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Carbon Mitigation in Indian Aviation by Blending Jet Fuel with Biofuels.

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Abstract:- The Indian Aviation Sector has been predicted to become the world's third largest carrier by 2020. It is expected to carry 460 million passengers per annum shortly. A sector of such magnitude need to be environment friendly. The International Air Transport Association has declared to cut its carbon emissions to 50% by 2050. The National Biofuels Policy has also targeted to blend 20% biofuels to its fossil fuel consumption. This paper aims in forecasting the jet fuel demand for the Indian Aviation sector and the subsequent carbon mitigation achieved by blending with biofuels. The utilization of the wastelands for the biofuel production in various states of India has also been forecasted.

Keywords: - Aviation Turbine Fuel, Biofuels, Blend, Carbon Mitigation, India, Wastelands

I. INTRODUCTION

The pertinent challenge of the 21st century is the impact of development initiatives without harmful effects on the environment. Global warming and climatic changes are now being addressed in every sector and steps are being taken to reduce the greenhouse gasemissions [1].

Indian Aviation Sector is said to be in turbulence now. But with the FDI opening India to the global market, the prospectus of the industry seems very promising [2]. The growth predicted has been very encouraging for this resurging sector. We must not forget to notice that, this increase in growth corresponds to increase in fuel consumption. Globally, Aviation sector corresponds to only 3% of the total carbon emissions [3]. This might be a small percentage, but it cannot be ignored. With India among the big players of the Aviation sector, this carbon footprint issue must be taken into consideration with utmost care.

The IATA has proposed many strategies for increasing the flight efficiency in all possible ways. Out of the many action plans analysed, flexible airspace, improvements in the engine design, enhancing airport infrastructure and blending sustainable biofuels are expected to reduce the carbon footprint in a much promising way.Biofuels is the next generation fuel. With researches and trials, running successfully, it is now time to put into implementation. Many air carriers have tried out biofuels for their journey and the results are satisfactory. Few international carriers have signed deal with various biofuel companies for the supply of biofuel.

Thus, the biofuel feasibility for blending with aviation biofuels have been confirmed and India has to make a move towards it. Our civil aviation sector needs to draft a policy that aims at an orderly sustainable development. It must also prepare a roadmap to implement methods to cap the carbon emissions.

II. FOOD SECURITY ISSUES

Biofuel comprises of both bioethanol and biodiesel. The production if biodiesel is now very meagre and no significant impact is made on the biofuel sector. This makes the Bio-Ethanol has been the biggest contributor in the biofuel category. Being an edible crop, the prospectus of this crop cultivation over large areas raises food security issues. Furthermore, the production of molasses is highly unpredictable [4]. Due to the uncertainty in the yield, there is always a gap between the supply and the demand.This effect induces problems during the fixation of prices every year. The Government has pre-negotiated prices and this often comes into debate depending upon the production. Lower production would eventually lead to higher prices, and vice versa. Additionally, since these are also used as feed for cattle and paper mills, their demand is also a much big factor when it comes to determining the prices every year. But, this temporary price change is not favourable and often leads to great crisis.

III. JATROPHA CURCAS AND PONGAMIA PINNATA

Jatropha Curcas and Pongamia Pinnata are the two sources of biodiesel which can be widely cultivated across India, after analysing their characteristics [5]. Both can be cultivated in wastelands which are a boon for the rural areas and the employment of the community.Furthermore, both are an inedible seed which makes them a non-threat to the food security issues. These added advantages would make these plants significant enough to cultivate them over the large areas of wasteland present in India.

Parameters	Jatropha Curcas	Pongamia Pinnata
Ideal Temperature	10-50 degree Celsius	0 to 50 degree Celsius
Annual Rainfall	25-100 cm	5 to 25 cm
Soil Types	Saline & Sandy	Saline, Sandy & Rocky
Oil Content	35-45%	30 to 40%
Seed Yield/Hectare	2 to 12 tons per year	3 to 10 tons per year
Oil Cakes	Bio-Fertilizer	Bio-Fertilizer
Biogas Generation	Possible	Possible

Table: I. Comparison of characteristics of Jatropha Curcas and Pongamia Pinnata

Additional features that add benefits are their hardy nature, longer productive life and drought resistant. They are not browsed by animals, but this does not affect the animal vegetation process, since only wastelands are used for cultivation.

IV. WASTELANDS FOR CULTIVATION

India has around 68 Mha of wastelands under different categories. Out of this, nearly 41 Mha can be used for Jatropha cultivation. This vast area is spread across the country [7]. Biofuels derived from these wastelands, would help reduce the food versus fuel threat and also would lead to increased afforestation cover.

