CHAPTER 1

PREAMBLE

1.1 INTRODUCTION

One of the biggest concerns today is the rapid annihilation of the biotic environment which is the abode of flora and fauna due to industrialization. Excessive use of fossil fuels has led to global environmental degradation and health hazards. The increasing concern of environmental protection and more stringent regulation on exhaust emissions, reduction in engine emissions becomes a major task in engine development. In addition to this, efforts need to be taken to reduce dependence on the petroleum fuels as it is obtained from limited reserves. These concerns led to research on alternative renewable fuels. Biofuels offer an attractive alternative to fossil fuels, but a consistent scientific framework is needed to ensure policies that maximize the positive and minimize the negative aspects of biofuels. Numerous countries are moving towards the partial and gradual replacement of fossil fuels with biofuels, mainly ethanol and biodiesel. The increased move towards biofuels is spurred by global political, economical and environmental events, especially rising crude oil prices.

1.2 ENERGY CRISIS

With over seven billion people and millions of cars in the world today, the global energy requirement is skyrocketing. From the increased pressure from international initiatives such as the Kyoto Agreement to reduce carbon emissions and the lobbying activities of environmental pressure
groups, it is clear that governments have a tough challenge on their hands. Over the past 30 years, governments in the world have been focusing on the utilization of renewable energy sources. The use of crops or waste as an efficient, cost-effective, locally-available and sustainable source of energy has increased, bringing opportunities for farmers and governments alike, while also benefiting the environment. In this context, research has been focused on bio-fuels as alternative fuels for internal combustion engines.

1.3 INTERNATIONAL SCENARIO

The world is currently facing the worst energy crisis. Worldwide many countries are still dependent on petroleum fuel as their main source of electricity and transportation fuel. But the fact is that the fossil based oil, coal and gas reserves will be exhausted in another 10 decades. Vegetable oil feedstock, worldwide is estimated to be 100 million tonnes (Hanna et al, 2005). From the year 2002 to 2007, the biodiesel production has raised from 1065 million tonnes to 10289 million tonnes in the European Union (EU) following the European Commission initiative on the promotion of the use of biodiesel for transport (Galbe et al, 2005).

Depending upon the availability and production capabilities, biodiesel is derived from a large variety of oilseed. In UK, most of the biodiesel is being produced from waste vegetable oil. In 2004, the UK produced 9000 tons of biodiesel and the European Union countries as a whole produced 1,504,000 tons of biodiesel (Hammond et al, 2008). In the EU, biodiesel is produced from rapeseed oil, sunflower oil and cottonseed oil. Germany is the leading producer and consumer of biodiesel in the EU. In the year 2005, the biodiesel production from waste vegetable oil has been estimated to be 1.9 billion liters or more than half the world. Other countries with significant biodiesel production included France, Italy, Brazil and USA. In Germany, biodiesel is also sold at a lower price than fossil diesel fuel.
(Yusuf et al 2011). Following European Directive on the promotion of the use of biofuels or other renewable fuels for transport, the Greek Government recently conducted a study on biofuels in Greece (Calliope Panoutsou et al 2008). Sunflower, soybean, cotton, tobacco, tomato and rapeseed are the main oil seeds in Greece.

To promote biodiesel consumption, on January 1st 2003 the Spanish parliament exempted biodiesel from fuel excise tax (Dorado et al 2006). Biodiesel in Lithuania is produced from rapeseed (Vladislovas et al 2007). In USA, Soya based biodiesel is being produced. In USA, Energy Policy Act 1992 recognizes biodiesel as alternative fuel for vehicles (Niraj Kumar et al 2013). A blend of 20% biodiesel with 80% diesel (B20) is considered to be the most suitable for transportation sector. Palm oil in Malaysia has been found to be suitable for biodiesel production. In Japan, as of March 2008, the total amount of biodiesel production has been estimated at 10,000 kiloliter. Japan has started around twenty biodiesel fuel projects since 2007. Rapeseed, Castor and Pongamia pinnata have been found to be suitable for biodiesel production (Niraj Kumar et al 2013). France is the world’s largest producer of biodiesel; its conventional diesel contains 2 to 5 per cent biodiesel.

1.4 INDIAN SCENARIO

India is both major energy producer and consumer. India ranked as the world’s seventh largest energy producer accounting about 2.49% of the world’s total annual energy production. At the same time, it was the world’s fifth largest energy consumer in the world accounting about 3.45% of world’s energy consumption as per 2004. By the year 2009, India became the fourth largest energy consumer in the world.

The share of commercial energy in total primary energy consumption rose from 59.9% in 1980-81 to 72.6% in 2006-07. It’s noted that
India’s per capita consumption is one of the lowest in the world. According to 2010 Key World Energy Statistics: IEA, India’s per capita consumption was 540 kgoe in 2008 compared to 1803 kgoe by the world, 4560 kgoe (kilogram of oil equivalent) by OECD (Organisation for Economic Cooperation and Development) countries, 1600 kgoe by China.

