour. Biochar has characteristics similar to black carbon, and it has recently been suggested as a sequestration pathway to remove CO_2 from the atmosphere, long term, due to its very stable chemical structure. One tonne of bagasse derived biochar would sequester in the order of 2.3 tonnes of CO_2 equivalents. In addition to C sequestration, biochar has other significant benefits such as offering improved soil quality, CEC, moisture retention etc. It also has the potential to reduce emissions of greenhouse gases from cane soils, including nitrous oxide and methane. Biochars derived from cane trash and bagasse were applied in incubation studies to soils from the Burdekin region in Australia to test for reductions in emissions of greenhouse gases. We found significant declines in emissions of the greenhouse gas, nitrous oxide (N_2O), from urea-fertilised soil when bagasse biochar was applied at a rate of 10 t/ha. The agronomic performance of biochar is being assessed in a 15 plot trial conducted on a sugarcane property in the Tweed Valley, NSW. Biochars from waste were tested and included paper mill biochar and council green waste biochar. Controls included lime treatments. Each plot used 3 rows of cane and was 30 m in length to enable commercial-scale harvesting. Although no significant effects in yield were recorded for year 1, this trial is expected to continue for two more seasons allowing additional data on yield effects to be demonstrated. Our work is demonstrating that implementation of slow pyrolysis and biochar utilisation in the sugarcane industry has potential to provide 1) renewable energy 2) income from waste 3) climate mitigation through stabilisation of carbon 4) climate mitigation through reduced emission of N_2O from soil, and 5) improved soil fertility and agronomic performance.

Introduction

Anthropogenic enhancement of soil by the application of charcoal has been implemented for several thousand years. The Terra Preta, dark earth, soils of the Amazon (Glaser *et al.*, 2001) highlight the possibilities of biochar amendment, as these soils maintain very high fertility long after application, while surrounding soils remain poor.

Black carbon manufactured through pyrolysis of biomass has become known as ‘biochar’ (Lehmann *et al*., 2006). A wide range of biomass sources have been used to make biochar, including: woody materials, agricultural and food wastes (Demirbas, 2004; Ioannidou and Zabaniotou, 2007), greenwaste (Chan *et al*., 2007) animal manures (Chan *et al.*, 2008) and wastes from the papermill industry (Van Zwieten *et al.*, 2009a).

The application of biochar to soil can improve soil quality and plant growth (Chan *et al.*, 2007; Chan *et al.*, 2008) and reduce emissions of greenhouse gases (GHGs), in particular nitrous oxide (Yanai *et al.*, 2007; Van Zwieten *et al.*, 2009b). Furthermore, biochar is protected from rapid microbial degradation, enabling the carbon stored in biochar to remain for hundreds of years (Lehmann *et al.*, 2006; Krull *et al.*, 2009).

There are many technologies that are capable of making biochar products. These include slow and fast pyrolysis, carbonisation, charcoal retorts and gasification. Slow pyrolysis typically utilises a kiln that is heated externally to achieve temperatures of around 500°C with a residence time of the biomass at this temperature around 30 min (Brown, 2009).

Slow pyrolysis yields two key products, biochar and syngas, although some systems may also yield pyrolysis oil. The syngas is a combustible mixture of methane, hydrogen and carbon monoxide which can be used to generate the heat required to dry and pyrolyse the biomass, with surplus gas being available to generate renewable energy, such as electricity (Downie *et al.*, 2007).

Recent work by Gaunt and Lehmann (2008) used a life cycle assessment approach to assess systems designed solely for energy production and compared these to pyrolysis which produced both energy and biochar. Their findings show that the avoided emissions of GHGs are between 2 and 5 times greater when biochar is applied to agricultural land (2–19 t CO_2/ha /y) than when used solely for fossil energy offsets.

