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Adoption of conservation agriculture in olive groves: Evidences from southern Spain

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ABSTRACT

The adoption of soil conservation practices (SCP) in olive groves in Andalusia, such as not burning olive-desuckering debris, shredding olive-pruning debris for use as inert soil cover and using cover crops under mower control, constitutes a huge advance towards sustainable olive growing. By adopting such SCP, olive growers can reduce the worrying level of erosion this activity causes, combat climate change and increase biodiversity. In this sense, the negative spillovers associated to the foregoing processes are highly significant both in qualitative and quantitative terms regarding the degradation of agricultural ecosystems. This paper seeks to identify the main factors that affect the adoption of these SCP. In order to do so, we use a trivariate probit model, therefore considering that the reasons behind adopting SCP may be interrelated. The results show how the factors that determine the adoption of such practices are related to the socio-demographic characteristics of olive growers, some of the characteristics of the olive grove itself and how it is managed and the role of social capital.

Introduction

The olive oil sector in Andalusia (Spain) has grown substantially over the last two decades, producing more than 1.3 million tonnes of olive oil in 2011, which represents 84% of the total for Spain (MAGRAMA, 2012a) and 40% of world production (IOC, 2012). This growth has mainly been due to an expansion and intensification of olive groves, which cover 1.5 million hectares, that is, 16% of the total surface area of Andalusia and 33% of total farm land (MAGRAMA, 2011).

According to data from Erosion National Inventory (MAGRAMA, 2012b), erosion is one of the foremost environmental problems in Andalusia, which is also the Spanish region that is most affected by serious erosion processes.[1] The olive oil sector is not exempt from this reality due to the inappropriate soil management practices employed by olive growers, who keep the soil permanently bare, removing weed cover crops and burning olive-desuckering and pruning debris systematically (Nekhay et al., 2009; Gómez and Giráldez, 2010). Moreover, soil erosion produces other negative externalities, including the pollution of rivers and bodies of water (Colombo et al., 2005), reservoir clogging, degradation of landscape (Parra-López et al., 2009), contribution to climate change (Rodríguez-Entrena et al., 2012) and loss of biodiversity. It is also worth highlighting the on-site effects, as such practices reduce soil fertility and therefore olive grove productivity, apart from increasing production costs to maintain the level of output (Calatrava-Leyva et al., 2007).

EU policymakers have undertaken successive reforms of Common Agricultural Policy (CAP) in order to reduce the negative externalities of farm activity, encouraging the provision of non market goods through joint production processes that favour multifunctionality and sustainability. In this regard, CAP has called for the agricultural model to respond to the overall interests and concerns of European citizens, searching for a sustainable agricultural paradigm that contributes with economic viability and environmental quality and enhances the quality of life for farmers and rural dwellers (Salazar-Ordónez et al., 2011). Thus, CAP has been reformulating[2] agricultural land use policy (De Graaff et al., 2013), redefining the limits of farmer property rights to achieve the goals of social legitimacy and sustainability (EC, 1997, 2010). Some of the instruments employed to this end include making cross-compliance progressively tougher, decoupling subsidies and developing agri-environmental programmes. In this sense, the

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[1] Some 23% of the total surface area of Andalusia suffer from erosion rates in excess of 25 t/ha·year.

[2] Since the signing of the Treaty of Amsterdam at the end of the 1990s and the Treaty of Nice some time later, EU policy has significantly shifted to focus on citizen structures, actions and behaviour, with the precept that policy interventions must reflect citizens' preferences in order to be efficient.

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practices to combat erosion prescribed by the requisites of cross-compliance oblige olive growers to leave a cover crop of at least one metre wide in olive groves with a slope of more than 10%. Furthermore, when the slope exceeds 15%, no tillage operations can be performed on the soil (CAP, 2009).

By considering the negative externalities of inadequate soil management in the olive groves of Southern Spain, the present study aims at identifying the factors which determine the adoption of soil conservation practices (SCP), namely no burning of olive-desuckering debris, shredding of olive-pruning debris as soil cover and the use of cover crops under mower control. In order to do so, an empirical application is carried out on a sample of olive groves in the region of Andalusia using a multivariate probit model.

The importance of the study lies, in the first place, in simultaneously modelling the influence of an exogenous variable on the adoption of SCP considering possible correlations among them. In the second place, performing the analysis at regional level allows us to ascertain the endogenous peculiarities and characteristics of these producers, which in turn could yield valuable information for the design of specific environmental programmes under rural development policy (RDP) (EC, 2011).

The next two sections of the paper define the conceptual framework of the research and describe the sample of olive groves used. In the fourth section the results and discussion regarding the factors that explain the adoption of SCP in the region of Andalusia are presented. Finally, the last section presents some conclusions aimed at improving agricultural and environmental policy.

