A CHARCOAL PRODUCTION AND COLLECTION SYSTEM THROUGH A PROPOSED COOPERATIF METHOD[1]

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Abstract

Among the huge quantity of biomass available in small rural establishments, these producers don't have access to the charcoal market, because they don't have a structure logistics for the charcoal collection and commercialization. The logistics where there is, is due by intermediaries that besides paying a low value to the producer, often are themselves outside the law. Similar situation existed in the past in the milk market. Then, the milk producers organized in cooperatives, which established a logistics of collecting milk and made possible their commercialization. This paper proposes the use of the milk collecting logistics of the existing cooperatives for the collection and commercialization of charcoal produced by small farmers.

Key words: Charcoal; Biomass; Carbonization; Logistic.

SISTEMA COOPERATIVO DE PRODUÇÃO E COLETA DE CARVÃO VEGETAL: PROPOSTA DE UMA LOGÍSTICA

Resumo

Apesar de existir uma grande quantidade de biomassa disponível nos pequenos estabelecimentos rurais, estes produtores não possuem acesso ao mercado de carvão vegetal, uma vez que não possuem uma estrutura logística para a coleta e comercialização deste carvão. A logística quando existe, encontra-se na mão de atravessadores, que além de pagar um baixo valor ao produtor, muitas vezes encontram-se à margem da legislação. Situação similar existia no passado no mercado de leite. Então, os produtores de leite se organizaram em cooperativas, que estabeleceram uma logística de coleta de leite e viabilizaram sua comercialização. Este trabalho propõe uma estratégia de gestão, aproveitando a logística de coleta de leite existente nas cooperativas para a coleta e comercialização do carvão vegetal produzido pelos pequenos produtores rurais.

Palavras-chave: Carvão vegetal; Biomassa; Carbonização; Logística.

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1 INTRODUCTION

The agricultural and forest activities generate large quantities of waste, which don't have any commercial value. The rural wastes are all kinds of waste generated by the productive activities in rural areas: agricultural, forestry and livestock wastes.

Agricultural waste are those produced in the field, resulting from crops remnants or the cleaning done to prevent pests and fires, which do not have further use on their own farm: weeds, leaves, cereals and corn straw, cob corn, rice and oats husks, among others. There are other agricultural wastes such as sawmills wastes (sawdust), from sugar and alcohol industries wastes (sugar-cane bagasse), juice and oil industries wastes, paper and pulp industries wastes, that are having increasing use for termo-generation.

Part of agricultural waste are left inside the culture field, for the soil protection and nutrient source, but the surplus of this waste, makes it become a methane emission source, soil and water (ground and surface) contamination risk, and contributed to the spread of pests and fires. Thus, those excess biomass wastes must be removed quickly from the field, to not interfere in other agricultural activities and avoid problems.

Forest waste is the waste generated and left in the forest, resulting from the forests maintenance, due pruning, cleaning, root removal etc. About 20% of the tree mass is left in the forest. Included in this group also the waste generated by wood and cellulose industries.

Livestock waste is the manure and other products derived from biological activity of cattle, pigs, goats and others.

It is estimated that about 40% of agricultural waste produced in developing countries (425 Mton/year of dry biomass) are burned in the field (Jallow, 1995). Worldwide, Woods & Hall (1994) estimated about 93.10^{15} kJ/year. Smil (1999), estimated the availability of agricultural waste between 3.5 and 4 billion ton/year, with an energy potential of 65.10^{15} kJ/year (1.5 Gtoe/year), including 1 and 1.4 Gton are burned without any exploitation. Andreae (1991) estimated the agricultural waste burning without exploitation of 2 Gton/year. Hall et al (1993) estimated that in wheat, rice, corn, barley and sugar-cane agriculture 25% of the waste can be used to energy way, generating 38.10^{15} kJ/year and avoiding 350-460 Mton/year of CO_2 emission. All this biomass is wasted without any economic or energy use, causing environmental and people health problems.

The energy potential of rural waste in Brazil is not precisely determined, but it can be estimated through the "harvest index". The harvest index is the apparent relationship between the amounts of product (grains etc.) harvested economically, and the total quantity of biomass generated per hectare planted in a particular culture:

$$IC = \frac{P_g}{(P_b + P_g)} \qquad\qquad P_b = P_g\left(\frac{1}{IC} - 1\right)$$

Where: **IC** is the harvest index; **Pg** the grains productivity (Mg/ha); **Pb** the productivity of aerial portion of biomass (Mg/ha). The medium apparent harvest index in Brazil is about 0.35 to 0.40 for soybeans, wheat and corn (Debarba, 2002), 0.30 to 0.60 for beans and cassava (IBGE, 1996).

