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SUSTAINABLE DEVELOPMENT AND BAMBOO CULTIVATION FOR COMBATING CLIMATE CHANGE IN THE INDIAN CONTEXT –A REVIEW

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ABSTRACT

Global climate change is the major problem in all over the world and its adverse affect on environment, economy, food production, health require a good scientific solution based on sustainable development and reuse of our natural resources. The present paper mainly deals with environmental sustainability along with bamboo cultivation. Bamboo has a large number of attractive qualities with special reference to the property to sequester substantial quantities of carbon in their biomass and the needs of the people can be fulfilled on sustainable basis with a comparison to traditional materials such as wood. The most widely known features of bamboo are its fast growth, adaptability, resilience and substantial biomass production. it also act as a environmentally friendly plant and net carbon sink , producing 35% more oxygen than wood plant whereas some species of bamboo can absorb up to more than 12 tones of carbon dioxide per hectares as well as it can play a important role in raising of forest cover to about 40-45% by 2020 . India as one of the World's oldest civilizations, the issue of climate change is situated in the context of Indian population and their increasing demand with the pay of environmental threats like fast urbanization, industrialization and degradation of forest cover. The development and enhancement of bamboo cultivation can promotes economic and environmental growth, mitigates deforestation and illegal logging, prevent soil degradation and restores degraded lands in both village as well as urban area of India.

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INTRODUCTION

Bamboos are grouped under the Subfamily Bambusoideae within the family Poaceae. There are 60 to 90 genera of bamboo with over 1200 species. Bamboo is mostly distributed in tropical and subtropical zones between 46 degree north and 47 degree south latitude in Asia, Africa and America (Jain and Biswas, 2001). People in Asia, Africa and South America rely on bamboo to fulfill their daily needs and provide livelihoods. It is one of the most versatile natural resources, and its strength, flexibility, light weight and hardness have led to its use in a wide range of products and applications, some of which can help us to adapt climate change. The most widely known features of bamboo are its fast growth, adaptability, resilience and substantial biomass production. In 15 – 20 years it has emerged as a valuable wood substitute. It can be used as a valuable resource in the production of boards, flooring, roofing, pulp and paper, fabrics and cloth, oil, gas and Substitution by bamboo of energy intensive products can indirectly reduce carbon dioxide emissions producing bamboo products usually needs much less energy than comparable fossil-fuel based products. Development of bamboo resources and industries worldwide promotes economic and environmental growth, mitigates deforestation and illegal logging, prevent soil degradation and restores degraded lands (Scurlock *et al.,* 2000).These qualities of bamboo have been well studied and are widely known.

Bamboo is also an environmentally friendly plant and net carbon sink, producing 35% more oxygen than wood. Carbon dioxide is one of the green house gases (GHGs) family responsible for global warming (Moore and Chapman, 1986).

The Kyoto protocol entered into force in 2005 and promoted the Clean Development Mechanism as a powerful vehicle for combating global warming or global climate change (Tripathi and Singh, 1994). Bamboo can easily compete with the most effective wood species in terms of carbon sequestration capacities. It was also proved by an experiment conducted by Photosynthesis meter upon five of the Bamboo species and five fast growing woody shat of pecies. The net photosynthesis rate and stomatal conductance was quite low in fast growing woody species than that of bamboos.

About the problem

Global climate change is the major problem in present scenario. James Hansen of the NASA Goddard Institute for space studies and his colleagues argue in a recent paper submitted to Science that the present carbon dioxide (CO_2) level in the atmosphere, 385 parts per million (ppm)., has already crossed into dangerous territory (Bellamy *et al.,* 2005). According to their study of past climatic sensitivity to changes in atmospheric carbon dioxide, there is substantial risk that within just a few centuries the earth could lose its great Antarctic and Greenland ice sheets, causing catastrophic rises in sea level, unless carbon dioxide levels are quickly brought back to 350 ppm.

All six of the scenario well thought-out by the Intergovernmental Panel on Climate change (IPCC) assume that by the end of this century atmospheric green house gases will reach the warming equivalent to 600ppm of CO_2 (600 ppm CO_2 – eq.) (Pachauri, 2007). At that level the IPCC pegs the chances at about two thirds that by 2100 the earth will have warmed between two and three degree Celsius (between 3.6 and 5.4 degree farenhiet) since preindustrial times. According to the Stern Review, a major report on the economics of climate change, a five degree increase would be “far outside the experience of human civilization”. It would also risk “irreversible ....physical changes, such as the collapse of ocean currents ‘’’, as well as “mass migrations and social instability.’’ It gets worse.

Climate change will cause harm heat waves, storms and floods will kill many people and harm many others. Future generations will suffer most of the harmful effects of global climate change (Singh and Singh, 1999).This is all about the global problem.

In the Indian context

India is one of the World’s oldest civilizations. The issue of climate change is situated in the context of the increasingly marginalized Indian population.

There are several consequences of climate change at the local level. Sudden variations in the monsoon months, frequent floods and droughts has always been experienced and dealt with by Indian Farmers (Nafisa Goga, 1997). Moreover, for a country like India to respond to climate change mitigation strategies would involve compromising the development of Economy. Climate change has great impact on in the field of. According to a study sponsored by the Asian Development Bank, India's geographical location makes it particularly vulnerable to the impact of global warming .Analysis of various climate change scenarios reveals that crop yields in India could be adversely affected by changes in temperature and concentration of carbon dioxide (Lehmann, 2007). The effect will be felt differently in different regions. Such an adverse impact on agriculture will be alarming in the Indian context, and a World Health Organization report clearly estates that malnutrition would increase due to the effects of climate change on food production systems (Christanty *et al.,* 1996).

