Result-Oriented Agri-Environmental-Climate Schemes as a means of promoting Climate Change Mitigation in Olive Growing.

Colombo, Sergio[a*]; Rocamora-Montiel, Beatriz[b]

[a]*Department of Agricultural Economics, IFAPA, Granada, Spain. E-mail:; sergio.colombo@juntadeandalucia.es*

[b] *Department of Health and Animal Production, Public Health, Veterinary and Food Science. Veterinary Faculty. CEU-Cardenal Herrera University, Alfara del Patriarca, Valencia, Spain. E-mail: beatriz.rocamora@uchceu.es*

[*]*Corresponding author*

Key-words: Agri-environmental policy instruments; olive cultivation; Mediterranean agri-environmental systems; Common Agricultural Policy; Carbon sequestration; Hybrid governance structures.

Abstract

The climate change mitigation potential of olive farming has been widely acknowledged. It has particular relevance in regions such as Andalusia (southern Spain) where olive growing is a key land-use activity with significant social, economic and environmental implications. This potential of olive farming, however, is not adequately embodied in current Agri-Environmental Climate Schemes (AECS), which often fail to deliver the expected outcomes. The present paper proposes an alternative strategy based on a result-oriented approach to AECS for enhancing soil-carbon sequestration in Andalusian olive growing. After reviewing the current legal and institutional situation which forbids the wide application of result-oriented agri-environmental schemes, we suggest the use of alternative territorial governance arrangements, such as Hybrid Governance Structures, as a framework to support the implementation of a result-oriented approach in the specific case of olive growing. Results indicate that the application of Hybrid Governance Structures can provide valuable benefits in terms of soil carbon storage. The information provided may be useful in the proposed new legislative framework, at both European and regional level, to promote more sustainable farming systems.

1. Introduction

Olive farming represents a significant part of the agricultural sector in the European Union (EU). Approximately 4.2 million hectares of olives were harvested in the EU in 2013 (Eurostat, 2015) with southern countries (Spain, Italy, Greece, and Portugal) accounting for 99 % of this surface area. Within these olive-producing countries, the Region of Andalusia (Spain) alone accounts for 32% of the total olive-growing area in the EU (60% of the total area in Spain), making Andalusia a world-leader in olive production. In this region, olive production is the primary source of agricultural employment and the main economic activity in over 300 (39 %) of the region's municipalities. Thus, olive production is a key land-use activity with significant social, economic and environmental implications.

Climate change mitigation through soil-carbon sequestration is one of the most important environmental implications of olive growing in Andalusia. Soil-carbon sequestration has been regarded as an affordable, cost-effective way of reducing the contribution made by agriculture to climate change (Glenk and Colombo, 2011; European Parliament, 2014). Research has shown that the implementation of a number of soil-management techniques could boost soil-carbon sequestration rates in Andalusian olive orchards from 2.2 M ton CO_2.year^{-1} up to 5.7 M ton CO_2.year^{-1} (Rodríguez-Entrena *et al*., 2014), equivalent to 6.53 % of all CO_2 emissions in Andalusia in 2011. On this basis, realising the carbon sequestration potential of olive growing could offset the total emissions from agriculture in Andalusia, which amounted to 5.5 M ton CO_2 in 2011 (Junta de Andalucía, 2011). These figures indicate that carbon sequestration in olive groves has the potential to satisfy the "no debit" commitment for the entire agricultural sector in Andalusia and to help meet the Effort Sharing Regulation target, in line with the recent proposal to integrate the land use sector into the EU Climate and Energy Framework (European Commission, 2016).

