IEA Bioenergy
Technology Collaboration Programme

Weighting sustainability criteria for biomass supply chains

Summary Series

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The sustainability of biomass supply chains

The sustainability of biomass supply chains is a controversially debated topic, especially given their important role in the growing bioeconomy. The use of biomass, in its different forms, produce effects on different dimensions, from greenhouse gas (GHG) emissions levels to the trade-offs in the local economy, among others. Whereas there are several existing methodologies to evaluate the overall sustainability profile of biomass supply chains, those usually make use of criteria grouped in three main categories: economic, social and environmental, each one with additional sub-criteria. A crucial question, however, is to identify which one of these criteria and sub-criteria should be considered over the others. In this study, we aimed to identify clear priorities among different criteria for that purpose. First, we proposed a hierarchy of criteria (**Fig 1**), considering the most common criteria found in the literature. To determine priority weights for each of the criteria, we consulted a large number of global bioenergy experts (N=122), who shared their insights in a questionnaire distributed from November 2019 to February 2020. In the questionnaire, we presented weighted pairwise comparisons of all the criteria and sub-criteria.

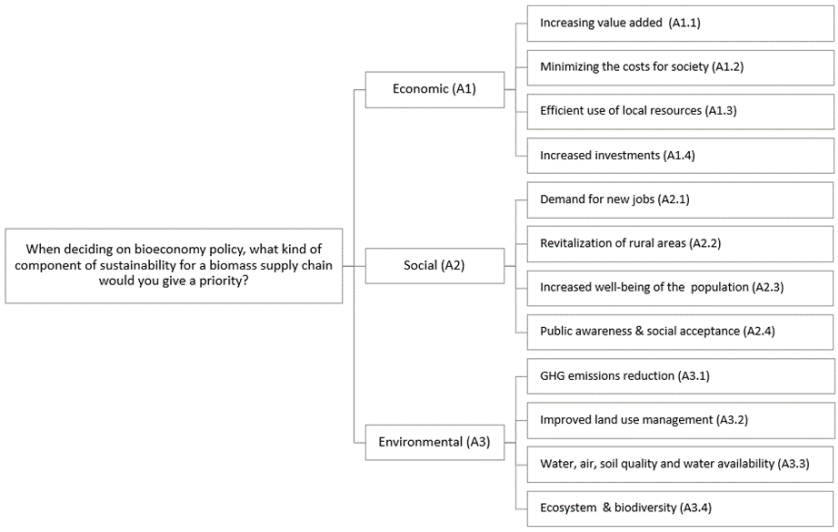

Fig 1. Hierarchy of the sustainability alternatives considered in the assessment. For each main sustainability criteria (economic, social and environmental) four sub-criteria are proposed.

Weighting priorities

The criteria were weighted using the analytic hierarchy process (AHP) approach. For each expert, we determined the relative priority of each criterion and sub-criterion as a percentage. To combine all individual experts' assessments, consensus regions (areas where answers from different experts coincide) were identified using kernel methods (**Fig 2**). By defining consensus regions rather than a single aggregated value, we can better reflect the complexities of comparing diverse criteria while at the same time providing viable recommendations to policy makers. We found that most of experts are clustered in two distinct priority groups (**Fig 2**). The trade-offs between the alternatives (sub-criteria) were also analysed pairwise.

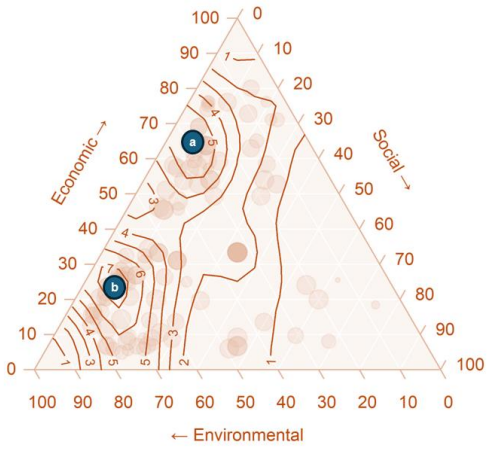

Fig 2. The priority weights of the individual experts in the three-scale chart are represented by a circle, the size of which is determined by the consistency achieved by the individual experts in the comparisons. The contour lines represent the coincidence of similar weights (*consensus regions*).

Two clusters appear in the values, (a) around a high-economic priority and (b) around a high-environmental priority.

Regardless of the estimated priorities of the main criteria, the experts agree that the use of local resources, the revitalization of rural areas and the reduction GHG emissions are the alternatives with the highest priority, for the economic, social and environmental alternatives, respectively. These are the factors that deserve special attention when assessing the sustainability of biomass supply chains and should be particularly emphasized when planning. The relatively lower rating of social criteria may be due to a lack of understanding of their long-term impacts or a lack of relevant literature on the topic, and it is possible that new social concerns will emerge in parallel with the development of the field.

Experts are divided in two main orientations, *economic* and *environmental*. The differences in priorities are partly due to the contextual factors and the background of the experts. In all cases, there is a consensus that the reduction of greenhouse gas emissions under the environmental criteria, the revitalization of rural areas under the social criteria and the use of local resources under the economic criteria must be priority.

The study provides solid results to assess the sustainability of different supply chains and specific priorities for all criteria considered, with applications to climate mitigation strategy, energy policy and biomass supply planning.

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