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## Ethanol fuel and environmental impacts: Advances and challenges

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Forty years after the implementation of the “Pró-Alcool” program in Brazil, ethanol fuel, initially an option tied to national security, is now related to environmental concerns. In the 70’s, Brazil became the first nation to run a large-scale program of using ethanol fuel. By 1974, Brazil imported 80% of the oil consumed in the country. Following oil production decreases by the Organization of Petroleum Exporting Countries (OPEC) that year, which raised oil prices from approximately US\$ 3.00 to US\$ 12.00 per barrel, Brazil spent 27% of its foreign earnings to import crude oil. At the same time, low prices for sugar were implying in huge surpluses in sugarcane production and processing capability. Adding to the scenario the military government concerns with national security, the basic foundations were established to lead Brazil to adopt a series of measures that would result in large-scale use of ethanol as fuel. After some ups and downs, ethanol fuel still has a significant participation on the country’s fuel consumption. Its production jumped from less than one billion liters in 1970, to about 30 billion liters in 2016. The emergence of flex fueled vehicles, associated with greenhouse gas emissions concerns led to a second boom in ethanol fuel production and consumption. Since the 70’s, ethanol production overcome some important environmental aspects of its production; like pre-harvest burning and vinasse discharge in water bodies. However, some aspects of its production are still subject to environmental concerns and debate, like land use change, N<sub>2</sub>O emissions, forest fragmentation and even the disposal of vinasse. A throughout evaluation and effort to minimize such environmental impacts is essential to a sustainable use of such important source of energy.

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