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Biodiversity Consequences of Biofuel Production

P Sreevani*

Abstract

The biodiversity impact of biofuels will depend on the biofuel crop and the previous land use. Biofuels can be beneficial to biodiversity when appropriate crops are grown in suitable areas. Conversion of protected areas is usually explicitly prohibited by sustainability standards, but many of these areas of high biodiversity importance fall outside of the protected area network. The paper examines research that investigates the impact on biodiversity; specifically, how the impact is measured as being dependent on the biofuel feedstocks, previous land use and agricultural practices employed and well-managed plantations. However, the paper also provides insights on the evidence that reveals that the cultivation of many of the biofuel feedstocks has a negative impact on biodiversity as a result of habitat conversion and the 'off-farm' impacts of pollution and soil erosion.

Keywords: Biodiversity and Biofuel Production, Ecosystem and Climate Change, Renewable Fossil Fuel

1. **Introduction**

Biofuels can provide answers to current global energy and economic crises - both as a sustainable energy source and through promoting economic development, especially in rural areas of

* Department of Botany, Dr. V.S.Krishna Govt. Degree & PG College (A), Visakhapatnam, India; srvani6@gmail.com

developing countries. Dependence on non-renewable fossil fuels as well as environmental concerns related to air pollution and greenhouse gas effects contributing to global warming and climate change have stimulated interests of policy makers and industry to promote bioenergy as part of energy security and climate change mitigation strategies. One of the major reasons for producing biofuels is to reduce greenhouse gas emissions and to mitigate the effects of global warming produced by fossil fuels. However some unintended impacts of biofuel production are on land, water and biodiversity. They are affected by agricultural production and if the agricultural production is intensified then the side effects are even greater.

The common conception is that growing crops for biofuels will offset the greenhouse gas emissions because they directly remove carbon dioxide from the air. Biofuels are a new priority in efforts to reduce dependence on fossil fuels; nevertheless, the rapid increase in production of biofuel feedstock may threaten biodiversity. There are general principles that should be used in developing guidelines for certifying biodiversity-friendly biofuels. First, biofuel feedstocks should be grown with environmentally safe and biodiversity-friendly agricultural practices. The sustainability of any biofuel feedstock depends on good growing practices and sound environmental practices throughout the fuel-production life cycle. Second, the ecological footprint of a biofuel, in terms of the land area needed to grow sufficient quantities of the feedstock, should be minimised. The best alternatives appear to be fuels of the future, especially fuels derived from microalgae. Third, biofuels that can sequester carbon or that have a negative or zero carbon balance when viewed over the entire production, life cycle should be given high priority. Corn-based ethanol is the worst among the alternatives that are available at present, although this is the biofuel that is most advanced for commercial production in the United States. The pursuit of alternatives to corn as a biofuel feedstock is being encouraged now. Conservation biologists can significantly broaden and deepen efforts to develop sustainable fuels by playing active roles in pursuing research on biodiversity-friendly biofuel production practices and by helping define biodiversity-friendly biofuel certification standards. However, expansion of the

feedstock production for biofuels has been controversial due to potential adverse side effects on natural ecosystems and the services they provide [5]. Ecosystem services are the benefits that humans derive from ecosystems [6] and offer a useful way to assess effects associated with biodiversity and energy use and its implications. There is lack of agreement on the degree to which biofuels both provide positive ecosystem services (e.g., fuel, climate regulation) and compromise other ecosystem services (e.g., biodiversity, food) [4], [9].

2. Biofuel Feedstock Production Interactions with Biodiversity

The choice of feedstock and its location and management is the first step in the biofuel supply system and has great implications for environmental effects. The use of crop, forest and urban wastes does not require any new land area. Residue removal can be done so as to reduce environmental impacts e.g., [8], and it supports the benefits of using biofuels to displace fossil fuels.

