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BIOMASS & BIOENERGY

Sustainability trade-offs in bioenergy development in the Philippines: An application of conjoint analysis

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ARTICLE INFO

Article history:
Received 15 July 2011
Received in revised form
4 March 2014
Accepted 11 March 2014
Available online 8 April 2014

Keywords:
Bioenergy
Biofuels
Conjoint analysis
Philippines
Sustainability
Trade-off analysis

ABSTRACT

Sustainability assessments of bioenergy production are essential because it can have both positive and negative impacts on society. Human preferences that influence trade-off decisions on the relevant determinants and indicators of sustainability should be taken into account in these assessments. In this paper, we conducted a survey with five groups of respondents including government officials and employees, academic and research professionals, private company managers and workers, farm owners and workers, and others (e.g. students, residents, etc.) to assess their trade-off decisions on bioenergy development in the Philippines. The analyses of the survey results reveal that sustainability of bioenergy production will depend on the choice of biomass feedstock and these choices depend on people's perceptions. Heterogeneous perceptions among the different groups of respondents on the appropriate bioenergy feedstock to achieve economic, social and ecological sustainability suggest that sustainability of bioenergy is not a generic concept. The use of aggregate indices for sustainability assessments that ignore these perceptions on bioenergy production can thus be very misleading. The preference weights from conjoint analysis, which measure human preferences on different determinants and indicators of economic, social and ecological sustainability, can help improve sustainability assessments.

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http://dx.doi.org/10.1016/j.biombioe.2014.03.015
0961-9534/

1. Introduction

Bioenergy production can have both positive and negative impacts on society. On the one hand, reduction in green house gases (GHG) emissions, increase in energy security, promotion of rural development, and increase in export revenues are the most cited arguments for bioenergy production [e.g. Refs. [1–4]]. On the other hand, the recent undesirable experiences concerning, among others, regional food availability and accessibility [e.g. Refs. [5–7]], forest degradation [e.g. Refs. [8–10]], and social conflicts [e.g. Refs. [11–13]] are key contemporary controversies confronting the bioenergy sector. Opinions are at odds because the institutional structure of bioenergy is complex. Bioenergy production involves different products, different sectors and a range of actors interacting at and across different levels [14]. Thus it not only provides opportunities to generate multiple benefits apart from energy generation, but also causes conflict with many interests due to these interlinkages [15]. Developing a bioenergy sector that is sustainable is thus an immense challenge because the long-term maintenance of economic, social and ecological well-being is not that straightforward. The sustainability of bioenergy is broadly gauged on its economic, social and ecological impacts. Understanding the scope and magnitude of these impacts depends largely on how we frame the interconnections and interdependencies between the economic, social and ecological determinants of sustainability. In this paper, we build on a framework for assessing the sustainability of bioenergy production that we have previously proposed, called STRAP (sustainability trade-offs and pathways) approach [16]. In this approach bioenergy sustainability is defined based on a region's capacity to achieve a balance between economic stability, social equity and ecological balance. For each sustainability dimension, we have identified the most relevant sustainability determinants based on available relevant theories and evidences from case studies. The determinants not only represent the complementary and/or competitive views on the use of first and second generation bioenergy crops for food and fuel production, but also capture the inherent potential contradictions and controversies in achieving a balance between the three sustainability dimensions.

Although the determinants of sustainability are valued differently in different regions or societies, in practice, they are at present combined somewhat arbitrarily into aggregated indices. Individual judgements and decisions that are critical to achieving the right balance between economic, social and ecological determinants are thus often neglected in sustainability assessments, decreasing the likelihood of broad acceptance of a balanced strategy by key actors and participants. Keeping a balance does not necessarily mean equal allocation but logical distribution of weights according to human needs and preferences. Sustainability assessment should thus set off from understanding how and why a society trades off one objective for the other to achieve its goals. In this paper, we aim to contribute to an understanding of trade-off decisions by a society through developing an empirical application to the STRAP framework. To do this, we followed the method of Sydorovych & Wossink [17], who were first to apply conjoint analysis to elicit preferences on agricultural sustainability. However, this paper improves the application of conjoint analysis for sustainability assessment in two aspects. First, whilst Sydorovych and Wossink took a very broad approach in assessing agricultural sustainability, we are more explicit in defining the context of the assessment. We explicitly link the determinants of sustainability to particular types of agricultural crops. This is important because sustainable development depends on the resource requirement, production structure, market infrastructure, welfare contribution, etc. of a specific agricultural system. Second, whilst their work only serves a pedagogical purpose thus justifying the use of a non-representative sample, here we applied the method to estimate utilities and preference weights that can be further used for assessing sustainability trade-offs and creating more sensible aggregate sustainability measures for bioenergy crops. Through a survey we elicited preferences of people who are working in the government, academe/research, private companies, on farm and others regarding their perception of different economic, social and ecological determinants of sustainability in the Philippines. The paper is organised as follows: Section 2 describes the energy sector in the Philippines, Section 3 presents the concept and methods for the analyses, Section 4 discusses the results of the survey and conjoint analyses, and Section 5 presents the conclusions from these results.

2. The Philippine energy sector

Energy demand in the Philippines was growing at an average annual rate of negative 0.3 percent from 24.4 to 23.8 MTOE (i.e. Million Tons of Oil Equivalent) from 1999 to 2009 [18] despite the increase in gross domestic product (GDP) and population [19]. The economy has been growing at an average annual rate of 4.5 percent, with GDP increasing from 918.2 to 1432.0 billion Pesos from 1999 to 2009. The average annual growth rate of the population was 2.1 percent, increasing from 74.7 million to 92.2 million for the same period. The negative growth in energy demand is also reflected in the constant decline in energy (−4.0 percent), oil (−6.4 percent) and electricity (−0.4 percent) intensity over the same period. The declining trend in energy consumption and intensity has been mainly contributed to the decline in energy demand in residential applications and in agriculture, which showed an average annual growth rate of −2.8 and −2.1 percent, respectively. The continuing increase in the prices of petroleum prompted the consumers to utilise energy in more prudent ways [20]. After the transport sector (36.5 percent), the residential sector (26 percent) accounted for the largest share in total domestic energy demand. Whilst energy demand declined, energy supply continued to increase, albeit at a slow rate of 0.4 percent per year from 38.1 to 39.6 MTOE. The self-sufficiency level in energy increased from 48.6 percent in 1999 to 59.2 percent in 2009 as a result of the increase in indigenously supplied energy. Renewable energy such as geothermal energy and biomass is important indigenous sources of energy in the Philippines (Fig. 3). The energy from biomass, which is mostly derived from forest and agriculture residues, and bagasse, is mainly used for traditional household cooking. Thus, there is