Table 1. Economic Charcoal Potential Production From Agricultural Waste.

Product	[1] Season 2007-08 1000 ton	Harvest index	Dry Waste Potential 1000 ton	Charcoal Production η = 0.30 1000 ton	Economic Potential at [6]US$ 400/ton
Cotton - Pit	2,434.1	[5]0.58	1,762	528.6	US$ 211 millions
Rice	12,070.0	[4]0.45	14,752	4,425.6	US$ 1,770 millions
Beans (1st, 2nd and 3rd seasons)	3,332.7	[3]0.30	5,443	1,632.9	US$ 653 millions
Corn (1st and 2nd seasons)	55,266.7	[2]0.40	82,900	24,870.0	US$ 9,948 millions
Soybeans	59,583.0	[2]0.35	110,654	33,196.2	US$13,278 millions
Wheat	3,831.4	[2]0.40	5,747	1,724.1	US$ 689 millions
Other Products	2,796.7	0.40	4,105	1,231.5	US$ 492 millions
Brazil	**139,314.5**		**225,363**	**67,600**	**US$ 27.0 Billions**

Source: [1]Conab Mar/2008.[2]Debarba, 2002. [3]IBGE. [4]Fagerial. [5]Lacerda (fiber+seed). [6]Abr 2008.

Table 2. Economic Charcoal Potential Production From Cane Straw.

Region	Cane Processed 1000 ton	Dry Waste Potential 1000 ton	Charcoal Production η = 0.25 1000 ton	Economic Potential at US$ 400/ton
Sao Paulo	181,500	25,400	6,350	2,540
Center - South	249,700	35,000	8,750	3,500
North - Northeast	51,900	7,200	1,800	720
Brazil	**301,600**	**67,600**	**16,900**	**US$ 6.7 Billions**

Source: Kolbitz

2 THE LOGISTICS OF MILK COLLECTION

Brazil is the 6th world largest milk producer, producing 24.6 billion liters of milk (2005), which 28% in Minas Gerais State. This production is scattered in about 1.2 million small milk producers (Benedetti, 2000), while in other countries is concentrated in major producers (80,000 in the United States and 30,000 in Argentina).

Milk is a product which spoils quickly by the bacteria action, losing in little time their nutrient and economic value. By the way, the milk is a product that requires a perfect transport logistics, for don't lose its quality. In the past, when there was not available a collection and distribution system, the milk produced was consumed within the farm and the surplus was used in the production of cheese or sweet. A small portion of the milk was sent to nearby communities for commercialization. Thus, the milk did not have great commercial value.

With the implementation of milk producer's cooperatives, promoted up the milk commercialization in cities, being necessary to establish a daily milk collection logistics, to not deteriorate the product. Have been established daily "milk routes", where a truck driver was responsible for a path through the farms, collecting the milk containers and taking them to the processing plants. During the raining seasons, the road was often impossible to transit, the milk route was stopped, and the producer lost its production. To fix that, year by year, the secondary roads in the milk routes are being continuously improved to ensure the milk delivery also in the raining season.

In the 90's began the implementation of the bulk milk collecting system in Brazil. In the bulk collecting system, the milk producer stores *in-situ* the milk in 4°C refrigerated tank (expansion tanks) for up to 48 hours, and a truck equipped with isothermal refrigerated tank do the milk collection of various producers and carry up to the industry. Thus, the milk remains cold throughout all the productive chain, since the milking until the dairy stores in cities. This process allows the use of milk from the second milking, inhibits bacterial growth and increased its quality, life time and its commercial value.

If the producer does not have conditions to install a refrigerated tank on its property (capital cost, lack of electricity, faraway from the milk route, insecurity or lack of roads), a group of producers is associated and install a public use tank in one of the properties along the milk route. Currently in Brazil about 80% of cooperatives use bulk milk collecting, and if are including private dairy industries, around 60%. Under this reality it became possible to implement an optimized transport logistics, reducing the number of refrigeration posts, reducing the collection routes, increasing the load carried by truck, generating a significant economy in the transport cost, and quality gain.

