Charcoal to Reduce Global Warming and Increase Soil Fertility: Costs and Benefits

> Ainiwaer Alimasi Clark University

## TERRA PRETA

An ancient Amazonian Indian technology to increase soil fertility and store carbon. Recently rediscovered, it is the best way to sequester CO2.

# What do we find in these anomalous black earths?







### "Terra Preta do Indio"

© Glaser

### Terra Preta: A 2000 Year Old Soil Experiment



(Steiner, 2002)

Man-Made Soil Plots

Average size 20 ha

Carbon dated at 800 B.C-500 A.D

High Carbon Content (9%)

Local farmers prize terra preta which yields as much as three fold crop yields as surrounding infertile tropical soils.

### **Dark Earth for Sale**



## New Mining Area









### Some of the many articles and movies

#### The Real Dirt on **Rainforest Fertility**



#### **Biological Fertile Soils**

#### Rial Presi: Sala (2002) 38 218-239 REVIEW ARTICLE

Olaver - Johannes Lehmonn - Wolfgung Zerb neliorating physical and chemical properties of highly weathered soils in the tropics with charcoal - a review

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#### Plant and Soil

#### INAL PAPER

Long term effects of manure, charcoal and mineral fertilization on crop production and fertility on a highly weathered Central Amazonian upland soil

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	W. E. H. Biano Institute of Soil Romanch, University of Natural Resources and Applied Life Sciences (DOKU), 1180 Vacuum, Anntra	Slash and burn agriculture is practiced by about 300-500 million people globally, affecting almost one third of the planet's 1,500 million has dramble land (Giardina et al. 2005; Goldammer 1903).	

2004 Book



#### **BBC Documentary**



s have uncovered the truth behind that myth. The iety, as advanced as the Egyptians or the Incas, right in the heart of the this is more than the story of a lost civilization re copie of the real El Dorado possessed a secret - something with the our world.

#### THURSDAY 19TH DECEMBER 2002 9pm BBC2



HORIZON

#### NATURE Magazine



#### Black is the new green





QuickTime™ and a TIFF (Uncompressed) decompressor are needed to see this picture.

### Science Magazine August 2002

### **Charcoal Carbon Sequestration**

- Biomass carbon is converted to charcoal and then put back into the soil.
- About 2500 gigatons (Gt) of carbon are stored in soils
- This is about 4 times as much as atmospheric CO2 or total global forest biomass carbon.

### Charcoal Carbon Sequestration (cont'd)

- Addition of charcoal to soils can store significant amount of carbon, for up to hundreds of millions of years.
- This is a permanent carbon sink, unlike forests which are only temporary
- However forest carbon is eligible for carbon credits while soil carbon is not!

### Conventional Carbon Sequestration Methods

- Currently carbon capture and storage (CCS) method is employing and the sequestration costs approximately between \$20-25/tCO2 which is including capturing, transporting and injecting costs. However, this cost is not include the cost of fossil fuel and of power plant which is part of the cost of producing CO2.
- Even if all fossil fuel carbon could be sequestered, this would only slow, not reverse, CO2 buildup in the atmosphere.

### **Carbon Sequestration by charcoal**

- Charcoal carbon sequestration is the only means that can reduce the 34% excess of CO2 already in the atmosphere
- The charcoal has many direct benefits, greatly increasing soil fertility through its capacity to retain water and nutrients.

#### **Benefits of Charcoal Carbon Sequestration**

- Direct benefits:
  - increase crop yields, up to 200%, and 266% in some cases
  - increase food security and decrease rural poverty
  - Reduce the amount of organic and inorganic fertilizer use
  - reduce soil erosion and degradation
  - improve soil quality by improving porosity, water holding capacity and cation exchange capacity
  - income generation by selling charcoal

# Benefits of Charcoal Carbon Sequestration (cont'd)

- improve soil fertility by reducing nutrient leaching.
- increase above ground and below ground biomass growth and carbon storage.
- reduce release of nitrous oxide and methane from soil.
- reduce need for deforestation.

### **Charcoal Research in Japan and Asia**

#### Effects of Soil Microbial Fertility by Charcoal in Soil

#### Charcoal!

Effects on microorganism propagation and plant growth, and future prospect to sequester CO2



Makoto Ogawa Prof. Oosaka Institute of Technology Director of Biological Environment Institute Kansai Environment Engineering Center Kansai Electric Power Co. Ltd



Forest floor of Acacia plantation was covered by rice husk charcoal 5 cm in depth. Earthworm population increased soon after the treatment because of neutralization of top soil.



Effect of bark charcoal and fertilizer on the plant growth and soil properties in south Sumatra (Yamato 2004 unpublished)

### Charcoal additions to *A. mangium* Seedlings Height and diameter significantly increased at age of 6 months in comparison to a control



Siregar, (2004 Indonesia), Forest and Nature Conservation Research and Development Center

#### Charcoal has Benefits for Existing Forests

#### Recovering of Pine Tree from Wilting by Charcoal Treatment after a year



Ogawa 1999, Kansai Environmental

#### Charcoal has Benefits for Existing Forests Results of Charcoal Treatment after a year



Results of Charcoal Treatment after a year

## **3 Year Field Trial Studies** Project 🖆 Introduction 🖆 Experiments, Trials & Results 🖆 Application Experiments **Rice/Sorghum Plots** Setup 15 treatments with 5 repetitions

- Experimental area 40 x 40 m
- Plot-size: 2 x 2 m
- Litter and roods removed
- Distance between the plots 1m and to secondary forest 6m

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# Application of charcoal and reduced carbon loss from soil

% C

OSS

25

22

8



### Relationship Between Charcoal Amendments to Soil and Crop Response

Treatment	Amendments (Mg/ha)	Biomass production (%)	Plant type	Soil type
Control		100	Cowpea	Xanthic ferralsol
Charcoal	135.2	200	Cowpea	Xanthic ferralsol
Charcoal	67.2	150	Cowpea	Xanthic ferrasol
Charcoal	67.2	120	Rice	Xanthic ferralsol
Charcoal	33.6	127	Oats	sand

## Char greatly increases biomass production



### Its Role in Preventing Desertification

- Increase soil fertility, water holding capacity, and improve nutrient retention rate.
- Charcoal application to sandy soils would increase plant growth rate of 127%.
- Charcoal application to sandy soils increase available soil moisture by 18%.

## Eliminating excess CO2

Atmospheric CO2 is already 34% higher than levels that caused global temperatures to rise by 1 degree C, sea level to rise by 7 metres (25 feet) and allowed crocodiles and hippopotamuses to live in London, England 130,000 years ago.

It is not enough to slow the growth of CO2, to avoid dangerous climate change the excess CO2 in the atmosphere must be removed

This can be done by increasing global soil carbon by only 8% from around 0.5% by weight to around 0.54% with char, but should be focused on agricultural soils

### **Conclusions and Summary**

- Charcoal application to soil has a huge carbon sequestration potential and it is a permanent carbon sink.
- Charcoal carbon sequestration is the only method that is able to reduce atmospheric CO2, not like other approaches which just slow down CO2 buildup speed.
- It can generate great benefits to farmers and has potential to poverty alleviation.
- It is a low-tech and cost-effective way to prevent/reverse desertification.

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