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Effect of Climate Change on Carbon Sequestration by *Cassia fistula* in Mukundara National Park, Kota, Rajasthan

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ABSTRACT

Study of the impact of climate change and soil composition on some important plants, to have an increase in the yield of useful substances has been presented and their national significance is highlighted. Knowing about the carbon sequestration mechanism, decrease in the atmospheric Carbon dioxide level could be understood in the interest of the nation. Present study presents the solution to many problems and shall specify studies of ethno forestry in Mukundara Hills National Park with special reference to carbon sequestration and climate change.

Keywords: *Carbon capture, Forest Ecosystem, Agroforestry, Clean Development Mechanism*

INTRODUCTION

The phrase carbon sequestration; refers to efforts to capture excess carbon dioxide from the atmosphere, condense it, and store it in some benign way. Carbon capture and storage (CCS) technologies are implemented in some limited way in many fossil fuel power plants. The technology for capturing is ahead of the technology for storing, which is just starting to be explored seriously. Carbon sequestration could be an important part of the fight against greenhouse gases. The most primitive form of carbon sequestration would be to simply plant more trees. Plants naturally take CO_2 from the atmosphere and output oxygen. Much of the carbon from the CO_2 is integrated into their biomass and released safely into the soil upon their deaths. Refer to the process of removing carbon from the atmosphere and depositing it in a reservoir i.e. Carbon sequestration is when carried out deliberately, this may also as carbon dioxide removal, which is a form of geo-engineering.

Carbon sequestration describes long-term storage of carbon dioxide or other forms of carbon to either mitigate or defer global warming. CO_2 may be captured as a pure by-product in processes related to petroleum refining or from flue gases from power generation. CO_2 sequestration includes the storage part of carbon capture and storage, which refers to large-scale, permanent artificial capture and sequestration of industrially produced CO_2 using subsurface saline aquifers, reservoirs, ocean water, aging oil fields, or other carbon sinks.

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Bio-sequestration or carbon sequestration through biological processes affects the Global carbon cycle. Examples include major climatic fluctuations, such as the Azolla event, which created the current Arctic climate. Such processes created fossil fuels, as well as clathrate or limestone. By manipulating such processes, geo-engineers seek to enhance sequestration. Reforestation is the replanting of trees on marginal crop and pasture lands to incorporate carbon from atmospheric CO_2 into biomass. For this process to succeed the carbon must not return to the atmosphere from burning or rotting when the trees die. To this end, the trees must grow in perpetuity or the wood from them must itself be sequestered, e.g., via biochar, bio-energy with carbon storage (BECS) or landfill. Carbon emission reduction methods in agriculture can be grouped into two categories: reducing and/or displacing emissions and enhancing carbon removal. Some of these reductions involve increasing the efficiency of farm operations (i.e. more fuel-efficient equipment) while some involve interruptions in the natural carbon cycle.

Carbon sequestration (CS) by Forest ecosystems (FE) is the net removal of carbon dioxide (CO_2) from the atmosphere or the avoidance of carbon dioxide (CO_2) emissions from Forest ecosystems into the atmosphere. The removal process includes CO_2 uptake from the atmosphere by all chlorophyllous plants, through photosynthesis. This C is stored as plant biomass (in the trunks, branches, leaves and roots of the plants) and organic matter in the soil.

STUDY AREA

The Mukundara National park is situated about 45 km. from Kota at the NH-12 towards Jhalawar. It lies between 24°37' to 25°2' N Latitude and 75°39' to 76°12' E Longitude. Darrah is the nearest railway head on Delhi-Bombay Broad gauge line. The total area of the National park is 239.76 Sq.km. There are 26 Forest Blocks in the sanctuary comprising over all area of 213.18 Sq.Km. out of which 190.10 Sq. Km. is Reserve Forest (RF) and 23.08 Sq.Km. is Protected Forests (PF).

The soil in this area is mainly formed by the disintegration of the Ganugarh shales, samariya shales and the Jhiri shales intermix with disintegrated sand stone grain. All over forest areas the soil is generally dry, impoverished and deficient in humus. On the slopes the soil is sandy loam, shallow and covered with stones and boulders. Soil of flat areas is sandy loam mixed with gravel and boulders and is reddish in colour. Temperature varies from 10°C to 45°C. Summer is hot and commences with beginning of March, stay up-to the end of the June. Hot westerly winds locally called "loo" are common during summer. Average temperature during these months is 25°C to 45°C. The period November to February constitute cold weather. The mean temperature during these months is 7°C to 25°C.

MATERIALS AND METHODS

Forested land and agricultural land are the land types most commonly associated with carbon sequestration. Within forested lands, the primary methods for promoting carbon sequestration are:

Afforestation: Afforestation is the conversion of previously non-forested land into forested land. A non-forested acre converted into a forested acre can result in a carbon sequestration rate of 0.6–2.6 MMT over a period of 90–120+ years (EPA 2006).