3 COOPERATIF PRODUCTION OF CHARCOAL

Although there is a large amount of biomass available in small rural establishments, these producers do not have access to the charcoal market, since they do not have a logistics structure for charcoal collection and commercialization. The logistics where it exists is done by intermediaries, which pays a low value to the producer, and often aren't outside of the law for other non legal sources of charcoal. In March 2008 the charcoal price in Sete Lagoas MG, was R$640/t and the price paid by intermediaries to small producers at northern of Minas was R$ 140/t. Similar situation existed in the past milk market. Then, milk producers were organized into cooperatives, which established a milk collecting logistics and made possible its commercialization.

The milk bulk collecting logistics was only possible because the existence of good quality roads and electricity in rural properties. The collection logistics supplies more than 60% of the 1.2 million of milk producers in Brazil, in all its regions and in more varied weather and economic conditions. The milk collecting logistics system is well established, spread across all Brazilian territory. In some cooperatives the use of management and logistics optimization software, and a satellite tracking system, make this collection highly effective.

Thus, considering the universality and reliability of existing milk collection structure logistics, it can be used to collect the agricultural, livestock and forestry waste. The biomass wastes are low density and low energetic intensity, it is not economically viable its transport over long distances. To become viable, it should increase the product energy intensity through an energy valorization process. The carbonization is a thermal process, low-cost, easy operation and that allows transform the rural waste into charcoal, for high-quality, high heat content, non-perishable, high demand and high economic value fuel.

The establishment of "charcoal routes" on the same milk routes, allows the use of existing milk collection logistic structure. The cooperatives have the organizational agricultural products collection, industrialization and marketing structure, in addition to technical and legal support to its members. It may be created a new department (or a secondary company) inside the cooperatives, aiming to efficiently charcoal collect and its commercialization. The landowners will produce charcoal in their properties and would deliver it to a post in front of the "charcoal route" where a truck pickup the charcoal bags and take them to a post for commercialization, or directly to the final consumer (industry consumers).

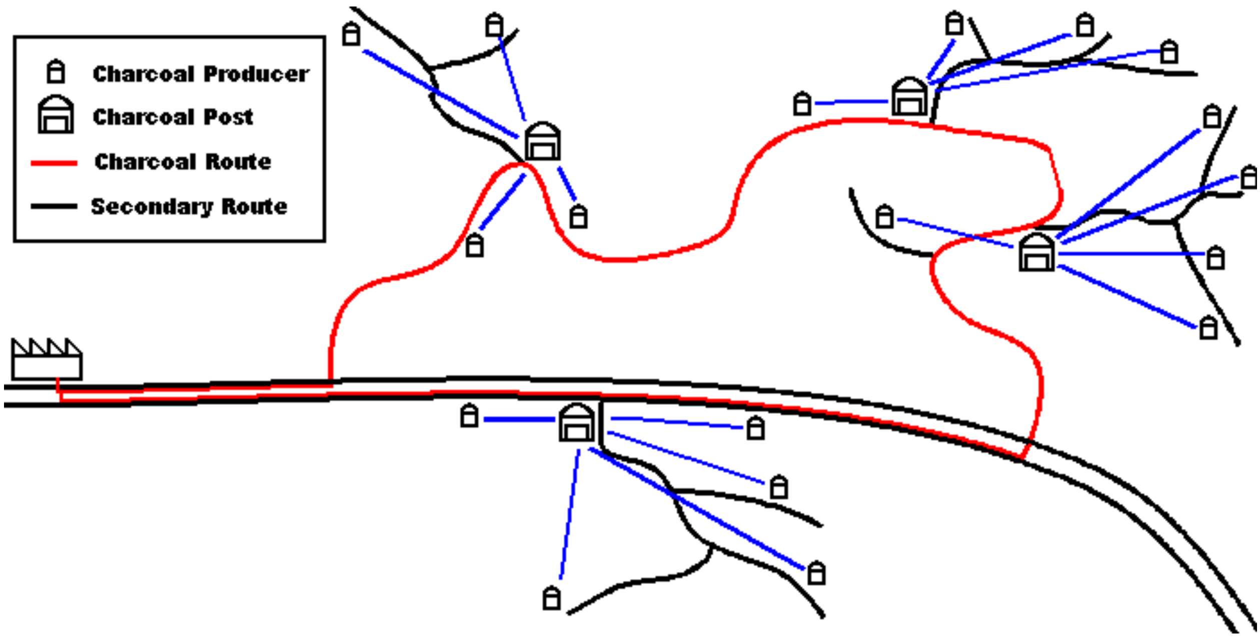

Figure 1. Example for the schedule of a charcoal route.

The bulk charcoal, originating from pruning, cleaning land, roots etc, would be commercialized directly. The charcoal fines, originating from straw, grass, branches etc, would be commercialized as fines (*moinha*) or transformed into briquettes in the posts. The very dirt charcoal fines also has use locally as natural fertilizer (*terra preta do indio* - Indian dark earth) in rural property.

