



## CLIMATE CHANGE DUE TO GLOBAL WARMING CAN BE REVERSED BY ADVANCED BIOFUELS

**Deepa Sharma**

Saraswati Mahila Mahavidyalaya ,Department of Zoology, Maharshi Dayanand University, Palwal, Pin.121102 (Haryana).

**Ashwani Kumar\***

Alexander von Humboldt Fellow (Germany) Department of Botany, University of Rajasthan, Jaipur 302004 \*Corresponding Author

**ABSTRACT** Climate change is taking place due to global warming and use of fossil fuels is contributing to it significantly by adding carbon dioxide to atmosphere at the rate of 15 billion tonnes of CO<sub>2</sub>. Recently research and development of biofuels and off late carbon-neutral alternatives including next-generation biofuels have gained importance. Second-generation biofuel molecules are likely to resemble those present in gasoline and expected to be compatible with existing infrastructure. Metabolic and protein engineering approaches can improve upon production of biofuels. With the advent of synthetic biology and advances in protein engineering, designing pathways with reactions not known in nature hitherto is now a possibility. Metabolic engineering of microbes and synthetic and systems biology, have allowed the engineering of microbes to produce advanced bio-fuels properties similar to petroleum-based fuels.

**KEYWORDS :** Biofuel, second generation fuels, synthetic fuels, greenhouse gases, climate change.

### INTRODUCTION:

Every year our earth's atmosphere receives more than 15 billion tones of CO<sub>2</sub>. The combustion of fossil fuels is a big contributor to the increase in the level of CO<sub>2</sub> in the atmosphere which is directly associated with global warming (Anonymous 2005, Kamm and Gruber 2006, Kumar et al. 2018a, Kumar 20018a, Saini et al. 2018).

Global warming is a long-term warming of the planet since the early 20th century, and most notably since the late 1970s, due to the increase in fossil fuel emissions. After Industrial Revolution since 1880, the average temperature has gone up by about 1 °C (about 2 °F), relative to the mid-20th-century baseline (of 1951-1980). This is on top of about an additional 0.15 °C of warming from between 1750 and 1880.

As a result of global warming the hot weather is recurring more frequently resulting and droughts and floods now in comparison to 60 years ago. Presently scientists expect heat waves to become more frequent and severe as global warming intensifies. This increase in heat waves creates serious health risks, and can lead to heat exhaustion, heat stroke, and aggravate existing medical conditions.

Four years ago, at the Conference of the Parties to the United Nations Framework Convention on Climate Change (COP21), over 190 nations committed themselves to keeping the increase in global average temperature 2 °C below pre-industrial levels, with an aim of limiting the increase to 1.5 °C. Different climate models suggest that current atmospheric greenhouse gas concentrations may already be very near those associated with a stable climate at 1.5 °C (Huntingford and Mercado 2016). The targets that are currently discussed for international climate policy will require the energy system to have net zero emissions (Collins et al. 2013, Clarke et al. 2014).

Plant biomass provides 10% of global primary energy today and is widely expected to provide on the order of a quarter of primary energy in prominent low-carbon scenarios for 2050 (Demirbas 2001, see also Kumar 2018, Saini et al. 2018, Kumar et al. 2019). Energy can be obtained from biomass in five ways: production of crops which yield sugar, starch, cellulose and oil; solid waste which can be burnt; anaerobic digesters which can produce biogas to be used to generate heat/electricity; landfill production for methane; and biofuel production which includes biodiesel, ethanol, methanol, and their derivatives (Kocar and Siva 2013).

Biomass provides as much energy as oil, natural gas, and coal combined and offers opportunities for carbon removal and offers more than a 50% chance of achieving the 2 °C goal (Smith et al. 2016). In the International Energy Agency (Paris) 2 °C scenario, low-carbon biofuels need to provide about 25 exajoules by 2050 (Fulton et al 2015), which is well within conservative estimates of the resource base (Slade et al. 2014).

