Impact of Forestry Products on Climate Change Mitigation in India

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Abstract

Climate change has emerged as a serious global environmental issue and poses a threat and challenge to human kind. Efficient utilization of forest products especially wood, which has carbon as its main element offers significant opportunities to reduce carbon in the air and thereby contribute to the climate change mitigation. Keeping this in view, IPIRTI has carried out a life cycle inventory on plywood and bamboo mat based composites so as to find whether the processing, development and usage of these products are carbon sink or neutral. The Carbon Emissions Audit identified that for the manufacture of Bamboo mat based composites per ton product a total of 1.308 tons of carbon dioxide emission equivalent is obtained compared to the emissions produced by steel being 3.8 tons and for Aluminium and plastic is 1.5 tons and 3.0 tons respectively. Studies have revealed that the processing of wood to panel products leads to a net carbon gain of 0.140 tons equivalent carbon dioxide per ton of plywood, while the measurement of carbon footprint of bamboo products from procurement of raw material to finished products indicates that there is a net gain of carbon in the process resulting in substantial storing of carbon.

Keywords: climate, carbon, emissions, plywood, bamboo

Introduction

Climate change is a global environmental problem that has been associated with increasing concentrations of greenhouse gases (GHGs). Our modern lifestyles, the products we choose, the emissions of carbon dioxide from industry, society, transport and from our homes, have increased the concentration of CO2 in the atmosphere. Forestry products definitely play a significant role in mitigating the adverse effects of climate change, by increasing the level of carbon removals from the atmosphere. Different corporate governance systems impact the ability of industries to adopt and transform their activities to meet issues associated with climate change. Until recently, relatively little has been done to measure the contribution made by forest based industries to mitigate the climate change.

The build-up of greenhouse gases (GHGs) in the atmosphere, much of it driven by human activity, is already affecting the global climate. Under current projections, concentrations of GHGs will continue to increase into the indefinite future, entailing a process of continued global warming.

Any basic component used in construction of house needs to be fabricated from raw material. Fabrication needs energy. The extent of energy consumed to produce unit quantity of a product is not same for all products. Energy in any form, either in the form of heat or electricity, comes from material of natural origin. Natural source may be coal, mineral oil, wood, solar energy, hydal energy, wind power etc. Whatever may be the basic source of energy, it is the heat and electrical energy which is predominantly used by the industry.

Both electricity and thermal power comes from burning of fossil fuel, coal or other lignocellulosic materials including wood. Burning of such fuels does not only release CO2 in the air but also release effluent which pollute environment. Thus a product made with high energy consumption is more harmful to environment than product needing less energy for production. In addition, manufacturers are also concerned with the cost of production which increases with the increase of higher consumption of energy

Studies(Kaul M et. al 2010) reveal that for short rotation species, the amount of carbon offset increases linearly with time since biomass is continuously harvested and replanted and used ..

Materials like plastic, metal and concrete all require a lot of energy for extraction of raw materials and manufacture. These materials all have negative carbon footprints. Wood has a positive footprint because of the carbon dioxide from air fixed by the original living tree. The emissions associated with harvesting, transporting and processing of wood products are small compared to the total amount of carbon stored in the wood. This means that even when energy used for harvesting, transport and processing are taken into account, wood still has a positive footprint.

Emphasis is being given to 'Green Product' made of renewable fibre coming out of nature. The green products are meant to replace conventional materials like cement, steel etc. in building construction, to replace metal and plastic in household products and so on. Wood is being used as replacement of metal and plastic and is undoubtedly carbon neutral, consumes lesser energy in conversion to users' products and least polluting.

Although bamboo has been in use for centuries in India and elsewhere in the world, such uses were limited to art crafts and among poor section of the society. Technical intervention has shown that bamboo can be suitably used to manufacture durable products similar to wood and wood products. Like wood product, bamboo products are low energy consuming and eco-friendly. A variety of products, which have been made, for example: Bamboo Mat Board (BMB), Bamboo Mat Veneer Composite (BMVC), Bamboo Mat Corrugated Sheets (BMCS), Laminates- all form components for house construction. Most of these products are now made commercially in India and are getting popular among the consumers.