The most exhaustively studied impact of climate change is on India's coastal regions. It is expected that a rise in global temperatures will bring a rise in sea levels, with adverse impact.

MATERIALS AND METHOD

Net photosynthesis and stomatal conductance were determined by photosynthesis meter in the field condition. Five species of Bamboos were taken for observation, these were *B. nutans, B. balcoa, B. striata, B. tulda, D. strictus*. The Fast growing woody species taken for observation were *Acacia nilotica, Melia azadirachta, Anthocephalus chinensis, Tectona grandis and Bombax ceiba*. The reading is taken for the three replicates and mean value was calculated which is shown in the Table 1 and 2.

RESULTS AND DISCUSSION

Bamboos grow very fast and establish rapidly. They grow both in natural forests and in managed stands or plantations. Bamboo has a great potential for biomass production and could be a significant net sink for Carbon dioxide Carbon sequestration;(Fig. 1) nevertheless by the highest whole culms; Photosynthetic rate (WNP = 272 $\pm$ 7.2 mu mol CO_2 per sec.) calculated by the total leaf surface area per culms (28.6 $\pm$1.1 m square) and the mean maximum yearly assimilation rate (9.5 $\pm$ 4.5 mu mol m. square per sec). Yiping, an INBAR scientist have as identified specific period in the life cycle for bamboo, when it can sequester the

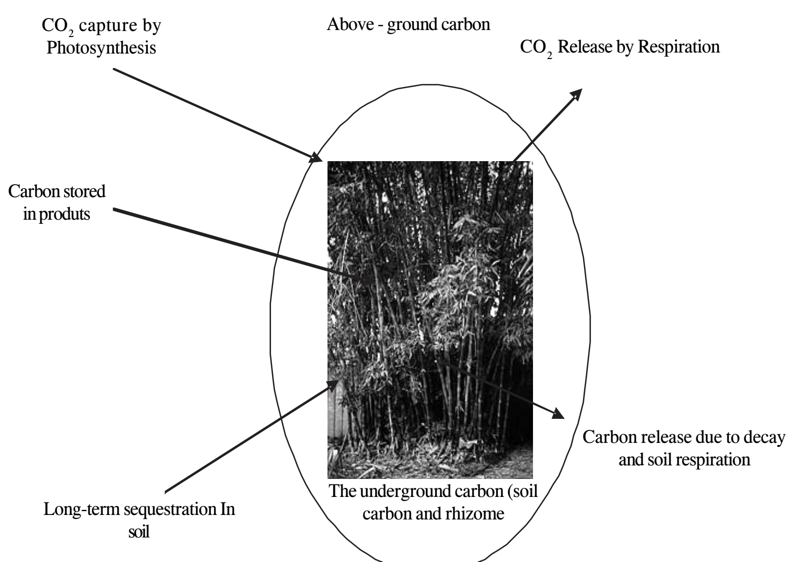

Figure 1: The Carbon Cycle and Bamboo

Table 1: Net photosynthesis and stomatal conductance in different species of bamboo

Bamboo species name	Pn(Net photosynthesis)	C(Stomatal conductance)
B. nutans	2.71	9.72
B. balcoa	3.47	25.9
B. striata	2.09	18.49
B. tulda	2.52	8.63
D. strictus	3.08	18.79

Table 2: Net photosynthesis and stomatal conductance in other fast growing species of bamboo.

Bamboo species name	Pn(Net photosynthesis)	C(Stomatal conductance)
Acacia nilotica	3.35	4.28
Melia azadirachta	3.18	3.75
Anthocephalus chinensis	2.78	3.18
Tectona grandis	3.15	5.13
Bombax ceiba	2.55	3.92

most carbon." INBAR'S modeling indicates that the carbon in nearly planted moso bamboo stands increases more rapidly per area unit than Chinese fir (*Cunninghamia lanceolata*) stands growing in similar conditions for about the first six or seven years, but also over longer periods such as two rotations of Chinese fir (60 years) (Biswas, 1995).Growth pattern and photosynthetic activity of different bamboo species can contribute a major role to carbon sequestration compared with the other considered species on the average 3.0±1.6 kg CO_2 per year mean value. The net photosynthetic rate and stomatal conductance of five bamboo species is observed and when compared to that of other fast growing species, it was found quite high in bamboos. In *Acacia nilotica* the mean net photosynthetic rate Pn observed was 3.35 and stomatal conductance was 4.28.In *Melia azadirachta* Pn was 3.18 and stomatal conductance as 3.75. In *Anthocephalus chinensis* in Pnwas measured as 2.78 and stomatal conductance as 3.18, *Bombax ceiba* showed Pn as 3.15 and stomatal conductance as 3.92. In *Tectona grandis* Pn is 3.15 and stomatal conductance is 5.13.In five of the bamboo species like *Bambusa balcoa* Pn observed was 3.47 and stomatal conductance was 25.9, in *Dendrocalamus strictus* Pn was 3.08 and stomatal conductance 18.79, in *Bambusa nutans* Pn=2.71 and Stomatal conductance was 9.72; In *Bambusa tulda* Pn =2.52 and stomatal conductance 8.63 and in *Bambusa striata* Pn=2.09 and stomatal conductance =18.49 (Table 1 and 2). From this data it was concluded that net photosynthesis and stomatal conductance was higher in bamboo species that those of fast growing woody species.

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