Between 41–64% of these emission reductions were credited to the retention of C in biochar, the rest to offsetting fossil fuel use for energy, fertiliser savings, and avoided soil emissions other than CO_2. Despite a reduction in energy output of approximately 30% where the slow pyrolysis technology was optimised to produce biochar for land application, the energy produced per unit energy input at between 2 and 7 MJ/MJ is greater than that of comparable technologies such as ethanol from corn.

Additionally, this study by Gaunt and Lehmann (2008) showed that C emissions per MWh of electricity produced range from 91–360 kg CO_2/MWh. Even before accounting for C offset due to the use of biochar, this figure is considerably lower than the lifecycle emissions associated with fossil fuel use for electricity generation (600–900 kg CO_2/MWh).

Slow-pyrolysis and the sugar industry

Globally, the requirements for food and energy are increasing. The sugarcane industry is well positioned, in that it can offer both food and energy production, in the form of fuels (first and second generation), and stationary energy from crop residues such as lignin wastes, bagasse and trash.

It provides these products without increasing the quantity of greenhouse gases in the atmosphere. Climate mitigation can be achieved through both displacing fossil fuels, as well as the conversion of labile organic carbon into very stable organic carbon (biochar) that is used as a soil amendment.

Recent work has demonstrated sugarcane residues can generate energy in the form of electricity through combustion of the syngas (methane, hydrogen and carbon monoxide) in a gas engine. Table 1 summarises results:

Table 1—Conversion of sugarcane waste into biochar and energy.

Feedstock	Biochar yield (dry basis) %	Syngasenergy produced MW/tonne dry feed)	Electricity production (MWh/tonne dry feed)
Sugarcane trash	33.6	1.33	0.5
Bagasse	31.3	1.35	0.5

Notes: Pyrolysed at a highest heating temperature of 550^0 C with mean residence time at this temperate of 40 minutes and a heating rate of 5^0 C/min. The electricity output is based on the use of a gas engine at 37% conversion efficiency. It should be noted that larger scale applications may use gas or steam cycle turbines with differing conversion efficiencies.

The ultimate analysis (Australian Standards 1038.6.3.3 method) revealed that the molar H/C ratio of feedstock was 1.50 and 1.45 for the trash and bagasse respectively, and this reduced to 0.45 for trash biochar and 0.43 for bagasse biochar. This indicates the disproportional loss of hydrogen as the carbon forms more stable, conjugated aromatic structures. In a review by Krull *et al.* (2009), it is suggested temperatures above 400°C form chars with H/C ratios below 0.5, and that these ratios demonstrate aromaticity and maturation. In recent work by Kuzyakov *et al.* (2009), biochars made at temperatures of 400°C were shown to have a turnover rate of around 2000 years. The sugarcane waste biochars in this study were produced at higher temperature (although lower residence time). Therefore, it can be expected that when applied in soil, they will remain there for many hundreds of years, highlighting their climate mitigation potential.

Table 2—Chemical analysis of feedstocks and biochars.

		Trash feedstock	Bagasse feedstock	Trash biochar	Bagasse biochar
EC	dS/m	na	na	4.8	0.18
pH ($CaCl_2$)	pH units	na	na	9.6	8.4
Bray 1 Phosphorus	mg/kg	na	na	250	67
KCl extractable Ammonium–N	mg/kg	20	16	0.73	2.2
KCl extractable Nitrate-N	mg/kg	7.5	10	<0.20	<0.20
Total Nitrogen	%	0.61	0.64	1.2	1.1
Total Potassium	%	0.64	0.14	2	0.25
Total Phosphorus	%	0.074	0.17	0.25	0.22
Total Carbon	%	41	38	68	65
Exchangeable Cations					
Aluminium	cmol(+)/kg	na	na	<0.03	<0.03
Calcium	cmol(+)/kg	na	na	6.4	2.1
Potassium	cmol(+)/kg	na	na	27	0.94
Magnesium	cmol(+)/kg	na	na	5.3	0.25
Sodium	cmol(+)/kg	na	na	0.9	0.25
CEC	cmol(+)/kg	na	na	40	3.5
Calcium/Magnesium ratio		na	na	1.2	8.5
Acid neutralising capacity	% $CaCO_3$	na	na	4.6	1.1
Molar H/C ratio		1.50	1.45	0.45	0.43

Trash biochar had high levels of total K, while levels of this mineral were lower in the bagasse biochar. In combustion systems like traditional co-generation facilities, alkali compounds such as potassium foul heat transfer surfaces, participate in slag formation in grate-fired units and contribute to the formation of fluidised bed agglomerates (Turn *et al*., 1997).

