

# Socio Economic Study of Farmer Charcoal Production in the Brazilian Amazon and implications for the slash-and-char praxis & carbon sequestration

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## Introduction

An anthropogenic soil probably created by Amerindian populations in pre Columbian times, known as Terra Preta de Indio called Amazonian Dark Earths, ADE), that can be found patchily distributed in the Brazilian Amazon is rich in Soil Organic Matter (SOM). Frequent findings of charcoal and highly aromatic humic substances suggest that residues of incomplete combustion of organic material (charcoal, black carbon) are a key factor in the persistence of SOM in this type of soil. In the soils of Brazilian Amazonia, SOM plays a key role in maintaining soil fertility. Scientists in Manaus in the Brazilian state of Amazonas are studying the effect of charcoal amendments to highly weathered soils near Manaus in attempts to create "Terra Preta Nova", and are also examining the possibility of defining a new agricultural praxis – 'slash and char' – as opposed to slash and burn, since the latter method results in a loss of SOM, whereas the former method shows potential for increasing SOM and soil fertility.

Charcoal additions to highly weathered Xanthic Ferrasols on *terra firme* north of Manaus, increased biomass production and microbial reproduction significantly in NPK plus lime-fertilized plots and showed evidence of charcoal's nutrient retention and absorption capacity and its positive effect on crop productivity. Also, charcoal formation during biomass burning is considered one of the few ways that carbon is transferred to refractory long-term pools. The production of charcoal is CO<sub>2</sub>-neutral if re-growing wood from plantations or secondary forest is used. Thus, 'slash-and-char' as an alternative to slash and burn could be a further step towards sustainability in agriculture in the Amazon while creating a sink for atmospheric CO<sub>2</sub> in the form of charcoal in soils. Small farmers and charcoal-producers in the vicinity of Manaus, Brazil already engage in charcoal production using wood from the forest in brick and earth kilns. Under the slash-and-char method, farmers would cut wood and use it to make charcoal which they would then add to the soil as a conditioner thus clearing land for planting, instead of cutting wood and burning it as a way to clean the land and release nutrients. Another suggestion under the praxis is to use only unmarketable charcoal powder as a soil conditioner, while selling the rest of the charcoal. Possibilities might exist for income for the farmers from carbon sequestration.

## Objectives

The objective was to conduct a socio-economic analysis of charcoal production near Manaus, Amazonas, Brazil in order to determine basic economic and social information necessary to evaluate the suitability of the slash-and-char method under the present socio-economic conditions, to determine the economic importance of charcoal to those who make it as well as to determine the economic sustainability of charcoal production as a household activity. Information that might help to gauge the potential of the slash-and-char method for carbon sequestration credits was also obtained. Specific attention was given to

- charcoal production process
- charcoal production parameters
- wood procurement
- labor requirements
- household economic activity
- charcoal output
- access to land, labor, and capital
- costs and revenues
- diameter of the wood trunks placed in the kiln
- weight of wood used to fill a kiln
- total amount of carbon entering kiln in the form of wood
- the weight of the charcoal formed
- the fixed carbon content of the charcoal
- the maximum temperature reached inside a brick kiln
- information on the use of charcoal powder (small, broken, unmarketable pieces) in agriculture

How will the current social, economic factors as well as the physical parameters of the wood and charcoal as measured by this study influence the implementation of the proposed slash-and-char method?

## Location and Method

Primary research was carried out in the Taruma Mirim Settlement situated at Km 21 on the BR 174 highway that links Manaus, Brazil to Caracas, Venezuela. The settlement was originally created to accommodate potential farmers without land who live in marginalized conditions in Manaus, thus making possible the conditions for them to engage in agriculture. 18 charcoal making households were interviewed.

• semi-structured questionnaire was first tested with the charcoal makers over the space of one month, and then revised to incorporate local words, terms and concepts in order to obtain more accurate information. • interviews solicited both quantitative and qualitative socio-economic information, and were semi-structured in format and in-depth in nature.

• for each species of wood that was loaded into each of the four kilns (hereon referred to as kilns A, B, C and D), disk shaped cross sections of wood were cut from different trunks and from different parts of the trunk, numbering three disks per species for kiln A, five disks per species for kiln B, eight disks per species for kiln C and ten disks per species for kiln D.

• a quarter of each of the cross sections was cut, dried, weighed and ground into a fine powder, from which three composite samples were prepared for each species used in each one of the four kilns.

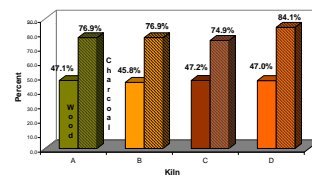
• composite samples analyzed for carbon content in an Elemental Analyzer at the EMBRAPA Soil Physics Laboratory

## Results

Economic and social data revealed that there exist differences between charcoal producers at the household level that results in two distinct groups of producers in the settlement.

