Environment Pollution and Climate Change

Abdelrhman. Environ Pollut Climate Change: 2021, 5.6

Research Article Open Access

Carbon Sequestration, Emission, Credit and Monetary Value of Kenaf Cultivation for Producing Fiber Utilized into Industrial Technology

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Received date: March 26, 2021; **Accepted date:** May 31, 2021; **Published date:** June 07, 2021

Abstract

The aim of this study is to quantify the carbon credit and monetary value of kenaf cultivation for producing fiber. The data used in this investigation were prepared according to the scenarios of the kenaf production for the suggested cultivated areas. The contributions of kenaf on the environment are obtained from many articles which conducted in Kenaf carbon footprint, sequestration and its carbon credit. The collected data were analyzed using different statistical methods. The study revealed that, the average estimated quantity of carbon sequestration of kenaf cultivation in the studied areas is approximately 110000 CO2eq. To trade on kenaf carbon dioxide sequestration, the projection of kenaf under Clean Development Mechanism is highly recommended for earning saleable certified emission reduction credits by government and generate additional income for Kenaf farmers.

Keywords: Carbon credit; Carbon sequestration; Kenaf cultivation; Emission reduction

Introduction

Carbon credit

The issue of carbon credits has raised due to increasing awareness of mitigating and controlling GHG emissions. Recently, the IPCC has observed that implication of the rules and policies create motivations for producers and consumers to invest in low-abated products, technologies and devices. Table 1 illustrates the steps of how the carbon credit has implemented by 192 countries in whole the world and agreed that they would cut the emissions of house green gasses by the year 2020. And applied the carbon credit to the released carbon dioxide and its sequestration as seller and buyers to help in implementing the strategies of reducing the emissions and alleviate the pressure on the environment.

Name of the Events	Outcomes
Montreal Protocol 1987	IPCC was established
Rio Summit 1992	Formation of UNFCC (effect in March, 1994)
Kyoto Protocol 1997	Adopted the concept of
	· Carbon Emission Trading
	· Emission Reduction Target
	· Joint implementation
	· CDM Project
Copenhagen summit 2009	192 countries agreed to cut emission by 2020
Durban 2011	All governments committed to preserve the right to sustainable development
Source: (Saha and Sagorika, 2013)	

Table 1: United Nations Framework Convention on Climate Change.

Canabinus and carbon credit

As revealed chemical structure of hemp stem contains cellulose, hemicellulose, and lignin, their carbon contents of one ton of harvested stem shown in the Table 2 has a significant importance to environment.

Weight	Carbon content ton
0.7 tonnes of cellulose	(45% Carbon)
0.22 tonnes of hemicellulose	(48% Carbon)
0.06 tonnes of lignin	(40% Carbon)

Table 2: Carbon contents of chemical structures of hemp stem.

Carbon markets

Carbon market contains the buyers and sellers which trade in ‘carbon offsets' or ‘carbon credits' where are units of carbon emissions reduced of the sources that release GHG. For example by reducing consumption of fossil fuels or units of carbon dioxide that have absorbed by forests from the atmosphere. The carbon markets comprise of two types of businesses there are:

- Trades of emission allowances, such as Assigned Amount Units (AAUs) under the Kyoto Protocol, or allowances under the EU Trading Scheme (EUAs). These allowances are created and allocated by a regulator, usually under a cap and-trade regime.
- Project-based transactions for this transaction the buyer participates in the financing of a project which reduces GHG emissions compared to what would have happened otherwise, and get "emission credits" in return. In contrast, allowance trading, project-based transactions can find even in the absence of a regulatory regime: the sign agreement between a buyer and a seller is sufficient.