The distributions of these 41.35 Mha of wastelands are varied. Such large scale utilization is an enormous task to enforce. Moreover, this cannot be tried in the first attempt. Considering the economies of individual states, the cultivation must be done in selected states, following the success of which it can be extended to others.

The Ministry of Rural Development have planned to tie up this biofuel cultivation with rural development schemes. These additional measures taken would lead to meeting the biofuel demand for aviation and would also enable the production price of biodiesel to come down.

States like Madhya Pradesh, Rajasthan, Andhra Pradesh and Maharashtra have the highest percentage of wastelands among the states in India. They account for nearly 28.5 Mha out of the 41 Mha suitable for Jatropha cultivation. But, being economically forward states, there is always a growth in infrastructure in the wastelands of these states. This leads to reduction of wastelands in these states, thus planning of Jatropha cultivation becomes very hectic process.

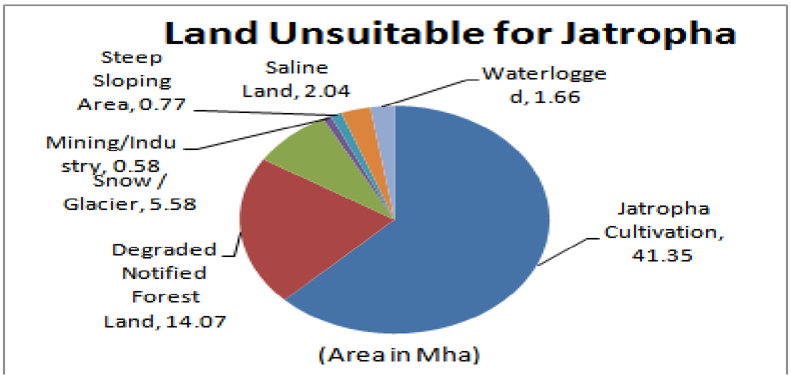

Figure:4.1.Land unsuitable for Jatropa

V. STATES FOR CULTIVATION

Analysis of states having wastelands of less than 1 Mha was done. These states had less total geographical area. The Jatropha cultivation over these places was feasible and would lead to the rural development and upliftment of the communities.

The North-Eastern states were forerunners for this cultivation, as per analysis. These economically backward states could be used for biofuel production, thus enhancing their economic status, meeting their energy needs and in creating employment opportunities. The by-products that these plants yield after extraction of oil are rich in nutrients which can act as an excellent bio-fertilizer. Additionally, the bio-gas production can be done from these oil cakes which can acts as a source of fuel for various purposes.

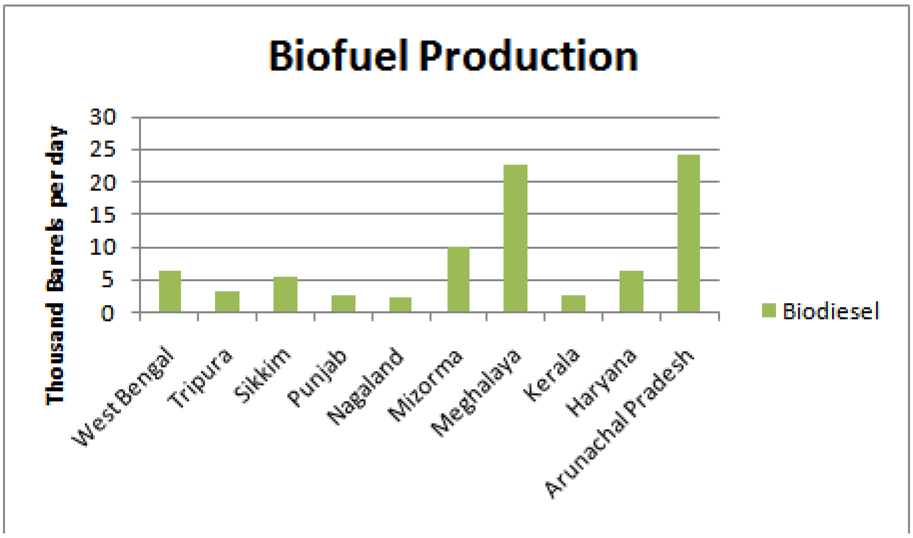

Figure:5.1. Biofuel Production

VI. FORECASTING JET FUEL DEMAND

The demand for the jet fuel in the near future was calculated using he causal method. This is the well-known method available for forecasting and the most widely used. This method can be used when historical data are available and the relationship between factors to be forecasted and external factors are available.