From a policy perspective, Agri-Environment Climate Schemes (AECS) have been widely regarded as the most suitable instrument for improving the environmental performance of agriculture and could therefore represent a valuable tool for developing a soil-carbon-sequestration strategy for olive growing. AECS were first introduced into the EU's Common Agricultural Policy (CAP) during the late 1980s as an optional measure to be applied by Member States. Since 1992, however, application has been compulsory for Member States within the framework of their Rural Development Programmes, although they remain optional for farmers (European Commission, 2014a). The rules and the payment mechanism of AECS have remained unchanged since their introduction. In AECS, farmers are paid to adopt certain land management practices that improve environmental outcomes. The payment mechanism for farmers within AECS is based on the income foregone; i.e. payments should contribute to covering additional costs and income foregone as a result of applying these environmentally friendly farming practices. and should only cover commitments above and beyond the relevant mandatory standards and requirements, in accordance with the “polluter pays” principle. This mechanism enables AECS to be considered as a non-trade distorting payment, which can therefore be included within the World Trade Organization’s (WTO) green-box payments.

The current design of AECS has the virtue of simplicity. It is based on actions, and there is therefore no need to establish a baseline and monitor the improvements; it ignores the spatial or temporal variation of the ecosystem services; and it can be evaluated in terms of enrolment or expenditure rather than service delivery. Furthermore, its compliance with WTO requirements has made AECS a widely used instrument in the last two decades. With respect to expenditure, AECS are the largest budget item (ECA, 2011) within the EU’s Rural Development Policy, accounting for 22 % of the total spending of 20 billion euros over the period 2007-2013 (European Commission, 2014a). However, emerging evidence points to inadequate performance in many aspects of AECS. First and foremost, from the purely environmental perspective, many AECS evaluations have concluded that their ecological effectiveness needs to be improved (Matzdorf *et al*., 2008), since large investments have been made in AECS despite patchy empirical evidence regarding their effectiveness (Armsworth *et al*., 2012). One of the main drawbacks threatening the environmental effectiveness of AECS is the lack of geographical targeting (ECA, 2011), given that AECS have been designed without considering the scale at which environmental and ecosystem processes operate. In addition, in terms of cost effectiveness, AECS payments are made on an income foregone basis, focusing on compensating the extra costs arising from a range of input-based actions, without taking into account that the costs of providing the same outcomes will vary from one farm to the next. The result is that the homogeneous payment scheme often acts as an income support tool, rather than as a means of offsetting the extra costs incurred by farmers. For instance, Armsworth *et al*. (2012) found that less than half (between 12% and 46%) the public funds invested in AECS were actually used to compensate farmers for the income they had foregone, with the remaining amount being pure subsidy. In research on their social efficiency, Per Hasund (2013) pointed out that uniform, non-targeted, cost-based payment tariffs do not consider the differences in environmental values, clearly threatening the inherent multi-dimensional heterogeneity of agricultural landscape and practices. Finally, from an innovation perspective, payments linked to inputs and production processes rather than to environmental outcomes hamper the development of incentives for producers themselves to seek innovative methods of reducing costs (Hodge, 2011).

The long-term sustainability of AECS is challenged by the evidence of failure in their overall cost effectiveness, the pressures of the WTO, the budgetary costs associated with the expansion of the EU in Eastern Europe and growing public expectations of transparent agricultural subsidies. The EU is therefore being forced to look for more cost-effective means of paying for agri-environmental provision. A result-oriented approach to AECS (ROAECS) could result in higher returns from the same amount of public spending. ROAECS are also known as “payment-by-results” (PBR), “outcome-based/oriented”, “success-oriented”, “objective-driven” and “performance payments” and are based on the concept of paying landowners for achieving specific environmental outcomes and not just for managing their farms in a particular way. Allowing farmers the freedom to apply the farming practices (actions) that they consider most appropriate to achieve the required outcomes (ECA, 2011) is, therefore, a key point of difference from the current, action-oriented AECS. In a ROAECS framework, farmers are considered to know best how to achieve a specified environmental improvement on their land, and are encouraged to innovate, drawing on their experience and local knowledge to achieve better, more cost-effective results. Nevertheless, the achievement of these outcomes depends on a set of factors some of which are beyond the farmers’ control, so exposing them to larger risks relative to input-based measures. Moreover, ROAECS are expected to be more expensive for the public purse, given the need to monitor the environmental indicators used as a basis for remuneration of the outcomes. Thus, ROAECS should not be seen as a “cure-all” mechanism for improving the efficiency of AECS, and their contribution relative to an action-oriented AECS should be demonstrated for each different crop.

