# Biofuels for energy security

Ever since Rudolf Diesel (inventor of the diesel engine) successfully operated a mechanical engine with peanut oil in 1893, it was predicted that vegetable oil will replace fossil fuels. However, availability of cheap and surplus fossil fuels had hindered research on vegetable oils (biofuels), and fossil fuels have continued to be the single most important source of energy. In India, diesel alone meets an estimated 73% of transportation fuel demand. However, domestic production caters to only 22% of the demand, the rest is imported and the amount of imports is increasing with every passing year, from 189.4 million tonnes (mt) in 2014–15 to 202.1 mt of crude oil in 2015–16. Continued dependence on fossil fuels, in addition to a huge strain on the government exchequer, has led to environmental pollution, and global warming, besides several health problems.

Against this background, promotion of biofuels presents a win-win situation, because on the one hand, they are derived from organic raw materials and are renewable in nature, while on the other, they can provide additional income to poor rural households. Technology for conventional biofuels (i.e. first-generation biofuels such as sugar and starch-based ethanol, oil crop-based biodiesel, biogas through anaerobic digestion) is well-established and widely used. However, technologies for second and/or third generation biofuels (based on lignocellulosic biomass as feedstock) are still in the research and development or demonstration stage.

India began its biofuels promotion programme with a 5% ethanol blending pilot programme in 2001. The National Policy on Biofuels, 2009, opting for non-edible feedstock only, proposed a non-mandatory blending target of 20% for both biodiesel and ethanol by 2017.

Among the 400 non-edible oilseed crops found in India, *Jatropha* was selected for the programme, because of its high oil content (40% by weight) and low gestation period compared to other crops, thus avoiding a possible conflict of fuel versus food security. At 20% blending, our current demand for biodiesel/ethanol is estimated at about 23,000 million litres and it would require about 19.5 million hectare *Jatropha* plantations to produce the same. The demand for biodiesel is estimated to escalate to 31,150 million litres by 2020. However, the present total commercial production and marketing of *Jatropha*-based biodiesel in India is small, with estimates varying from 140 to 300 million litres per year and mostly consumed in the unorganized sector (irrigation pumps, mobile towers, kilns, agricultural usage, diesel generators, etc.). Thus, there is a need for developing a strong biofuel industry to tackle the challenges of energy security and fuel self-sufficiency.

At this juncture, the Karnataka model may be considered for boosting biodiesel production. Karnataka, deviating from sole dependence on *Jatropha* as in majority of the Indian states, has adopted multi-species (*Pongamia* species as well) and farmer-centric approach (cultivation of non-edible oil plants on field bunds and wastelands as a subsidiary occupation). Further, Demonstration and Information Centres, with a facility to generate 100 l of fuel, serving as catalyst for biofuel production and consumption have been established in each district for promotion of production and use of biodiesel. This model may be introduced across the country as well.

However, as previous two decades of experience suggests, ethanol and/or biodiesels alone cannot meet the ever-growing need for biofuels. Substantial research thrust is necessary for development of second- and third-generation feedstocks as well, to address the ever-growing future energy needs of the country. Such development would not only provide better energy security, but several environmental, social and economic benefits as well.

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# CWUR Subject Rankings 2017

The Center for World University Rankings (CWUR) lists the top 1000 out of 27,000+ degree-granting institutions of higher education worldwide[1]. Arguably this is the the largest academic rankings of global universities. It assesses the quality of education, alumni employment, research quality and innovation, without relying on surveys and university data submissions.

An interesting offering that CWUR makes is the Subject Rankings[2]. These rank the world's leading universities in 227 subject categories, based on the number of research articles in top-tier journals. Data are obtained from Clarivate Analytics (previously the Intellectual Property and Science business of Thomson Reuters). The methodology is non-trivial and is described in detail in their portal[3], and will not be discussed here.

Table 1 is a summary list of the 61 countries that contribute to the top 1000 universities. It is also possible to determine that only universities from 36 countries have at least one unit of assessment in the top 10 in one of the 227 subject categories. Altogether, the 1000 universities contributed 2293 units of assessment. In some subjects, due to ties at rank 9 or rank 10, more than 10 universities are found in the top 10. The 225 universities of USA appear at 1047 places in the top 10 in the 227 subjects. Harvard University appears 112 times, and is ranked first in 72 subject areas. From India only one university appears in the top 10 – Annamalai University is ranked third in spectroscopy. No other university from India appears in any of the remaining 226 subject categories.