The concentrations of potassium in bagasse feedstock are not significant; however, concentrations in the cane trash would certainly contribute to fouling. These fouling problems are overcome through the use of slow pyrolysis. In addition, potassium, an important sugarcane nutrient, is recycled with an almost 100% efficiency back into the biochar for soil application.

Both biochars have small amounts of plant available P (Bray P), but negligible plant available N. The trash biochar has a CEC of 40 cmol(+)/kg, much higher than the bagasse biochar from these analyses or other CECs reported in the literature (Van Zwieten *et al*., 2009; Chan *et al*., 2007, 2008). This highlights their potential to be applied in conjunction with fertilisers to enhance fertiliser use efficiency.

The trash biochar had an acid neutralising capacity of 4.6% compared to agricultural lime. Previous research on biochar from papermill residues has demonstrated that much of this acid neutralising capacity from biochar comes from Ca complexes on the surface, such as hydroxides, oxides and carbonates (Van Zwieten *et al*., 2009).

Many of the biochar trials undertaken have used values of 10 t/ha application rate. This equates roughly to 1% w/w assuming incorporation into the 0–10 cm soil profile. Applications of this rate would be equivalent to increasing soil carbon from a hypothetical value of 2.0% to close to 2.5% carbon, assuming a bulk density of 1.5 g/cm^3.

The application would be equivalent to a 200 kg application of K, which would satisfy the K requirement of the crop, as well as a minor addition of P. The pH of soil would be expected to increase, equivalent to an addition of 460 kg agricultural lime. The effects on soil fertility including CEC, however, can not be fully predicted and field assessments are necessary.

It has been estimated that over 2.5 Mt of unutilised biomass exists in the Australian sugarcane industry every year (Bernard Milford, pers. comm.). This waste biomass could generate around 156 MW/h of electricity if processed via slow pyrolysis, and close to 855 000 t biochar production annually.

Putting numbers into perspective, this would equate to ca. 350 000 t avoided CO_2 emissions through offsetting fossil fuels, and around 2 Mt CO_2 equivalents locked up in soil. An average motor vehicle travelling about 20 000 km per year emits an equivalent of 5.2 t CO_2 (US EPA, 2000). This would equate to offsetting emissions from around 500 000 motor vehicles.

Reduction of non-CO_2 GHG emissions from soil

Climate change caused by increase in atmospheric concentrations of greenhouse gases (GHGs) is predicted to cause catastrophic impacts (IPCC, 2006). Human-influenced sources of nitrous oxide (N_2O) contributed 3 GT CO_2e (carbon dioxide equivalents), around 8% of global emissions, in 2004.

It was estimated that agriculture was responsible for 42% of this total (Denman *et al*.., 2007). Sources for N_2O emissions from soils include application of N fertilisers, biological N fixation and excreta of grazing animals. A range of factors influence the emission of N_2O including N application rate, crop type, fertiliser type, soil organic C content, soil pH and texture (Dalal *et al.*, 2003).

Soil is both a significant source and sink for the greenhouse gases nitrous oxide (N_2O) and methane (CH_4). Emissions from sugarcane soils in Australia have shown very significant production of nitrous oxide (21% of applied N converted to N_2O) (Denmead *et al*., 2008). A total of 45.9 kg N/ha was emitted from a northern NSW sugarcane farm in the season following application of 160 kg N fertiliser.

