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AVALIATION OF CARBON CREDITS ON SUGARCANE INDUSTRIES: PROPOSED METHODOLOGY AND CASE STUDY IN NORTHEAST BRAZIL

Miguel Otavio B C. Melo[1]
Bruno L.Vilar[2]
Luiz G. Cabral[3]
Ricardo M. Silva[4]
Marcia B. Fonseca[5]

ABSTRACT: The market for Carbon Credits presents itself as a source of obtaining financing for agribusiness industries, providing a new source of financial operations capable of generating an expansion of cash flow. These financial resources could be via marketing products through the use of Green Marketing, or simply employing aspects of social and environmental responsibility. The main companies in Brazil are the sugar mills, paper, pulp, timber accompanied to a lesser extent by government initiatives. Even registering a considerable amount of negotiation is still a largely unexplored market for the sugarcane and the alcohol sector. The purpose of this paper is to present a methodology for evaluation of carbon credits in the sugarcane industry estimating the financial potential of these projects, and present a case study in Northeast Brazil. There is a potential volume of carbon credits the company's annual turnover U$ 170 million in the case study analysed.

Keywords: Clean Development Mechanism. Carbon Credits. Sustainability in the sugarcane industries. Energy Efficiency.

[1]Center University UNITA. Av. Portugal, 584, Caruaru, PE, Brazil. E-mail: miguelmelo@asces.edu.br
[2]Federal University of Paraiba, Cidade Universitária, João Pessoa, PB, Brazil. E-mail: secmestrado@ct.ufpb.br
[3]Center University UNITA. Av. Portugal, 584, Caruaru, PE, Brazil. E-mail: luizcabral@asces.edu.br
[4]Federal University of Paraiba, Cidade Universitária, João Pessoa – PB, Brazil. E-mail: ricardomoreira0203@hotmail.com
[5]Federal University of Paraiba. Cidade Universitária, João Pessoa – PB, Brazil. E-mail: secmestrado@ct.ufpb.br

1 INTRODUCTION

In the last century the scientific community has initiated a series of studies and debates on consumption of fossil fuels in the context of climate change. The earth poles regions suffer strongly from the destruction of the ozone layer since they lose a big part of their ice caps that are important for biodiversity and for the control of sea levels. The main target is to reduce global CO_2 emissions to 3.7 Gt/a in 2050, thus limiting global average temperature increase to below 2°C (TESKE *et al*., 2011). In the last decade many researches were realized about technical processes to CO_2 reduction in many countries like German, USA, Swedish, Netherlands (SANDS; SCHUMAKER, 2009; MILLS; JACOBSON, 2011; MLENICL, 2012; MARTINEZ; SILVEIRA, 2013; ROSENOW, 2013). Many sectors of activities like vehicles, building, illumination and transport were analysed and also the definition of zero carbon (ÜRGE-VORSATZ et al., 2009; RAUX, 2010; RAUX *et al*., 2010, MILLS, 2011; BERRY *et al*., 2013).

Due to this problem the United Nations established in 2008 the Kyoto Protocol. This protocol determines the creation of three flexible mechanisms, which aims to assist countries in meeting their goals. The first mechanism is about the Emissions Trading Scheme in which a country attending the Protocol to achieve a reduction in emissions to a level below its target can transfer their surplus carbon credits to another country that has not achieved the same goal. The second was the Clean Development Mechanism (CDM) which seeks to encourage investments in developed countries considered in developping nations by buying direct credit or finance projects to capture Greenhouse Gas Emissions (GGE) (GIOMETTI *et al.*, 2008).

The carbon Credits providing a new source of financial operations capable of generating an expansion of cash flow via marketing products through the use of green marketing or simply employing aspects of environmental responsibility (GALLAHER *et al.,* 2009)

In Brazil this market is the sugar, paper, pulp, timber and plants in general, followed to a lesser extent by government initiatives like the substitution of refrigerators and energy efficiency industrial studies (VENDRUSCULO; QUEIROZ, 2009; MELO *et al*., 2012). According to the ecosystem marketplace in 2010 the trading volume of carbon credits in the world was US$ 114,3 million and it still a largely unexplored market for the sugarcane sector in Brazil (ECOSYSTEM, 2012).