Any production unit of building component releases Co_2 due to burning of various types of fuel. Bamboo products, on the other hand, store a net amount of carbon in end products. Thus growing and use of bamboo and products from bamboo, a net amount of Co_2 is being removed from air and stored in the bamboo products. IPIRTI has undertaken a study on the flow of carbon from raw material to finished product and indicate that how environment friendly will be practice of using Forestry products.

Literature Survey

The climate change benefits of wood products lie in the combination of long-term carbon storage with substitution for other materials with higher emissions. As wood can substitute for fossil fuel intensive products, the reduction in carbon emissions to the atmosphere is comparatively larger than even the benefit of the carbon stored in wood products. This effect—displacement of fossil fuel sources—could make wood products the most important carbon pool of all (Malmsheimer, *et. al.,* 2008).

The current political momentum behind reducing emissions from deforestation initiative in conjunction with the dynamic negotiations for a post- 2012 climate regime could link tropical forest conservation with carbon markets. Carbon markets alone cannot be expected to overcome all hurdles; it may require significant non-carbon-based support (Ebeling and Yasue, 2008).

An appropriately designed community- based forest management policy can provide the means to sustain and strengthen community livelihoods and at the same time avoid deforestation, restore forest cover and density, provide carbon mitigation, and create rural assets (Singh, 2008).

Carbon sequestration in wood products requires cooperation of multiple parties from the forest owner and product manufacturer to the product user, and perhaps others. Credit for sequestering carbon away from the atmosphere could go to the contributions of these multiple parties (Tonn and Marland, 2007). Wood products contribute 15-22 per cent of the total emissions to the atmosphere. Carbon sequestration potentials are much greater for shorter periods than over longer periods (Karjalainen and Kellomaki, 1995). Policy instruments that internalize the external costs of carbon emission should encourage a structural change towards the increased use of sustainably produced wood products (Sathre and Gustavsson, 2009).

Life Cycle Assessment and Carbon Foot Prints for Panel Products

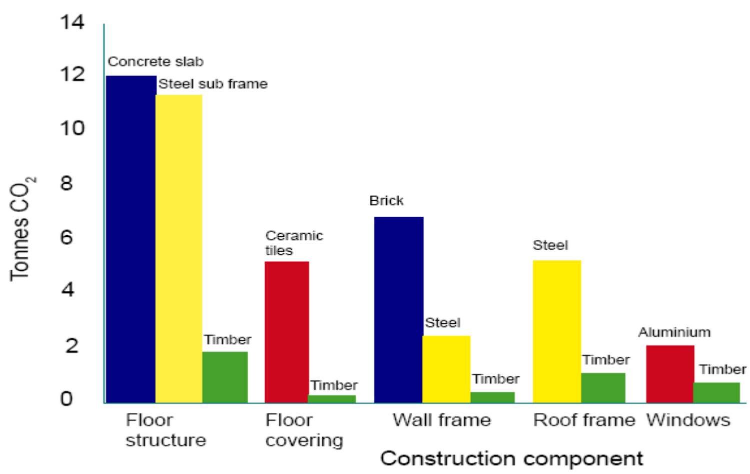
Life cycle assessment of every product being used is very essential tool . In India, the studies related to durability or service life of wood based panel products have been studied which would form a part of life cycle assessment. However, not many studies were made to study the energy, pollution and other issues involved from the manufacturing stage to the final usage of the panel products. IPIRTI has taken up a project to assess the life cycle of wood based panel products. It has been found that the pollution released from panel industries are very negligible compared to concrete, brick, ceramic tiles, aluminium and steel. The energy involved in the production is also less.