India’s oil consumption is considerably raising but the production is still flatter. India is one of the top ten oil consuming countries in the world. The country’s annual production of the crude oil is about 32 million tones but its requirement is about 110 million tons (Niraj Kumar et al 2013) i.e. the country is dependent on the import of the oils. During 2004-2005, the country imported 95.86 million tons of crude oil valued at 26 billion U.S dollar. The Indian economy is expected to grow at the rate of more than 6% per annum which will raise the energy demand to 166 million tons by 2019 and 622 million tons by 2047 (Gaurav Dwivedi et al 2011). Transportation sector is the primary energy consumer in India, with diesel and petrol contributing to 98% of the energy consumed in that sector (Niraj Kumar et al 2013). However, the production and utilization of biodiesel in the developing country like India will reduce the dependency of imported oil (Niraj Kumar et al 2013).

India is a net importer of edible vegetable oils and it may not be possible to set aside farmland for bio-crops due to the pressure of producing food grains. However, a very vast land area in India is classified as below marginal/waste land. It is estimated that currently about 145 million-hectares has been designated as wasteland and presently these are not under regular farming. Considering this, the cultivation of bio-crops could be taken up to serve two major objectives.
Firstly, with proper selection of low nutrition demanding oil bearing species, the waste land can be brought under compact plantation.

Secondly, rejuvenation of the wasteland can also be achieved by upgrading the soil quality by addition of seed meal, which is obtained after extraction oil that has a high nutrition value.

India has a tropical advantage and several species capable of giving oil-bearing seeds are known to grow. The production of main non edible oils like Neem (*Azadirachta indica*), Karanja (*Pongamia pinnata*), Sal (*Shorea robusta*), Kusum (*Schleichera oleosa*) and Ratanjyot (*Jatropha curcas*) are about 100,000, 55,000, 180,000, 25,000 and 15,000 tons per annum respectively (Niraj Kumar et al 2013). Different organization in India like Indian Oil Corporation and Indian Railway are vigorously trying and are working together to develop biodiesel for captive use. The Railways have shown an interest in planting these bio-crops along the rail tracks. It is estimated that the Railways can produce enough biodiesel to replace about 5 to 10% of diesel required for their use. Though, Indian biodiesel program is still in nascent phase, it has enormous potential. At this stage it is beneficial for India to restructure its research and development program in order to deal with the different related issues such as

- Utilization of different oils and oil blends.
- Genetically improved tree species.
- Technology practices for adoption at grass root level.
- Research on inter-cropping.
- Processing techniques including bio-diesel and uses of by-products.
- Blending, storage and transport of biodiesel.
- Engine development and modification.

1.5 ECONOMIC ANALYSIS

One of the limiting factors for widespread application of biodiesel is the cost of biodiesel. Currently, the cost of biodiesel is competitive only when excise tax is not applied as the production cost is higher than diesel fuel. The cost of the biodiesel consists of raw material (processing technique), labour, methanol, catalyst, transportation (raw material and final products) and local and national taxes. Among these, the cost of the raw material contributes the most, which accounts to about 60-80% of the total cost of biodiesel production (Yusuf et al 2011). The cost of the biodiesel is also affected by the base stock, geographic area, season of the year and other factors. In the US, the biodiesel cost varies from US $ 0.396/l - US $ 0.528/l before tax. The rough projection of the cost of biodiesel from vegetable oil is about US$0.54- US $ 0.62/l (Niraj Kumar et al 2013). At the same time, diesel price is US $0.18/l before tax in the US and US $ 0.20–0.24/l before tax in some European countries (Niraj Kumar et al 2013).

It is estimated that the price of biodiesel produced from palm oil in the Malaysia is about US $ 784–804/tonne. The production cost of biodiesel obtained from rapeseed in the EU is US$1035/tonne and from soybean oil in the US is US$840/tonne as of March 2007. These figures are based on the average prices of each vegetable oil, including an approximately 20% cost of production, international freight and domestic distribution charges. The consumer biodiesel price in Germany, based on a three-month average retail price from November 2006 to January 2007, was US$1332/ton (Yusuf et al 2011).
Biodiesel is commercially available in most oilseed-producing countries. As the production costs of biodiesel is much higher than for petroleum diesel, biodiesel is not competitive to petroleum diesel under current economic conditions and more research and technological development will be needed to make biodiesel more competitive in terms of cost. In addition, for biofuels to become commercially successful on a large scale will require favorable economics for the supply chain of biodiesel industry, namely, Feedstock production, Feedstock logistics, Biodiesel production, Biodiesel distribution (Niraj Kumar et al 2013).

Based on this chapter, it is found that producing biodiesel from tree-borne oil seeds (Non-edible oil) is a bright scope for the nation to eradicate the problems of energy crisis, environmental pollution, utilization of waste land and generate job opportunities. With this intention, the research work focus on CI engine fuelled with biodiesel produced from *Azadirachta indica* seed oil.