INSTITUTE FOR DEFENCE STUDIES & ANALYSES
रक्षा अध्ययन एवं विश्लेषण संस्थान

IDSA
Backgrounder

# The Food versus Fuel Debate

*Ekta Niranjan*

January 04, 2017

## Summary

The debate on food versus fuel became intense during the past decade, especially following the 2007-08 world food price crisis. But now the Food and Agricultural Organization (FAO) has proposed that the terms of the debate be moved from food versus fuel to food and fuel. Against this backdrop, this backgrounder offers a summary of the challenges presented by biofuels to food security.

Bioenergy is the largest used renewable energy source in the world.[1] It accounts for 14 per cent of the 18 per cent "renewables used in the global energy mix."[2] Bioenergy includes both traditional and modern biomass and biofuels.[3] Traditional sources like fuelwood and charcoal, predominantly used in rural areas and in developing countries for heating and cooking, account for 90 per cent of bioenergy use. Modern bioenergy like biogas and biofuels account for only 10 per cent of bioenergy use.[4]

According to the World Energy Council, biofuels are the "most viable and sustainable option in replacing oil dependency."[5] At present, four per cent of the arable area in the world is dedicated to biofuel production.[6] Transport biofuels like bioethanol and biodiesel that are blended with petrol and diesel are the fastest growing bioenergy in the world.[7] They account for three to four percent of total road transport fuel. Environmental concerns and the need to improve energy security by reducing import dependence on traditional fuels have both contributed to the growth of bioenergy. The rise of biofuel use in the future is unavoidable.[8]

Broadly speaking, there are four generations of biofuels. First generation biofuels are manufactured using food crops like sugarcane, maize and oilseed. Second generation biofuels are produced from non-food produce like organic waste, wood and food crop waste. Third generation biofuels are "based on improvements in the production of biomass" by taking "advantage of specially engineered energy crops such as algae". [9] Fourth generation biofuels are based on more advanced technology which aims to

---

[1] World Energy Council, "World Energy Resources: Bioenergy 2016", p. 2, at https://www.worldenergy.org/wp-content/uploads/2017/03/WEResources_Bioenergy_2016.pdf (Accessed December 20, 2017).

[2] Ibid.

[3] Ibid, p. 3.

[4] ibid, pp. 7-8.

[5] Ibid, p. 2.

[6] Maria Rulli, Davide Bellomi, Andrea Cazzoli, Giulia Carolis and Paolo D'Odorico, "The water-land-food nexus of first generation biofuels", *Nature*, March 2016, p. 1, at https://www.nature.com/articles/srep22521 (Accessed December 20, 2017).

[7] J. Popp, Z. Lakner, M. Harangi-Rakos, M. Fari, "The effect of bioenergy expansion: Food, energy, and environment", *Renewable and Sustainable Energy Reviews*, 32, 2014, p. 562, https://www.sciencedirect.com/science/article/pii/S1364032114000677 (Accessed December 20, 2017).

[8] Jose Escobar, Electo Lora, Osvaldo Venturini, Edgar Yáñez, Edgar Castillo and Oscar Almazan, "Biofuels: environment, technology and food security", *Renewable and sustainable energy reviews*, 13(6), 2009, pp. 1275-87, https://econpapers.repec.org/article/eeerensus/v_3a13_3ay_3a2009_3ai_3a6-7_3ap_3a1275-1287.htm (Accessed December 20, 2017).

[9] "Generations of Biofuels," at http://energyfromwasteandwood.weebly.com/generations-of-biofuels.html (Accessed December 20, 2017).

capture and store carbon dioxide (CO2) at every production stage. Currently, first generation biofuels are the most common type of biofuels used, and second, third and fourth generation biofuel technology are still being developed.

The debate on food versus fuel became intense during the past decade, especially following the 2007-08 world food price crisis. But now the Food and Agricultural Organization (FAO) has proposed that the terms of the debate be moved from food *versus* fuel to food *and* fuel.[10] Against this backdrop, this backgrounder offers a summary of the challenges presented by biofuels to food security.