### Energy crops:

Energy crops constitute significant potential for meeting the future energy need worldwide (Kumar 2018a, Kumar 2018b). Some C<sub>4</sub> energy crops, such as miscanthus, switchgrass and sweet sorghum, can grow with high biomass yield even in infertile land.

Biomass can be defined as the collection of all organic matter composing biological organisms, but the main components utilized for biofuel production are sugars (starch, simple sugars, and lignocelluloses) and lipids (Kumar, 2001, Hill et al. 20006, Roy and Kumar 2011).

In 2010 worldwide biofuel production reached 105 billion liters (28 billion gallons US), increasing by 17% from 2009, and biofuels provided 2.7% of the world's fuels for road transport, a contribution largely made up of ethanol and biodiesel (Swanson, et al. 2010).

### Biodiesel:

Currently, biodiesel is produced from plant and cooking oils (Zhang et al. 2003, Araujo et al. 2010) but these traditional methods have low production yields (Johnston & Holloway 2010) and their use competes with the use of plant oils in human nutrition.

The typical ranges of biodiesel costs vary between \$0.55–\$1.2 per liter, \$0.58–\$1.45 per liter and \$0.45–\$0.83 per liter when produced from plant oils (Apostolakou et al. 2009) cooking oils (Araujo et al. 2010) and biomass based on gasification. respectively (Swanson et al. 2010).

### Microalgal biofuel production:

Microalgal oils represent another attractive option for biodiesel production because microalgae require less arable land than plant-based feedstocks. According to Stephens et al. (2010) alga based production is challenging in regard to obtaining productivities and separation processes that can meet the requirement for an economically viable process (Kumar et al. 2018 see also Gajraj et al).

### GASIFICATION:

Recently biodiesel production based on gasification is currently being investigated, but, again, its current utilization is limited by commercially available technologies. The techno-economic feasibility of these processes suggests that they can reach good energy balances (80–90% more energy produced than energy invested, with the lowest values for the gasification process) and decreased CO<sub>2</sub> emissions (41–100% lower than for the equivalent fossil fuel) (Stephens et al. 2010, Swanson et al. 2010, Rickman et al. 2013).

### Advanced biofuels:

#### Butanol:

Short-chain or higher alcohols for example, Butanol, has 84% of the energy content of gasoline, It can be added to gasoline as oxygenates or, in some cases, to replace gasoline altogether. Butanol is produced

by the natural host *Clostridium* sp. In an effort to improve butanol production, species of *Escherichia coli* have been engineered to use feedstocks such as glucose, liquefied cornflour, glycerol, and even syngas (a mixture of hydrogen and carbon monoxide) (see Kumar et al. 2018).

#### Second generation biofuels:

Second-generation biofuel molecules are likely to resemble those present in gasoline (that is, C<sub>4</sub>-C<sub>10</sub> branched chain hydrocarbons or derivatives thereof including alcohols) and expected to be compatible with existing infrastructure. A robust second-generation biofuels industry based on inedible cellulosic biomass available as wood, grass, and various wastes was widely expected to be in place by now (Roy and Kumar 2013, Kumar et al. 2018). Anticipated benefits include climate change mitigation and rural economic development while avoiding the limitations of first-generation biofuels.

#### Cellulosic biofuels:

Lignocellulosic biomass can be converted to cellulosic ethanol which provides the most direct path to a low-cost platform for biological production of fuels from inedible biomass. The new technology is aimed at overcoming the recalcitrance barrier for biological processing, but is not yet cost competitive and needs innovation to become so (Lynd 2015, see also Kumar et al 2018a, Kumar and Gupta 2018).

#### Synthetic biofuels:

Exciting research is also under way on a third generation of synthetic biofuels- specially engineered microorganisms (Bhansali and Kumar, 2018)

#### United Nations Environment Programme:

The eighth UN Environment Emissions Gap Report provides an up-to-date scientific assessment of the global progress towards the emissions reductions required to be on track to meet the long-term goal of the United Nations Framework Convention on Climate Change (UNFCCC). The overall conclusion of the assessment is that government and other stakeholder's emissions reduction commitments are far from the level of ambition required for an emissions pathway consistent with staying below a 2°C, let alone a 1.5°C, temperature increase.

