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Economic and environmental sustainability of forestry measures in Apulia Region Rural Development Plan: An application of life cycle approach

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ABSTRACT

This article investigates the applicability of combined Life Cycle Assessment and market analysis, to support efficiency evaluation of rural development strategies developed by the Apulian Rural Development Plan 2007–2013 (BURP n 93 26/05/2010). Measure 122 "Improving the economic value of forest" had the aim to improve of forestry farms technological resources addressing them toward the biomass production. As an example pellet production from sawmill residues (PSR) and firewood productions have been compared both under environmental and economic performances. The functional unit (FU) is 1 kWh of residential thermal energy. Environmental impacts of both fuels have been evaluated through the Life Cycle Assessment methodology, considering the most relevant impact categories: the damages on human health, the ecosystems qualities, the kg of CO_2 eq. produced (GWP100) and the balance between energy requests and consumed (Cumulative Energy Demand – CED). About the economic analysis, data on pellet and firewood local market prices have been collected and consumer's expenditure for FU calculated. Results supplied relevant suggestions to improve efficiency and farmer's subscription to Apulia Regional Development Plan forestry measures.

Introduction

The most recent Common Agricultural Policy (CAP) gave a strong boost to agricultural policy transformation, in terms of the shift from subsidies coupled to production to the "Single Farm Payment" approach (Galko and Jayet, 2011; Maye et al., 2009). This huge transformation of European agriculture is the end point of a long process involving the role of agriculture, its multifunctional nature, but also the development of policies, including wider participation by stakeholders. The CAP reform leans strongly in the direction of the diversification farmer's income by "environmental payments" incorporated into the *second pillar* of CAP (European Commission, 2005) in order to reduce agricultural environmental pollution. These instruments aim to strengthen the role of environmental services and natural capitals, focusing on their relevant role in the mitigation of climate change and to offer opportunities for the diversification of farmers' income (Costanza et al., 1997).

In this paper, we analyze the role of forests in terms of their relevance in rural development (European Commission, 2005, p. 4), and as "non-commodity products". The increasing concern regarding the effects of climate change has stimulated research into alternative energy sources, and in particular biomass energy. Forests and forest products can thus play a relevant role, especially at a regional scale (Graymore et al., 2008). Policy makers need indicators capable of increasing the consistency and reliability of decision-making in achieving sustainability (Sieber and Domínguez, 2011).

The increased importance of the Life Cycle Assessment (LCA) as a tool for environmental impact assessment of bioenergy systems (Fazio and Monti, 2011; Monti et al., 2009) and more recently for policy evaluation (Wardenaar et al., 2012; Zamagni, 2012; De Blasi et al., 2011; Thabrew et al., 2009), has led to a strong impulse to extend this approach to other regulatory domains such as agriculture and rural development. An application of LCA to pellet production routes and related economic, environmental and energetic implications in Puglia was proposed in Pantaleo et al. (2009).

The enhancement of thermal energy production from biomass is one of the main targets of EU energy policy, and several studies have focused on the market segmentation of the potential heat demand from biomass sources at an EU level (Jablonski et al., 2008). One of the most promising and fast growing biomass to energy chains for

Abbreviations: kW, kilowatt; kWh, kilowatt hour; NCV, net calorific value; UAA, Utilized Agricultural Area; CV, coefficient of variation.

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heat generation is the pellet route, where the input biomass can be obtained by forestry management, agricultural lignocellulosic by-products or wood processing residues (Carone et al., 2011). A number of techno-economic studies and business models to assess the whole pellet to heat chains have also been proposed (Pantaleo et al., 2014), including optimization tools for the integration of pellet routes into energy systems and meeting the residential heat demands of urban areas (Keierstead et al., 2012).

We investigated the suitability of LCA combined with an economic analysis, to assess local development programs such as the Rural Development Plan 2007–2013 (RDP 2007–2013), and to stimulate discussions on the need to supply decision makers with efficient and simplified indicators that improve effectiveness of such programs in order to achieve the desired environmental and economic impacts. We examined a local government-sponsored initiative in Puglia (Italy) entitled "Improving the economic value of forests", presented in the last Apulian RDP 2007–2013 (BUR No. 62 08/04/2010). We used LCA analysis to evaluate both the environmental impacts and the economic profitability of pellet from sawmill residues[1] (PSR) and firewood along their supply chains.

The paper is structured as follows. Section "Definition and context of policy evaluation" overviews of the characteristics of the Apulian forests and a description of the measures carried out for these areas in RDP 2007–2013. This is followed by a description of the study and methodology. The findings are then presented, followed by the discussion and conclusions.

