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# Prioritizing objectives to evaluate the environmental, economic and social impacts of biofuel in Spain

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**Abstract—** A variety of opinions either in favour or against development of biofuels has risen in the last years related to the environmental, economic and social impacts that its diffusion could entail compared to petroleum. Although the EU, in general, and Spain, in particular, are strongly supporting the development of biofuels they highlight that energy planning must be based on a sound analysis of the impacts of the diverse alternatives. This poster is a preliminary approach to this analysis. The main aim is to prioritize a set of environmental, economic and social objectives to identify the most relevant issues that would allow evaluating the impacts of the biofuel production and consumption in Spain. Analytic Network Process (ANP) and Analytic Hierarchy Process (AHP) are the multicriteria decision-making methodologies implemented to deal with the problem based on experts' knowledge. The superiority of ANP versus AHP is discussed and the former is recommended. Results indicate that the most important objectives for a sustainable development of biofuels in Spain are conservation of non-renewable resources, within the environmental issues, the ease to be technically implemented in production, storage, distribution, and consumption, within the economic issues, and the direct employment in the agro-energy system, within the social issues.

**Keywords—** : Biofuel, sustainability, ANP

## I. INTRODUCTION

The EU is strongly supporting the development of biofuels in the last years. The main objectives are the abatement of GHG emissions and the development of alternatives to petroleum. The EU highlights, however, that energy management must be based on a sound analysis of the economic, environmental and social impacts of the diverse alternatives [1]. Spanish Reg. "Ley 34/1998" establishes that fuels for transport must contain an increasing percentage of biofuels: 1.9% in 2008, 3.4% in 2009, and 5.83% in 2010. Therefore a

research on the evaluation of the multiple impacts of foreseeable scenarios of biofuel production and consumption in Spain is necessary to support policy decision-making guiding technological change towards sustainable development. This poster is a preliminary approach to this evaluation and is in the framework of a wider research on the economic and environmental analysis of agricultural systems oriented toward energy production. The main aim of the poster is to prioritize a set of environmental, economic and social objectives to identify the most relevant issues that would allow evaluating the impacts of the biofuel production and consumption.

## II. METHODOLOGY

ANP, Analytic Network Process [2] is a multicriteria decision-making tool. It is a generalization of the widely used AHP, Analytic Hierarchy Process [3], and includes dependence and feedback among decisional elements. Results obtained with ANP are more precise than those obtained with AHP. However the former methodology is not so frequently implemented in the literature. ANP and AHP are used to deal with complex, uncertain and risky decision problems. ANP (AHP) proposes to break down a decision problem in a network (hierarchy) of objectives that allow comparing a set of discrete alternatives. Global performance of the alternatives with respect to all the objectives determines the relative priority of each alternative in terms of importance, preference or probability. Alternatives (foreseeable scenarios of production and consumption of biofuel) will be defined and incorporated in the evaluation process in subsequent research. In this poster, as a first step, objectives have been prioritized. Knowledge of seven experts on agricultural sustainability was used to evaluate the ANP network

and AHP hierarchy. ‘Direct rating’ assessment [4] was used as elicitation method.

prioritization of these objectives was carried out by applying ANP and AHP. Differences among results are due to the consideration of interdependences among objectives in ANP (Fig. 1 to Fig. 3).

### III. RESULTS

On the basis of a predefined set of economic, environmental and social objectives [5], a