#### IEA efforts:

IEA Greenhouse Gas R&D Programme (IEAGHG) is an international research body established in 1991, evaluating technologies to reduce greenhouse gas emissions from the use of fossil fuels, with a focus on carbon dioxide capture and storage (CCS). During 1991 a number of countries signed an agreement to take part in a programme of research and development aimed at potential mitigation techniques as a response to the issue of global warming. It involves techniques, costs, and environmental consequences of removing CO<sub>2</sub> from power station flue gases and storing or otherwise disposing it (Kumar et al. 2018).

#### Biofuels and employment:

Bioenergy is responsible directly and indirectly for almost 3 million global jobs globally—about the same as photovoltaics and three times that of wind—with liquid biofuels responsible for a little over half this total, and solid biomass and biogas making up the balance. Sugarcane production in Brazil, about half of which is used for ethanol, is the largest agricultural employer in that country. Compared with other agricultural workers, laborers in the cane industry have the greatest representation in the formal economy and achieve higher levels of education. Towns with ethanol plants in Brazil have higher tax revenues than comparable towns that do not (Hill et al. 2006).

#### Microbial biotechnology:

Hydrocarbons produced from biomass using microbial fermentation processes can serve as high-quality liquid transportation fuels and may contribute to a reduction in GHG emissions.

#### DISCUSSION:

Sustainable transportation biofuels may require considerable changes in land use to meet mandated targets. Energy crops that are suitable for biofuel production have been identified based on their biological characteristics, environmental requirements, developmental status, the type of farming system and natural geographic conditions (Tian et al. 2009, Lynd, 2017, Kumar, 2018b, Kumar et al. 2018a, 2018b, Kumar and Roy, 2018, Kumar et al. 2019). Bioenergy production

(with the exception of residues) is associated with land-use change (LUC), which leads to changes in both above- and belowground carbon stocks and consequent emissions (Leemans et al. 1996, Kumar, 2001, Kumar, 2018, Kumar et al. 2018, Kumar 2018b, Kotiya et al. 2018) These have major consequences for the effectiveness of GHG emissions reductions, while LUC could also have negative implications for biodiversity and food production (Searchinger et al. 2008, Shaik and Kumar 2014). Cellulosic ethanol, which can be produced from prairie grasses, municipal waste or just about any carbon-based materials, might well resolve these problems by expanding the feedstock away from food crops (Kumar and Gupta 2018). However important considerations are: how to ensure the biomass as per the International Energy Agency (IEA) and Intergovernmental Panel for Climate Change (IPCC) recommendations — maximizing the use of forestry, farm, and municipal wastes, besides encouraging cultivation of dedicated energy crops away from lands that provide carbon sequestration and other critical environmental services. (IEA World Energy Outlook 2014, OECD/IEA, 2014)

In addition, there are further emissions associated with fertilizer and non-renewable energy use in the production of bioenergy (Hoefnagels et al. 2010). Progress in biofuels requires not just technical advances, but a level of predictability in the economic and policy terrain.

So what has been different about cellulosic biofuels? Overestimation of technological readiness is part of the answer. There has been a marked tendency, encouraged by both government and private sector investors, to focus on large, expensive, stand-alone facilities rather than niche applications. Particularly in the United States, funding agencies prematurely turned away from cellulosic ethanol, although it is now clear that further development is needed to achieve cost-competitive fuel production even with oil prices at \$100/barrel (Zhang et al. 2003).

#### CONCLUSION:

Gracefully integrating bioenergy technologies into the agricultural, social, and environmental systems with which they interact is a challenge that can only be resolved by experience. The recent technical advances in next-generation sequencing, high sensitivity proteomic and metabolomic methods, and developments in fluxomic techniques make systems biology methods more powerful and accessible to the synthetic biology community. The uses of synthetic biology showcase the extraordinary opportunities in what has been called the century of biology, from understanding fundamental scientific questions to unique practical applications.

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