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Corrigendum

Corrigendum to “A framework proposal for sustainability assessment of sugarcane in Brazil” [Land Use Policy 68 (2017) 597–603]

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ABSTRACT

In many countries the biofuel sector was encouraged to expand its activities, supported by public policies incentives, with the main aims to improve energy security and to reduce greenhouse gas (GHG) emissions. The Brazilian government followed these initiatives and undertook its responsibilities considering the international consensus related to the need to mitigate climate change. One of the theses commitments concerned actions to reduce the GHG emissions by 37% in 2020. The Sugarcane Agroecology Zoning provides technical support to policy makers in order to direct sugarcane expansion to permitted areas. It is considered a guideline to achieve sustainable sugarcane production in Brazil. However, although the zoning aimed at sustainable production, it only considered natural aspects of the country, as soils and climate. Currently an approach that considers all three dimensions of sustainability (environmental, economic, social) is still missing. This paper proposes a framework to evaluate biofuel sustainability to support public policies, especially concerning improvements in Brazilian decision-support tools.

1. Introduction

Supported by incentives and policy measures, such as Directive 2009/28/EC of the European Parliament and of the Council, the 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 by 2024 (OECD/FAO, 2015). Thus, sustainable biomass for biofuel production from agricultural crops continues to ignite debate on sustainability (Buyx and Tait, 2011; Florin et al., 2014). These discussions often revolve around the three dimensions of sustainability (environmental, economic, and social), their trade-offs, how these trade-offs should be analysed, and hence how the relative importance of the underlying dimensions should be valued. The concept of trade-offs (rather than that of the common discourse on win-win situations) stresses that the system cannot be maximised for sustainability in all these three dimensions (Kuyper and Struik, 2014). While systems can be optimised for some dimension, it needs a political process to balance environmental, economic and social sustainability.

Biofuels are a complex system that includes 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 (the interagency formation on energy under United Nations; UN-ENERGY, 2007), the United Nations department of Economic and Social Affairs (UNDESA, 2017), the World Wildlife Fund, the German Federal Ministry for Economic Cooperation and Development (Fritsche et al., 2006), and the EU *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, 2008).

Sustainability criteria for biofuels are currently being developed, implying that:

- A certain percentage of greenhouse gas reduction should be attained compared to the use of fossil fuels;
- Competition with food should not endanger food security and other local applications of plant biomass, e.g. medicines;

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- Protected or vulnerable biodiversity may not be affected;
- The quality of soil, air and water must be sustained;
- Biofuel production must contribute to local welfare;
- Biofuels must contribute to the well-being of employees and local population (Bindraban et al., 2009).

This list summarises 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 importantly, to define criteria and find indicators that could show the performance of each aspect. Brazilian et al. (2011) provided a rationale for addressing the nexus in a quantitative manner and presented a modelling framework that could support effective policy and regulatory design. Case studies clearly showed the need for this type of analysis and consequent upon the analysis, the implementation of the required institutional changes. However, Buchholz et al. (2009) noted the lack of clear consensus amongst bioenergy experts and other stakeholders which indicators are critical and mandatory and which framework should become standard practice.

Sustainability is an essentially integrative concept and it has been 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 imperative of agricultural production for future generations, one concept championed to produce win–win situations for food production and biodiversity is “sustainable intensification” (Nimmo, 2014). However, Loos et al. (2014) and Struik and Kuyper (2014) pointed out that assumptions of win-win situations are often naive and that sustainable solutions for food security must address issues such as food accessibility, which is a social issue rather than a agronomic challenge. Many authors discussed the sustainability of crop production, including the production of 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*. 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 activities that may have lasting effects.

The European Union (EU) also pursues sustainability criteria for biofuel production, processing and trade, since the rapid expansion of biofuel production and consumption has raised concerns over social and environmental sustainability (German and Schoneveld, 2012). The Renewable Energy Directive (RED) 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, 2009a). Similar sustainability requirements were set in the Fuel Quality Directive 2009/30/EC (EU, 2009b) 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, for use 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 furthermore not be made from material from peatland and land with high carbon stocks, 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 by the project group has resulted in what is known as Cramer's index and it proposes criteria for the production and the processing of biomass in energy, fuels and chemistry (Cramer Commission, 2007). In this regard it does not make any difference if the biomass originates from the Netherlands, from the EU, or from outside the EU. The project group has consistently consulted the different parties involved in order to ensure a broad support base for its proposed policies. For the development of Cramer's index (Cramer Commission, 2007) six relevant questions were distinguished:

- 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?
- 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?
- 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?
- 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?
- Prosperity: Does the production of biomass contribute towards the local economy?
- Social well-being: Does the production improve the social living conditions of the local population and employees?

Isolated initiatives concerning sustainability of biofuels can also be found in Brazil, but all of them have limitations in quantity, quality and integration of criteria (Goldemberg et al., 2008; Gomes et al., 2016; Machado et al., 2015; Silva Lora et al., 2011). This paper aims to propose a framework to evaluate biofuel sustainability to support public policies, especially concerning improvements in Brazilian decision-support tools. To do so, an extensive literature review was done and fifteen scientists from various disciplines with experience in biofuel sustainability issues were interviewed.

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 at the centre of discussions by experts and global authorities. This new perspective on biofuels has led ethanol into policy agendas, especially in developed countries, like the United States and members of the EU. Bio-ethanol 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). By growing sugarcane in order to produce bio-ethanol, the Brazilian government undertook some of its responsibilities to make its national contribution to the attempts to reduce climate change. One of these commitments concerned actions to reduce GHG emissions by 37% by the year 2020 (Brasil, 2009).