The Effect of Biochar Amendments on *Andropogon gerardii* (Big Bluestem) Seedling Growth First

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More than 90% of tallgrass prairie in North America has been lost since European colonization with substantial accompanying reductions in biodiversity and ecosystem services. Effective weed management is essential to successful prairie restoration efforts, particularly during the early stages of plant establishment. High levels of soil nitrogen appear to favor weedy species over native prairie species and may facilitate the invasion of restoration sites by non-native plant species. Several studies support the hypothesis that weed growth can be reduced in restored sites by adding organic carbon to limit soil N availability. Biochar, a carbon-rich product obtained from burned biomass has proven to benefit crop productivity and improve degraded soils, but has yet to be considered in prairie restoration. This study examines the response of big bluestem (*Androgen gerrardii*), a key tallgrass prairie species, to biochar amendments. A greenhouse experiment was conducted using two soil types (silt clay loam and a sandy loam) mixed with biochar at six rates: 0, 1, 2, 4, 8 and 16%, with and without nitrogen (10 g N/ m^2) in a complete randomized block design. Percent germination and early growth (height, number of tillers, biomass) were recorded and the experiment was replicated. Initial results suggest that early establishment was strongly affected by soil type and biochar concentration. This research demonstrates native prairie response to biochar, specifically during early development and also Investigates the potential of biochar to be used as a management tool to restore tallgrass prairie.

Innovative Building Capacity Program

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Purpose – the paper aims to assure building capacity quality in the term of biochar sustainable technology. The building capacity program has become vital for the process of achieving sustainable development priorities in Egypt. The program be appropriate to all biochar professionals, policy analysts, policy makers, users, producers, investors, and students. The planned participants are graduates of engineering, agriculture technology, and applied science.
Design/methodology/approach – this paper presents the structure of building capacity program, and assesses its outcome. The focus of the program is to guarantee that the participants have an adequate knowledge about related biochar sustainable technology disciplines. Integrated biochar systems, biochar quantification in the environment, climate change mitigation, sustainability, certification, and legislation, commercializing biochar, emissions trading and climate change policy are introduced.
The researcher has developed a program assessment package using micro and macro analysis to assess the program performance toward the achievement of superiority criteria. Data collected from the implementation has been analyzed and results indicate that pre- and postcourse assessments provide valuable information about cadet knowledge. Moreover, the results can be used to continue improving effectiveness of training.
Findings – The outcome of this innovative biochar sustainable training program is guarantee that the participants have an adequate knowledge in these disciplines. The graduates possess professional biochar knowledge. They will be capable of doing their best in biochar different fields. The results indicate that pre- and postcourse assessments with micro and macro analysis provide valuable information about cadet knowledge.
The researchers are encouraged to test the proposed building capacity program in Arab and Nile basin countries. The paper concludes that the capacity building program for biochar sustainable technology has a good human resource impact. After training, biochar sustainable technology professionals can propose and campaign practical solutions to sustainable development problems.

Biochar Offset Protocol Initiative

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In order to position biochar to access the carbon offset markets, there is a need for approved greenhouse gas (GHG) emission reduction quantification protocols to be developed that meet the needs of such projects. Each protocol for biochar projects would need to reflect the range of platforms and meet the requirements for each of the applicable offset systems.
Of particular interest in the North American context, are two opportunities for industry-led GHG protocol development: the Voluntary Carbon Standard (VCS) and the Alberta Offset Standard (AOS) Protocols for these systems would need to meet the ISO 14064 pt II standard. Under this approach, and with due consideration to the variance in carbon market standards, a protocol under the VCS and AOS could be leveraged into other carbon markets – across North America and globally.
As protocol documents reside in the public domain, and given the considerable associated costs, there is a natural hesitancy for project developers to undertake this work on their own. Further, when left to do this work on their own, project developers can limit the scopes of the protocol to those configurations contemplated by that particular project developer. This serves as a means of hindering others in applying the protocol for related projects.
Carbon Consulting and Blue Source are leading an effort that will follow a different approach; technically more challenging, but ultimately of far greater value as a public domain effort. We will deliver a design for Protocol Development that is not tied to specific projects but which meet the needs of foreseeable pyrolysis projects. This design will identify appropriate structures that will enable the protocol to be robust across the number of project types anticipated.
In developing this protocol in the public domain, we are soliciting input from the biochar community and offering primers and presentations on the science and policy

implications behind biochar. Our goal is simple: to open up carbon markets to biochar and pyrolysis technologies. Information can be found at www.biocharprotocol.org.This presentation will address:

- Basics of GHG Protocols and Available Markets
- GHG Emission Reduction Mechanisms and Available Science

The BlackCarbon Project: Pyrolysis/Stirling Engine Co-generation at micro scale (250-500 kW)

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BlackCarbon has commissioned and financed a pilot plant that combines ScrewPyrolysis and StirlingEngine technology to create a cost-effective, robust and resource efficient multifunctional biomass energy unit. The unit is the first of its kind anywhere in the world to combine these technologies.