As the global warming potential of N_2O is 298 times greater than the equivalent mass of CO_2 in the atmosphere (Forster *et al.*, 2007), this equated to emissions of 43 t CO_2e/ha. Hence, small reductions in emissions could potentially provide significant benefits for climate mitigation.

Recent work by Van Zwieten *et al*. (2009b) has demonstrated the potential for biochar to reduce emissions of N_2O from soil. Current work using soils from the Burdekin region in Queensland, Australia, and bagasse and trash biochars are demonstrating very significant potential for reducing emissions of this potent GHG from soil.

Experimental microcosms containing soils from the Burdekin cane region in Queensland, Australia were used to demonstrate the GHG reduction potential of biochar. Soils were amended with biochars derived from trash and bagasse, to a rate of 10 t/ha equivalent, and compared to control (unamended) soil. Nitrogen was applied at either 0 or 165 kg/ha to all treatments. The atmosphere in the microcosms was analysed at days 1, 2, 4, 7 and 14. The microcosms were flooded at day 21, and the atmosphere was sampled again at days 21, 22, 23, 24, 28, 35, 42 and 49. Results for nitrous oxide emissions from the bagasse and trash biochars are depicted in Figures 1 and 2 respectively.

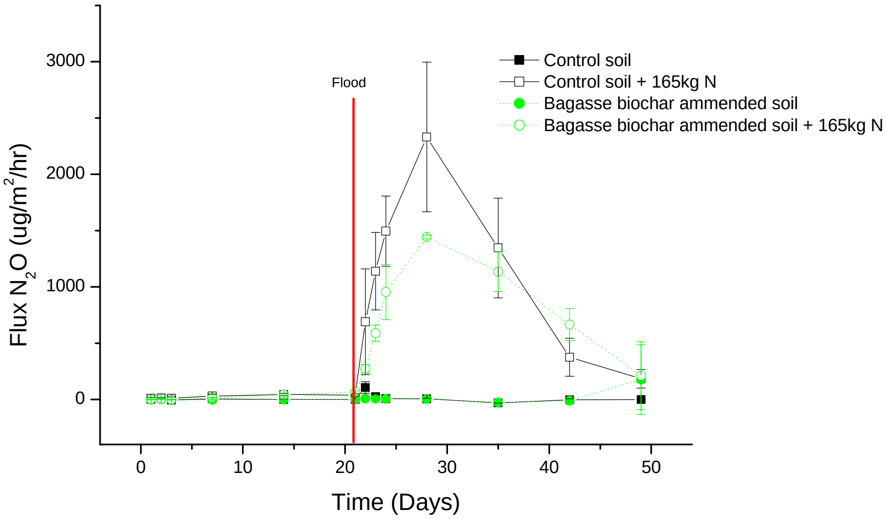

Fig. 1—The production of nitrous oxide from control and bagasse biochar amended soils incubated with and without nitrogen amendment.