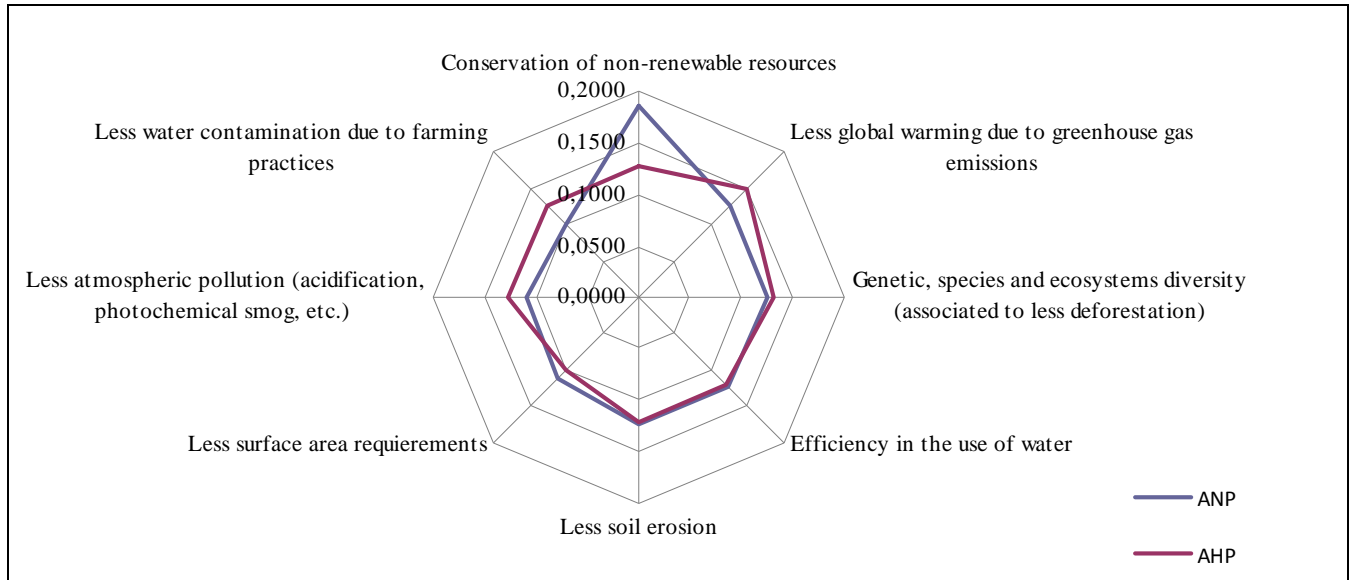


Fig. 1. Comparison of environmental objectives' priorities with ANP and AHP

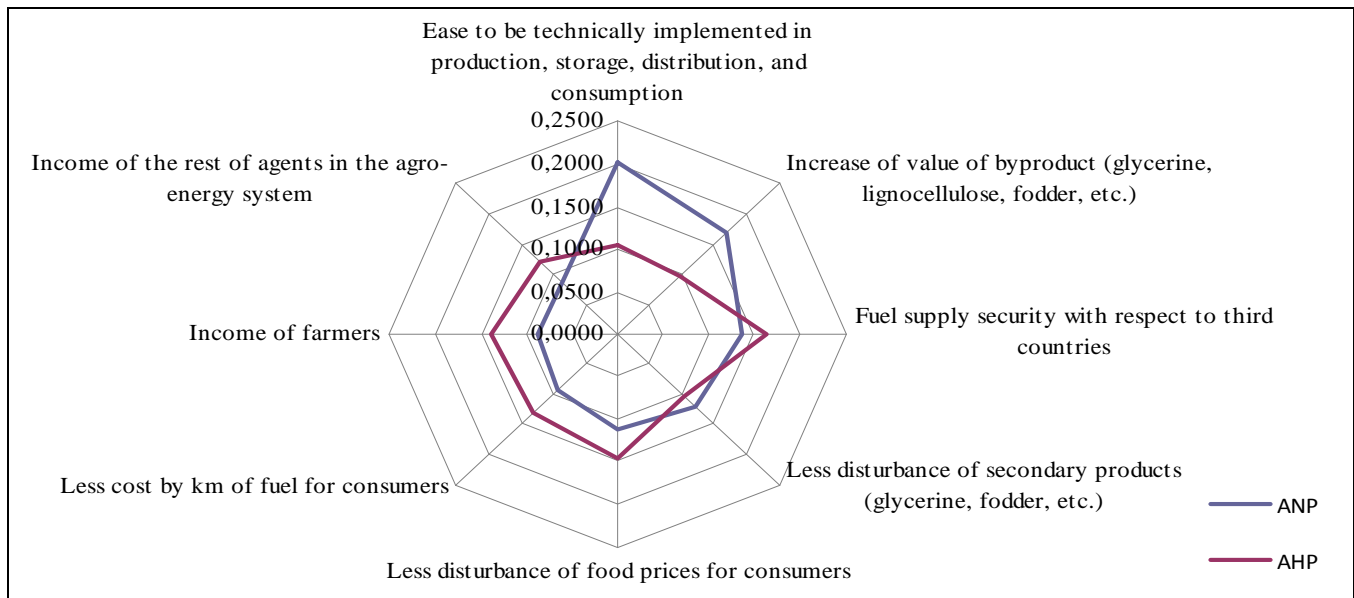


Fig. 2. Comparison of economic objectives' priorities with ANP and AHP

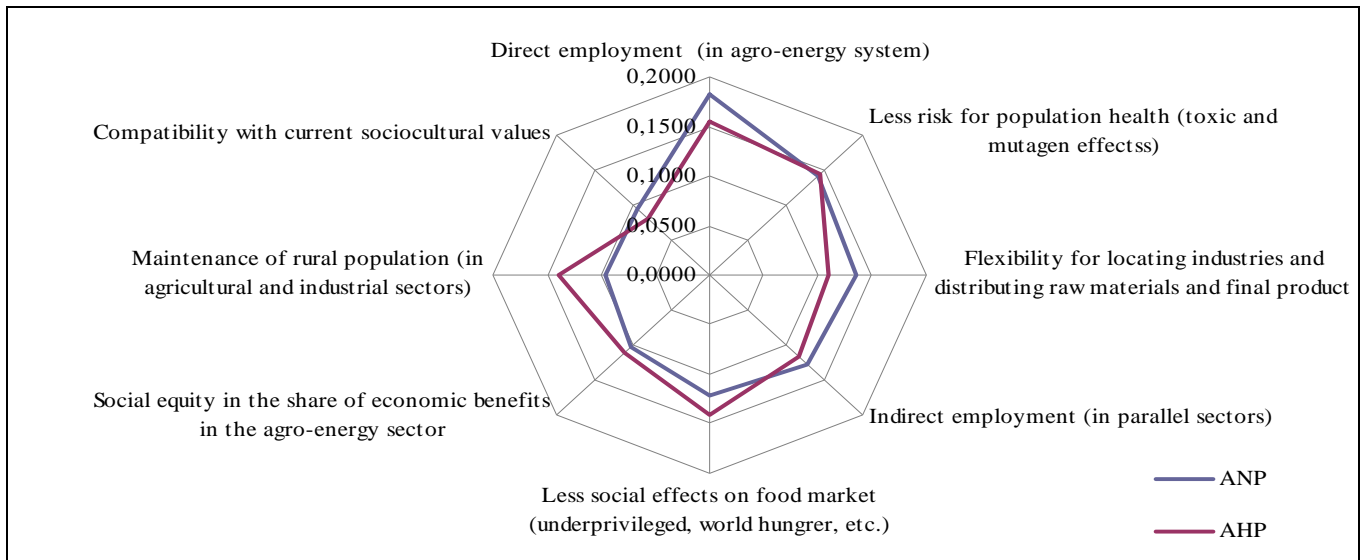


Fig. 3. Comparison of social objectives' priorities with ANP and AHP

The more sound results obtained with ANP allowed ranking the importance of the objectives to evaluate the impacts of the biofuel production and consumption in Spain (Fig. 4 to Fig. 6).

The first aspect to highlight is that results obtained with both methodologies are very different. For example, for the environmental dimension the prime objective is "less global warming due to greenhouse gas emissions" (Fig. 1). However, with ANP, the prime objective is "conservation of non-renewable resources". The priority of the later isolate objective (obtained with AHP) increased

when interdependences among objectives were taken into account (obtained with ANP) since the achievement of this objective would favour the achievement of the others according to experts' judgements. It is also important to point out that the greatest discordances among both methods were found for economic objectives (Fig. 5). In this respect ANP is considered a generalisation and refinement of AHP [2]. Therefore a wider use of ANP is desired in the literature.