In this paper, we analyse the potential of ROAECS as an efficient tool for increasing soil-carbon content in the olive groves of Andalusia, so contributing to the integration of the olive sector into the EU 2030 Climate and Energy Framework (European Commission, 2016). In the following section, we describe the advantages and limitations of this approach in the specific case of carbon sequestration in olive groves. We then analyse how ROAECS can be adjusted to meet current regulations by means of hybrid governance structures. The paper concludes by discussing the main findings, which provide useful information for policy makers that can be used in the forthcoming review of Rural Development Programs that will be implemented within the CAP post 2020 framework. To the best of our knowledge, this is the first research on the application of ROAECS in a typical Mediterranean agricultural system such as olive growing, and on their potential as a means of mitigating the climate change impacts of agriculture.

2. Result-oriented AECS for enhancing soil-carbon sequestration in olive orchards

Mediterranean olive growing has great potential for soil-carbon sequestration. Research has shown that the abandonment of tillage and bare soil management in favour of more sustainable agricultural practices, such as the use of weed cover crops with mechanical control and the incorporation of shredded pruning debris into the soil, can significantly increase the soil-carbon content (Nieto *et al*., 2010). The implementation of these soil-management practices also improves soil structure, reduces water losses, and discourages soil erosion (Nieto *et al*., 2012), while increasing biodiversity and landscape aesthetics (Glenk and Colombo, 2011). Overall, they increase the capacity of agricultural land to adapt to (adverse) climate change impacts (Frelih-Larsen *et al*., 2008). Negative side effects of these soil management practices, such as increases in water consumption, are however also expected and have to be considered and offset against the estimated benefits. The adoption of these management practises is not of primary concern for farmers, because the resulting benefits are public goods that are not rewarded by markets:

that is, farmers have to bear the extra financial burden of applying these measures without being sure of receiving any return.

The soil-carbon sequestration potential of this sector varies enormously from one olive grove to the next due to a huge spatial variation in biophysical and management conditions. In Mediterranean olive farming, the production structure has traditionally been highly fragmented and diverse (Colombo and Perujo-Villanueva, 2017), ranging from the low-intensity, low-input olive plantations on mountainsides, to the highly intensive plain-land farms. This diversity results in highly varying performances in terms of environmental objectives (in this case the capacity for storing carbon), hence the need for assorted and targeted approaches. The action-based AECS implemented to date in the olive-growing sector have proved to be insufficiently differentiated to address this heterogeneity efficiently, giving rise to the over- (or under-) compensation of some farms (ECA, 2011). Clearly, ROAECS can overcome this limitation, in that they are designed to adapt not only to each production system but also to the management practises used on each farm, which may also vary as a result of the specific physical conditions such as climate, soil structure, slope, local customs and traditions.

At present, ROAECS are not being implemented in a generalized manner in the EU, and instead are restricted to cases in which there are well defined indicators that can monitor successful fulfilment of the desired outcomes or objectives. Indeed, finding appropriate indicators is not an easy task and presents a major hurdle for a broader use of ROAECS in agriculture. This is because the indicators have to fulfil four criteria to be valid: (i) they have to be measurable and identifiable; (ii) they must not conflict with agricultural goals; (iii) they must be consistent with organic farming goals and (iv) they must clearly reflect the additionality of the measure, i.e. that the environmental improvement would not occur without the action in question being taken.