The problem of greenhouses gas has been discussed and tackled for numerous years ago and appears to remain for some time. Transportation and human activities such as (manufacturing, cultivations, etc.) are the main contributor and causes of the greenhouse gas emissions. The percentage of CO2 emissions of the EU almost 20%, In North America approximately 30%, while the share of Asia is around10%, most of the percentage mentioned above caused by transportation. Moreover, the unstable society's demands from fossil to renewable crop and tree plantation as resources for energy is noticed as a significant contributor to providing an efficient management of GHG emissions. Additionally, this replacement of fossil has significant indications to avoid gas emissions. The adoption of a mandatory Green House Gas emissions reduction program, with a high price per ton of CO2 credits, will improve income opportunities for the farmers due to enhancement of the agricultural sector. That will create benefits as additional income when quantifying carbon sequestration in their farms and they claim it as carbon credits using the protocols and agreements of carbon reductions (Rice and Reed, 2007).

The method used for calculation for carbon sequestration caused by land-use change for Chinese bamboo (Phyllostachys pubescent) as well as the calculation for carbon sequestration caused by land use change for wood which was adopted by their investigation revealed that dry matter planted timber can stored up to 6.97 kg CO2 in the forest and 0.55 kg CO2 per kilogram dry matter sawn wood of Chinese bamboo [1-3].

Change, The methodology with ISO 14040 and ISO 14044 (PAS 2050 2011) to evaluate carbon a greenhouse gas balance in addition to carbon dioxide (CO2), also comprises methane (CH4), nitrous oxide (NO2) and chlorofluorocarbons in their evaluation through different life cycle assessment, according to IPCC 2013, their result clarifies by Table 3 which illustrated global warming potential of green gaseous emission, they are the main gasses that warm the planet due to their emission from the human activities, their characterization and equivalent to CO2 emissions were very crucial for avoiding the activities that contains a very high quantities of such emitted gasses.

Greenhouse gas emissions	Emitted gaseous	Characterization factor
Carbon dioxide	1	CO2
Methane	28	CH4
Nitrous oxide	265	N2O

Table 3: Global warming potential of green gaseous emission.

Methodology

Sources of data

This work is an analytical study. The secondary data of this research were collected from the following Sources: environmental review, books and journals as well as Internet web site. The data of production area were obtained from four kenaf farms with their annually cultivated area of 2000 hectares. The contributions of kenaf on the environment are obtained from many articles which conducted in Kenaf carbon credit.

The quantifying of carbon credit of the kenaf cultivation

Carbon (C) saving and CO2 sequestration in many developing countries needs to be complemented by socio-economic improvements. Crops can be planted for climate change alleviation as well as driving economic development by trading on CO2 sequestration in addition to supplying another product to meet local and global market requirements. Clean Development Mechanism (CDM) used as tools to compensate the farmers and government by converting the potential plantation area into financial credit under the United Nations Framework Convention on Climate Change (FCCC) Kyoto Protocol. As well as integration into REDD (Reducing Emissions from Deforestation, Forest Degradation, and Enhancement of forest carbon stocks) [4-9].

There are two major types of Carbon Credits they are:

- Carbon offset credits, which focused on producing clean energy, wind, solar, hydro and biofuels.
- Carbon Reduction credits, it is the gathering and saving of carbon from our planet through reforestation, forestation, ocean and soil fixation and storage efforts.

The adoption of an implemented greenhouse gasses emissions reduction program with a high price per ton of CO2 credits, will improve income opportunities for the farmers due to enhancing of the agricultural sector, and reasonably this will increase participation rates of farmers and ranchers. There are several studies conducted to estimate carbon sequestration by kenaf cultivation for producing fiber, currently the trading in carbon dioxide has been one of the major factors that can help the government and the farmer to get allowances using their cultivated lands. Recently kenaf was nominated as one of the main natural fiber plants that can contribute to mitigating carbon dioxide emission from the atmosphere [9-13].