Regarding the ranking of the objectives (with ANP) it is important to highlight that:

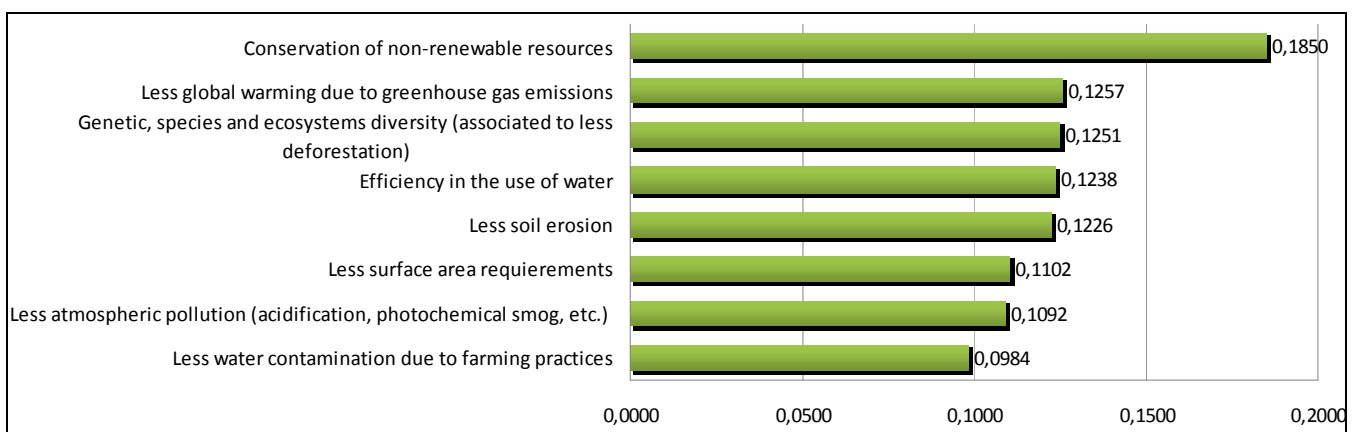


Fig. 4. Environmental objectives' priorities ranking with ANP for biofuel sustainability

1. In the environmental dimension (Fig. 4) the by-far most important issue is “conservation of non-renewable resources”, whereas the less one is “less water contamination”.
2. In the economic dimension (Fig. 5) the “ease to be technically implemented in production, storage, distribution, and consumption” is the most important objective according to experts. It is remarkable that “fuel supply security with respect to third countries”, a prime objective in the EU energy policy, is the third objective if interdependences are considered.
3. In the social dimension (Fig. 6) “direct employment (in agro-energy system)” is considered the most important objective. Probably due to a high correlation with the latter objective, “maintenance of rural population (in agricultural and industrial sectors)” is one of the less important issues when interdependences are incorporated.