In the specific case of carbon sequestration in olive orchards, Soil Organic Carbon (SOC) can be considered a valid indicator in that it fulfils all of the above requirements. It is clearly measurable and is attributable to specific management actions. It does not conflict with agricultural goals and is consistent with organic farming requirements. In particular, the SOC concentration can be accurately measured and monitored with standardised methods at very low cost; SOC can only be increased via the implementation of specific land management measures (Nieto *et al*., 2010); and higher concentrations of SOC improve crop productivity and soil quality (Lal, 2006).

The implementation of ROAECS for carbon sequestration also requires the identification and pricing of the other environmental services (or public goods) it provides. This has proven to be challenging for dynamic, spatially complex ecosystem services (Glenk *et al*., 2014), often because of the multifunctional nature of agricultural production. When several services are jointly produced it can be difficult to identify and price each individual service separately. However, unlike other ecosystem services such as biodiversity in which there is no market, carbon emissions have been marketed in recent years within the EU Carbon Trading Scheme and the existence of the SOC indicator can help to clearly separate the amount of soil carbon content sequestered from the remaining multifunctional performance of olive growing. Although the price of CO_2 remained stable at 30 €/ tonne for the first few years after it was first traded in 2008 (Carbon Market Watch, 2014), since 2012 the price has persistently been under 10 €/tonne. In 2017, according to the European Bourse for Unit Allowances (EUA) and Carbon Credits (CER's) (SENDECO2, 2018) the average price of CO_2 dropped to 5.83 €/tonne, as a result of the large amount of excess emissions allowances, mainly due to weak emission reduction targets and the resulting inflow of carbon offsets. Nevertheless, voluntary carbon offset prices are also affected by the compliance market, and can be higher or lower, depending on the buyer (Quick *et al*., 2013). Given the variation in carbon prices in recent years and the uncertainty over future prices, various scenarios should be considered at the design stage of any ROAECS scheme for soil carbon sequestration. According to Carbon Brief (2017), the most recent reform of the EU Emission Trading System (ETS) will raise carbon prices in the short term to around €10 through 2018 and up to around 38 € by 2030. However, as previously stated, there can be no guarantee of future carbon prices. The uncertainty this creates is an additional source of risk for farmers and may reduce their involvement in a result-based scheme for carbon sequestration. A possible solution would be to set a price floor for carbon to ensure that the price would not drop below a pre-specified value (Wood and Jotzo, 2011).

Transaction costs deserve further analysis due to their importance in policy instruments applied to agriculture and land-use sectors and to the fact that they can act as a significant constraint on farmers' participation. Administrative costs can be a discouraging factor when it comes to enrolling farmers in AECS (Mettepenningen *et al*., 2009), and in the case of ROAECS this impact is expected to be even larger. Nonetheless, according to the European Parliament (2014), implementing AECS aimed directly at enhancing carbon sequestration at farm level would enable farmers to organize themselves in order to achieve effective results with low implementation costs. Organizing small farmers into associations or successfully linking them to larger farming businesses could also reduce the transaction costs of carbon trading, monitoring and accounting and thus help to efficiently compensate farmers for the ecosystem services provided. In olive groves, Moragues-Faus and Ortiz-Miranda (2012) demonstrated the importance of the social and cultural context in reducing potential sources of tension amongst participants when implementing new quality schemes. Rodriguez-Entrena and Arriaza (2013) concluded that the social capital created by farmers' networks can help to reduce the transaction costs and contribute to the success of adopting innovative management practices. These transversal efforts should result not only in improvements in soil carbon levels, but also in better environmental performance at the landscape scale by simultaneously boosting the ancillary benefits from soil carbon sequestration (Glenk and Colombo, 2011). However, Villanueva *et al*. (2015) warned that olive farmers are unlikely to participate collectively in AECS, thus diminishing the possibilities of reducing transaction costs. Specific policy measures, such as administrative support and advisers, should therefore be implemented to reduce farmers' transaction costs.