The aim of this paper is to present a methodology for evaluation of carbon credits in the sugarcane industry estimating the financial potential of these projects and present a case study in Northeast Brazil.

2 THEORETICAL ANALYSIS

The nomenclature of carbon credits was adopted because of the gases such as methane (CH_4), nitrous oxide (N_2O), sulfur hexafluoride (SF_6) and the families of carbides and hydro-fluoro-carbons (HFCs) in ton of carbon dioxide (CO_2). Each kind of gas is equivalent to an amount of CO_2. It is used as a carbon dioxide equivalent converter in which the variation depends on the degree of difficulty of absorption of the gas by the proposed project, structured according to the Kyoto Protocol. HCs emerged with the purpose to solve the externalities interventions generated by human actions on the environment. The following section will explain how this process took place.

The cyclical process of the Clean Development Mechanism (CDM) consists of seven phases namely (Figure 1): 1-Project Design Document; 2- Obtaining Approval in each country involved 3-Validation Project Public Consultation; 4-Registration; 5-Monitoring; 6-Verification and Issuance of CERs (Designated Operational Institution); 7-Renewal Period Credit (RPC).

The CDM Executive Board shall issue the CER (Designated Operational Institution) and if the project proves that absorbs greenhouse gases at a rate higher than the normal cycle, the project was not implemented. Thus if the project presented shows that it absorbs more gases that the natural cycle, the certificate is issued. The incentives for CDM projects can be considered as instruments of public policy and international environmental regulations.

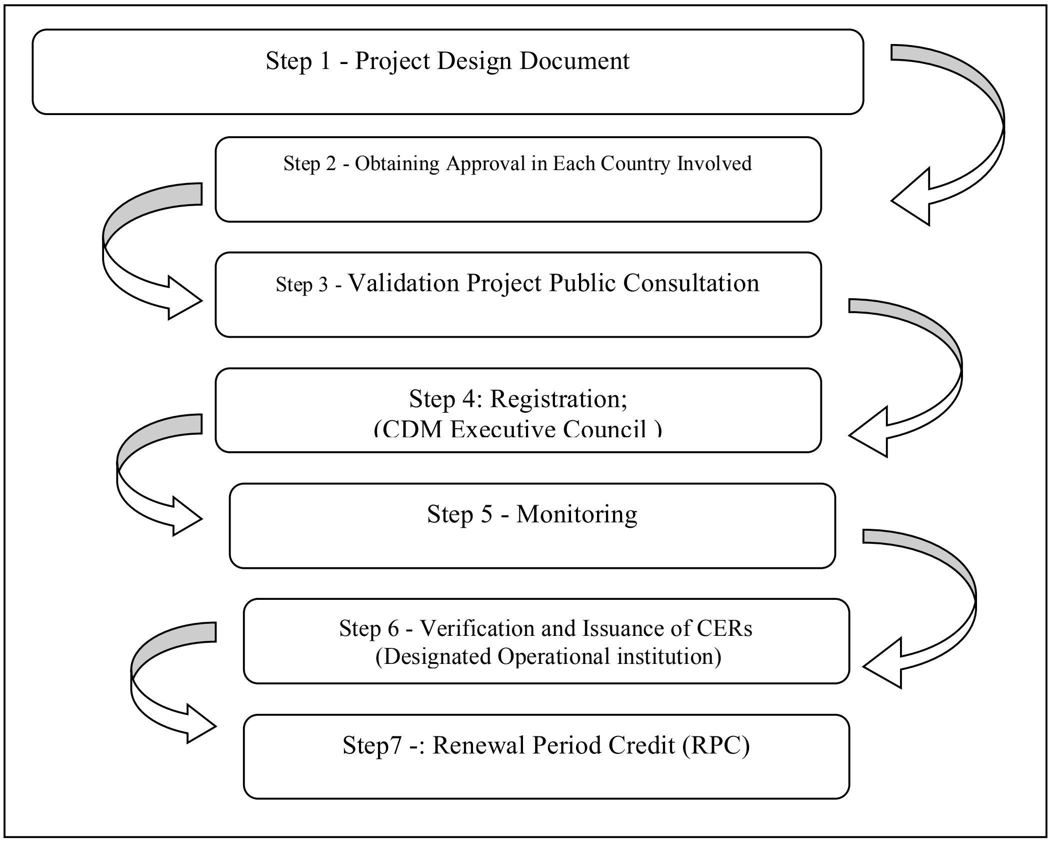

Figure 1 – Flow of Clean Development Mechanism (CDM)
Source: Carbon Marketwatch, 2010.