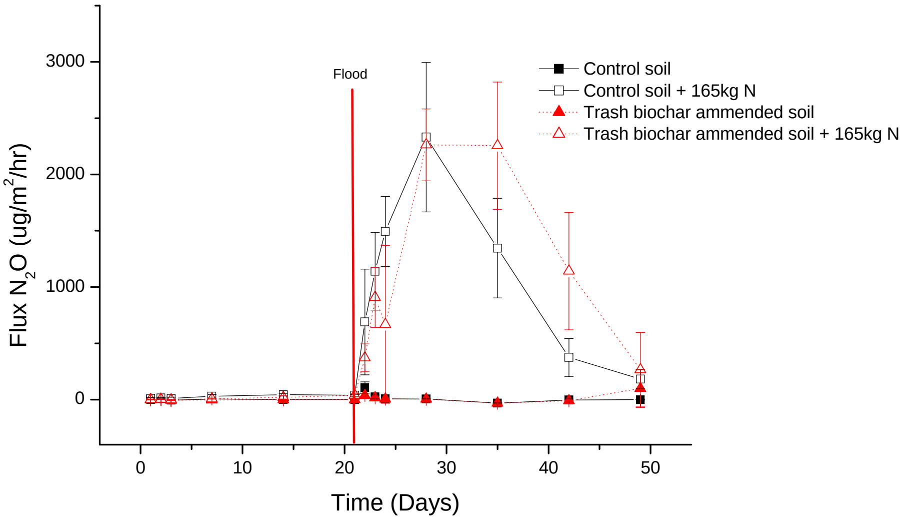

Fig. 2—The production of nitrous oxide from control and trash biochar amended soils incubated with and without nitrogen amendment.

The control soil with 165 kg N/Ha lost 0.7% of total nitrogen as N_2O in the 28 days following flooding. All of the N loss as N_2O was following flooding. Bagasse biochar significantly reduced N_2O emissions (0.55% of total N). A 21% reduction in N_2O emission compared to both fertilised control and 38% compared to the trash biochar (0.88% N loss) amended soils. The bagasse biochar amended, fertilised soil had higher nitrate: ammonium N ratio than either the fertilised control or trash biochar amended soils. This indicates an improvement in N mineralisation through nitrification. Further losses could have been reduced by suppression of denitrification enzymes (Van Zwieten *et al.*., 2009).

Field assessment of biochar in sugarcane

A field trial testing biochar was set up on the Tweed Valley, northern NSW. Plots were 30 m long and contained three rows of cane. The outside rows of the cane were used as buffers, and the inside row was used for soil analyses, GHG emissions testing and yield data. At the ends of each row, an additional 2 m buffer was used between plots. Treatments were allocated to experimental units in a randomised complete block design using the three rows of five plots as the blocking factor. Treatments included; control (standard farming practice), papermill biochar at 5 t/ha, council greenwaste biochar at 5 t/ha, council greenwaste biochar at 10 t/ha and lime (1.5 t/ha). Note the chemical properties of these biochars are different to the properties of the sugarcane derived biochars shown in the previous section.

Yield from the first season (2008) following planting is shown in Table 3. Yield measurements were assessed using standard commercial harvesting equipment, and weights of bins were recorded at the completion of each 30 m harvest length. Although no significant differences were seen with yield or leaf nutrient analysis in the first harvest, these trials are expected to continue until 2011, with annual harvesting. It is well recognised that the benefits of biochar application on crop yield may not be expected immediately, but develop over time as soil CEC increases upon biochar oxidation (Chan and Xu, 2009).

Table 3—Yield (kg fresh weight) from field plots in 2008.

Treatment	Yield (kg)	Std dev.	N in leaf tissue (% dry matter)	Std dev.
Papermill biochar 5 t/ha	433	28	2.13	0.05
Greenwaste biochar 5 t/ha	450	100	2.13	0.05
Greenwaste biochar 10 t/ha	416	76	2.10	0.1
Control	433	76	2.00	0.05
Lime 1.5 t/ha	416	76	2.00	0.10

Conclusions

- The research trials to-date have shown that the slow pyrolysis of sugarcane bagasse and cane trash can provide the energy to generate 1 MWh for each two tonnes of dry material. Cane trash, a material potentially problematic during co-generation was shown to be an ideal feed-stock for slow pyrolysis.
- The research shows that the majority of the nutrients in the cane feedstocks are retained in the biochar; thus can be returned to the field along with the carbon.
- Biochar from trash and bagasse had low molar H/C ratios indicating their aromaticity and hence long-term stability in soils.
- A significant reduction in the emissions of nitrous oxide from soil was shown following the application of varying biochar products.
- This manuscript has demonstrated numerous benefits for the Australian and international sugarcane industry. Field scale assessment of this technology is warranted as significant economic, environmental and climate outcomes may be achieved.

