Environmental Development 15 (2015) 64–78

Contents lists available at ScienceDirect

Environmental Development

journal homepage: www.elsevier.com/locate/envdev

Biofuels and biodiversity: Challenges and opportunities

Luciano M. Verdade [a], Carlos I. Piña [b], Luís Miguel Rosalino [c]

[a] Laboratório de Ecologia Isotópica/CENA/Universidade de São Paulo, Caixa Postal 96, Piracicaba, SP 13416-000, Brazil
[b] CICyTTP-CONICET/Fac. CyT, UAdER, Dr. Materi y España, CP 3105 Diamante, Entre Ríos, Argentina
[c] Centre for Ecology, Evolution and Environmental Changes – cE3c, Faculdade de Ciências, Universidade de Lisboa, Campo Grande, 1749-016 Lisboa, Portugal

ARTICLE INFO

Article history:
Received 20 September 2014
Accepted 7 May 2015

Keywords:
Agricultural landscapes
Land use change (LUC)
Agriculture intensification
Bioenergy
Agriculture zoning
Wildlife-friendly agricultural techniques

ABSTRACT

The use of biofuels can result on a decrease of greenhouse gas (GHG) emissions when compared to fossil fuels. However, the expansion of biofuels crops has been either based on direct or indirect displacement of natural ecosystems or on the use of degraded or marginal lands. The former results in direct habitat loss, whereas the later results in usual agricultural impacts (e.g., soil and biotic contamination and water eutrophication). However, in some circumstances biofuels crops can result on an increase in biodiversity compared to other agricultural crops. Agricultural zoning can mitigate the impacts of land use change (LUC), either direct (dLUC) or indirect (iLUC), whereas the use of wildlife-friendly techniques can mitigate the impacts of agriculture intensification. However, in both cases long-term biodiversity monitoring programs should be established in order to help the decision making process concerning the conflict between the expansion of biofuels crops and the conservation of biodiversity.

E-mail addresses: lmverdade@usp.br (L.M. Verdade), cidcarlos@infoaire.com.ar (C.I. Piña), lmrosalino@fc.ul.pt (L.M. Rosalino).

http://dx.doi.org/10.1016/j.envdev.2015.05.003
2211-4645/

1. General impacts of biofuel crops expansion on biodiversity

The environmental concerns related to the dependence on non-renewable fossil fuels (e.g., air pollution, greenhouse effect, global warming and climate change) have been stimulating the bioenergy production based on agricultural crop biomass in many countries of the Southern and Northern hemispheres (Bhattacharya et al., 2003; Cuvilas et al., 2010; Dauber et al., 2010; Dermibas, 2009; Fernando et al., 2010; Fischer et al., 2010a, 2010b; Goldemberg et al., 2008; Junfeng and Runqing, 2003; Koh and Hoi, 2003; Powlson et al., 2005; Sorda et al., 2010; Williams et al., 2009). Oil palm (*Elaeis guineensis*) in Southeast Asia and recently in Central and South America, soybean (*Glycine max*) and sugarcane (*Saccharum officinarum*) in Brazil, soybean in Argentina, sweet sorghum (*Sorghum vulgare*) in China, maize (*Zea mays*) and soybean in USA, wheat (*Triticum aestivum*), sugar beet (*Beta vulgaris*) and rapeseed (*Brassica napus*) in Northern Europe, and jatropha (*Jatropha curcas*) in Southern Asia and in Africa are the main crops used for liquid biofuels production in terms of cultivated area and volume produced (de Vries et al., 2010; Openshaw, 2000). Other sources of organic matter may be used to produce biofuels, like algae (Ferrell and Sarisky-Reed, 2010), perennial grasses (Tilman et al., 2006a) and woody biomass (for both liquid biofuels and coals) (Bright et al., 2010; Fung et al., 2002; Raison, 2006). However, the expansion of biofuel crops may result in direct or indirect environmental impacts (e.g., alterations in habitat quality, pollution, and bioinvasions), besides conflicts between different sectors of society (Koh and Ghazoul, 2008; Wilcove and Koh, 2010). Such impacts are mostly related to land use change (LUC) and/or agriculture intensification and should be rather considered as of primary not secondary concern as suggested by Milazzo et al. (2013). The evaluation of such impacts should be prioritized by scientists and policy makers in order to establish effective mitigating practices. In addition, long-term biodiversity monitoring programs should be established in biofuels landscapes in order to evaluate their long-term environmental impacts. In the following sections challenges and opportunities concerning the expansion of biofuel crops are presented and discussed.

1.1. Land use change

The expansion of biofuels production has been based on land use change (LUC) directly over pristine ecosystems (dLUC), including biodiversity hotspots (Fig. 1) (Fitzherbert et al., 2008), less

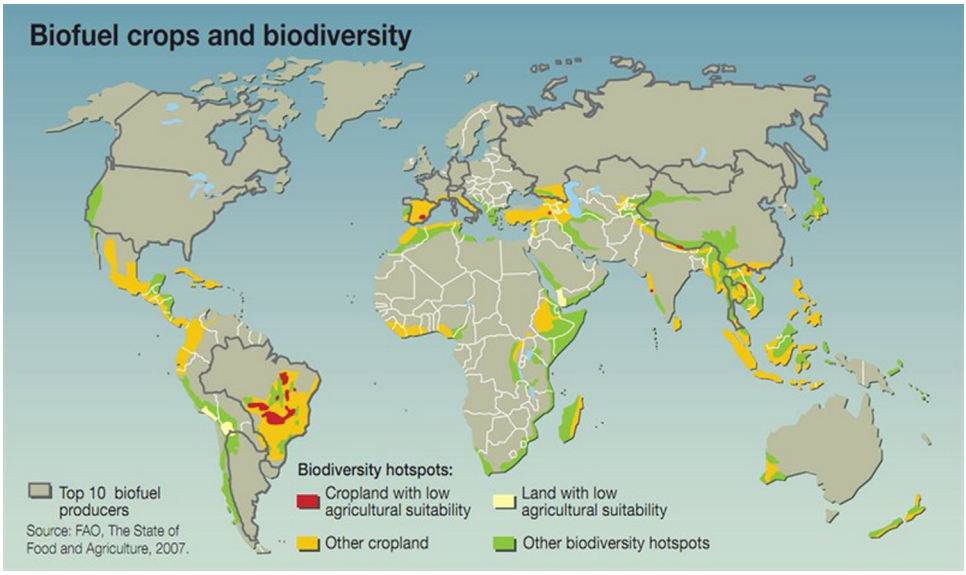

Fig. 1. World distribution of biofuel producers and biodiversity hot spots. (Source: FAO, 2007. The state of food and agriculture).