In a result-based approach to AECS, farmers are also exposed to other exogenous risks that can diminish the expected environmental outcomes at the same level of effort or investment. This may also discourage farmers from enrolling in ROAECS relative to the simpler action-based schemes. Nevertheless, ROAECS call for a different concept of risk that enhances the "dynamic efficiency" of the scheme. Here, the evidence in the literature indicates that the experience acquired via learning processes, the development of farmers' innovation skills, greater flexibility to adapt to new circumstances and social capital act as catalysts for progressive risk mitigation (Sligo and Massey, 2007). Furthermore, the risk of not recovering the initial investment inherent in ROAECS for storing carbon in soil can be softened, in the specific case of olive groves, by the implementation of a “weak result-oriented” scheme, with a base payment that “guarantees” a minimum premium for farmers achieving a minimum threshold. Within such a scheme, base payments could be offered to farmers who implement management practices that go beyond both cross compliance and greening requirements and achieve an SOC threshold. Examples of these practises include the reduction or abandonment of tillage and specific bare soil management. The extra costs incurred by farmers that implement these practices could be used as a “proxy” for the base payment, which would only be triggered if SOC levels are above the specified threshold. A second level of payments could be made to those farmers able (or willing) to raise soil-carbon above the thresholds. This second level could also comprise several tranches allowing farmers to choose the one that best fits their specific situation. In this way, ROAECS could tackle the heterogeneity of the entire olive growing sector. Such heterogeneity is also addressed by avoiding compulsory implementation of management practices that fail to take into consideration the particular limitations and/or potential of individual farms. Indeed, this approach is committed to the development of farmers’ innovation skills not only through its carbon-levels-enhancement option, but also through the base payments which encourage them to innovate in order to reach the basic standards.

AECS contracts between the administration and farmers typically last for five years, although there are several exceptions such as Higher Level Stewardship agreements, which last for 10 years, or afforestation projects with 20-year contracts. In the case of soil carbon sequestration, long-term continuity is a decisive issue. According to the results of Nieto *et al*. (2010) SOC improvements are more pronounced in the first 10 years after changing soil management practices; after this period, the SOC continues to increase, albeit at a lower rate, and eventually stabilizes. A minimum period of 10 years must therefore be assigned to the contracts. Additionally, given that the SOC previously stored in soils can return to the atmosphere even more quickly than it was sequestered (Smith, 2005), the continuation of conservation measures after SOC has reached equilibrium is paramount, at least until other technologies to tackle climate change become available or more cost effective. In this context, maintenance contracts should also be granted to incentivize landowners who have reached “maximum” SOC capacity to continue its storage.

3. The institutional setting: a challenge for implementing ROAECS

The current Rural Development Regulation remains a major impediment to further development of ROAECS in the EU (Matthews, 2014). In particular, Article 28 states that payments shall be dependent on the fulfilment of specific conditions related to production methods or inputs and should be based on the income foregone and the additional costs incurred, namely: i) opportunity costs; ii) costs associated with the changes in existing management practices required to achieve improved results; and iii) additional costs connected with specific new management practices (European Commission 2014b). Thus, payments under result-oriented AECS based exclusively on the value of the delivered outcomes do not comply with the current legal framework.

Several attempts have been made to bring ROAECS into line with EU legislation. In Baden Wüttemberg (Germany), in an application of ROAECS aimed at supporting the protection and maintenance of biodiversity in traditionally managed grassland, the result-oriented programme included a restriction on silage in order to create an income forgone, so as to bring it into line with current EU regulations (Matzdorf and Lorenz, 2010). In the Netherlands, the well-established agri-environmental cooperatives have acquired a prominent role in developing a framework that enables compliance with current regulations while implementing ROAECS. This involves a system for capping and redistributing payments, based on a private agreement between the cooperative association and its members that allows the cooperative to manage part of the agri-environmental payment and redistribute it among farmers according to the results they have effectively delivered (Runhaar *et al.*, 2016).