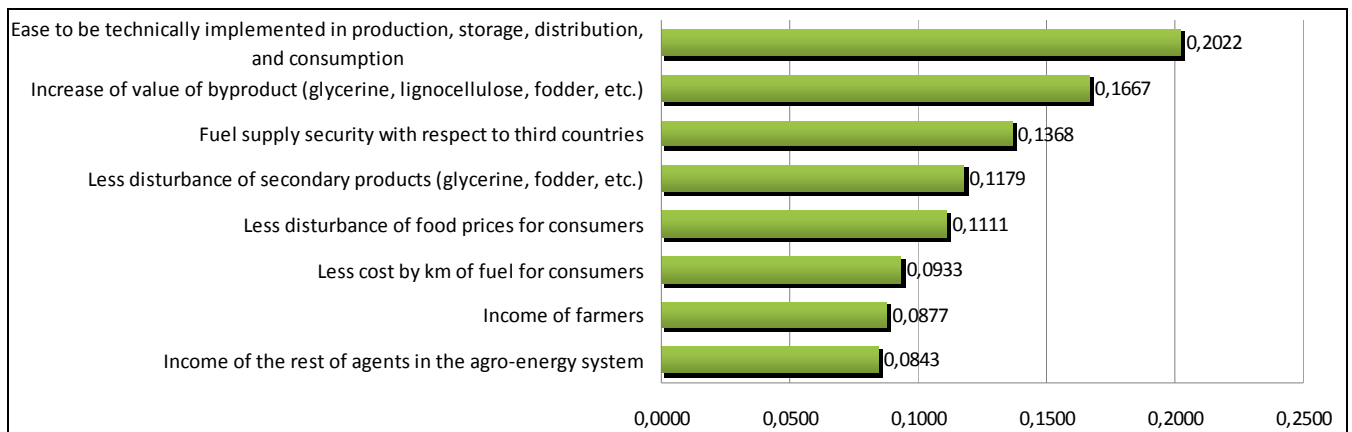


Fig. 5. Economic objectives' priorities ranking with ANP for biofuel sustainability

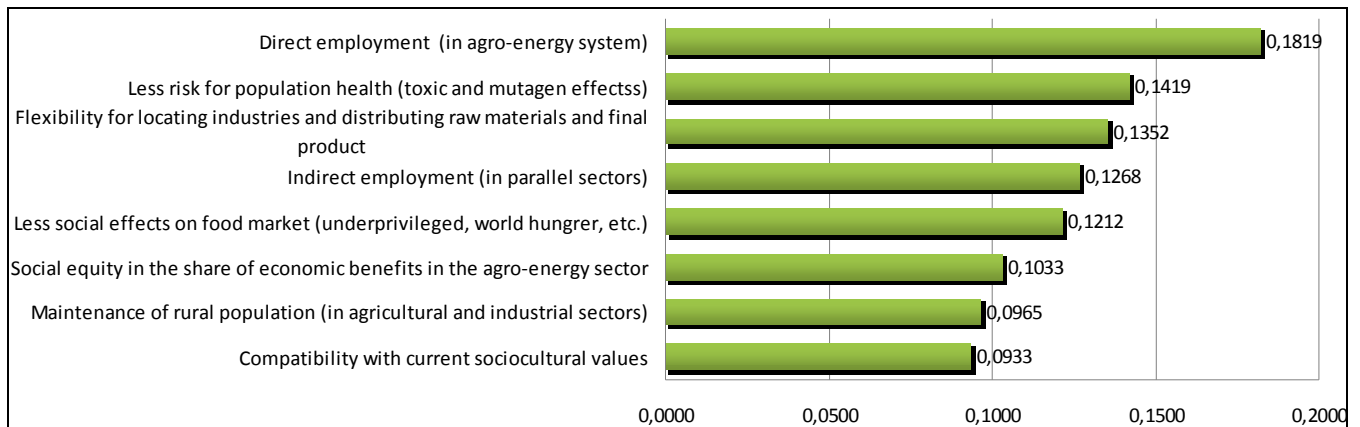


Fig. 6. Social objectives' priorities ranking with ANP for biofuel sustainability

#### IV. CONCLUSIONS

Defining a sustainable development model for biofuels requires reconciling the objective of economic prosperity with social issues and the respect of environment [6]. Consideration of trade-offs, synergies and dependences among these usually conflicting objectives is essential to prioritize and detect the most relevant issues to evaluate the performance of alternative models of production and consumption. Ranking objectives is the first step to establish efficient policy strategies for sustainability, such as subsidies and tax exemptions to agriculture and industry or incentives to consumption. Increase global social welfare entails to jointly consider the environmental, economic and social dimensions of sustainable development.

ANP proved itself as an appropriate decision-making methodology to deal with this kind of problem, overcoming some limitations of AHP such as the proper inclusion of dependence and feedback among objectives. The use of ANP is recommended instead of common implementation of ANP in policy planning due to the importance of fine-tune the results in this kind of problems where the significance of 'what is at stake' is very high for society as a whole.

The most important objectives, according to experts' knowledge, for a sustainable development of biofuels in Spain are the conservation of non-renewable resources, within the environmental dimension, the ease to be technically implemented in production, storage, distribution, and consumption, within the economic dimension, and the direct employment (in agro-energy system), within the social dimension of sustainable development.

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