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

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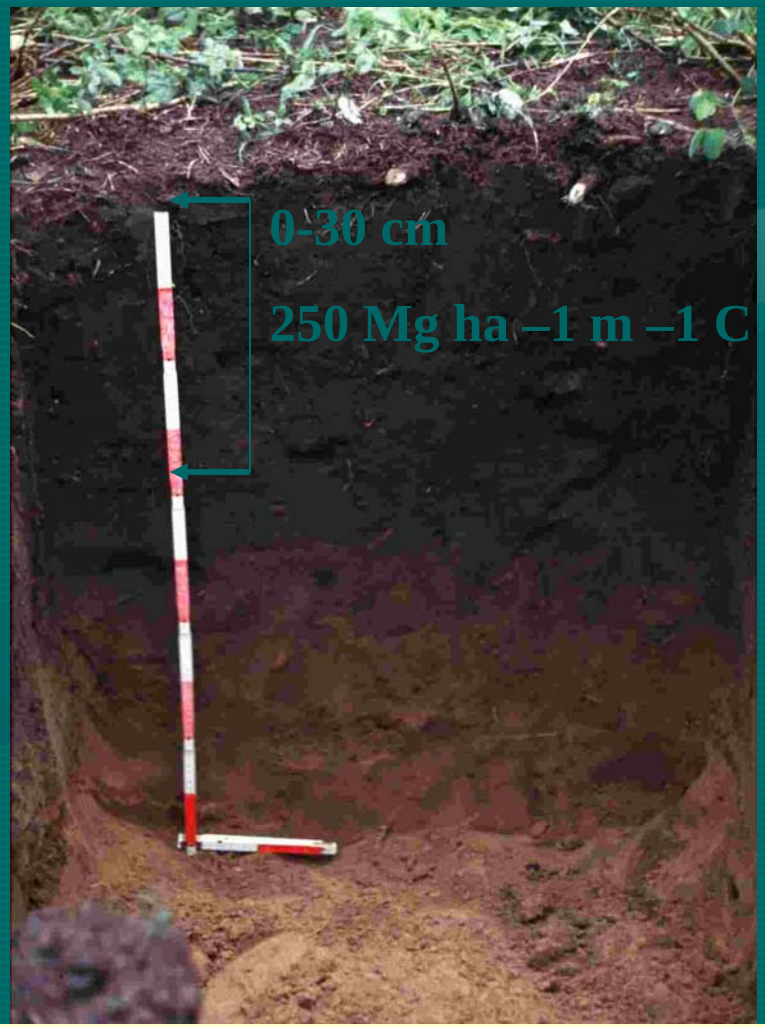
TERRA PRETA

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

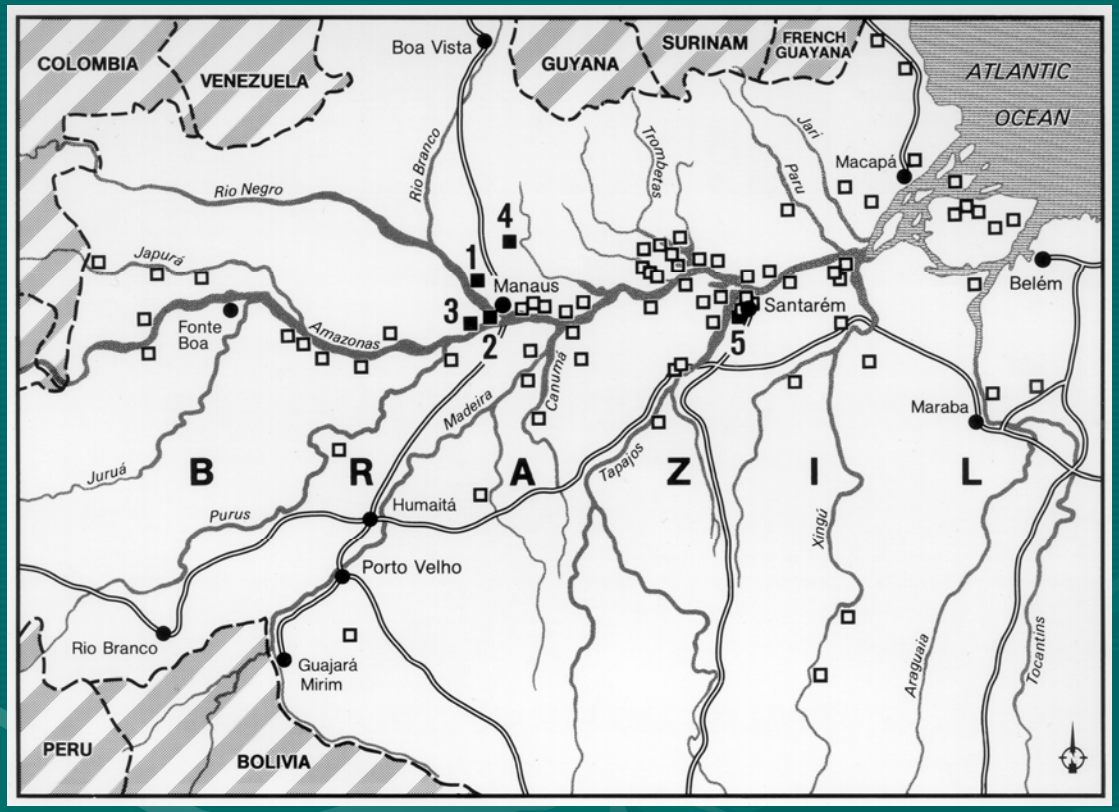
What do we find in these anomalous black earths?