WTO requirements remain, however, a major obstacle to ROAECS which, despite the aforementioned alternative pathways, cannot currently be implemented as stand-alone agri-environmental policy measures. A more flexible interpretation of WTO requirements, based on the implicit acknowledgement of the legitimacy of domestic policies to address environmental market failures as non-trade concerns, could allow agri-environmental schemes to be considered non-trade distorting instruments, thereby enabling ROAECS to comply with the legal requirements of the WTO Agreement on Agriculture. Several authors have proposed different modifications to the WTO green-box criteria so as to facilitate a result-oriented approach to AECS. Potter and Burney (2002) suggested a much more broadly defined green box in which trade distortion rules could be relaxed, provided that certain tests of environmental stringency could be met. Brunner and Huyton (2009), focusing particularly on the payment mechanism, proposed a combination of the current income foregone approach with the value of the environmental benefits actually delivered. According to these authors the present formula, based exclusively on the cost incurred, does not provide the incentive needed for a large-scale implementation of AECS and penalizes extensive, less productive farmers who often deliver the most environmental benefits at the lowest cost. Nevertheless, it remains “curious” that an approach said to reduce the passivity that current AECS may induce in farmers’ production strategies by largely guaranteeing payments is so difficult to fit into a legal framework, which in theory at least seeks to foster a more active approach to achieving outcomes.

These options, however, require WTO criteria to be explicitly modified, and under the current scenario an agri-environmental support formula based exclusively on results cannot be applied. Nevertheless, the linkage introduced in the last CAP reform between direct payments and the “active farmer” criterion is certainly inviting a challenge in terms of WTO green-box disciplines, as it could undermine the green-box status of direct payments in terms of WTO disciplines (Matthews, 2012). This linkage may be empirically evidencing some room for flexibility in the interpretation of WTO green-box criteria so as to introduce a result-oriented approach to AECS. Either way, within a consistent, strong, result-based approach, payments could no longer be referred to as the cost of actions, as established in the WTO criteria and thus alternative institutional arrangements would need to be explored.

The strategy proposed in this article calls for a more innovative institutional setting, in which more importance is given to new governance structures, while respecting the limits of the current policy framework. Within this context, hybrid governance structures (HGS) are an approach worth considering, as they can improve the provision and functioning of public goods markets in rural areas by engaging the agents, beneficiaries and intermediaries actually involved in their production and delivery (Van

Huylenbroeck and Mettepenningen, 2011). The theory of HGS has been developed mainly for private goods markets, although it can easily be extended to public goods markets in which a public body demands services from the private agents able to provide them (Van Huylenbroeck and Mettepenningen, 2011). HGS in agriculture would therefore involve partnerships between public and private actors aimed at transversally addressing the different dimensions comprised by the concept of "multifunctional agriculture" beyond its current definition, limited to the legitimization of public subsidies through the supply of positive externalities (Renting *et al.*, 2009).

A HGS aimed at enhancing soil carbon sequestration in olive growing could combine a "weak" result-oriented approach within AECS that fulfils WTO green box criteria and a private system for Payments for Ecosystem Services (PES). PES schemes improve multiple ecosystem services through a voluntary transaction in which a known quantity of ecosystem services is purchased by one or more buyers, leading to an overall increase in the provision of the service that would not have otherwise occurred (Quick *et al.*, 2013). PES can therefore facilitate and deliver new and additional investment in the agricultural sector, seeking better targeting and value for money of existing funding streams (UK-DEFRA, 2013).

