Land Use Policy 68 (2017) 597–603

Contents lists available at ScienceDirect

Land Use Policy

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

A framework proposal for sustainability assessment of sugarcane in Brazil

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ARTICLE INFO

Keywords:
Biofuels
Etanol
Public policies
Sustainability evaluation

ABSTRACT

In many countries, the biofuels sector was encouraged to expand its activities supported by public policies incentives, especially to achieve improvements in energy security and to reduce greenhouse gas (GHG) emission. The Brazilian government followed these initiatives and undertook some responsibilities against the international scenario related to climate change. One of the theses commitments concerning actions to reduce the GEE emissions by some 37% by 2020. The Sugarcane Agroecology Zoning provides technical subside to policy makers to direct sugarcane expansion to permitted areas and a sustainable production in Brazil and is considered a guideline to sustainable sugarcane production in Brazil. However, although aiming at a sustainable production, the zoning only considered natural aspects of the country, as soils and climate and an approach that consider all the dimensions of the sustainability is still missing. Hence, this paper aims to propose a framework to evaluate biofuel sustainability to support public policies, especially concerning improvements in Brazilian decision-supporting tools.

1. Introduction

Supported on some cases of incentives and policy measures, as Directive 2009/28/Ec of the European Parliament and of the Council, Cramer Certification, The Renewable Transport Fuel Obligation (RTFO) and others, global ethanol and biodiesel production are both expected to expand to reach, respectively, almost 134.5 and 39 billion litres (BlnL) by 2024 (OECD/FAO, 2015). Thus, sustainable biomass for biofuel production from agricultural crops continues to ignite debate and discussion (Buyx and Tait, 2011; Florin et al., 2014). Some discussion that could be added to the criteria presented above are about trade-offs, how these show trade-offs; and hence how to value their relative importance. However, Kuyper (oral communication) stresses that it is useful that trade-offs imply that the system cannot be maximised for sustainability in all three dimensions; it can be optimised, but it needs a political process to balance and evaluate environmental, economic and social sustainability.

Biofuels are a complex system that consider the social, economic and environmental sustainability domains (Mangoyana, 2009). Academics, state governments, government agencies, non-governmental organisations, and international agencies seeking to identify the key sustainability issues in biofuel developments have produced many publications providing insights into the social, economic and environmental issues related to the development of biofuel systems. Notable contributions include the UN-Energy's (the interagency formation on energy under United Nations), (UN-ENERGY, 2007), United Nations department of Economic and Social Affairs' (UNDESA) (UNDESA, 2017), the World Wide Fund for Nature funded and the German Federal Ministry for Economic Cooperation and Development Commissioned (Fritsche et al., 2006) and the EU's "Proposal for a directive of the European Parliament and of the Council on the promotion of the use of energy from renewable sources" (European Commission, 2016).

Mangoyana (2009) highlighted some common conclusions regarding these publications:

_ Biofuel systems are complex systems characterised by interacting human and natural systems. They are characterised by trade-offs between social, economic and environmental dimensions of biofuels sustainability;

_ There is need for a holistic approach which integrates social, economic and environmental issues to determine the sustainability of the total biofuel system;

_ Spatial scale issues influence sustainability outcomes with community oriented decentralised systems scoring high on improving local sustainable development and centralised production systems scoring

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http://dx.doi.org/10.1016/j.landusepol.2017.08.011
Received 7 April 2017; Received in revised form 7 August 2017; Accepted 10 August 2017

high on economies from scale production.

A fierce debate about the sustainability of biofuels has developed over the course of 2007, as the rush for energy crops might have contributed to the unprecedented increase in the number of food insecure people while benefits for greenhouse gas reductions are unclear. Sustainability criteria for biofuels are being developed currently, implying that: a) A certain percentage of greenhouse gas reduction should be attained compared to the use of fossil fuels; b) Competition with food should not endanger food security and other local applications of plant biomass, e.g. medicines; c) Protected or vulnerable biodiversity may not be affected; d) The quality of soil, air and water must be sustained; e) Biofuel production must contribute to local welfare; f) Biofuels must contribute to the well-being of employees and local population (Bindraban et al., 2009). Thus, this list seems to summarize the sustainability issues as it includes the environmental, economic and social aspects. However, the difficulty is to use all of these aspects in an integrative way and, more than that, to define criteria and find indicators that could show the performance of each aspects.

This paper aims to propose a framework to evaluate biofuel sustainability to support public policies, especially concerning improvements in Brazilian decision-supporting tools. To do so, an extensive literature review was done and fifteen scientists with multidisciplinary experience in biofuel sustainability issues were interviewed.

1.1. Sustainability of biofuels

Sustainability is an essentially integrative concept and it was defined in many ways. The most frequently quoted definition is from *Our Common Future*, also known as the *Brundtland Report* (WCED, 1987): "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts: the concept of needs, in particular the essential needs of the world's poor, to which overriding priority should be given; and the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs."