The environmental and charcoal production legal issues would be administered by the cooperative with the environmental agencies. The preliminary survey of protected areas and the origin of biomass to be used, allows the production of charcoal with a "certificate of origin", allowing the legal commercialization of charcoal and obtaining carbon credits. The cooperatives have technical support to its members to training them so as to produce a charcoal with good quality and good efficiency with all kinds of available waste. The charcoal must be paid for their quality, and better quality charcoal a high price.

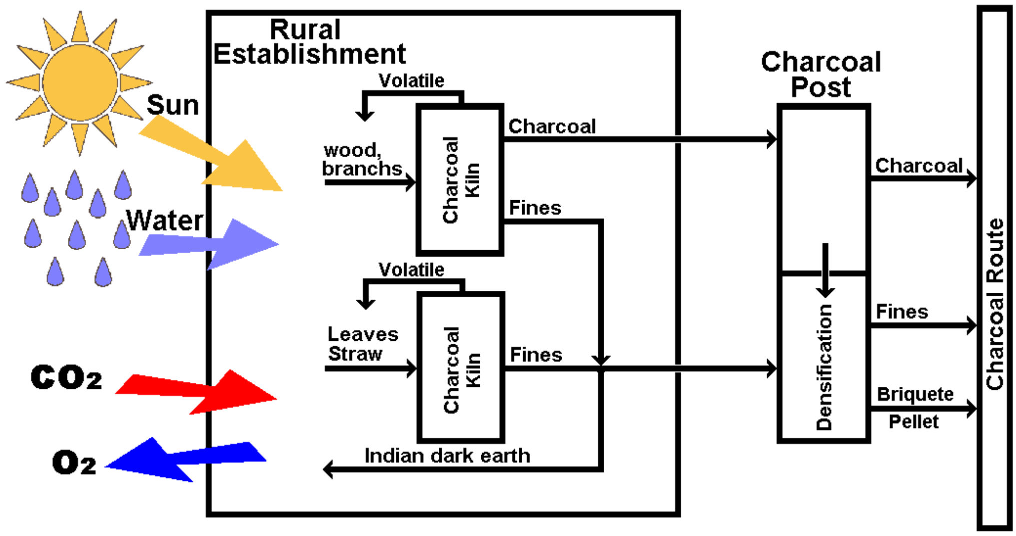

Figure 2. Flowchart of Charcoal Cooperative Production System

4 SMALL SCALE CHARCOAL PRODUCTION

The milk routes serve many small milk producers, for this reason may become small charcoal producers. Thus it is necessary to implement a charcoal producing technology adapted to these producers. For a charcoal production of 25 to 100 kg/day, it is recommended to use the LC2-200L metal kiln (Figure 3) (Pinheiro, 2008). In this kiln can be used wood, twigs, bark, coconut, babassu, straw or grass. This kiln does not work well with pulverized material: sawdust, rice hulls, peanut shell, etc.

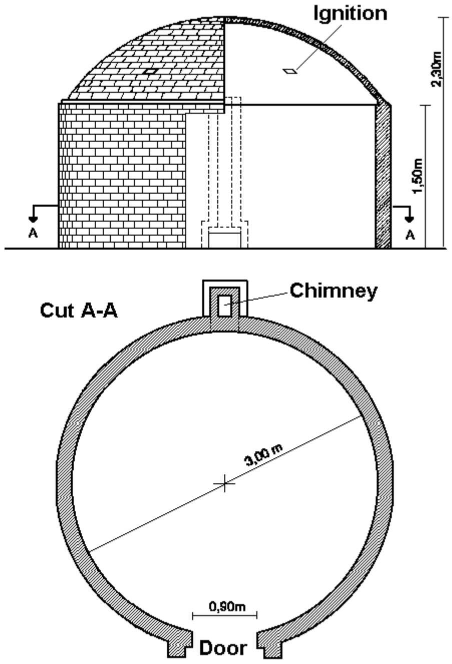

Figure 3. LC2-200L Charcoal Kiln.