Background information on the adoption of soil conservation practices

The adoption of SCP in agriculture has been studied since the 1950s (Ervin and Ervin, 1982). According to Feder and Umali (1993), the adoption process is based on a sequence of decisions that individuals make to adopt or reject an innovation. From a micro-level approach, the adoption process can be interpreted as individual adoption behaviour when a series of intrinsic and extrinsic factors determine adoption. In contrast, a macro-level approach examines the adoption process over time to identify a specific functional form within the aggregate diffusion pattern.

Generally speaking, studies aim to relate the factors linked to farms and farmer characteristics that affect the adoption process using different econometric models (Norris and Batie, 1987; Feder and Umali, 1993; Knowler and Bradshaw, 2007). The literature provides multiple factors that influence the adoption of agricultural innovations, of which the following are most frequently mentioned: farmer age and human capital qualifications, generational renewal, social capital, management capacity, availability of machinery, type of land ownership, farm size, crop performance, farm profitability and type of soils (Rahm and Huffman, 1984; Feder and Umali, 1993; Abadi-Ghadim and Pannell, 1999; Knowler and Bradshaw, 2007). Notwithstanding, following the review of the literature, it is worth underlining that the factors that determine the adoption of SCP are not conclusive and difficult to extrapolate from one region or crop to another (Knowler and Bradshaw, 2007).

At European level Prager and Posthumus (2010) systematise the socio-economic factors influencing farmers' adoption of SCP by category. Lahmar (2010) finds that soil conservation concerns do not appear to be the main drivers behind European farmers' decision to make the change, or not, to conservation agriculture. In Spain various authors have studied the adoption and diffusion of agricultural innovations (Gómez-Muñoz, 1988; Martínez-Paz et al., 2003; Carmona et al., 2005; Alcón et al., 2006; Parra-Lopez et al., 2007; Franco-Martínez and Rodríguez-Entrena, 2009; Calatrava and Franco-Martínez, 2011), but very few have explored the adoption of SCP, the research by Calatrava-Leyva et al. (2007) figuring prominently.

Analytical and econometric framework

This study employs a micro approach to analyse which factors determine the behaviour of olive producers in Andalusia regarding the adoption of certain SCP,[3] namely:

1. Not burning olive-desuckering debris[4] (NBODD)
2. Using shredded olive-pruning debris as soil cover[5] (SOPD)
3. Cover crops under mower control[6] (CCMC)

These farming practices are the best management practices (BMP) currently available and they are also compatible because they are used to perform different olive grove management tasks. These practices account for a large proportion of olive grove management, as they encompass olive desuckering and pruning and how to handle weeds. More specifically, not burning olive-desuckering debris mainly helps to combat climate change. Using shredded olive-pruning debris improves soil texture and also acts as inert cover to reduce the impact of rain and water run-offs. Finally, adopting cover crops under mower control has proven to be the most eco-compatible option, as it protects the soil the most.[7] In this sense, if olive grove managers opt for more eco-compatible practices such as those described above, the sustainability of the olive growing sector and its impact on social wellbeing would increase (Gómez-Limón and Arriaza, 2011; Rodríguez-Entrena et al., 2012).

Bearing this in mind, this research proposes an econometric model following a micro-level approach which explains the adoption decision-making process by means of both the economic constraints and the adopter perception paradigm (Prager and Posthumus, 2010). We do not, therefore, analyse the pattern of aggregate adoption over time to identify the specific trends in the technology diffusion cycle. Instead, we identify the intrinsic and extrinsic factors that determine farmers' SCP adoption behaviour. As regards the sample of olive groves, 25% have adopted CCMC, 40% SOPD and 50% NBODD, respectively (these figures measure how much these BMP had spread at a specific time). In this regard, the adoption decision-making process was modelled when technology innovations were not in the final stage[8] of the diffusion process,[9] following Rogers (2003).

[3] Prior to implementing the questionnaire, a group of experts selected the most important SCP alternatives in the region.

[4] Olive-desuckering is normally performed between August and September, removing the annual shoots that require a large amount of energy and therefore reduce the harvest.

[5] Olive-pruning is normally performed after the harvest is collected (February–March) at variable regularity (between 1 and 3 years), although olive trees are normally pruned on a two-year basis. The reason for pruning is to preserve the leaf-to-wood ratio, apart from airing the tree to prevent the emergence of pests and diseases and therefore improving output.

[6] Weed management is the greatest challenge faced by olive groves in Andalusia. There are normally two large categories, namely bare soil and soil with cover. Bare soil is either tilled or not tilled, but treated with herbicides, while soil with cover is tilled, treated with herbicides or mown. The cover is normally removed when it begins to compete with the olive trees for water. The cover crop control under mowing normally implies the latest removal date, due to this operation requires an adequate development of the weeds.

[7] There are other ways to manage plant covers, such as chemical mowing and minimal tillage, but they are considered less sustainable than mechanical mowing due to use of biocides and soil structure alteration, respectively.

[8] Feder and Umali (1993) warn that many factors are no longer significant when technology has reached the final stage of the diffusion process.

[9] It is assumed that the cumulative adoption curves of the above mentioned BMP follow a logistic function (*S*-curve).