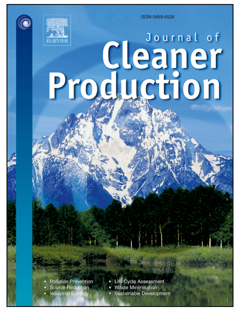
Accepted Manuscript



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PII: S0959-6526(18)30105-7

DOI: 10.1016/j.jclepro.2018.01.090

Reference: JCLP 11770

To appear in: *Journal of Cleaner Production*

Received Date: 23 August 2017

Revised Date: 11 January 2018

Accepted Date: 12 January 2018

Please cite this article as: Liu X, Singh S, Gibbemeyer EL, Tam BE, Urban RA, Bakshi BR, The carbon-nitrogen nexus of transportation fuels, *Journal of Cleaner Production* (2018), doi: 10.1016/j.jclepro.2018.01.090.

The Carbon-Nitrogen Nexus of Transportation Fuels

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Abstract

The advocation of a biobased economy has created a compelling case for consideration of biofuels as an alternative to conventional fossil fuels. However, biofuels must be evaluated on multiple criteria to ensure they truly are an improvement over the fossil fuels they are to replace. This study evaluates the carbon (C) footprint (emissions − sequestration) and reactive nitrogen (Nr) emissions footprint of two fossil fuels, two first generation biofuels, and eight cellulosic fuels, many with process inputs allocated multiple ways to allow for different valuation of inputs and products. For both C and Nr results, fossil and first generation fuels were often the worst options, while cellulosic fuels look notably better, often in both criteria. For most fuels, there is a trade-off between a low C footprint and low Nr emissions footprint, which is investigated throughout the entire nutrient cycles here. Biofuels usually have lower C footprints and higher Nr emissions due to intensive farming processes, while fossil fuels have a high C footprint and lower Nr emissions. However, cellulosic fuels from feedstocks with low farming inputs switchgrass and low intensity high diversity grassland, or from waste feedstocks, such as municipal solid waste and newsprint have low C and Nr footprints, making them better options for transportation fuels. However, just because these fuels have smaller C and Nr footprints than other fuels does not imply they are absolutely sustainable. The capacity of ecosystems to supply ecosystem services should also be considered before sustainability claims are made.

Keywords: carbon-nitrogen nexus, transportation fuels

1. Introduction

Globally, the concerns about climate change, depleting resources, and energy security persist which further pushes the necessity of developing products from biomass and waste. In the United States (US), the Energy Independence and Security Act of 2007 states that production of biofuels must reach 36 billion US gallons ($1.36 \times 10^8\ m^3$) by 2022, with 21

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