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Research Paper

Synthetic Paraffinic Kerosene (SPK) from *Jatropha Curcas*: Overall Impact on Environment

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Abstract *- Aviation provides the only rapid worldwide transport network, is indispensible for tourism and facilitates world trade. Annually air transport moves over 2.2 billion passengers worldwide and aviation industry generates 32 million jobs globally. So, aviation industry has its own impact on various strata of life. It contributes to almost 2% of manmade CO_2 emissions and this is expected to increase for 5% by 2050. Fuel is one of the biggest operating costs for aviation industry. The changing price of crude oil also makes it difficult to plan and budget for operating expenses long- term. So, Aviation industry is now focusing on an alternative source to reduce its dependence on fossil based fuels. Many researchers recommend Bio-fuel s may act as a partial or complete substitute for fossil fuels and also reduce CO_2 emissions. Second generation Bio-fuel feed stocks (e.g., Jatropha curcas, Camelina etc) may be able to meet the technical requirements of aviation fuel. But there are serious debates about the environmental impacts of these Bio-fuel s. This paper analyses an important Bio-fuel crop used in Aviation industry, Jatropha Curcas Linn for its eco-sustainability.*

Key words: Aviation Bio-fuels, *Jatropha curcas*, *Camelina,* Second generation Bio-fuel s, Jet A-1.

Introduction

Aviation is one of the most wide transportation networks which facilitate world trade. Air transport improves the quality of life in number of ways. It is one of the biggest employers in global employment sector and generates a total of 32 million jobs annually. Its global impact is about 7.5% of world's gross Domestic Product (GDP), which is estimated that USD 3560 billion. Aviation is one of the major contributor of climatic change which represents 2% of manmade Carbon dioxide(CO_2) emissions, which is expected to reach above 3% by 2050[1]. Up till now aviation industry has been parasitic on fossil based oils. But the world's supply of oil has been difficulty in keeping up with demand and also has a larger impact on global CO_2 increase. Emission from aircraft like CO_2, regulated pollutants like Carbon monoxide (CO), Oxides of Nitrogen (NO_x), and Sulphur (SO_x), Hydro carbons, pose serious affects both on local air quality and global climate change [2]. Even though air craft entering today's fleet are 70% more fuel efficient than that of 40 years ago, the fuel challenges faced by today's aviation industry is not a smaller one. So, the Industry is searching for an alternate fuel so that they can reduce their dependence on petroleum derived fuels.

Aviation Bio-fuels

Many alternatives like Unconventional oil (Shale Oil, Oil sands), Jet fuel from Coal, Cellulosic Biomass, Microalgae, *Jatropha*, *Camelina* are gaining importance in recent days [3]. They are believed to reduce the overall CO_2 emissions. Substituting Aviation fuel is not a simple issue, because a fuel in aircraft handles many functions like hydraulic fluid in engine control systems and coolant for certain fuel system components in addition with acting as a fuel. So, thermal stability is an essential characteristic of the fuel [4]. Bio-derived jet fuel has become key element of the aviation industry to address the environmental challenges and fossil fuel dependency. Significant research has been made in verifying Synthetic Paraffinic Kerosene (SPK), made from biomass, as an alternative for fossil derived fuels. A two-hour test flight using a 50-50 mixture of the new bio-fuel with Jet A- 1 in the number one Rolls Royce RB-211 engine of 747-400 ZK-NBS, was successfully completed on 30 December 2008 [5]. The engine was then removed to be scrutinized and studied to identify any differences between the *Jatropha* blend and regular Jet A-1. No effects to performances were found. Since, the feedstocks for these bio- fuels are plant biomass, the sustainability of these bio- fuels depend on their environmental impact. So, this paper analyses Social, environmental and economical effects of these bio-fuel feed stocks. See Figure 1.