The present work relies on a study conducted, To estimated carbon credit for kenaf cultivation area by hectare. They concluded that kenaf ready for harvest on 4-5 months plant age could save 2.9-12.1 tons C/ha or absorb 21-89 tons CO2/ha/year this relies on the agronomic management and environmental conditions. Thus, to propose and build an equation, the area of cultivated kenaf was used to estimate the carbon dioxide sequestration and carbon saved by kenaf plant as the carbon credit. The effort which follows emerged new philosophy can consider carbon as the economic commodity which can be trade on. The conversion of greenhouse gasses to CO2 equivalents is measured as a commodity which can be sold and bought. The CO2-eqs sold on carbon markets which is identified as the financial place where can trade the carbon credit. The agreement between the two parties in trading carbon is between those who alleviate emissions or save carbon, earn an income and those who have to decrease emissions can buy carbon credits to offset their emissions. On the other hand, the

prices which is received for one ton of CO2 depend on the type of market and the type of carbon offset project as well as following the (IPCC, 2007) guidelines for carbon trades [14-17] .

Carbon credit modeling

There are many models used to estimate the cost, benefit, and pricing of carbon sequestration and emission of the plantation, in this study, the PROCOMAP (Project Comprehensive Mitigation Analysis Process) model was adopted to assess the carbon credit of kenaf cultivation. This model was developed by LBNL (Lawrence Berkeley National Laboratory) with the aim to quantify carbon credit of plantation over one year as well as the financial implications and cost-effectiveness of mitigation projects. Also, A PROCOMAP model estimates the following under baseline and mitigation scenario:

- The annually and cumulatively carbon stock.
- Ton C/ha for the total area of plantation
- Cost-effectiveness indicators such as cost in $/tC sequestered $/tC for sequestered or emission carbon

These models have been widely used for assessing and quantifying carbon dioxide trade.

The monetary value of kenaf cultivation

To monetary evaluation of aboveground biomass which can sequester carbon dioxide was based on the intergovernmental panel on climate change (IPCC) guideline. The dollar value of the estimated kenaf carbon emissions was evaluated by multiplying of the emitted carbon dioxide valued with the carbon market trade based on forest carbon market price [18-21].

Results and Discussion

Carbon dioxide sequestration and emission of kenaf cultivation in four the areas

Figures 1 and 2, illustrates the results of carbon sequestration and emission of kenaf cultivation in four studied area, including area A, B, C, and D. The minimum sequester CO2 by the four studied is 42000 tons, while the maximum CO2 released is 178000 tons during the period of kenaf cultivation. On the other hand, approximately 1200 tons carbon dioxide is emitted during kenaf cultivation. The percentage of minimum and maximum carbon dioxide sequestration, as well as CO2 emission by the studied areas indicated that kenaf can cultivated for reducing the CO2 emission in the highly emitted industries such as petroleum refinery, rice and cattle breeders. The results shown above are calculated based on the kenaf crop cultivation ton per hectare. Depending on the above results, we can conclude that kenaf cultivation will result in low emission and highest absorption to CO2 and will create an environmental benefit and microclimate to the growers in the mentioned studied areas. Also, the study concluded that to increase environmental impact the additional areas of kenaf cultivation is highly recommended globally. As reported by kenaf plant ready for harvesting, can save 2.9-12.1 tons C/ha and sequestrate 21-89 tons CO2/ha/year; this will help in carbon sink for a long period in the future. Also comparing the amount of CO2 sequestrated for a single production cycle, one hectare of kenaf can absorb the amount of CO2 that is released by 20 car engines for the entire year (e.g. combustion engine). Also, kenaf can save much carbon when compared with other plants. The method used for calculation of carbon sequestration caused by land-use change for Chinese bamboo (Phyllostachys pubescent) as well as the calculation of carbon sequestration caused by land use change for wood are also adopted. Their calculation revealed that dry matter planted timber can stored up to 6.97 kg CO2 in the forest and 0.55 kg CO2 per kilogram dry matter sawn wood of Chinese bamboo.