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REFERENCES

Brown, R. (2009). Biochar production technology. In: Lehmann, J. and Joseph, S. (eds.) Biochar for Environmental Management. Earthscan Publications Ltd. ISBN: 9781844076581 127-146.

Chan, K.Y., Van Zwieten, L., Meszaros, I., Downie, A. and Joseph, S. (2007). Agronomic values of greenwaste biochar as a soil amendment. Aust. J. Soil Res., 45: 629–634.

Chan, K.Y., Van Zwieten, L., Meszaros, I., Downie, A. and Joseph, S. (2008). Using poultry litter biochars as soil amendments. Aust. J. Soil Res., 46: 437–444.

Chan, K.Y. and Xu, Z. (2009) Biochar: Nutrients properties and their enhancement. In: Lehmann, J. and Joseph, S. (eds.) Biochar for Environmental Management. Earthscan Publications Ltd. ISBN: 9781844076581, 67–84.

Dalal, R.C., Wang, W.J., Robertson, G.P. and Parton, W.J. (2003). Nitrous oxide emission from Australian agricultural lands and mitigation options: A review. Australian Journal of Soil Research. 41: 165–195.

Demirbas, A. (2004). Effects of temperature and particle size on bio-char yield from pyrolysis of agricultural residues. J. Anal. Appl. Pyrol., 72: 243–248.

Denmead. O.T., Macdonald, B.C.T., Naylor, T., Wand, W., Salter, B., White, I., Wilson, S., Griffith, D.W.T. and Moody, P. (2008). Whole of season greenhouse gas emissions from Australian sugarcane soils. Proc. Aust. Soc. Sugar Cane Technol., 30: 105–114.

Downie, A., Klatt, P., Downie, R. and Munroe, P. (2007). Slow pyrolysis: Australian Demonstration Plant successful on multi-feedstocks. In: ‘Bioenergy 2007 Conference’. Jyvaskyla, Finland.

Forster, P., Ramaswamy, V., Artaxo, P., Berntsen, T., Betts, R., Fahey, D.W., Haywood, J., Lean, J., Lowe, D.C., Myhre, G., Nganga, J., Prinn, R., Raga, G., Schulz, M. and Van Dorland, R. (2007). Changes in Atmospheric Constituents and in Radiative Forcing. In:: Solomon, S., Qin, D., Manning, M., Chen, Z., Marquis, M., Averyt, K.B., Tignor, M. and Miller, H.L. (eds) Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change’. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Gaunt, J.L. and Lehmann, J. (2008). Energy balance and emissions associated with biochar sequestration and pyrolysis bioenergy production. Environ. Sci. Technol., 42: 4152–4158.

Glaser, B., Haumaier, L., Guggenberger, G. and Zech, W. (2001). The 'Terra Preta' phenomenon: A model for sustainable agriculture in the humid tropics. Naturwissenschaften, 88: 37–41.

Ioannidou, O. and Zabaniotou, A. (2007). Agricultural residues as precursors for activated carbon production—A review. Renewable Sustainable Energy Rev., 11: 1966–2005.

IPCC (Intergovernmental Panel on Climate Change) (2006). 2006 IPCC Guidelines for National Greenhouse Gas Inventories, National Greenhouse Gas Inventories Programme, Hayama, Japan. Available at: http://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html.

Krull, E.S., Baldock, J.A., Skjemstad, J.O. and Smernik, R.J. (2009). Characteristics of biochar: organo-chemical properties. In: Lehmann, J. and Joseph, S. (eds) Biochar for Environmental Management. Earthscan Publications Ltd. ISBN: 9781844076581, 53–65.

Kuzyakov, Y., Subbotina, I., Chen, H., Bogomolova, I. and Xu, X. (2009). Black carbon decomposition and incorporation into soil microbial biomass estimated by ^{14}C labelling. Soil Biol. Biochem., 41: 210–219.

