

ENVIRONMENTAL IMPACT ASSESSMENT OF DIFFERENT SUGARCANE BIOREFINERIES CONFIGURATIONS WITH INTEGRAL USE OF BIOMASS

Otávio Cavalett

Brazilian Bioethanol Science and Technology Laboratory (CTBE) / National Center for Research in Energy and Materials
 FAPESP Process 2010/17139-3 | Term: Sep 2011 to Aug 2016 | Young Investigator

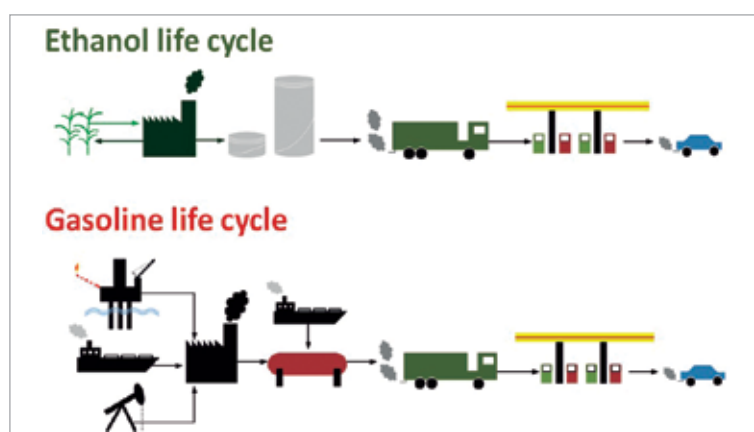


Figure 1. Simplified representation of ethanol and gasoline life cycle stages

Replacement of fossil fuels by biofuels has been considered an important alternative in the transition process to a economy based in higher proportion of renewable resources in several countries. It is recognized that large-scale production of ethanol, sugar and electricity from sugarcane in Brazil presents some environmental, economic, social and energy security benefits. However, new production routes for sugarcane biorefinery considering also the integral use of sugarcane biomass will be more and more important for the strategic plans of bioenergy production expansion in Brazil. Comprehensive studies of the environmental impacts of these

novel biorefineries are important as the different routes/alternatives for use of lignocellulosic material contained in the sugarcane lignocellulosic material (bagasse and straw) are still not consolidated. These studies will require internationally competitive research, development and innovation to ensure sustainable production of the various products that may be obtained from sugarcane biorefinery. This research project will contribute to this scientific and technological demand evaluating the environmental impacts of different alternatives/routes for ethanol, co-products and derivatives production in a sugarcane biorefinery including processes for better integral use of available biomass. This assessment is based on the integration of Life Cycle Assessment with computer simulation platforms and will contribute to the constructions of a tool so called "Virtual Sugarcane Biorefinery".

SUMMARY OF RESULTS TO DATE AND PERSPECTIVES

Various sugarcane biorefinery pathways were evaluated including agricultural, transportation and industrial conversion stages. Significant advances were achieved in the environmental assessment of current and novel sugarcane agricultural production systems; straw recovery alternatives; different technological scenarios for first and second generation ethanol production; different products using green chemistry and thermochemistry routes integrated to a sugarcane biorefinery; and different technological options for second generation ethanol production. Other project results include application of different environmental impact assessment methods and methodological concepts involved in the life cycle assessment of sugarcane ethanol in Brazil. The main findings highlight the importance of comprehensive and reliable tools and methods for environmental impacts assessment applied to all the life cycle stages of different products can be obtained in a sugarcane biorefinery.

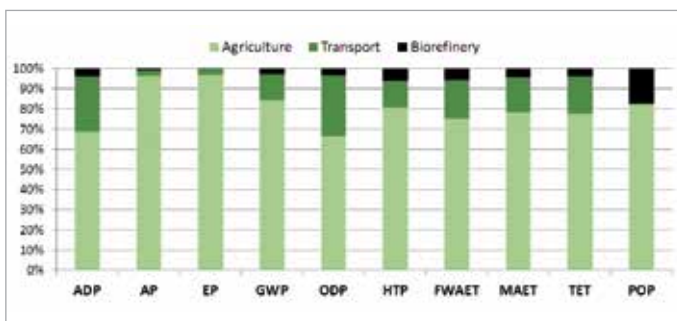


Figure 2. Environmental impacts breakdown for ethanol production stages (environmental impacts: ADP: abiotic depletion, AP: acidification, EP: eutrophication, GWP: global warming, ODP: ozone layer depletion, HTP: human toxicity, FWAET: fresh water aquatic ecotoxicity, MAET: marine aquatic ecotoxicity, TET: terrestrial ecotoxicity, POP: photochemical oxidation) (CAVALETT et al., 2012)

MAIN PUBLICATIONS

- Cardoso TF, Chagas MF, Rivera EC, Cavalett O, Morais ER, Geraldo VC, Braunbeck O, Cunha MP, Cortez LAB, Bonomi A. 2015. A vertically integrated simplified model for straw recovery and use in sugarcane biorefineries. *Biomass and Bioenergy*. **81**: 216-226.
- Cavalett O, Chagas MF, Seabra JEA, Bonomi A. 2013. Comparison of different life cycle impact assessment methods applied to ethanol versus gasoline case study. *The International Journal of Life Cycle Assessment*. **18**: 647-658.
- Cavalett O, Junqueira TL, Dias MOS, Jesus CDF, Mantelatto PE, Cunha MP, Franco HCJ, Cardoso TF, Maciel Filho R, Rossell CEV, Bonomi A. 2012. Environmental and economic assessment of sugarcane first generation biorefineries in Brazil. *Clean Technologies and Environmental Policy*. **14**: 399-410.
- Dias MOS, Junqueira TL, Cavalett O, Cunha MP, Jesus CDF, Rossell CEV, Maciel FILHO R, Bonomi A. 2012. Integrated versus stand-alone second generation ethanol production from sugarcane bagasse and trash. *Bioresource Technology*. **103**: 152-161.
- Dias MOS, Junqueira TL, Cavalett O, Pavanetto LG, Cunha MP, Jesus CDF, Maciel Filho R, Bonomi A. 2013. Biorefineries for the production of first and second generation ethanol and electricity from sugarcane. *Applied Energy*. **109**: 72-78.
- Galdos M, Cavalett O, Seabra JEA, Nogueira LAH, Bonomi A. 2013. Trends in global warming and human health impacts related to Brazilian sugarcane ethanol production considering black carbon emissions. *Applied Energy*. **104**: 576-582.
- Milanez AY, Nyko D, Valente MS, Xavier CEO, Kulay L, Donke CG, Matsuura MISF, Ramos NP, Morandi MAB, Bonomi A, Capitani DHD, Chagas MF, Cavalett O, Gouveia VLR. 2014. A produção de etanol pela integração do milho-safrinha às usinas de cana-de-açúcar: avaliação ambiental, econômica e sugestões de política. *Revista do BNDES*. **41**: 147-208.

Otávio Cavalett

Laboratório Nacional de Ciência e Tecnologia do Bioetanol (CTBE), Centro Nacional de Pesquisa em Energia e Materiais (CNPEM)
Rua Guisepe Máximo Scolfaro 10000
CEP 13083-970 – Campinas, SP – Brasil

+55-19-3518-3197
otavio.cavalett@bioetanol.org.br