Little research has been done into the possibility of simultaneously combining private place-based PES and public funding from AECS under a hybrid-governance funding structure. In the UK, for instance, a similar approach has been implemented for woodland creation projects, in which landowners are eligible to receive funding through both Higher Level Stewardship (HLS), i.e. within AECS, and also by selling carbon credits through the Woodland Carbon Code (Quick *et al*., 2013). The latter is a voluntary market within sectors of the economy which are not regulated but contribute to the UK's national targets for reducing greenhouse gas emissions. In this market public and private agents can buy carbon credits from specific forestation projects[1]. In this case, public funding is deemed base revenue, whilst private capital is used to introduce new funding opportunities in addition to HLS, on the basis of the results achieved. A

[1] A total of 240 projects were registered under the Woodland Carbon Code at 30th September 2016, covering an area of 16,000 hectares of woodland. They are projected to sequester 5.9 million tonnes of carbon dioxide over their lifetime.

PES system to increase soil carbon concentration could also be implemented through the development of a compliance offset market, an example of which is the Carbon Farming Initiative (CFI) developed in Australia. In the CFI, farmers and land managers can earn carbon credits by storing carbon or reducing greenhouse gas emissions on their land; such credits can then be sold to other organizations wishing to offset their emissions. Under a cap-and-trade emissions-trading system, increases in SOC achieved by an unregulated party (olive growing farmers and landowners) can be used to offset emissions from a regulated party within the EU Emissions Trading System (ETS) (Matthews, 2014). Potential buyers would then be involved in a cross-sector partnership, led by the public administration, where farmers' associations and other interested stakeholders such as intermediaries, industries, monitoring agencies or Conservation, Amenity and Recreation Trusts (Hodge, 2011) can trade the carbon credits. To avoid conflicts arising from international trade and competition issues, the payments could be limited to specific types of farms or farmers —i.e. smallholdings, low income farmers, etc.— or capped to a percentage of total agricultural income.

The legislation being prepared by the Regional Government of Andalusia appears to follow a similar approach in an attempt to improve the region's contribution to climate change mitigation (Andalusian Government, 2017). The new Act is expected to implement both soil carbon storage and a regional emissions trading system. Projects aimed at enhancing agricultural soil carbon contents are therefore expected to be included. This is also in line with the EU proposal to integrate the land use sector into the EU 2030 climate and energy framework. Under this scheme, in order to fulfil the EU commitment on climate change adopted in Paris in 2015, EU member states would be allowed to use removals from the LULUCF (Land Use, Land-Use Change and Forestry) sector towards their obligation under the proposed effort sharing regulation[2]. Although this possibility is limited[3], it is a significant initiative that could have important implications for land use climate actions in agriculture within the EU.

[2] The effort sharing regulation is a proposal for greenhouse gas reduction in the non-ETS sector which includes transport, building, agriculture, small industry and waste (European Parliament, 2016).

This means that the HGS could be stratified into two levels; a base level, where current AECS –and therefore public funding— could embrace the measures needed to achieve minimum threshold SOC levels; and a second level comprised by additional payments systems provided by private agents who trade on carbon credit markets. This approach would enable compliance with WTO rules by simultaneously delivering improved environmental results within a more cost-effective strategy.

Nonetheless, putting into practise the proposed approach to enhance carbon sequestration in olive growing requires several considerations. Firstly, additionality should be demonstrated by clearly establishing that the improvements in SOC sequestration would not have occurred in the absence of the additional funding made available through the combination of private and public resources (Hodge, 2011; Quick *et al*., 2013). Secondly, funding should be efficiently allocated to facilitate the fulfilment not only of the additionality criterion, but also of the EU and WTO rules on CAP financial support allocation (Quick *et al*., 2013). Finally, enabling participation from private and public bodies necessarily implies tighter coordination and more concerted efforts to engage stakeholders and this must be adequately handled.