Jatropha Curcas Linn

Jatropha Curcas L is a perennial, drought resistant shrub cultivated worldwide. It has been used for soap production and traditional medicine. It is best grown in tropics adapted to temp 200-280^0 C. They have capacity to grow even in poor, low nutrient soils [6].It grows faster under good conditions and produce fruit within 2- 3 years. It can grow up to 5m in height and can live up to 50 years [7]. Figure 2 shows a typical *Jatropha* plant. See Figure 2

The fruits of *Jatropha* are found to be toxic and inedible to man and even to animals [6, 8, 9] and seeds of fruit contain about 30-35% of oil and this percentage differs according to climate. Oil content can be extracted with a mechanical press or Chemical extraction as shown in Figure 3.

Methodology

Sustainability of Bio- fuels is of major concern today. In order to assess its sustainability, following dimensions are relevant [9].

(i) Ecological Dimension

(ii) Social Dimension

(iii) Economic Dimension

(iv) Political and Institutional Dimension

(v) Time Dimension

This paper analyses whether SPK from *Jatropha Curcas* as a viable alternative for conventional aviation fuel such as Jet A-1. Bio mass for SPK from *Jatropha Curcas* has been assessed based on data available in literatures based on above mentioned dimensions. For the Bio-fuel to be sustainable, it must have a positive effect on at least several of these dimensions without having negative impacts on the other [7, 9]. Here, we have considered Bio mass production in national, plantation scale and their effects on environment is analyzed.

Results and Discussion

There is a widespread interest in bio-fuel crops as a solution for world’s energy demands and also reduces harmful effects of Green House Gas emissions to environment. Despite of wide spread debate about the potential viability of Bio mass feedstock, it continues to be planted on large scale. So, there is a need of overall analysis of potential sustainability of these feed stocks. Experts suggest that increased bio-fuel production has a major role in food price hike by shifting land away from food production. Nevertheless bio-fuel s have presented as a potentially significant contributor to the strategies for reducing net greenhouse gas emissions from aviation sector. Overall impact of bio-fuel development on climate is more complex still.

Ecological Impacts

Jatropha Curcas L. is a perennial drought resistant shrub usually grown tropical and sub tropical climatic conditions. Semi arid climates of India are suitable for *Jatropha* [7]. cultivation. Heavy variability of growth and performance has been observed in *Jatropha* fields. Worldwide aviation industry consumes about 1.5-1.7 billion barrels of Jet A-1 annually. So, in order to meet at least 1% of the above demand, large amounts of *Jatropha* feed stocks have to be produced[1]. Growing *Jatropha* according to modern intensive practices would result to monoculture [11, 12]. There are many problems associated with monoculture, Increased risk of soil erosion and mechanical degradation, increased risk of nutrition depletion, problems associated with irrigation, problems associated with pests etc [8] . Since, research for pest control in *Jatropha* is in its infancy, it will be very difficult to maintain growth in monoculture. If planted correctly, especially in hedges in marginal lands, it is supposed to increase the fertility of the soil by shading of leaves, decrease soil erosion and increase infiltration of rain water [13]. However there is a large need of further research regarding the environmental impacts of cultivation of *Jatropha* in monoculture and as a mixed crop [11, 13, 14, 15, 16]. Recent works have shown that growing *Jatropha* in monoculture is more susceptible to pests and thus use of large amount pesticides may cause severe eutrophication and other environmental issues [13, 17]. Current plans for cultivation of *Jatropha* are in marginal lands [18]. But, several studies have shown that the yield of fruits in marginal lands is small [13]. So, there is a fear that farmers switch over to cultivable lands for the production of *Jatropha*. With regard to land use patterns, if prime land is used for production and food crops are displaced to more marginal soils, food security may be endangered. If ecology or soil quality is improved by *Jatropha* cultivation, this may positively influence food security in the long run. On the other hand, if soils are further degraded, food security will be decreased in the long run. Considering experiences with large-scale plantations of oil palm and sugar cane, monoculture and intensified production may be a risk factor.