Due to the creation of this instrument, we sought to induce in the productive sector best practices of Greenhouse Gas Emissions (GGE) reduction and encourage the development of the securities market. Thus, for the actual functioning of the market as well as to encourage new competitors, it is necessary to integrate this mechanism with other policy instruments, both nationally (federal, state and municipal) and internationally.

According to Seiffert (2009) the entire process of issuance of CERs has a similarity with the certification of management systems according to the normative model of the International for Standardization Organizations (ISO). Thus, different agents are directly and indirectly involved with the project approval, in order to maintain the credibility of the entire certification process of Carbon Credits.

2.1 Market Profile of Carbon Credits

According to the report State of the Voluntary Carbon Markets 2012, in 2011 the transactions of carbon credits in the voluntary market reached a turnover of $ 576 million, second only to the year 2008, when it negotiated a volume of US$ 776 million (ECOSYSTEM MARKETPLACE, 2012). According to the UN Convention on Climate Change (UNFCCC), the average growth rate of the number of validated projects is 14 % per year in the timeline of the last five years.

According to the UNFCCC, until July 2012 China led the ranking of projects validated with 49.82 % followed by India with 19.46 % and Brazil with 4.60 %, as can be ascertained in the Figure 2.

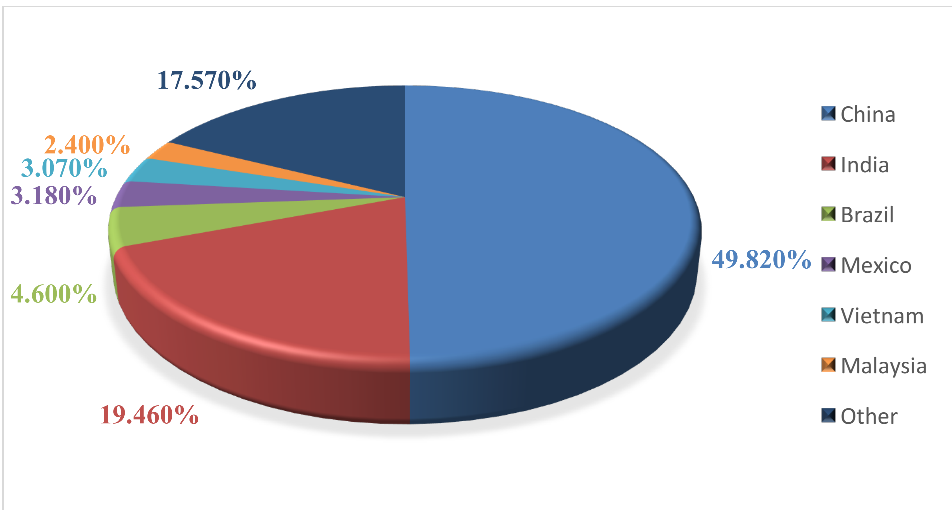

Figure 2 – Number of projects approved by country

Source: UNFCCC, 2012.

The countries of the European Union are the major financers and buyers of carbon credits generated as seen in Figure 3:

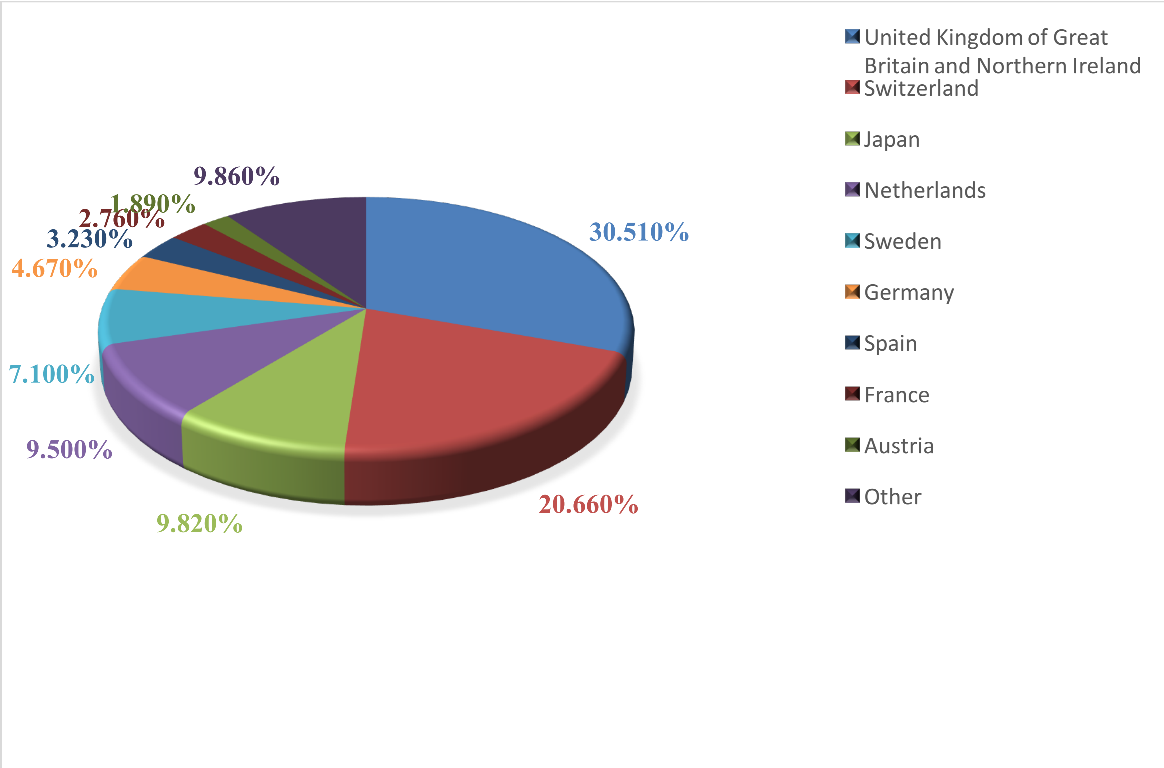

Figure 3 – Top countries requested carbon projects
Source: UNFCCC, 2012.

Corporate buyers hold large portion of market environment projects, contributing about $ 368 million or approximately 65 % of the turnover recorded only in 2012. Much of the financial transactions originated in Europe but this market already is commercially interesting to U.S. companies.

3 INDUSTRY APPLICATION

The Sugarcane Supply Chainis the set of economic activities involved in the production. The links corresponding to each sector are interconnected, offering and demanding products and services. This leads to a relationship of interdependence, so the gains earned in a particular sector may influence financial results of another correlated sector.

The main chain refers to the productive structure of a sugarcane. By harvesting the sugarcane, directly into the grinder, the stem raw materials essential for the whole chain are crushed. After this step the cane is crushed thus removing the concentrated broth, which is directed to the boil resulting in honey. This generates sugar, as well as produce by-product: molasses or honey (HIRATSUKA, 2009).

Finally, the chain originates downstream for the majority of by-products in the main chain. This has achieved considerable diversity in recent years, such as organic fertilizer or vinasse originating segregation of sugar and alcohol. Another consequence is the filter cake, residue from the manufacturing process of sugar. However, within the main chain there is a noticeable segregation in two systems: agriculture and industrial.

3.1 Agricultural Process

According to Oliveira et al., (2011) the planning of activities to be implemented in the culture of sugar cane should range from planting to harvesting by considering primordial future economic exploitation.

The form of the crop may be two: manual and mechanized (Figure 4). The mechanized adds one machine in the various steps of collection. Showing up can run from the cut to the conduct of raw material to storage, such equipment performs its action on a line at a time. Making use of a vehicle that travels in parallel to the harvester, which receives the raw material separates the parts of the leaves and pointers, which are released again into the soil taken from the area.

Manual harvesting employs two methods for harvesting: one in which the sugar cane is harvested green and the other in which it is burned. Manual harvesting raw is rarely used, since the worker must remove all leaves and green stems before cutting them which reduces worker productivity.