Lehmann, J., Gaunt, J. and Rondon, M. (2006). Bio-char sequestration in terrestrial ecosystems-A review. Mitig. Adapt. Strat. Glob. Change, 11: 403–427.

Turn, S.Q., Kinoshita, C.M. and Ishimura, D.M. (1997). Removal of inorganic constituents of biomass feedstocks by mechanical dewatering and leaching. Biomass and Bioenergy, 12: 241–252.

US EPA. Office of Transportation and Air Quality NVFEL Library 2000, Traverwood Crive, Ann Arbor, MI 48105

Van Zwieten, L., Kimber, S., Morris, S., Chan, Y.K., Downie, A., Rust, J., Joseph, S. and Cowie, A. (2009a). Effects of biochar from slow pyrolysis of papermill waste on agronomic performance and soil fertility. Plant and Soil (online) DOI: 10.1007/s11104-009-0050-x.

Van Zwieten, L., Bhupinderpal-Singh, Joseph S., Kimber, S., Cowie, A. and Chan, Y. (2009b). Biochar reduces emissions of non-CO2 GHG from soil. In: Lehmann, J. and Joseph, S. (eds) Biochar for Environmental Management. Earthscan Publications Ltd. ISBN: 9781844076581 227–249.

Yanai, Y., Toyota, K. and Okazaki, M. (2007). Effects of charcoal addition on N_2O emissions from soil resulting from rewetting air-dried soil in short-term laboratory experiments. Soil Science and Plant Nutrition, 53: 181–188.

LE ROLE DU BIOCHARBON DANS LA GESTION DE LA CANNE A SUCRE

Par

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MOTS-CLES: Biocharbon, Pyrolise, Energie,
Fertilité du Sol, Gaz a Effet de Serre (GES).

Résumé

DANS DE NOMBREUSES parties du monde, l'industrie sucrière à base de canne à sucre produit à la fois des denrées et de l'énergie. Cette industrie procure une diminution des gaz à effet de serre et une atténuation du changement climatique. Par un procédé de pyrolyse lente, la conversion thermique des résidus de canne tels que le paillis de récolte en vert et la bagasse peut produire à la fois une énergie supplémentaire thermique ou électrique et du biocharbon. Des études ont montré qu'une unité de pyrolyse lente pouvait générer plus de 3MWh d'électricité à partie de 4 tonnes de résidus secs ou 1.3 tonnes de biocharbon par heure. Le biocharbon a des caractéristiques similaires au carbone noir, et a été récemment proposé comme voie de séquestration pour éliminer à long terme le CO2 de l'atmosphère, à cause de sa structure chimique stable. Le biocharbon provenant d'une tonne de bagasse pourrait séquestrer environ 2.3 tonnes d'équivalents CO2. En plus de la séquestration de C, le biocharbon a d'autres avantages incontestables tels que l'amélioration de la qualité du sol, de la CEC, de la rétention en eau etc. Il a aussi la capacité de réduire les émissions de gaz à effet de serre provenant du sol, tels que l'oxyde nitreux et le méthane. Des biocharbons provenant des résidus de canne et de bagasse ont été incubés dans des sols du Burdekin en Australie afin de tester les réductions de gaz à effet de serre. Des applications de 10 t/ha de biocharbon de bagasse ont diminué significativement les émissions de gaz à effet de serre comme l'oxyde nitreux (N_2O) provenant de sols fertilisés avec de l'urée. La performance agronomique du biocharbon a été évaluée dans un essai de 15 parcelles conduit dans une exploitation de la Tweed Valley, NSW. Des biocharbons de détritus, de papeterie et de déchets verts ont été testés. Les témoins incluaient des traitements chaulés. Chaque parcelle était constituée de 3 rangs de canne de 30 m pour permettre la récolte à l'échelle commerciale. Bien qu'aucun effet significatif sur le rendement ne fût observé l'année 1, cet essai doit continuer sur deux cycles supplémentaires pour estimer les effets sur le rendement. Le biocharbon a été inclus dans l'agenda de la conférence de 2012 sur le climat à Copenhague, comme un moyen de séquestrer à long terme le carbone et comme remède sur les terres dégradées pour la production alimentaire et la reforestation. Notre travail est de démontrer que l'utilisation de biocharbon dans l'industrie sucrière peut potentiellement fournir 1) de l'énergie renouvelable, 2) un revenu à partir des déchets, 3) une atténuation du changement climatique au travers de la stabilisation du carbone, 4) une atténuation du changement climatique au travers de la réduction des émissions de CO_2 du sol et 5) une amélioration de la fertilité du sol et des performances agronomiques.