Oxisol



"Terra Preta do Indio"

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

Terra preta sites are so valued

they are dug up and sold for potting soil

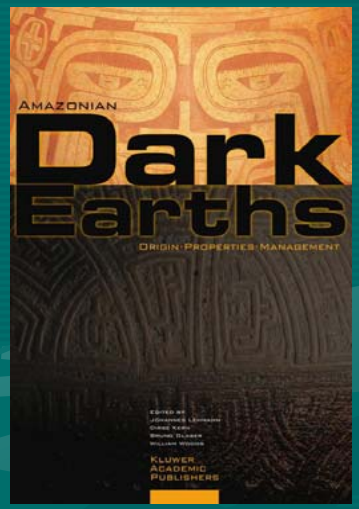
Some of the many articles and movies

Science Magazine

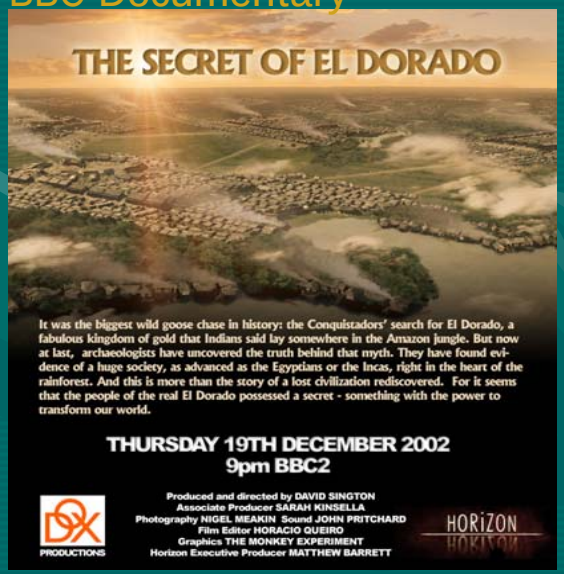
Biological Fertile Soils

Plant and Soil

2004 Book



BBC Documentary



NATURE Magazine

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

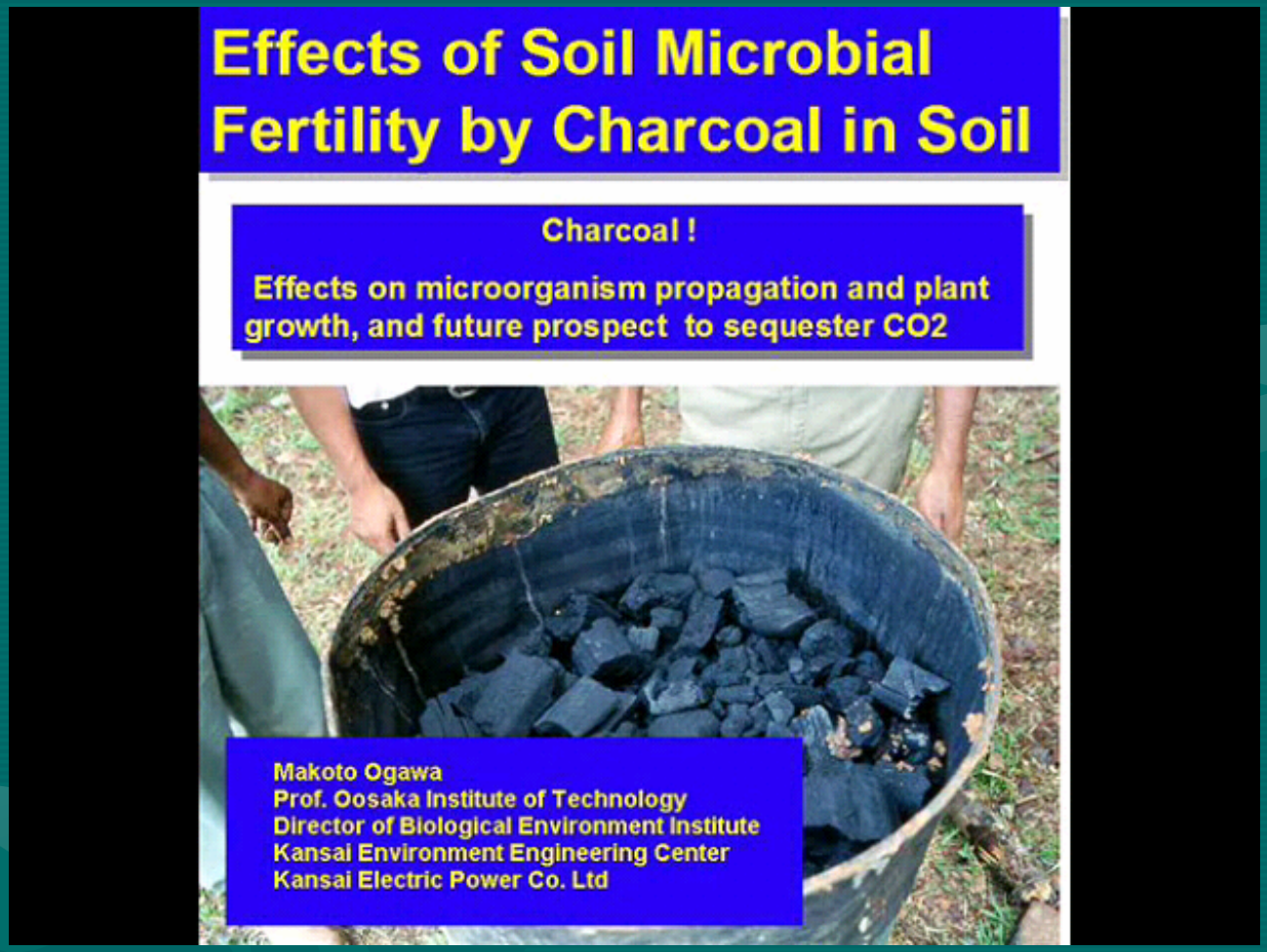
- improve soil quality by improving porosity, water holding capacity and cation exchange capacity

- 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



Effect of charcoal on Acacia mangium

Root growth and nodule formation - Indonesia (Okimori, Yamato 2000)

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.