## Food vs Fuel Debate

The food versus fuel debate is, in short, a dispute over the impact of biofuel production on food security. According to the FAO, the world population will reach 9.1 billion by 2050.[11] This rise in population will be accompanied by rapid urbanisation, increase in income levels and changing dietary habits. A 70 per cent increase in agricultural output is needed to meet the future projected demand for food. It is alleged that biofuel production from first generation sources are in competition with food production over land and other resources like water and increases food prices.

## Impact on prices

The impact of biofuels on food prices is a hotly debated topic amongst researchers whose views remain divergent despite many years of research. Different researchers have calculated the impact of biofuels on food prices to be as little as a three per cent increase to as much as a 75 per cent increase.[12] During the 2007-08 food price crisis, food prices had doubled, with that of rice climbing from USD 375 per tonne to 757 per tonne in the course of five months.[13] The increase in demand for maize for biofuel production was found to contribute to 70 per cent of the total increase in maize

[10] "The food systems of the future need to be smarter, more efficient", at http://www.fao.org/news/story/en/item/275009/icode/ (Accessed December 20, 2017).

[11] FAO, "How to Feed the Word in 2050", 2009, p 2, at http://www.fao.org/fileadmin/templates/wsfs/docs/expert_paper/How_to_Feed_the_World_in_2050.pdf (Accessed December 20, 2017).

[12] Olivier Dubois, "Moving from "Food versus Fuel" towards "Food and Fuel", FAO, October 2015, p. 12, http://www.worldagroforestry.org/berlin-conference-presentations/thematic-fora/thematic-forum-2/olivier-dubois.pdf (Accessed December 20, 2017).

[13] John Baffes, Tassos Haniotis, "Placing the 2006/08 Commodity Price Boom into Perspective" (Working Paper), World Bank, July 2010, p. 3, https://papers.ssrn.com/sol3/Delivery.cfm/5371.pdf?abstractid=1646794&mirid=1 (Accessed December 20, 2017).

prices[14] (maize is popularly used in the US for ethanol production). From 2002 to June 2008, the International Monetary Fund's (IMF) index of internationally traded food prices increased by 130 per cent.[15] According to a 2008 World Bank report titled 'A Note on Rising Food Prices', biofuels production was responsible for a 70 to 75 per cent increase in the prices of food commodities.[16] The report noted that biofuel related policies adopted by the US and EU, such as subsidies, import tariffs and fuel-blending mandates, led to increased biofuel production and that, if such policies had not existed, the impact of biofuel on food prices would have been lower. The report goes on to cite Brazil's example in lower-cost ethanol production from sugarcane, which did not cause a significant rise in sugar prices. In this respect, the report states that the removal of import tariffs in the US and EU would facilitate the sale of more economically viable biofuels from Brazil and other developing countries and warns against subsidies for biofuel production.

On the other hand, another World Bank paper released in July 2010 found that the impact of biofuels on food prices during the 2008 price boom was "much less than initially thought" and that the "index fund activity" played an important role in the price boom.[17] It went on to state that:

> "Clearly US maize-based ethanol production, and (to a lesser extent, EU biodiesel production) affected the corresponding market balances and land use in both US maize and EU oilseeds. Yet, worldwide, biofuels account for only about 1.5 percent of the area under grains/oilseeds. This raises serious doubts about claims that biofuels account for a big shift in global demand. Even though widespread perceptions about such a shift played a big role during the recent commodity price boom, it is striking that maize prices hardly moved during the first period of increase in US ethanol production, and oilseed prices dropped when the EU increased impressively its use of biodiesel. On the other hand, prices spiked while ethanol use was slowing down in the US and biodiesel use was stabilizing in the EU".

According to the US government, biofuels contributed to less than three percent of the price increase during the 2008 price boom.[18] The Renewable Fuels Association (a US trade association) found that "retail food prices were not impacted in any

[14] Donald Mitchell, "A Note on Rising Food Prices", (Working Paper), World Bank, July 2008, p. 4, https://elibrary.worldbank.org/doi/pdf/10.1596/1813-9450-4682 (Accessed December 20, 2017).

[15] Ibid, p. 2.

[16] Ibid, p. 17.

