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Analysis of socio-economic impacts of sustainable sugarcane–ethanol production by means of inter-regional Input–Output analysis: Demonstrated for Northeast Brazil

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ABSTRACT

This study assesses the socio-economic impacts in terms of value added, imports and employment of sugarcane-derived bioethanol production in Northeast (NE) Brazil. An extended inter-regional Input–Output (IO) model has been developed and is used to analyse three scenarios, all projected for 2020: a business-as-usual scenario (BaU) which projects current practices, and two scenarios that consider more efficient agricultural practices and processing efficiency (scenario A) and in addition an expansion of the sector into new areas (scenario B). By 2020 in all scenarios, value added and imports increase compared to the current situation. The value added by the sugarcane–ethanol sector in the NE region is 2.8 billion US$ in the BaU scenario, almost 4 billion US$ in scenario A, and 9.4 billion US$ in scenario B. The imports in the region will grow with 4% (BaU scenario), 38% (scenario A) and 262% (scenario B). This study shows that the large reduction of employment (114,000 jobs) due to the replacement of manual harvesting by mechanical harvesting can be offset by additional production and indirect effects. The total employment in the region by 2020 grows with 10% in scenario A (around 12,500 jobs) and 126% in scenario B (around 160,000 jobs). The indirect effects of sugarcane production in the NE are large in the rest of Brazil due to the import of inputs from these regions. The use of an extended inter-regional IO model can quantify direct and indirect socio-economic effects at regional level and can provide insight in the linkages between regions. The application of the model to NE Brazil has demonstrated significant positive socio-economic impacts that can be achieved when developing and expanding the sugarcane–ethanol sector in the region under the conditions studied here, not only for the NE region itself but also for the economy of the rest of Brazil.

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1. Introduction

Among first generation biofuels, sugarcane derived ethanol produced in Brazil is one of the most competitive fuels and is, together with corn based ethanol from the US, one of the two world leading sources of biofuel, covering 87% of global production [1,2]. The production of fuel ethanol has increased enormously over the last decade, from 340 PJ in 2000 to 1540 PJ in 2009, and to over 1780 PJ in 2011 [2,4]. Sugarcane–ethanol also has a favourable GHG balance, compared to other crops such as sugar beet, wheat straw and corn [1,5]. Brazil is a large producer thanks to amongst other reasons, the supportive governmental policies [6,7]. Brazil also has a favourable tropical climate with sufficient rainfall and high temperatures. Brazil produced 506 PJ ethanol in 2009, and around 540 PJ in 2011,which is about one-third of the total global fuel ethanol production. The majority ($>80\%$) is used within Brazil, export is limited and fluctuates with the price of sugar [2]. The majority of sugarcane and ethanol production in Brazil, is located in the Centre-South (CS) of Brazil. In the Northeast (NE) of Brazil, on the other hand, mostly sugar is produced and only 7% of the total national ethanol production [8].

In order to facilitate manual harvesting, sugarcane fields need to be set on fire to remove dry leaves and repel poisonous animals. There are numerous negative impacts associated with burning sugarcane such as soil degradation and increased air pollution. Therefore, a Brazilian regulation that came up in 2002 (11241/02), aimed to gradually eliminate this practice by limiting manual harvesting and replacing it with mechanised harvesting. Mechanised harvesting brings along a number of benefits such as soil improvement; leaves of the sugarcane are left on the ground, instead of being burned, acting as fertilizers and maintaining the humidity of the soil. Furthermore, it is more cost effective. On the other hand, mechanised harvesting negatively impacts employment, an estimated 114,000 sugarcane cutters are expected to lose their jobs in the CS region between 2006 and 2020 [9]. Most of these workers are immigrants from the NE.

There are large differences between the production systems of sugarcane–ethanol of the CS and the NE regions. While the production in the CS is well developed and continuously improving in terms of efficiency and sustainability, the productivity achieved in the NE is lower due to climate, terrain characteristics and lower technological levels. Although the sector in the NE has some benefits compared to the sector in the CS such as good storage and loading infrastructure in the terminals, lower transport costs, higher incentives for sugar exports, there is still room for improvement in the production sector of the NE [10]. In the CS region, 50% of the sugarcane is mechanically harvested while in the NE manual harvesting still predominates in 95% of the areas. This is due to the uneven topography of the NE where 50% of the sugarcane production areas has slopes above 12%. Areas in the NE that have slopes lower than 12%, need to comply with the law whereby mechanisation of harvesting is required by 2018. In the remaining areas, mechanised harvesting will theoretically be implemented by 2031. However, due to the lack of operational harvesting machines for steep slopes, the deadline to comply with the regulation in the areas with slopes steeper than 12%, is still not clear. The NE region stands out as the poorest region of the country with a high number of people living under the poverty line and a high rate of illiteracy. There is a need to develop the NE region to promote economic growth and to create job opportunities. Gaining more insight into