Bark Charcoal and Fertilizer

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

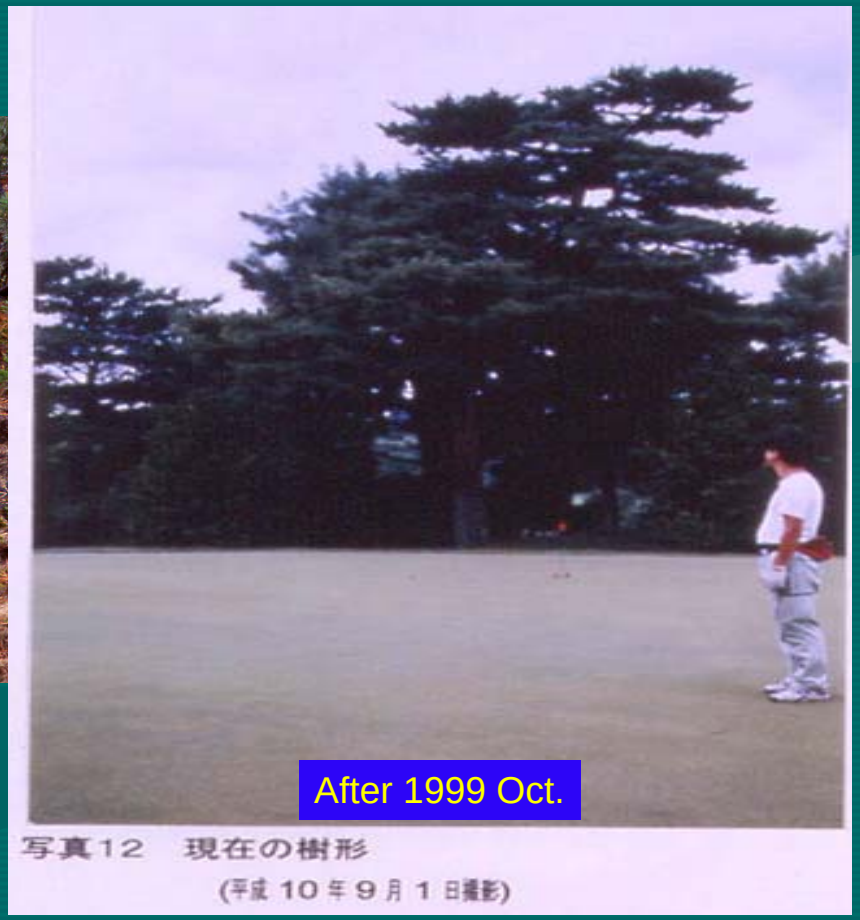
Ogawa 1999, Kansai Environmental

Charcoal has Benefits for Existing Forests

Results of Charcoal Treatment after a year

Before 1998 Sep.

写真11　施工前の樹形
(平成９年９月17日撮影)



After 1999 Oct.

写真12　現在の樹形
(平成10年９月１日撮影)

Ogawa 1999, Kansai Environmental

The growth of pine root and mycorrhiza formation started at 5 to 6 months after treatment

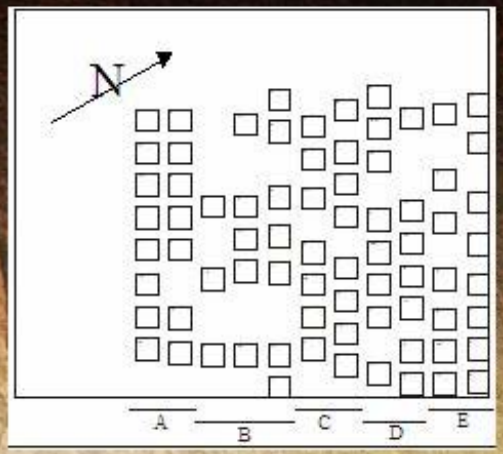
Results of Charcoal Treatment after a year