Reforestation: Reforestation is the restoration of previously forested land. Doing so can produce an increase in carbon uptake of around 2.1 MMT per acre over a period of 90–120+ years (EPA 2006).

Sustainable forest management: Sustainable forest management techniques include forest preservation, adoption of low-impact harvesting methods, lengthening of forest rotation cycles, agroforestry, and the adoption of other methods aimed at increasing carbon uptake (Richards et al. 2004).

Carbon Sequestration in Agro-forestry Systems

Management of trees in agro-ecosystems such as agro-forestry, ethno-forests, and trees outside forests can mitigate green house gas

(GHG) emissions under the Kyoto Protocol (Pandey, Deep Narayan -2002).

Besides there are Physical Processes, Biomass-Related Processes and Bio-Energy with Carbon Capture and Storage (BECCS). BECCS refers to biomass in power stations and boilers that use carbon capture and storage.

Burial

Burying biomass (such as trees) directly mimics the natural processes that created fossil fuels. Landfills also represent a physical method of sequestration.

Biochar Burial

Biochar is charcoal created by pyrolysis of biomass waste. The resulting material is added to a landfill or used as a soil improver to create terra preta**.**

Grazing Land Management

Effective grazing land management can be expected to increase carbon sequestration rates by 0.02–0.5 MMT of carbon per acre (EPA, 2006).

Wetland Restoration

Wetlands are frequently drained to produce dry, fertile soil for agricultural use. Wetland soil contains a very concentrated amount of carbon; 14.5% of the world's soil carbon is found in wetlands, while only 6% of the world's land is composed of wetlands (Nilsson et al, 2008).

Biofuel Substitution

Biofuel Substitution is the use of agricultural land for the production of biomass that can be converted to biofuel. Every acre used for biofuel production can produce a net sequestration rate of 1.5 MMT of carbon (EPA, 2006).

In order to measure Carbon sequestration in Mukundara National Park (MNP) its profile was studied on the basis of primary and secondary data. Primary data are mainly obtained for *Cassia fistula*.

OBSERVATION AND RESULTS

The Observations made for the presence of each selected tree species in five Transects of 1000M X 100M MNP in each direction were recorded. The individual presence of Cassia fistula in MNP in all four directions i.e. East, West, South and North, average number in five Transects of 1000M X 100M MNP, is shown in Table-1.

Table:1- The presence of *Cassia fistula* in MNP in all four directions i.e. East, West, South and North

Direction	Transect 1000 M X 1000 M					Average
	1	2	3	4	5	
East	615	510	329	513	490	491
West	313	421	513	236	321	361
South	516	426	318	310	417	397
North	116	228	319	326	192	236
Average	390	396	370	346	355	371

Calculation for obtaining the average weight of CO_2 sequestered per year by the average number of *Cassia fistula* present in an average Transect of 1000M X 100M in all four directions i.e. East, West, South and North in MNP:

The Average CBH (Cms) of Cassia fistula in MNP

= 82.15 cms

= 82.15/2.54 inches

= 32.34 inches

The Average Height (feet) of Cassia fistula in MNP = 21.36 ft

The Average Age (Yrs) of Cassia fistula in MNP = 23.59 years

The Average Number of trees in an average Transect of 1000M X 100M in all four directions i.e. East, West, South and North in MNP = 371

For trees with D≥11:

W = 0.15D 2 H
D = 32.34 inches
H = 21.36 ft
W = 0.15 (32.34X32.34) 21.36
W = 3350.98 pounds

The average total weight of a tree = w X 120/100 = 4021.18 pounds

The average dry weight of a tree = the average total weight of a tree X 72.5%. = 2915.36 pounds

The average weight of carbon in a tree = the average dry weight of a tree X 50% = 1457.68 pounds

The average weight of carbon dioxide sequestered in a tree
= The weight of carbon in the tree X 3.6663 = 5344.29 pounds

The average weight of CO_2 sequestered in a tree per year = The average weight of carbon dioxide sequestered in a tree /the average age of the tree.
= 5344.29 /23.59 pounds/year
= 226.55 pounds/year
= 226.55 /2.20452262 Kgs/year
= 102.77 Kgs/year

The average number of Cassia fistula in an average Transect of 1000M X 100M in all four directions i.e. East, West, South and North in MNP = 371

The average weight of CO_2 sequestered by the average number of *Cassia fistula* present in an average Transect of 1000M X 100M in all four directions i.e. East, West, South and North in MNP= 371 X 102.77 Kgs/year
= 38127.67 Kgs/year