It has now run for 1000 hours and has produced 25.000 kW of electricity and 20 tonnes of Biochar. A small number of technical questions need to be resolved before the unit can enter into commercial use. These will be dealt with over the next 3 months.

The expected annual production of BioChar is 20 kg/h for 7.500 hrs, equal to 150 tonnes of Biochar per annum.

The test runs have confirmed this performance.

Quality of Char:

The main concern has been whether the char would meet the strict standards in Denmark with regard to heavy metal and PAH content. Early lab tests and recent tests of an actual char batch from the unit have confirmed that the char easily meets the standard.

Energy economics:

The expected Turn-Key delivery cost of a 350 kW unit is 250.000 €.

If the feedstock (dry (15%) wood chip) is valued at 50 € per tonne the annual cost is: 37.500 €

Annual Capital costs (i=8 and n=10) 37.500 €

Maintenance and personnel costs 60.000 €

Overhead 25 % 15.000 €

Total annual costs 150.000 €

Value of electricity at a feed-in-tariff of 20 €-cent 52.500 €

Value of heat at 10 €-cent per kWt 91.500 €

Production Cost of Bio-char 6.000 €

Production cost per tonne of Bio-char 40 €

Production cost per tonne of CO_2 equivalents in char 11 €

Challenges:

- In order to reach stable hour-on-hour energy output and high quality Bio-char production the unit has to achieve a fine calibration of feed-stock input, residence time, and re-use of exhaust heat. Presently, the use of exhaust gas to heat the pyrolysis screw is not delivering enough heat to make the entire unit fully exothermic. If we force more wood-chip through the screw, the char contains too much tar.
- The syn-gas contains a lot of tar - at the tar sometimes combines with char-dust, which clogs up the gas pipe leading from the screw to the combustion chamber. Right now it is still necessary to “burn-out” the pipe every 24 hours.
- Other feed stocks: We need to ascertain whether other feed stocks than wood chip can be used: straw, corn stover, rice husks, olive pits.
- Safe cooling of biochar - we have experienced reignition of biochar- even when it has been stored at ambient temperature for a number of days.
- Agricultural use of bio-char-the rules in Denmark are quite strict - especially on land which is certified organic. The rules specifically state that biomass waste with a residual energy content (ie. biochar) need aspecial permit.

Treatment of greywater and wastewater with char coal

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Char coal has been used for millennia to clean liquids and air from certain elements or compounds. Recently, biochar as a soil improver and simultaneously a carbon sink has been acknowledged. To balance the high carbon content of biochar, its application as a soil improver may need an additional nitrogen application. One way to obtain a favorable carbon/nitrogen ratio of the biochar would be to expose the biochar to household effluents rich in nitrogen.Here we present results on different qualities of char coal exposed to grey water, nitrogen solution, human urine, and wastewater, respectively. Nitrogen sorption and transformation were studied in laboratory and field in order to evaluate the potential of char coal as a means for treating greywater and wastewater in robust treatment plants based on principles of nutrient cycling.

Charvester development for a sustainable biomass production

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In recent years, the usage of biomass for heating purposes of houses has increased in Sweden as a means to replace burning of fossil fuels. However, this will lead to decreased content of soil organic matter, being important for maintaining soil fertility. A sustainable approach would be to insulate the houses better so less heating will be needed and use excess biomass for biochar production and apply to productive soils. Technology used for gathering branches and straw for biomass could be used also for gathering biomass to pyrolysis, while suitable equipment for pyrolysis needs to be developed.

The current state of the Swedish ’Charvester’ project is described. The goal of this project is to create a prototype for a mobile pyrolyser autonomously moving using the pyrolysis heat for movement as well as internal energy needs for biomass processing, as chipping and drying. Possibly, a surplus fraction of the pyrolysis gases/liquids will be converted into biodiesel or other products in the synthetic industry. The produced char will be optimized for biological virtues, length of heating time, and pyrolysis temperature. As improving biological virtues may increase machinery size and process time, an optimization will be found, using specific surface area (BET analyses) and micrography methods as proxys for biological virtue.