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

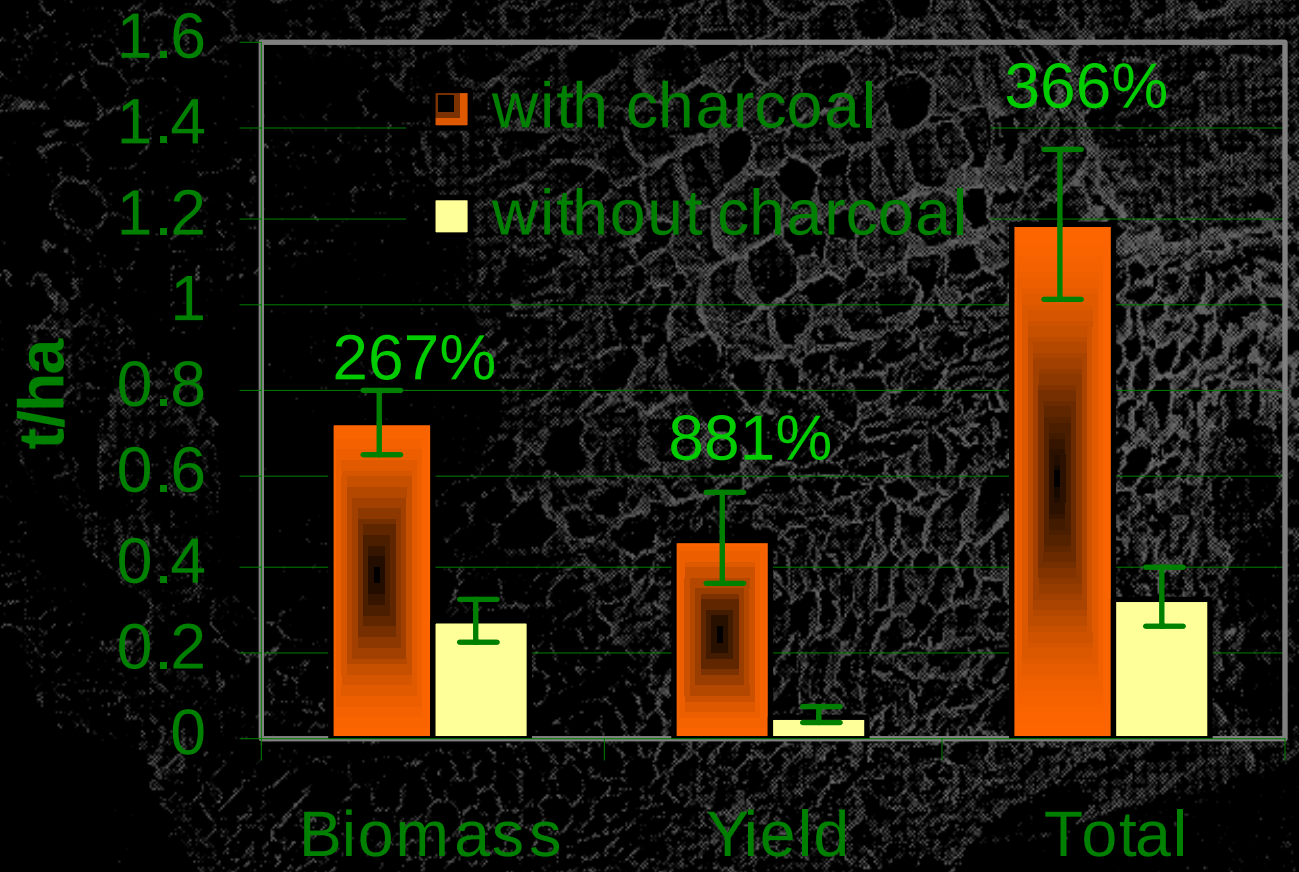
Christoph Steiner[1], W. G. Teixeira[2], J. Lehmann[3] and W. Zech[1]

1 *Institute of Soil Science, University of Bayreuth, Germany- 2 Embrapa Amazonia Ocidental, Manaus, Brazil*