EL PAPEL DEL BIOCARBÓN EN EL MANEJO DE LA CAÑA DE AZUCAR

Por

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PALABRAS CLAVE: Biocarbón, Pirólisis, Energía,
Fertilidad del Suelo, Gas de Efecto Invernadero (GEI).

Resumen

EN MUCHAS PARTES del mundo la industria de la caña de azúcar produce alimentos y energía (estacionaria y combustible). La industria está bien posicionada para ofrecer reducción de los gases de efecto invernadero y mitigación del cambio climático. La conversión térmica de residuos de caña tales como residuos del corte en verde y bagazo, a través de un proceso de pirólisis lenta, puede producir energía térmica o eléctrica adicional, así como biocarbón. Los estudios han demostrado que una unidad comercial de pirólisis lenta podría generar más de 2MWh de electricidad de cada cuatro toneladas de basura seca, así como 1.3 toneladas de biocarbón por hora. El biochar tiene características similares a las del carbón vegetal, y recientemente ha sido sugerido como una forma viable para fijar CO_2 de la atmósfera a largo plazo - debido a su estructura química muy estable. Una tonelada de biocarbón derivado de bagazo fijaría carbono en el orden de 2.3 toneladas equivalentes de CO_2. Además de la fijación de carbono, el biocarbón ofrece otros beneficios importantes tales como mejoras de la calidad del suelo, de la CIC, retención de la humedad etc. También tiene el potencial para reducir las emisiones de gases de efecto invernadero, incluidos el óxido nitroso y el metano, desde los suelos de caña. Se realizaron estudios de incubación de suelos de la región de Burkedin en Australia a los cuales se les aplicó biocarbón derivado de residuos de caña y bagazo para demostrar la reducción en la emisión de gases de efecto invernadero. Encontramos reducción significativa de la emisión del gas de efecto invernadero, óxido nitroso (N_2O), desde un suelo fertilizado con urea al cual se le aplicó biocarbón de bagazo a una dosis de 10 t/ha. El comportamiento agronómico del biocarbón está siendo evaluado en un ensayo de 15 parcelas realizado en una propiedad con caña de azúcar en Tweed Valley, NSW. Se incluyeron biocarbones de fábrica de papel y de residuos verdes de caña. Los controles incluyeron tratamiento de encalado. Cada parcela fue compuesta por 3 surcos de caña de 30 m de longitud para permitir la cosecha a escala comercial. Aunque no se registraron efectos significativos en el rendimiento durante el año 1, se espera que este ensayo continúe durante dos temporadas más permitiendo obtener datos adicionales que permitan demostrar los efectos sobre el rendimiento. El biocarbón se ha incluido en la agenda del protocolo de Copenhague 2012 como una forma de fijación de carbono a largo plazo, y para rehabilitación de tierras degradadas que se destinarían a la producción de alimentos y la reforestación. Nuestro trabajo está demostrando que la implementación de la pirólisis lenta y la utilización del biocarbón en la industria de la caña de azúcar tiene potencial para proveer 1) energía renovable 2) ganancia a partir de residuos 3) mitigación del cambio climático a través de la estabilización del carbono 4) mitigación del cambio climático a través de la reducción de emisiones de N_2O desde el suelo, y 5) mejoramiento de la fertilidad del suelo y del rendimiento agronómico.