[17] Baffes, Haniotis, Note 13, p. 3.

[18] Aditya Chakrabortty, "Secret report: biofuels caused fuel crisis", *The Guardian*, July 3, 2008, at https://www.theguardian.com/environment/2008/jul/03/biofuels.renewableenergy (Accessed December 20, 2017).

demonstrable way by expansion of U.S. grain ethanol production under the Renewable Fuel Standard (RFS) over the past decade."[19] In 2016, the US ethanol industry achieved its highest production even as FAO reported that the Food Price Index commodity average was 1.5 percent below 2015 levels.[20]

Thus, the debate on the impact of biofuels on food prices is still unresolved. Other factors like stock market speculation, climate factors, and the rising cost of petroleum could also have played important roles in driving up the food prices in 2008.[21]

## Impact on land use

Future estimates of land demand for biofuel production vary from 40 to 800 million hectare (Mha).[22] Biofuels can impact land use change through direct or indirect land use. Direct land use change happens when biofuel feedstocks are grown on land made available by clearing forests, whereas indirect land use change (ILUC) occurs when biofuel feedstock are grown on land previously used for cultivating other crops, which latter then have to encroach on more land for their production.[23]

Rosillo-Calle states "it is almost impossible to provide any reliable estimates at this point on time" about the future demand for biofuel land use. The pressure from biofuels on land use in the future could be either weaker or stronger.[24] The pressure could be weaker if second and third generation biofuel technology becomes economically feasible. On the other hand, the pressure could be stronger if energy costs grow and the demand for alternative fuels go up. Second generation biofuels could compete with food crops if plantations are set up for the sole purpose of growing crops for second generation use. Also, if by-products of crops are used for second generation technology, they will compete with the use of by-products for other

[19] "UN Data Reveals Increased Corn, Ethanol Production Not Causing Food Price Rise," at http://www.ethanolrfa.org/2017/01/un-data-demonstrates-increased-corn-ethanol-production-not-causing-food-price-rise/ (Accessed December 20, 2017).

[20] ibid.

[21] Duncan Graham-Rowe, "Agriculture: Beyond food versus fuel", *Nature*, 474 (7352), June 2011, pp. S6-S8, https://www.nature.com/articles/474S06a (Accessed December 20, 2017).

[22] Frank Rosillo-Calle, "Food versus Fuel: Toward a New Paradigm: The Need for a Holistic Approach", *International Scholarly Research Network*, 2012, p. 5, https://www.hindawi.com/journals/isrn/2012/954180/ (Accessed December 20, 2017).

[23] J. Popp, Z. Lakner, M. Harangi-Rakos, M. Fari, Note 7, p. 574.

[24] Andrei Jean Vasile, Ion Raluca Andreea, Gheorghe H. Popescu, Nica Elvira and Zaharia Maria, "Implications of agricultural bioenergy crop production and prices in changing the land use paradigm- The case of Romania", *Land Use Policy*, 50, 2016, p. 405, http://www.sciencedirect.com/science/article/pii/S0264837715003087 (Accessed December 19, 2017).

uses such as animal feed.[25] Future increase in productivity and yields will help to lower land use demand of biofuels,[26] but climate change will affect future land productivity by impacting soil salinity levels, erosion and increasing water stress,[27] and could further intensify the competition between food crops and biofuels for land.

Most experts do not believe that "expansion of bioenergy use will set serious competition with food".[28] As mentioned earlier, the FAO has projected that world population will reach 9.1 billion by 2050. FAO states that "globally 90 percent (80 percent in developing countries) of the growth in crop production will come from intensification, in particular higher yields and increased cropping intensity. This would be in line with past trends, but represents a major challenge for future private and public research, including research for greater resilience of farming systems."[29]

It should be noted that at the "currently prevailing ('first generation') conversion technology, a further rise in the use of agricultural feedstock for the production of biofuels would be a real risk for food security."[30] First generation biofuels will continue to be used in the near future.[31] It will take five to ten years for second generation biofuels to be produced on a large scale.[32] Additionally, second, third and fourth generation biofuels have the potential to reduce greenhouse gases (GHGs) more than the first generation biofuels but are currently unviable.[33]