-3 Department of Crop and Soil Sciences, Cornell University, USA

Experiments

Rice/Sorghum Plots
second harvest



3 Year Results Summary

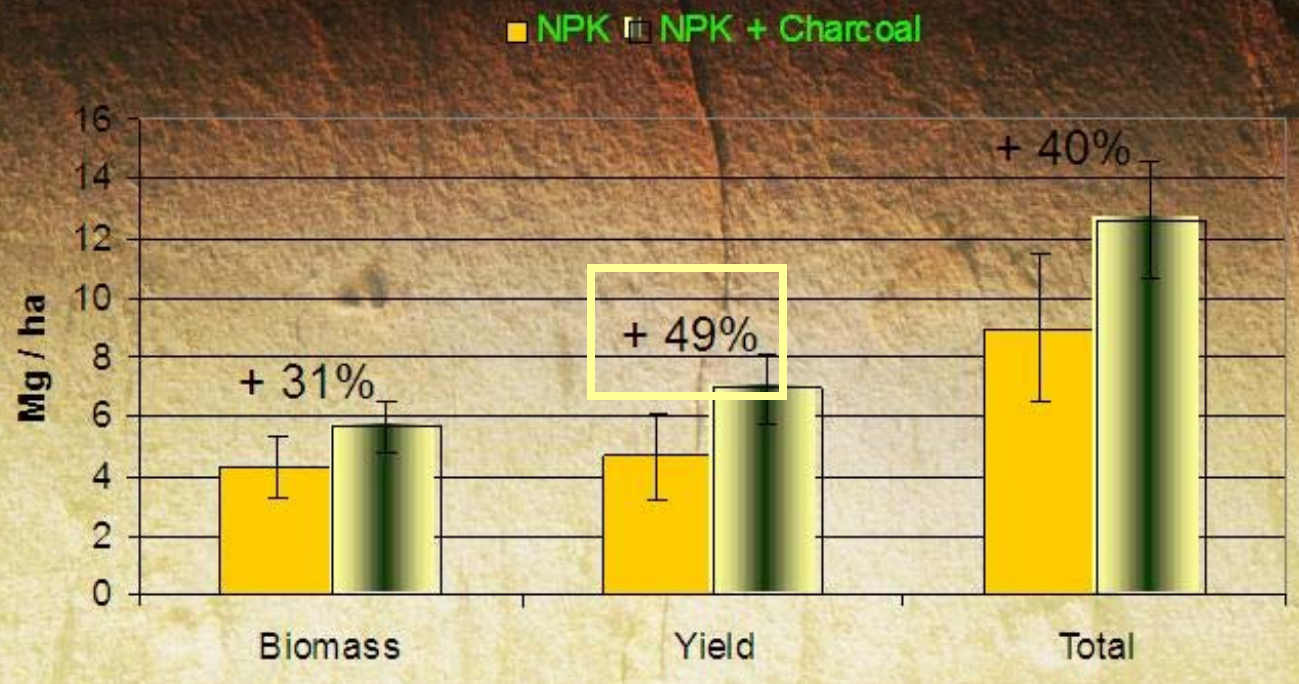
Project Introduction **Experiments, Trials & Results** Application