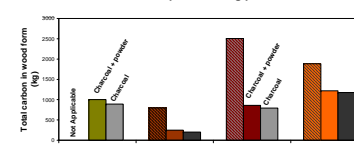
	Group 1	Group 2
Number of sacks produced per month	230	643
Net income per month from charcoal sales	RS 383	Above RS 2700
Number of sources of income	One	2 or more
Does the group make charcoal every month?	Yes	No
Do group members have private transport?	No	Yes
Are group members involved in production?	Yes	No
Do group members hire labor always?	No	Yes
Do group members sell charcoal in Manaus?	No	Yes
Do group members sell to middle-men?	Yes	No
Average number of kilns	1-2	2 or more
Do group members rely only on income from charcoal?	Yes	No

Carbon content of wood and charcoal



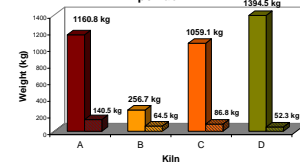
Shows the carbon content of the feed wood and of the produced charcoal output as a percentage

Total Carbon content (in kg) of wood feed and charcoal output including powder

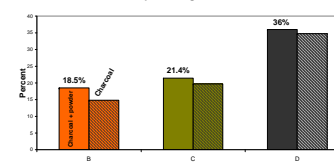


Shows total carbon entering kiln as wood and exiting the kiln as charcoal output in kilograms. Total input of kiln A could not be assessed

Total weights of charcoal and charcoal powder

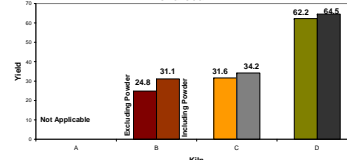


Charcoal and combined charcoal and powder recovery as percentage of biomass



Shows how much biomass of original feed was converted to charcoal as a percentage

Carbon yield from original biomass C for charcoal



Shows how much carbon in the feed was converted to carbon in charcoal as a percentage – efficiency

## Discussion and Conclusion

• There are two distinct groups of charcoal producers in Taruma Mirim and these household level differences are significant enough to account for large differences in income and access to labor and capital. Group 1 is especially reliant on income from charcoal sales, which goes towards sustaining the household at a very basic level. Their monthly income is highly variable, being influenced by conditions such as the ability to hire labor, the successful carbonization of the majority of the wood (which in many cases depends on the condition of the kiln), the conditions to pay for fuel for the motor saw and for the sacks. Group 2 consists of those who are not dependent on charcoal as their principal source of income. All members of this group have more than one source of income. They produce charcoal as a supplement to their income

• Charcoal making is a highly labor intensive activity. The more labor involved in production, the more charcoal one can produce. Small farmers who make charcoal as their only livelihood usually cannot afford to hire more than one other person to help them make charcoal and they cannot afford this often. This limits their production capacity

• The slash-and-char method requires that charcoal used as soil conditioner must be produced from the same land that is about to be cropped. Studies suggest that charcoal applications in the range of 1 – 3 Mg ha<sup>-1</sup> could be sufficient to increase crop production. Although we did not assess the area from which the biomass was cut, in many cases the quantity of charcoal produced in a brick kiln by a small farmer would not be a high enough quantity required for optimal crop production if just charcoal powder is used, as suggested by the kilns studied where the amount of charcoal powder produced showed large variations in weight and volume, especially for Group 1. It might look different if all woody biomass is used for carbonization, and not just the selected tree trunks that the producers use in order to minimize the probability that the process will produce charcoal powder and maximize intact charcoal output for sale. Charcoal residues might most likely be applied in planting holes giving high enough concentrations for optimal plant growth. Many small farmers will also be limited by labor requirements.

• Studies on the amount of land cleared to make a given amount of charcoal (say 100 sacks or one ton) would be very useful in determining the amount of labor required to sustain production at these levels as well as the extent of deforestation that would have to take place in order to produce sufficient charcoal for application.

• From the carbon analysis in charcoal and powder, making charcoal with the express purpose of using it as a soil conditioner could be one way to increase the amount of C in the soil, benefiting the farmer by providing him with a land clearing method that increases SOM in the form of SOC, while creating a refractory soil carbon pool.

• An interesting and perhaps necessary investigation is to determine whether the slash-and-char practice is financially viable to the extent that it can compensate for startup costs, transaction costs such as monitoring and evaluation of carbon stocks and the number of years to positive cash flow through revenue from carbon sequestration.

• Well-off households, such as those in Group 2, that engage in charcoal production can perhaps pay for the required organic inputs through the income from charcoal sales, but poorer households such as those in Group 1 might have difficulty paying for organic inputs with the income from charcoal sales, since this income is also used to sustain the household at a very basic level in most cases. The slash-and-char methods successful implementation will require external stimuli in the form of additional organic inputs, improved access to markets and better access to credit, amongst other things.

Acknowledgments: Grace Kelly Souza and Estevo Santos for field and laboratory assistance. INPA (Instituto Nacional para Pesquisas da Amazonia) Manaus and EMBRAPA Amazonia Ocidental for use of facilities. Cornell University for financial assistance for this study. Christoph Steiner for photographs.