## Impact on environment

According to Popp et al.,

> "To date, there is no scientific consensus on whether bioenergy as a whole contributes to or abates global climate change. Rather, scientific evidence appears to indicate that "it depends". First generation biofuel systems, such as ethanol made from corn grain, tend to emit more GHGs than cellulosic ethanol systems, particularly CO2… Bioenergy is often considered carbon neutral, as the carbon dioxide released in combustion is assumed to be

[25] "FAO Official: Food-based biofuels not necessarily bad," at https://www.euractiv.com/section/biofuels/news/fao-official-food-based-biofuels-not-necessarily-bad/ (Accessed December 19, 2017).

[26] Frank Rosillo-Calle, Note 22, p 5.

[27] J. Popp, Z. Lakner, M. Harangi-Rakos, M. Fari, Note 7, p. 575.

[28] Ibid, p. 563.

[29] Ibid, p. 10.

[30] FAO, 'How to Feed the World in 2050', Note 11, p. 31.

[31] Frank Rosillo-Calle, Note 22, p. 2.

[32] Duncan Graham-Rowe, Note 21, pp. S6-S8.

[33] J. Popp, Z. Lakner, M. Harangi-Rakos, M. Fari, Note 7, p. 576.

> compensated by the CO2 absorbed during plant growth. However, indirect land use change can negate any greenhouse gas savings from biofuel production based on energy crops."[34]

The authors go on to state that second, third and fourth generation biofuels would be better at mitigating GHG emissions but they are not viable yet.

For Rosillo-Calle, the impact of biofuels on GHG mitigation depends on the feedstock used (like sugar cane, vegetable oil, etc.) and the "circumstances of production and processing. Each crop has its pros and cons that need to be considered."[35] A feedstock can result in negative GHG savings if it is grown on converted forest land. Ethanol from sugarcane has recorded the largest savings (more than 70 per cent) but corn based ethanol "can save up to 60% but may also cause 5% more GHG emissions… though there remain strong disagreements".[36] Rosillo-Calle further states:

"Some G1 (first generation) biofuel crops provide net GHG benefits only under certain conditions such as use of abandoned or degraded lands (involving no direct or ILUC), utilisation of co products, adoption of sustainable production practices (excluding use of nitrogenous fertilisers), and so forth.

The conclusion of most of the scientific literature published in the recent past indicates that in a life cycle analysis basis, biofuels provide a net GHG benefit (30–100% compared to petroleum fuels), when use of co products are included and GHG emissions from land conversion are excluded in the analysis.

These findings are, however, constantly being challenged as new data comes into light."[37]

## Biofuels in India

According to British Petroleum (BP), by 2035, India will have the largest growth in energy consumption amongst all the major economies and it will remain dependent on energy imports to meet its needs.[38] BP predicts that India's need for natural gas will increase by 162 per cent, that of oil by 120 per cent, coal by 105 per cent, renewables by 699 per cent, nuclear by 317 per cent and hydro by 97 per cent. This

[34] Ibid, p. 576.

[35] Frank Rosillo-Calle, Note 22, p. 5.

[36] ibid, p. 6.

[37] Frank Rosillo-Calle, Note 22, p. 6.

[38] "Country and regional insights- India," at https://www.bp.com/content/dam/bp/pdf/energy-economics/energy-outlook-2017/bp-energy-outlook-2017-country-insight-india.pdf (Accessed December 20, 2017).

will need to be met by a 165 per cent increase in oil imports, a 173 per cent increase in gas imports and a 105 per cent increase in coal imports. Renewables will become the second largest fuel produced in India by 2035, surpassing oil.[39]

Indian biofuel initiatives began in 2003.[40] To promote biofuels, the Ministry of Petroleum and Natural Gas has undertaken measures like setting up a Steering Committee for biofuels and creating a dedicated Biofuel Cell within the Ministry.[41] The biofuel programme in India differs from that of other countries because of the government's focus on producing biofuels from non-feed stocks "raised on degraded land or wasteland that are not suited to agriculture. This has avoided a possible conflict of fuel verses food security."[42] Bioethanol in India is largely produced from molasses (a by-product of sugar production) and biodiesel is largely produced from non-edible oil like jatropha seeds. India needs to produce 10 GW of energy from biomass to meet its commitments under the Paris climate treaty.[43]