Experiments

Rice/Sorghum Plots

4 harvests - NPK with or without charcoal

49% ave crop yield increase over the 3 year study



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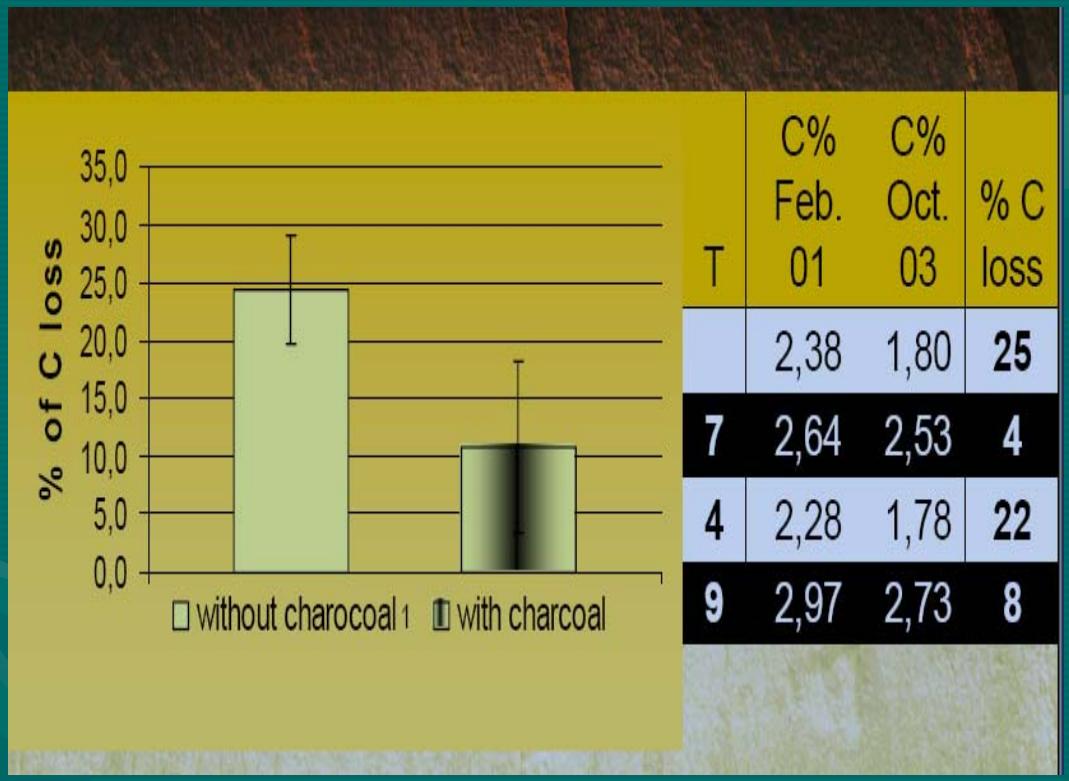
Application of charcoal and reduced carbon loss from soil