Considering the insurance for agricultural production for future, one concept championed to produce a 'win–win' for food production and biodiversity is "sustainable intensification" (Nimmo, 2014). However, Loos et al. (2014) highlight that sustainable solution for food security must be holistic and must address issues such as food accessibility.

Many authors discussed about the sustainability of crop production, including biofuels. For Smyth and Dumanski (1993), sustainable production systems can be defined as: "systems that have an economically and socially acceptable, stable production level while natural resources in the ecosystem are protected and soil and water degradation is avoided" (Florin et al., 2014). For Mangoyana (2009) the process of establishing a biofuel sustainability framework involves identifying key dimensions, each of them considered critical in the process of understanding the sustainability issues of biofuels and hence system learning. For Gibson (2006), it seems reasonable, then, to design sustainability assessment as an essentially integrative process and framework for decision making on undertakings that may have lasting effects.

The European Union (EU) also pursues sustainability criteria for biofuels feedstock production, processing and trade, since the rapid expansion of biofuel production and consumption has raised concerns over the social and environmental sustainability (German and Schoneveld, 2012). The Renewable Energy Directive 2009/28/EC of the European Union includes a set of mandatory sustainability criteria as part of an EU sustainability scheme and monitoring and reporting requirements for biofuels and bioliquids (EU, 2009). Similar sustainability requirements were set in the Fuel Quality Directive 2009/30/EC (EC, 2009) on the specification of petrol, diesel and gas–oil and introducing a mechanism to monitor and reduce GHG emissions. Biofuels are required to fulfil all sustainability criteria to count towards EU targets and to be eligible for financial support. The EU Member States are responsible for checking compliance with the sustainability criteria, but the European Commission can recognise voluntary sustainability certification schemes. The EU-RED excludes several land categories, with recognised high biodiversity value, from being used for biofuel production: (a) primary forests and other wooded land; (b) areas designated for nature protection or for the protection of rare, threatened or endangered ecosystems or species; (c) highly biodiverse grassland, either natural or non-natural. Biofuels should not be made from material from peatland and land with high carbon stock, such as: (a) wetlands; (b) continuously forested areas; (c) land covered by trees higher than 5 m and a canopy cover between 10% and 30% (Scarlat et al., 2011).

To ensure that biomass as a source of renewable sustainable energy is produced and processed in a responsible manner, the Dutch government incorporated sustainability criteria for biomass into the relevant policy instruments. In preparation for the above-mentioned policy, the Dutch government has set up the "Sustainable production of biomass" project group. This work is known as Cramer's index and it proposes criteria for the production and the processing of biomass in energy, fuels and chemistry. Here it does not make any difference if the biomass originates from the Netherlands, from the EU or outside the EU. In this matter, the project group has always consulted the different parties involved, to ensure a broad support base. For the development of Cramer' index (Cramer COMMISSION, 2017) six relevant themes were distinguishes: 1) How much emission reduction does the use of biomass yield for a specific producer, calculated from its source up to its use, and compared with the average use of fossil fuel? 2) Competition with food and other local applications: Does large-scale production of biomass for energy supply supplant other uses of the land, for example for the cultivation of food or wood as building material, and what are their consequences? 3) Biodiversity: Does the local natural ecological system of land and water lose any variation in forms of life because of the large-scale cultivation of energy crops? 4) Environment: Are there any effects of the use of pesticides and fertilizers, or are there other local effects on soil, water and air because of the large-scale production of biomass? 5) Prosperity: Does the production of biomass contribute towards the local economy? 6) Social well-being: Does the production improve the social living conditions of the local population and employees?

2. Material and methods

2.1. Study case – Brazilian ethanol

Since the concern with Kyoto Protocol targets, the energy matrix and the strategies for sustainable economic development have been the centre of discussions of experts and global authorities. This new scenario inserted has led ethanol into agendas and policies, especially in developed countries, like the United States and members of the EU. Bioethanol from Brazil is an attractive biofuel because of its low price and relatively large greenhouse gas emissions reduction potential (Buckeridge et al., 2012; Martinelli and Filoso, 2008). In this way, the Brazilian government undertook some responsibilities against the international scenario related to climate change. One of the theses commitments concerning actions to reduce the GEE emissions by some 37% by 2020 (BRASIL, 2009).

Concerning the sugarcane expansion in Brazil from 1975 to 2012, it increased 413% in growing area, which represents some 7 million of hectares. It is important to highlight that in 1975 there was an important public policy to stimulate sugarcane production called *Proalcool*. During the entire period, many public policies were designed but most of them were related to economic incentives to sugarcane production. Only in 2009, with Decree 6.961, a public instrument to be used as a guideline for sugar cane expansion was created – the *Sugarcane Agroecology Zoning* (Manzatto et al., 2009) – considered a guideline to sustainable sugarcane production in Brazil. The main aim