Socio-economic Impacts

One of the major benefits of cultivating *Jatropha* for bio-fuel production is the creation of employment opportunities for the rural poor since no expertise is needed for the cultivation of these crops [19]. Economic fruit yield from *Jatropha* takes 3-4 years and hence interest among farmers for *Jatropha* cultivation is currently low because of low profit margin and larger idle time [20]. India one of the largest *Jatropha* cultivators for oil production but a little amount research has been done in commercial viability of *Jatropha* based SPK in aviation industry. In densely populated country like India, so called "Wastelands", is often used by poor livestock keepers and other landless people and occupation of this land causes severe economic crisis on the rural people [16]. Further large scale cultivation of *Jatropha* in developing country like India will largely depend on government policies. Factors that influence economic viability of cultivation of *Jatropha* in large scale depend on many factors like labor availability, availability of land etc. For establishment of *Jatropha* as a large scale oil crop, a bottom up organization of production may even be critical, as successful *Jatropha* production needs long term time commitment current experiences with *Jatropha* seem to indicate that profit margin is still low for large scale production of *Jatropha* is viable[7]. There is a possibility of negative impact on rural society when cultivation takes in large scale by big companies and land owners. Poor farmers will be seriously affected by this.

Conclusion

From the above mentioned facts cultivation of *Jatropha* in large scale so as to produce SPK from it has a large number of hurdles right now. The existing economic and environmental situation pose a large hindrance for cultivation non edible *Jatropha*, nevertheless good Bio-fuel policies may affect the large scale production in a positive way. Government policies should support small land holders and rural farmers for the cultivation of *Jatropha*, otherwise it will create a large socio-economic gap between various classes of society. So we conclude that cultivation of *Jatropha* as a feedstock for aviation graded Bio-fuel seems largely an undiscovered option and further research and analysis is needed for sustainable cultivation of it.

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Fig.1: Figure showing *Jatropha* oil
[Courtesy: Bio- fuel Park, Centre for Agricultural Research, Madenur, Hassan, Karnataka, INDIA]

Fig.2: Figure showing *Jatropha* Plant
[Courtesy: Bio-fuel Park, Centre for Agricultural Research, Madenur, Hassan, Karnataka, INDIA]

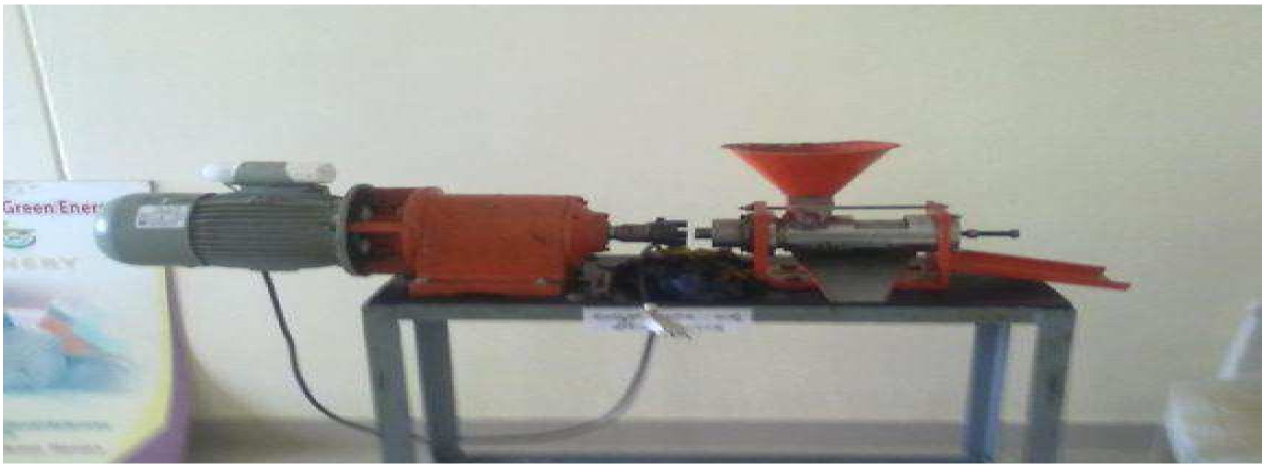

Fig.3: Figure showing Mechanical Extractor of *Jatropha* Oil
[Courtesy: Bio-fuel Park, Centre for Agricultural Research, Madenur, Hassan, Karnataka, INDIA]