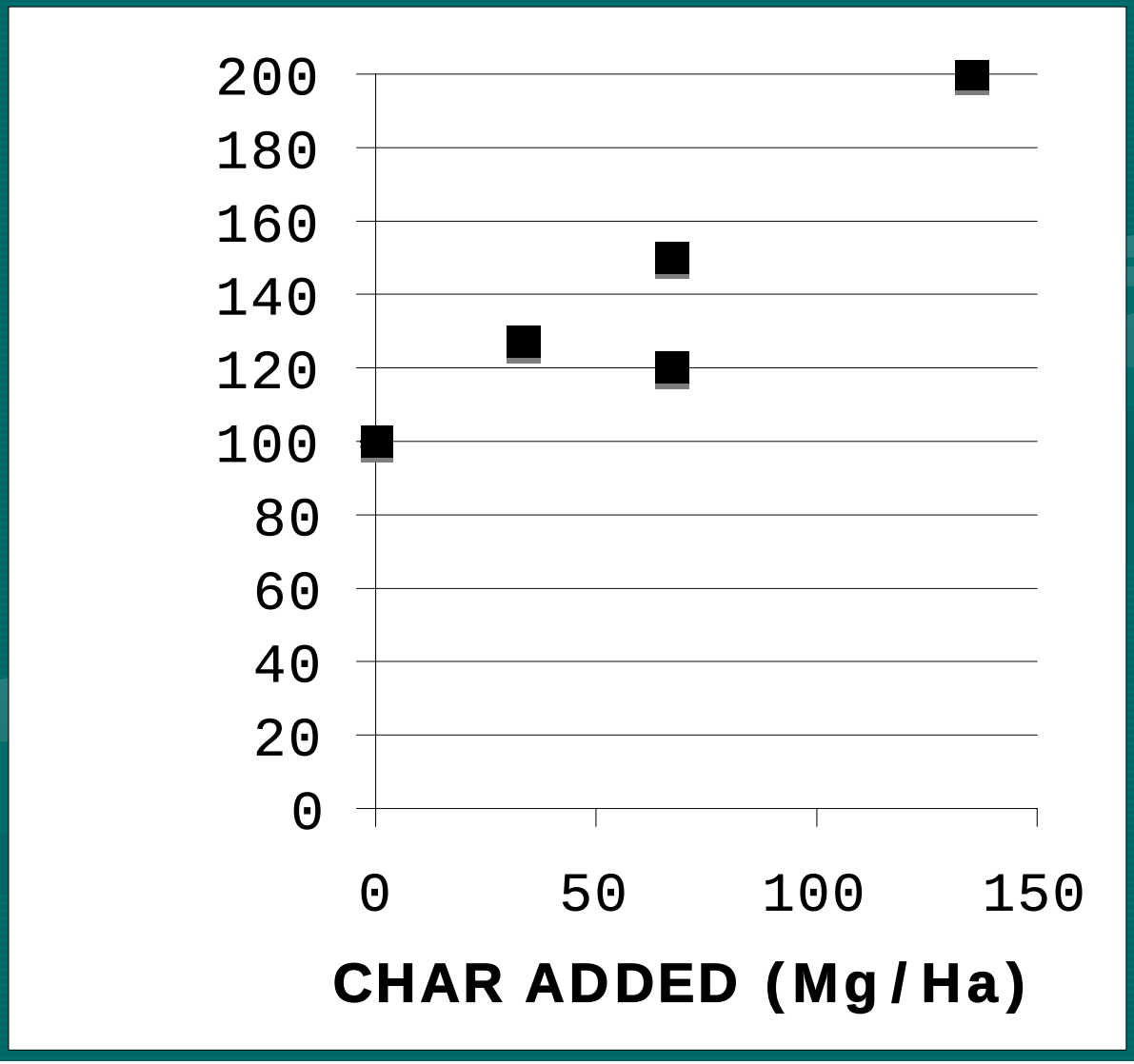


T	C% Feb. 01	C% Oct. 03	% C loss
	2,38	1,80	**25**
7	2,64	2,53	**4**
4	2,28	1,78	**22**
9	2,97	2,73	**8**

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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