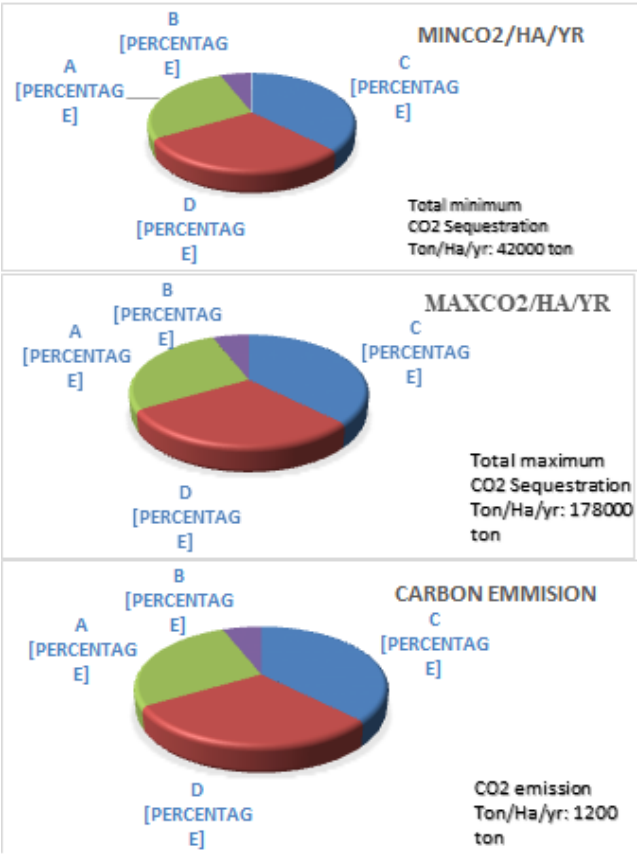

Figure 1: Carbon dioxide sequestration and emission of Kenaf cultivated areas .

Assessment and quantifying the carbon credit of kenaf cultivation in the four studied areas

The result of the analysis of kenaf cultivated area clarified in figure 2 shows the carbon credit could receive from the four areas that cultivated kenaf to produce fiber for industrial products. The figure depicted that, kenaf which is grown in area A can earn an amount of CER ranges between 15750-67000 ton CO2, followed by area B and area C which can give CER between (12180-51620 and 11550-48950) ton CO2, while area D which has small cultivated area can give CER ranges between 2520- 10680. As revealed by the analysis the sum of CO2 sequestrated by all the four areas can reduce the pollution and has a vital contribution to environmental performance.

The green products will be one of the important mitigation strategies that can help the countries to achieve the carbon dioxide emissions reduction target. Nevertheless, Mustapa and Bekhet (2015) conducted research in the factors affecting CO2 emission, they found that transportation as the main factor has a significant effect on the emissions and they concluded that, increasing vehicle taxes and carbon credit is highly encouraged. The research results of this

investigation can consider the cultivation of kenaf as carbon sequestrated plant as the main contributor in climate change mitigation.

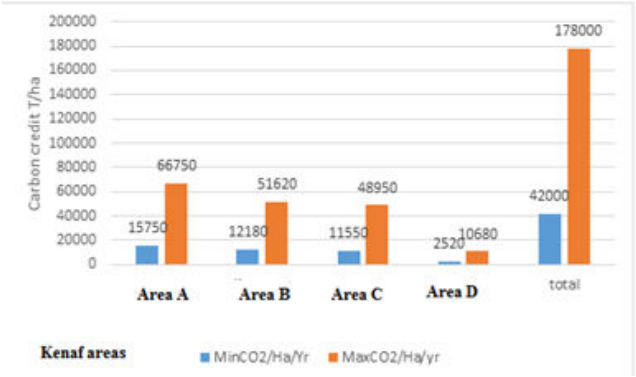

Figure 2: Carbon credit estimation ton/ hectare among the Kenaf cultivated Areas.

Conclusion

The study concluded that, the total estimated quantity of carbon sequestration of kenaf cultivation in the studied area is approximately 178000 ton CO2/ton. Additionally, the cultivated area of kenaf can consume total amount of CO2 per year approximately of about 42000 -178000 tons which are equivalent to 178000 Certified Emission Reduction (CER). At the rate of carbon market price/ton of CO2, the total value is 664,533.3 USD; the estimated revenue per hectare out of kenaf cultivation is about 4.2$.

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