2.1 Environmental Impacts

Use of herbicides, pesticides and nitrogenous fertilizers will lead to eutrophication of water bodies and thus will affect the aquatic biodiversity. However, in India since the dominant biofuel crop Jatropha is likely to be grown with no irrigation and no or marginal fertilizer application, the pollution of water bodies is unlikely. Further, the wastelands are not suitable for irrigation. The convention on biodiversity(CBD) has all the regards for both positive as well as the negative impact of biofuel production on biodiversity Sala et al. [] and FAO (2008) stated that increased biofuel production will have negative implications on biodiversity due to (i) habitat conversion and loss; (ii) agricultural intensification; (iii) invasive species; and (iv) pollution. Currently the understanding of the implications of biofuel production from first generation and next generation crops is less well understood, requiring more research.

2.2. Mitigating Impacts of Biofuel Production on Biodiversity and Ecosystem Services

There are several measures for avoiding or reducing environmental impacts of biofuel expansion. First, land-use planning with clearly defined agricultural production zoning can limit the expansion of biofuel crops into pristine ecosystems. Spatial planning based on biofuels is a new priority in the sustained efforts to reduce dependence on fossil fuels; nevertheless, the rapid increase in production of biofuel feedstock may threaten biodiversity. Conservation biologists can significantly broaden and deepen efforts to develop sustainable fuels by playing active roles in pursuing research on biodiversity-friendly biofuel production practices and by helping define biodiversity-friendly biofuel certification standards.

Interest in liquid biofuels production and use has increased worldwide as part of government policies to address the growing scarcity and riskiness of petroleum use, and, at least in theory, to help mitigate adverse global climate change. Promising efforts have included programs to shift toward the production and use of biofuels based on residues and waste materials from the agricultural and forestry sectors, and perennial grasses, such as switchgrass and miscanthus--so-called cellulosic ethanol.

2.3 Biofuel for Subsitituting Petroleum Fuels

India's emerging economy has a growing demand for energy. In 2040, India is expected to account for 15% of the world's oil demand [1]. Facing the decline of global fossil fuel resources and the risk of climate change, the Indian government and energy industry are considering the long-term expansion of biofuel production in order to increase energy security [7]. Biodiesel and bioethanol will play a prominent role to meet the growing fuel demands of the transport sector [10]. While biodiesel has a wide range of applications for trucks, busses, agricultural machinery or for water pumps [1], [11] ethanol is mainly used to substitute petrol for individual transport, which is projected to have enormous growth rates over the coming 30 years [10]. The interest in biofuels in the industrialised countries, apart from promoting energy security, is also aimed at mitigating the threat of climate change by

substituting petroleum fuels. According to IPCC (2007) biofuels have a large potential towards GHG emissions reduction in the transportation sector. On the other hand, developing countries such as India have multiple goals in promoting biofuels, such as promoting energy security, rural development and reclamation of degraded lands. The Government of India has been actively exploring its biofuel potential since 2001 (Government of India, 2005, 2006). The biofuel policy adopted in 2009, an important milestone of India's biofuels initiatives, envisages 20% blending of both biodiesel and bioethanol by 2017 [3].

3. Conclusion

As with all land transformation activities, effects on biodiversity and ecosystem services of producing feedstocks for biofuel are highly variable and context specific. Advances towards more sustainable biofuel production benefit from a system's perspective, recognising spatial heterogeneity and scale, landscape-design principles, and addressing the influences of context, such as the particular products and their distribution, policy background, stakeholder values, location, temporal influences, and baseline conditions. Good governance, strong institutions, market based voluntary certification, and access to information about appropriate management strategies and tactics - all support sustainable resource use and management that can benefit biodiversity. Developing those management strategies takes time and effort. In summary, the negative effects of production of feedstocks for biofuel can be avoided or reduced by conservation of priority biodiversity areas, recognising the context specific effects of feedstock production, and adopting location-specific management of production systems. However, caution is required in interpreting the environmental and socio-economic implications of biofuel production due to limited field experience as well as absence of evidence from the field studies on the negative impacts of biofuel production. India has to develop and adapt sustainable biofuel production practices to minimise any adverse impact and to promote potential synergies with respect to reclamation of degraded lands, creation of rural livelihoods and promotion of energy security. India can go for next generation biofuels which are advantageous over the first generation crops and include the

potential to use a wide variety of feed-stocks, residues and wastes and even whole plants, with potentially higher biofuel yields per hectare.

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