Definition and context of policy evaluation

The cultivated area of the region of Apulia (southern Italy) is characterized by high agricultural pressure due to a high level of profitability. Only a few areas are covered by forests, which however represent a huge source of natural capital, because of the widely diversified forestry ecosystems, originating from the adaptation to harsh weather conditions (Minotta et al., 2010). These particular characteristics have prevented the forestry sector from playing a role with respect to agriculture, but at the same time, enhanced its "non market" role (landscape and ecological preservation). According to the "National Inventory of forest and carbon sink" (Tabacchi et al., 2005), the forest area in Apulia covers 179,040 hectares, and has the lowest density of forests in Italy (index of woodiness: Apulia 8%; southern Italy 16%; Italy 22%) (Tabacchi et al., 2005).

The forestry areas in Apulia are classified as high forests, mainly made up of native oak-trees such as: *Quercus trojana* Webb, *Quercus pubescens*, *Quercus robur* and *Quercus macrolepis* which result from a natural process of secondary succession, triggered by the abandonment of agricultural land (Minotta et al., 2010). About 50% of the region's assets are located in the "Gargano National Park" which there is an exceptional concentration of different habitats. The second forestry core is located in the "Murgia" landscape, which includes the "Alta Murgia National Park" (Fig. 1).

Forestry measures in the Apulian Rural Development Plan 2007–2013

The RDP 2007–2013 strategy aims to create the conditions for the preservation of the environment and rural areas and on an inclusive development of the areas. In order to achieve these goals, the strategy focuses on the forestry sector, because of its location in rural areas and its relevance in environmental degradation. This theoretical framework was clear in the RDP's keynote, emphasizing

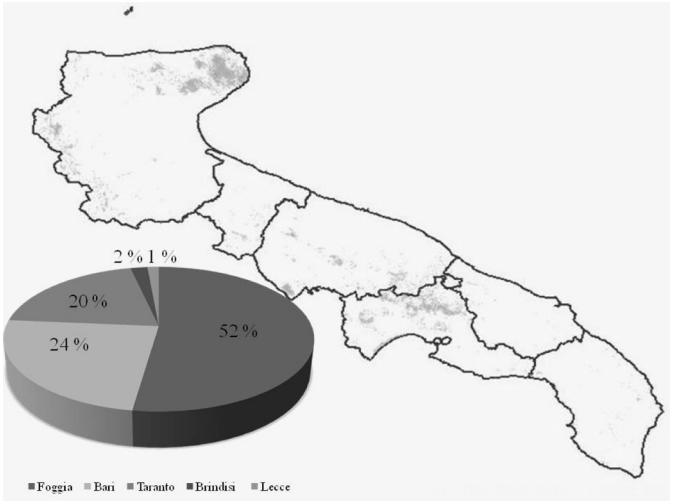

Fig. 1. Distribution of forest areas in Apulia (Apulia Region, 2010).

the non-food production and forestation role that became crosswise to the rural development's strategies, connecting it to the economic and environmental needs in rural areas.

Of the various measures highlighted in the Apulian RDP 2007–2013, the first Axis (improving the competitiveness of the agricultural sector), and within it measure 122 (improving the economic value of forest), in particular, were chosen because of the related structural improvements for productive woods, aimed at enhancing the forest's productivity. The financial aid allocated to this measure is almost 2.35% of the RDPs budget. Two different pathways are involved in achieving this aim:

- increase the forest's biodiversity in terms of numbers of species, focusing the regional wood supply chain on the production of high quality wood products;
- optimize the efficiency and effectiveness of forest management plans, improving the technological resources of forestry farms, in order to target the entire chain on the biomass production for energy uses.

The first pathway seems to play a marginal role in a region which, according to the agronomical and climatic conditions, is hostile to the cultivation of forestry species (8% of regional UAA). The second pathway seems to better fit the goals of RDP and the EU 2020 strategy (European Commission, 2010), in terms of the increasing use of forest-based biomass.

Materials and methods

The Life Cycle Assessment

A Life Cycle Assessment analysis (LCA) was performed to analyze the relationship between firewood and PSR manufacturing and the environment, by evaluating the most important environmental features of two thermal energy production alternatives for the domestic sector. The goal of this LCA study was to compare the environmental sustainability of firewood and PSR used for domestic thermal energy production. For this study, the main data sources were found in the literature (Johansson et al., 2004; Progressi, 2008). SimaPro 7 software, developed by PRé Consultants was used for the environmental evaluation of the two scenarios. When additional data were needed, data and parameters of the Ecoinvent databases (Ecoinvent Centre, 2007) were adapted as much as possible to the local context.

[1] Which could be sold to small-scale consumers (Wolf et al., 2006).