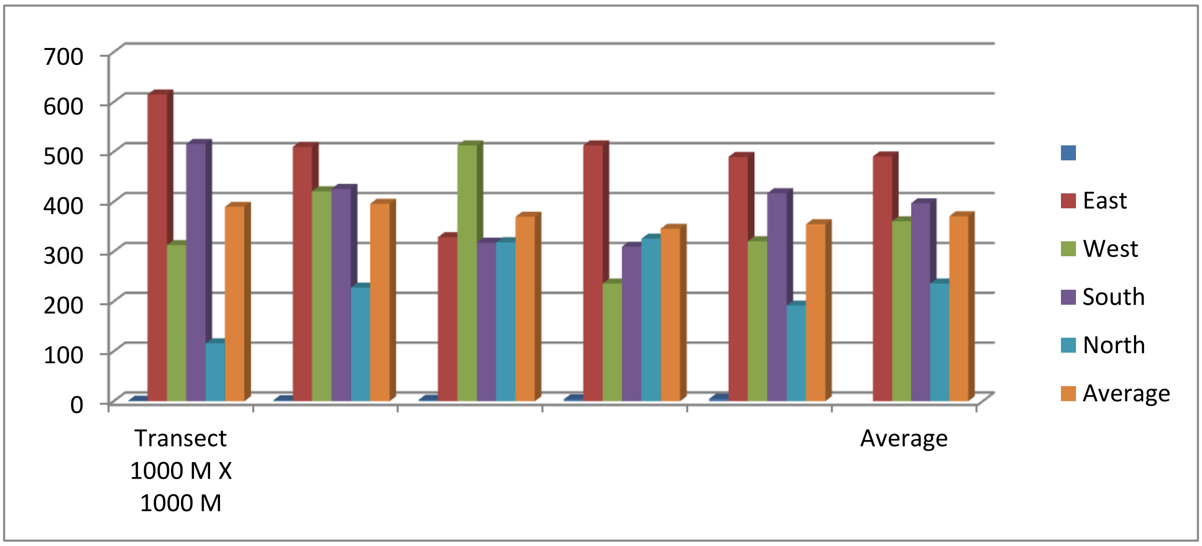

Fig. Average population of *Cassia fistula* in all directions of MNP

DISCUSSION

Since ecological boundaries of Mukundara forest types are defined by several climatic factors, climate change may affect the distribution and composition of its vegetation. Climate change will compound local anthropogenic factors, such as deforestation. Disturbance to ecosystems may bring changes of the magnitude not yet known in Rajasthan. Because of the complexity of local and global change, even if climatic conditions favour expansion, forest area is unlikely to expand; it may decrease in parts where deforestation and degradation are intense.

Increasing levels of atmospheric CO_2 are expected to enhance the growth rate of trees. Current estimates of annual terrestrial plant uptake of carbon to CO_2 fertilization are within the range 0.5-2.0×10 g, which is about 8-33% of annual fossil-fuel emissions. Depletion of soil organic C (SOC) pool have contributed 78±12 Pg of C to the atmosphere. Some cultivated soils have lost one-half to two-thirds of the original SOC pool with a cumulative loss of 30–40 Mg C/ha (Mg=mega gram=10 6 G=1 ton). (R. Lal, 2008).

Since the industrial revolution, global emissions of carbon (C) are estimated at 270±30 Pg (Pg=petagram=10 15 G=1 billion ton) due to fossil fuel combustion and 136±55 Pg due to land use change and soil cultivation. Emissions due to land use change include those by deforestation, biomass burning, conversion of natural to agricultural ecosystems, drainage of wetlands and soil cultivation.

The global wood production amounts to 3.5 billion m 3 yr -1 , that leads to a net sink of carbon of 139 TgC y -1 (tera grams or 10 12 grams carbon per year), as the production is larger than the decay of the wood products manufactured earlier. Carbon sequestration benefits can be maximized further by linking the bio-energy options with CDM (Schlesinger et al., 2001).

CONCLUSION

The study concludes that the management of multifunctional forests over landscape continuum, employing tools of conservation biology and restoration ecology, shall be the vital option for climate change mitigation in future. Looking to the above it was interesting to record in the present work the quantity of Carbon sequestration by the studied plant present in an average Transect of 1000M X 100M in all four directions i.e. East, West, South and North in MNP.

Cassia fistula available in the study area could sequester 38127.67 Kgs/year. Observed changes specifically explain about temperature, precipitation, weather conditions in relation to Carbon sequestration and global warming. Variability in above Carbon result, a more complex system to be followed by the MNP ecosystem. This is in confirmation of the results indicated by Pandey (2003) that ecological degradation, deforestation and biodiversity loss have emerged as major challenges for society.

Agro-forestry systems have less biodiversity compared to forests, but they can also act as an effective buffer to deforestation and conversion of forestlands to other land uses, which threaten forests (Raheja, 1965).

Trees in agro-eco-systems also support threatened cavity nesting birds, and offer forage and habitat to many species of birds (Pandey, 1991).

Total above-ground and below-ground biomass in Mukundara forests has been estimated as 835.7 and 196.8 Mt, contributing 79 and 21% to the total biomass respectively. The mean biomass density is 39.1 t ha -1 .

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