The use of wood based panel products as a building material creates a much lower carbon footprint than does the use of other common building materials. The research showed that more than 25 tonnes of greenhouse gases could be saved if timber products were used instead of the common alternatives. Greenhouse gas emissions from the manufacture of different building components in a family home are shown in **Fig.1.** The chemical analysis of wood products buried for 25yrs have revealed that only up to 3.5% of the Carbon in wood products was lost through decomposition (Gardner et al.2002). It is reported that timber can store up to 15 times the amount of carbon that is released during its manufacture.

The manufacture of timber building components uses considerably less energy than the manufacture of other major products such concrete, brick, ceramic tiles, aluminium and steel. It therefore follows that usage of timber and timber will leave a smaller carbon footprint.

Using trees for timber and other wood products in this way creates space in plantations and hardwood production forests for replacement trees to absorb more carbon from the atmosphere (this is called carbon sequestration).

Fig.1 Greenhouse Gas Emissions from the Manufacture of Different Building Components in a Family Home



(Source: CRC for Greenhouse Accounting)

Methodology

Life Cycle Analysis (LCA) is an important tool to find out energy requirement for different stages of production of a product from raw material procurement to final products, during useful life and also when the material is dumped into soil, reused or burnt after the useful life is over.

LCA has been taken up at IPIRTI for the study on Bamboo Mat Corrugated Sheet & Bamboo Mat Ridge Cap – Bamboo mat based products.

The LCA study has been limited to raw material procurement to final usable product (gate to gate study).

Two aspects have been taken during study i.e., energy required for production and conversion ratio from raw material to final products. This study results in magnitude of carbon storage in final products. Both electrical energy and heat energy as required for production were calculated separately. As production of heat requires burning of coal/ agro based/ wood, the emission of CO_2 during the process was also calculated.

Data were collected from manufacturing units of plywood and bamboo based industry:

1. For consumption of electrical energy, each machine was taken separately for study and total consumption in the total working hours in a day was added. Total electrical energy required for a day was multiplied by the total working day in a month to find out total electricity consumption by machinery in the factory. This data was then added with general electricity consumption for lighting to find out total electricity consumption in the factory. Finally the consumption thus calculated was compared with the monthly consumption of electricity shown by electric meter in different sectors of the factory.
2. Records of fuel consumed for generating heat energy in the boiler was collected from the factories to calculate (i) heat energy requirement (ii) emission of CO_2 due to burning of different types of fuel.
3. For calculation of conversion ratio of raw material to final products, the raw material input per day to the factory was found out. Conversion in each stage of production and losses occurred was calculated. Finally volume/weight of the final products was taken. In this way conversion ratio in a month for a particular product was found out. The data, thus generated, was compared with the monthly raw material input and final production from the record of the factory.

Bamboo Mat Corrugated Sheet (BMCS) and Bamboo Mat Ridge Cap (BMRC):

Raw material for manufacture of Bamboo Mat Corrugated Sheet (BMCS) and Bamboo Mat Ridge Cap (BMRC): Woven bamboo mat, synthetic resin as binder.

Process

Bamboo mats are dried to moisture content of 6-8% and dipped into adhesive solution. Adhesive coated mats are wet and needs to be dried to 10-12% moisture content. These are laid one above another and hot pressed under temperature and pressure. The data were collected and the net carbon dioxide released were calculated for the production of 1 ton of the product.

The Net CO_2 released during production of 1 Ton of different products and the energy required per tons of different roofing sheets is given in **Table I** and **II** respectively.