The linear regression method was chosen over the causal regression because of the complexity. The linear regression method involved a dependant variable related to an independent variable by a linear equation.

$$Y = a + bX \quad \textbf{(6.1)}$$

where Y = dependant variable (jet fuel demand)

X= independent variable (time period)

a = Y-intercept of the line

b= slope of the line

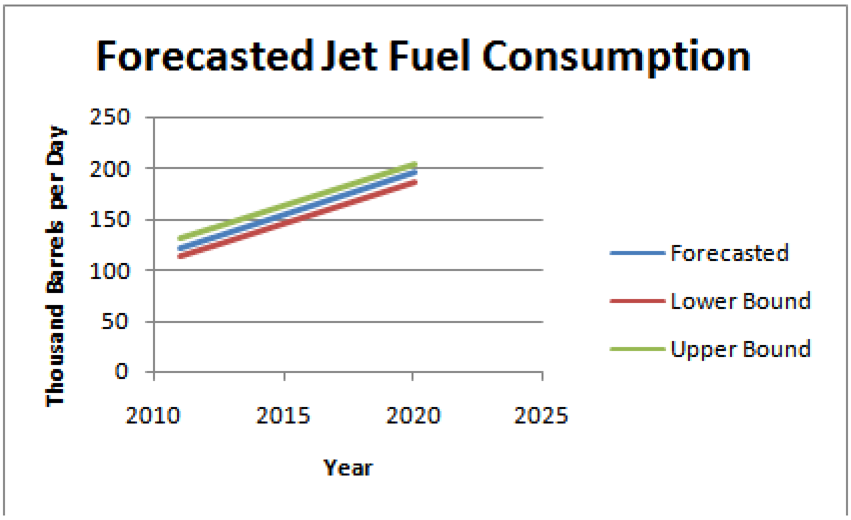

Figure: 6.1. Forecasted Jet fuel consumption

A certainty factor of 80% was considered, based on the future trends that is unlikely. The upper bound plot shows the 100% certainty factor and the lower bound the 60%. As 100% and 60% can never happen according to the forecasting method principle, the values of 80% were finalized for forecasting.

VII. CARBON MITIGATION

The primary aim of blending biofuels is to reduce the carbon emissions. The consumption of the jet fuels in the future has already been predicted by the linear transgression method. By 2020, it is estimated that 200 thousand barrels of jet fuel would be needed for the India Aviation Industry. This demand can be met by the North-Eastern states taken for estimation namely Meghalaya, Tripura, Mizoram and Nagaland. This calculation was made considering the upliftment of these economically backward states.

Taking those demand values, the quantity of fuel needed to achieve the blend was formulated. The carbon emissions occurred for every blend of fuel over the years was calculated, taking into fact that an average of 3.15 kg of carbon-di-oxide is emitted for one kg of jet fuel being burnt. The tabular column below shows the carbon mitigation that could be achieved in the future due to the blending with biofuels.

Year	No Blend	5% blend	10% blend	15% blend	20% blend
2010	16433668.65	15611985.2	14790301.78	13968618.35	13146935
2011	18165898.23	17257603.3	16349308.41	15441013.5	14532719
2012	19374779.42	18406040.4	17437301.47	16468562.5	15499824
2013	20583660.6	19554477.6	18525294.54	17496111.51	16466928
2014	21792541.78	20702914.7	19613287.6	18523660.51	17434033
2015	23001422.96	21851351.8	20701280.67	19551209.52	18401138
2016	24210304.15	22999788.9	21789273.73	20578758.52	19368243
2017	25419185.33	24148226.1	22877266.8	21606307.53	20335348
2018	26628066.51	25296663.2	23965259.86	22633856.53	21302453
2019	27836947.69	26445100.3	25053252.92	23661405.54	22269558

Table: II.Years with Carbon blending (Tonnes per year)

VII. CONCLUSION

The analysis done has forecasted that few states in India are sufficient enough to meet the forecasted demand for the blend of biofuels needed for the aviation industry. The projections are possible considering the fact that these large areas are used for cultivation by 2013.Further delay in starting this massive cultivation would lead to increase in demand for biofuel, thus bringing more land under cultivation than estimated, which is not feasible considering the fact that wastelands are decreasing with respect to time.It has also been forecasted that utilizing all the wastelands in India for Jatropha cultivation could easily meet the demands of National Biofuel Policy in years to come.

Since, the current forecast has satisfactory results of carbon mitigation, future analysis has been planned involves testing of biofuel blends with different aviation turbines and subsequent recording of carbon emissions. This study would aim at determining which blend would be suitable to experience better flying efficiency and also to cut carbon emissions to the maximum.

The Jatropha species available in India are 18. Identifying the oil characteristics of each species for blending with aviation biofuels would lead to another new research.

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