India had set a target of 20 per cent blending of bioethanol with petrol and biodiesel with diesel by 2017.[44] Though this has not been achieved, a 3.3 per cent blending of bioethanol with petrol was achieved in 2016.[45] The Global Agricultural Information Network (GAIN) Report predicts that ethanol supplies in 2018 in India will be insufficient and could hamper the blending target achieved and thus the ethanol-blending programme will progress only slowly. It also goes on to state that the "blend targets were partially successful in years of surplus sugar production but unfulfilled when sugar production declines. Since sugarcane production in India is cyclical, ethanol production also varies accordingly and therefore does not assure optimum supply levels needed to meet the demand at any given time."[46] GAIN predicts that 20

[39] Ibid.

[40] Mambully Gopinathan and Rajasekaran Sudhakaran, "Biofuels: opportunities and challenges in India", *In Vitro Cellular & Developmental Biology Plant*, 45 (3) May 2009, p. 350.

[41] "Initiatives taken to take forward Biodiesel program," at http://pib.nic.in/newsite/PrintRelease.aspx?relid=148141 (Accessed December 20, 2017).

[42] Neha Patni, Shibu Pillai and Ankur Dwivedi, "Analysis of current scenario of Biofuels in India specifically Bio-diesel and Bio-ethanol", International Conference on Current Trends in Technology, NUiCONE, 2011, p. 3 http://nuicone.org/site/common/proceedings/Chemical/oral/CH_21.pdf (Accessed December 20, 2017).

[43] Kumar Sambhav Shrivastav, "India ratifies Paris climate treaty: Here's all you need to know", *Hindustan Times*, October 3, 2006, at http://www.hindustantimes.com/india-news/what-signing-the-paris-climate-change-treaty-means-for-india/story-RsDH1IAohQNEqRxb426YbM.html (Accessed December 20, 2017).

[44] GAIN Report, "India Biofuels Annual 2017", 2017, p. 3.

[45] ibid, p. 2.

[46] ibid, p. 3.

per cent less ethanol will be produced in 2017 compared to the year before and that "theoretically, the ethanol available is sufficient to meet the 5 percent blend target, but demand rationing, particularly from potable and industrial sectors, will limit ethanol market penetration close to 2 percent."[47] Ethanol imports have grown over the past years but the government currently only allows for indigenously produced ethanol to be used for biofuel generation.[48] The government also has plans to set up 12 second generation ethanol bio-refineries in India.[49]

With regards to biodiesel, agronomical and economic problems have resulted in the biodiesel project becoming unfeasible for now and "research trials have failed to build commercially viable biodiesel industry based on 'jatropha' (Jatropha curcus), and there is little indication that it can eventually succeed."[50] It was hoped that the jatropha plant (which is not native to India) would be high yielding without the use of irrigation, fertilisers and pesticides, but this has not been the case.[51] Additionally, factors like high plantation maintenance costs and inadequate availability of wasteland also contributed to the current unfeasible use of jatropha for biodiesel production.[52] GAIN also reports that "advanced biofuel development remains at the experimental stage with no viable plans for scaling it up."[53] In the past, low procurement prices for biodiesel has been known to be a hindrance to the growth of the industry.[54] The regulation of diesel prices by the government in the past made it competitive with biodiesel, but the deregulation of diesel in 2014 is perceived as incentivising more investments in biodiesel.[55] Before 2015, only state owned firms and private firms with INR 2,000 crore in oil investments were allowed to retail biodiesel to customers, but this regulation was amended in 2015 to make biodiesel more easily available to users by allowing authorised manufacturers to sell directly

[47] ibid, p. 14.

[48] ibid, p. 16.

[49] "First 2G (Second Generation) Ethanol Bio-refinery in India to be set up at Bathinda (Punjab)," at http://pib.nic.in/newsite/PrintRelease.aspx?relid=155782 (Accessed December 21, 2017).