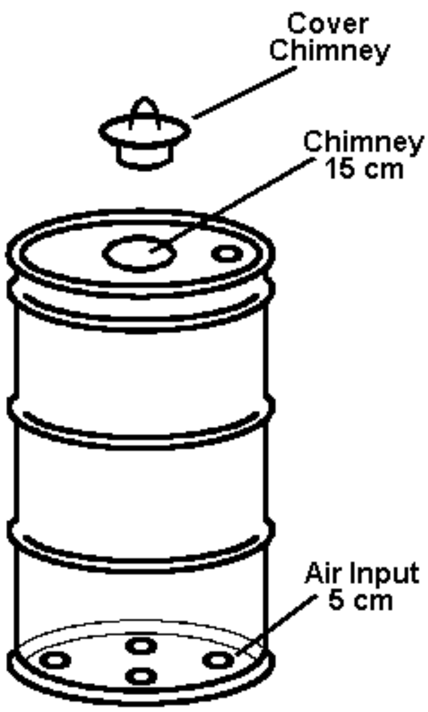

Figure 4. LC2-3.0m Charcoal Kiln

For a charcoal production of 1,000 to 2,000 kg/week is recommended to use the LC2-3.0m brick kiln (Figure 4). In this kiln can be used firewood, branches, sawmills remains and a small amount of granular material (coconut husk, babassu, straw and grass). It doesn't work very well with granular material, and doesn't work with pulverized material.

For the charcoal production with granulated or powdered material, the LC2 Combustion and Carbonization Laboratory of UFMG is developing new very simple and low cost and good performance charcoal kilns (Figure 5).

Figure 5. Prototypes charcoal kilns for granulated material.

5 CO_2 CREDITS

Whereas agricultural waste are now abandoned in the field, decomposed by microorganisms and emitting methane into the atmosphere, may be advise a CO_2 credits project for the use of this waste to charcoal production. The addition of charcoal in the soil (*terra preta do indio*), may also be subject to a CO_2 credits project since charcoal will remain fixated in the soil for thousands of years. The CO_2 project implementation is expensive and it is not feasible for a small rural producer, but is feasible for a medium size cooperative, bringing economic and environmental benefits for its associated.

The practice of mixing charcoal in the agricultural soil increases the soil fertility by improving the cations exchange, which facilitates the plant nutrients capture and inhibits its loss during the rains. Apart the soil fertility increasing, the charcoal addition in the soil encourages the microorganisms' proliferation, improves the water retention, neutralizes the acidic soil and reduces the greenhouse gases emission (methane and nitrous oxide). Furthermore, the use of charcoal to enrich the soil is a practical way to permanent atmosphere carbon sequestration, with the potential to sequester up to 12% per annum carbon emissions. In addition to reducing pollution, the black earth remains fertile and needs less fertilizer for the cultivation.

6 CONCLUSIONS

Brazil has a large range of agricultural and agro-industry wastes, which can be exploited, and whose use has great economic and social interest. Generally, the energetic applications are the only possible use for this waste. The waste diversity, low density and low energetic intensity, restricts the use of such waste, which can (and should!) be valued by the carbonization.

The charcoal production from waste rural, allows the agricultural and forestry waste recovery, encourages the biomass use; stimulates the rational and efficient use of local energy resources, enables additional income gain, creates jobs, fixes the man in the rural place. The agricultural waste production is directly linked to food production, and the critical of agricultural areas conversion for the renewable fuels production does not apply here.

Due to the low cost of raw materials and low cost of charcoal collection and distribution logistics, the capital risk of this system implementation is low, and this charcoal will reach consumer markets at competitive prices, creating new business opportunities, new market niches, replacing the conventional fuels at competitive prices

The use of charcoal to replace fossil fuels, reduce the Brazilian dependence on importation fossil fuels, reduce our emission of greenhouse gases and enable the implementation of CO_2 credits projects.

The use of charcoal fine as soil nutrient (*terra preta do indio*), will allow an increase in agricultural production, with a corresponding increase in waste generation, and a decrease in consumption of industrialized fertilizers, increasing the income of the agricultural business and reducing the costs.

The small technology necessary for the establishment of this model, allows energy independence and sustainability of farmers, agribusiness and isolated communities. The logistics implemented by the cooperative avoids the presence of intermediaries, increasing the producers' income. This charcoal production methodology solves several problems in terms of socio sustainability, price, quality, delivery regularity, origin and traceability, logistics, transportation and commercialization.

The biggest obstacles to be overcome are the fossil fuels oligopolies that create economic barriers for all renewable fuels, and regulatory organizations, which create obstacles to the use of renewable fuels. Therefore, the challenges of the agricultural sector are enormous.

The paradigms established blind the rural producers for new arguments, new products and new markets and hinder the emergence of creative solutions to the economic viability of agribusiness. Abandon the old paradigms, can be the basis for new solutions for agribusiness.

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