Figure 4 - Harvesting done automatically and manually

In Figure 5 the simplified flow from planting to sugarcane harvest is shown:

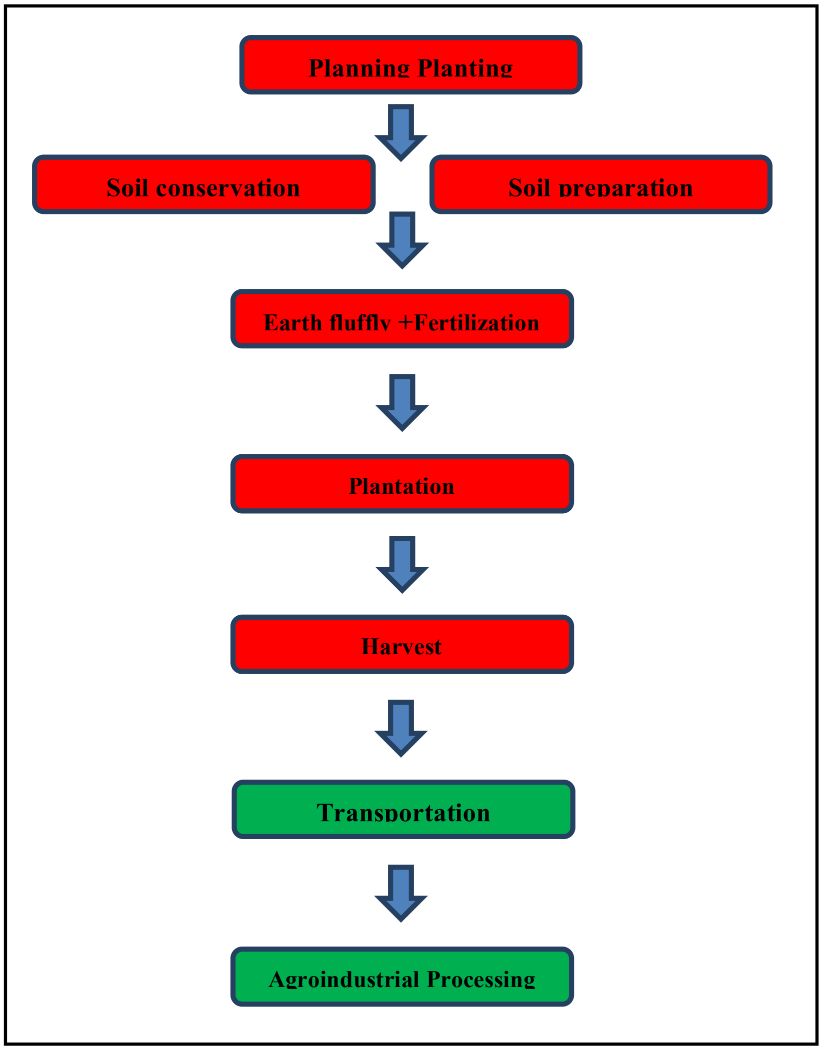

Figure 5 – Process flow of sugarcane agroindustries
Source: DONZELLI, 2009.

3.2 Industrial System

After harvesting, the sugar cane is transported to the plant which lies between 30 and 50 miles from the crop area because if the distance is much greater there is a reduction in levels of sucrose plants

Inside of this sector there are distilleries specialized in the production of ethanol. They produce molasses from the distillation of alcohol and itsby products found among the vinasse or stillage. For a long time, this product was treated as a waste problem of the plants since it had no way of storing. However in the last decade, it has begun to be widely used as a fertilizer in sugarcane and supply to market as organic fertilizer.

3.3 Obtaining carbon credits in the agricultural phase

The sugarcane plants like any other production system generates economic and social benefits, but it also generates harm especially to nature by producing polluting residues. The the plantation absorbs large amounts of CO_2 gas in the medium term, and it does not contribute to the greenhouse effect, since the same amount absorbed is eliminated again in a new cycle.

However there are two facts. The first point refers to the gas absorbed during the maturation period which rather than being retained within the plant biochemical structure is released almost instantaneously upon firing. This generates a concentration of the polluting gases in the regions of operation. The second point is that the CO_2 released also eliminates chemicals used in farming, as well as heavy metals that could harm the health of surrounding communities.