[50] "India Biofuels Annual 2017", Note 44, pp. 18-19.

[51] Mambully Gopinathan and Rajasekaran Sudhakaran, Note 40, p. 366.

[52] "India Biofuels Annual 2017", Note 44, p 21.

[53] Ibid, p. 2.

[54] Erin Voegele, "Study recommends raising biodiesel price in India," January 11, 2011, at http://www.biodieselmagazine.com/articles/7508/study-recommends-raising-biodiesel-price-in-india (Accessed December 21, 2017).

[55] "India Biofuels Annual 2017", Note 44, p 27.

to consumers.[56] It should be noted that India's diesel demand is five times higher than its petrol demand.[57]

With the recent implementation of the Goods and Services Tax (GST), an 18 per cent tax is now levied on both biodiesel and ethanol.[58] This has resulted in biodiesel becoming more expensive than diesel and has almost brought the sale of biodiesel to a "halt".[59] Ethanol, on the other hand, which is a bigger industry, could survive the GST.[60] News portals have reported that the petroleum ministry is working towards the reduction of the GST levied on biofuels. Interestingly, GST has not been levied on petroleum products yet, although recent reports suggest that the central government is interested in levying GST on petroleum products,[61] which could level the field for biofuels.

## Conclusion

The future of biofuels is a hotly debated topic. Views of researchers vary on almost every issue but one thing is for sure and that is that biofuels are here to stay and conflict can arise from several fronts. Even though GHG mitigation from first generation biofuels varies, second, third and fourth generation biofuels hold more opportunities for unlocking the potential of biofuels and help achieve climate mitigation targets but they are not yet commercially viable and the technology is still being developed. Bioenergy will be a "significant part of energy mix" in the future.[62] In the end "the use of biomass for energy in a large scale must go hand-in-hand with a modern, diversified, and scientifically driven agricultural sector."[63]

---

[56] "Govt allows direct sale of bio-diesel by manufacturers", *The Hindu*, January 16, 2015, at http://www.thehindu.com/news/national/govt-allows-direct-sale-of-biodiesel-by-manufacturers/article6793994.ece (Accessed December 21, 2017).

[57] Mambully Gopinathan and Rajasekaran Sudhakaran, Note 40, p. 352.

[58] Kalpana Pathak, "Higher GST rates will make biodiesel costlier than diesel: manufacturers", *The Mint*, June 16, 2017, at http://www.livemint.com/Industry/1wOIylfa3pKkcMFGK3fq5I/Higher-GST-rates-will-make-biodiesel-costlier-than-diesel-m.html (Accessed December 21, 2017).

[59] Shankar Abidi, "Bio-diesel sales come to a halt on higher GST rate", *DNA*, November 22, 2017, at http://www.dnaindia.com/business/report-bio-diesel-sales-come-to-a-halt-on-higher-gst-rate-2561637 (Accessed December 21, 2017).

[60] Kalpana Pathak, Note 58.

[61] "Centre wants GST on fuel: Arun Jaitley", *The Hindu*, December 19, 2017, at http://www.thehindu.com/business/Economy/centre-wants-gst-on-fuel-jaitley/article21940182.ece (Accessed December 21, 2017).

[62] Olivier Dubois, Note 12, p. 21.

[63] Frank Rosillo-Calle, Note 22, p. 2.

## About the Authors

**Ekta Niranjan** is Research Intern with Non Traditional Security Centre of Institute for Defence Studies and Analyses (IDSA), New Delhi.

**The Institute for Defence Studies and Analyses (IDSA)** is a non-partisan, autonomous body dedicated to objective research and policy relevant studies on all aspects of defence and security. Its mission is to promote national and international security through the generation and dissemination of knowledge on defence and security-related issues.



Institute for Defence Studies and Analyses
1, Development Enclave, Rao Tula Ram Marg
New Delhi 110 010 India
T +91-11-2671 7983 F +91-11-2615 4191
contact.idsa@nic.in www.idsa.in
Twitter @IDSAIndia
www.facebook.com/InstituteforDefenceStudiesAnalyses