Table I: Net CO_2 Released During Production of 1 Ton of Different Products

Sl. No.	Name of the Products	CO_2 released (Tons)
1	Stainless steel	3.8
2	Cement	1.0
3	Aluminium	1.5
4	Plastic	3.0
5	**Bamboo Mat Corrugated Sheets**	1.308

Table II: Energy requirement for Roofing/ Corrugated sheets

Sl. No.	Name of the Products	Net energy required (MJ per tons)	Net energy required (Kw-hr per sq. m)
1	Aluminium	89,408	38.0
2	Galvanized iron	32,541.7	36.6
3	Asbestos	300	1.0
4	Fibre reinforced plastics (FRP)	77,190	-
5	**Bamboo Mat Corrugated Sheets**	**23382.4**	**26.61**

Source: Asbestos Cement Products Manufacturers Association (ACPMA) 2010 © ACPMA LTD.

For producing 1 m^3 of plywood 465.69 kgs of CO_2 is being produced in the process of burning various types of fuel. Included in this is 406.39 kgs of CO_2 generated due to burning of waste wood accumulated during production of plywood. Hence net CO_2 produced due to burning of fossil fuel (465.69 – 406.39) kgs = 59.3 kgs/m^3 of plywood or 16.17 kgs of carbon.

Net carbon gain = (281.195 – 16.17) kgs or 264.83 kgs of carbon per m^3 of plywood produced.

Results and Discussions

Wood based panel products like plywood, particle board, medium density fibre board, oriented strand board, hard board are examples of structural material widely used in housing and making of various utilities, household etc., studies have been undertaken by IPIRTI to evaluate the energy requirement to manufacture unit quantity of plywood and to find out the amount of carbon stored in the final products under manufacturing practices and use pattern in India.

Data generated from the study and given above clearly indicates that substantial amount of energy is been saved in the manufacture of panel from wood compared to conventional structural/material from raw materials excavated from soil and non-recyclable in nature. More important in making and use of wood panel product is the net storage of carbon in final product for period from 25 to 100 years.

The use of biodegradable bamboo as raw material for manufacture of durable roofing sheet is unique by itself. The present study has conclusively shown that it is low energy consuming compared to conventional roofing sheet like GI, plastic, aluminium etc. Although the energy consumption in the manufacture of BMCS is higher than ACC sheet, BMCS is eco-friendly while ACC sheet is unhygienic in nature. Moreover, using bamboo in making roofing sheet, a substantial amount of CO_2 is removed from air and stored in BMCS as lignocellulose material. Polluting effect of environment due to effluent or emission during manufacture of BMCS is very low.

The Net Carbon dioxide released during the production of BMCS & BMRC **(Table I)** per ton is found to be 1.308 tons and that of steel being 3.8 tons and for Aluminium and plastic is 1.5 tons and 3.0 tons respectively. The carbon dioxide released during the production of BMCS & BMRC is less by 14% - 190% when compared to the other existing roofing materials.

The energy audits determined that the combined total energy consumption was 22784 MJ for the manufacture of one ton of BMCS (**Table II**), while for Aluminium, Galvanized iron and fibre reinforced plastic corrugated sheets energy consumption is 32,541.7MJ 89,408 MJ and 77,190MJ respectively which are very high compared to BMCS & BMRC while for Asbestos roofing sheet the energy consumption is 430 MJ which is very less compared to all the existing roofing materials. However during the processing of Asbestos roofing sheet the health hazards (carcinogenic) is higher and is being banned in most of the countries.

Plywood and bamboo products are very useful carbon storage as the amount of carbon stored in these products is several times bigger than used during manufacturing.

Conclusions

The manufacture of BMCS is thus has an edge over the other competitive roofing material with respect to energy efficiency, green house effect, storage of carbon and affect on environment. In the early days of development of plywood and panel industries, environmental issues represented a very small component of any decision to build and operate a wood composite plant. However, in today's highly sensitive environmental climate, these issues have come to represent a significant initial and operating investment.

The most suitable option for a developing country like India lies in the use of non forest lands for fast growing short rotation plantations. Short rotations plantations with higher growth rates result in greater net carbon benefit at the end of 100 year as compared to long rotation forests used for permanent carbon storage. An understanding of promising new environmental friendly technologies and their application will go a long way in sustainable development of these industries.

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