However the harvesting done manually becomes more interesting for agribusiness, provided some modifications and adaptations in the system of collection are made, in addition to improvements in the working class.

Thus the removal process can generate fires in the area of carbon credits to be characterized as carbon sinks. A sink can be any process activity or mechanism which has the property of absorbing and retaining the atmosphere of greenhouse gases (FAIRBAIRN, 2012). According Buckeridge (2007) it was analysed in laboratory some varieties of cane sugar the CO_2 retention power, and found that a single plant cane held about 1.2 kg of CO_2 in its composition.

4 METHODS AND MODELS

The case study was conducted in the Northeast Brazil in the state of Paraiba. The company holds a production capacity of about 6,000 (six thousand) bags of 50kg of sugar a day. The main product is crushed sugar which accounts for 80 % of production, followed by the VHP (very high purity sugar) to 15 % which is intended for export because its manufacturing process complies with the laws of different countries.

Besides sugar production the plant also produces some kinds of anhydrous and hydrated alcohol. The company has an area of 13.9 thousand hectares divided between industries and the planting of sugar cane.

4.1 Proposed Methodology for the calculation of the economic gain (VGeP1) for the carbon absorbed by sugarcane

For the calculation, it will be considered the total area devoted to cultivation of cane sugar. According to Buckeridge (2007) a plant of sugarcanes one year old, dehydrated, weights on average 2.5 kg. In this weight 1.5 kg refers to the stem, which concentrates sugars employed in the process of producing sugar and ethanol.

To construct the model we assume that the plant is in an artificial environment in the laboratory. At least 40% of the stem is composed of carbon. A healthy plant is about 0.6 kg (600 grams) of carbon. As the study was conducted in natural environment conditions, exposed to adverse weather and soil, it was assumed that each stem holds twice the amount of carbon. Each plant has 1.2 kg of carbon and that became the total sugar or alcohol (BUCKERIDGE, 2007).

To find the total number of plants per hectare (10,000 m^2) we used the following equation:

$$P_{H1} = \left(\frac{100}{D}\right) x \left(\frac{100}{E}\right) \tag{1}$$

Where:

P_{H1} = Number of plants in one hectare

D = Distance between plants of the same row

E = spacing between rows

After finding P_{H1} it was necessary to locate the existing plants in the total cultivated area of the plant.

$$N_{Total} = P_{H1} \text{ x } HP \quad (2)$$

Where:

Ntotal = Total cultivated plants

P_{H1} = Number of plants per hectare

HP = Hectares planted

It was assumed that each plant of sugarcane absorbed 1.2 kg of carbon dioxide (BUCKERIDGE, 2007). thus:

$$TAC_1 = 1.2kg \text{ x } N_{Total...} \quad (3)$$

Where:

TAC_1 = Total absorbed tons of CO_2

From the data obtained in the previous phases, it was possible to calculate the Economic Value of Gain (VGep1) of sugarcane mill considering the level of absorption of planting. In designing this study, it was taken as the equivalence factor of 1 ton of CO_2 (TAC_1) generating 1 Carbon Credit (MANTOVANI, 2012). Thus, to find TAC_1 in tons of carbon absorbed provided the generation units of Carbon Credits (CC_{P1}), from the formula developed and adapted to obtain economic gain described (FINCO, 2006).

$$VGe_{P1} = CC_{P1} \text{ x } TC_1P \quad (4)$$

Where:

VGeP1 = value economic gain in 1 project

CC_{P1} = Carbon Credits (Units)

TC_1 P = market price for carbon credit

From the data obtained in developing this work, it is possible to obtain the VGep1 multiplying the amount of carbon credits (CC_{P1}) by the market price of carbon recorded in official bodies.

5 RESULTS

According to the data provided by the company, it was used the distance of 0.40 m between plants of the same groove and 1.20 m spacing between the grooves, spread over an area of 6,900 hectares of cultivation.

To find the total number of plants per hectare (10,000 m^2) we used the equation (1), where P_{H1} = Number of plants in one hectare; D = Distance between plants of the same row and E = spacing between rows

$$P_{H1} = \left(\frac{100}{D}\right) x \left(\frac{100}{E}\right)$$

$$P_{H1} = \left(\frac{100}{0.40}\right) x \left(\frac{100}{1.20}\right) \quad (5)$$

$$P_{H1} = 250 \text{ x } 83.33 \text{ plants/hectare.} \quad (6)$$

$$P_{H1} = 20{,}832.50 \text{ plants/hectare.} \quad (7)$$

Thus there are 20,832.50 plants distributed in an area of 10,000 m^2. In possession of this information it is possible to find the amount of cultivated plants by applying to 6,900 hectares:

$$N_{Total} = 20{,}832.50 \text{ x } 6{,}900 = 143{,}744{,}250 \text{ plants.} \quad (8)$$

143,744,250 (one hundred forty three million seven hundred forty four thousand and two hundred fifty) plants are grown in an area of 69 million m^2 (sixty and ninety million square meters).

As mentioned in the previous section, it was considered that all the crop is homogeneous with respect to the cultivated varieties which will hold in its physico-chemical structure about 1.2 kg CO_2 per plant. The CO_2 absorbed is:

$$TAC_1 = 1.2 \text{ Kg x } 143{,}744{,}250 \quad (9)$$

$$TAC_1 = 172{,}493.10 \text{ tons. } CO_2 \text{ absorbed} \quad (10)$$

The whole area cultivated with sugar cane absorbed about 172,493.10 tons. CO_2 absorbed and by equation 4 it was obtain the value of Gain Economic (VGep2). To construct this value, it is considered that 1 ton of CO_2 is 1 credit carbon.

$$VGep_1 = 172{,}493.10 \text{ x US\$ } 6.19^{*} = \text{US\$ } 1{,}067{,}732.30 \quad (11)$$

* Quotation Carbon Credit

Thus, the plant may contribute an increase in its annual gross revenue of $VGep_1$ = US$ 1,067,732.30 which could substantially contribute to the company's financial results.

6 CONCLUSION

The international carbon credit market was formulated to encourage the implementation of more sustainable production models, associated with the change of perception on the part of the productive sector, which is no longer seen only as an input for its activities, thus starting to act more Effective way within companies, by providing resources capable of maintaining and enhancing the conservation of the environment. This case study project has the capacity to contribute an increase in its annual gross revenue and would benefit the sugarcane industry in the Northeast Brazil that uses this initiative.

It is noteworthy that Brazil is being structured to build a functioning structure capable of subsidizing the productive sector in registering its projects in this market. For this purpose, the Interministerial Commission for Climate was created to select the eligible projects for the United nations Registry Council, thus acting more effectively within the international community, as well as increasing income generation in the domestic economy.

This methodology will be of great utility to the Brazil sugarcane industry management by making information for sustainable strategic planning and would also contribute to the economic viability of eliminating the step of burning the sugarcane agro-industrial process.

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AVALIAÇÃO DE CRÉDITOS DE CARBONO EM INDÚSTRIAS DE CANA: PROPOSTA DE METODOLOGIA E ESTUDO DE CASO NO NORDESTE DO BRASIL

RESUMO: O mercado de Créditos de Carbono se apresenta como uma fonte de financiamento para as indústrias do agronegócio, proporcionando uma nova fonte de operações financeiras capazes de gerar uma expansão do fluxo de caixa. Estes recursos financeiros podem ser gerados através de produtos de uso de Marketing Verde, ou simplesmente empregando aspectos de responsabilidade social e ambiental. As principais empresas do Brasil são as usinas de açúcar, papel, celulose, madeira acompanhada em menor medida por iniciativas governamentais. Mesmo tendo registro de uma quantidade considerável de negociação ainda é um mercado em grande parte inexplorado para a cana-de-açúcar e o setor de álcool. O objetivo deste trabalho é apresentar uma metodologia para avaliação de créditos de carbono na indústria de cana-de-açúcar, estimando o potencial financeiro desses projetos, e apresentar um estudo de caso no Nordeste do Brasil. Há um volume potencial de créditos de carbono no volume de negócios anual da empresa de U $ 170 milhões no estudo de caso analisado.

Palavras-chave: Mecanismo de Desenvolvimento Limpo. Créditos de Carbono. Sustentabilidade nas indústrias de cana-de-açúcar. Eficiência energética.

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