In the specific case of carbon sequestration in olive groves, the additionality criterion is expected to be satisfied given the empirical evidence demonstrating that basic management practises, such as reduced tillage or no tillage, and the abandonment of bare soil management, increase SOC but without it passing a certain threshold (Nieto *et al*., 2010). Achieving better coordination and stronger engagement by all the parties involved in the scheme remains challenging. In this context, if social capital were taken into account in the design of the scheme, this would help improve coordination, as it would reduce operational costs and encourage more farmers to participate (Rodriguez-Entrena and Arriaza, 2013). Better coordination could also be encouraged by the European Innovation Partnership for Agricultural Productivity and Sustainability (EIP-AGRI). Under this initiative a group made up of farmers, advisors,

[3] The proposal caps the amount to 280 Million tonnes at the EU level over the period 2021-2030, so as not to discourage emission reductions in other sectors. However, member states with a larger agricultural sector will be given greater flexibility.

researchers, business owners and other stakeholders is incentivized to work together to find specific, practical solutions to problems, using bottom-up approaches (EIP-AGRI, 2014). In this way, the EIP-AGRI could try to implement the approach proposed in this article in pilot schemes. The experience and information obtained could then be applied on a wider scale.

4. Concluding comments

In the future climate change agenda, land use and forestry must contribute to the EU target to reduce greenhouse gas emissions by at least 40 % by 2030 compared to 1990 levels. However, there is little or no incentive for farmers to introduce the necessary measures to reduce the contribution made by agriculture and forestry to climate change, because under the current agri-environmental regulation they receive little reward for providing this service to society. Allowing farmers to receive a payment proportional to their contribution to greenhouse gas removal would encourage them to take steps to reduce the agricultural contribution to climate change.

In this paper we theorize about how this can be achieved in the specific case of soil carbon sequestration in olive growing. This agricultural ecosystem has several features that make it suitable for implementing an outcome-based system aimed at improving climate change mitigation through soil carbon sequestration. Firstly, the existence of a direct and easily measurable indicator (SOC), which accurately identifies the improvements resulting from the farm management practices implemented to increase soil carbon sequestration. Secondly, the immense scope of the olive growing sector for climate change mitigation in the Mediterranean area by offsetting agricultural CO_2 emissions and thirdly, the positive externalities that will be delivered by enhancing soil carbon sequestration, such as: reducing soil erosion and water pollution, fomenting biodiversity and improving landscape scenery. The approach proposed, however, is not just restricted to olive growing and can be extended to any other agricultural systems that have the potential to increase the soil carbon content by means of simple actions such as the reduction of tillage or covering the soil with plant debris. The extension of this system to other crops would be an interesting avenue of future research.

The regulations set out in the WTO Agreement on Agriculture remain a major impediment for the implementation of a ROAECS approach. A comprehensive paradigm shift is therefore required and alternative institutional arrangements must be explored. An HGS system based on mixing public and private payments to farmers could be worth considering as an alternative option. In such a system, public funding -under the current agri-environmental regulation- would be used to reward farmers that increase the environmental quality of their land (in this case by reaching a specified threshold of soil organic carbon content), whilst private funding would be used to compensate any improvements above this threshold based on an outcome-oriented scheme. This system should not be viewed as a market-based successor to action-oriented approaches, but rather as part of a broader mix of agri-environmental policy strategies that can be targeted at particular situations. From a more generalist perspective, this is the main paradigm change proposed in this paper.

Several obstacles must be overcome in order to guarantee a successful shift towards this new approach. The limited experience that has so far been acquired with respect to implementing ROAECS and hybrid funding approaches in Mediterranean agricultural ecosystems clearly requires further investigation. In this context, at the European level, the EIP-AGRI offers a wide array of funding possibilities for pilot projects aimed at improving climate change mitigation. Along the same lines, farmers' participation is essential for a successful, effective implementation of the proposed scheme, and their opinions must therefore be taken into account in the definitive design.

Implementing ROAECS for enhancing SOC sequestration in this farming system will be far from easy due to the lack of experimental evidence and the wide inherent heterogeneity in olive growing. A rushed implementation of comprehensive, result-oriented payments will not facilitate expected outcomes. Instead, what is required is to progressively combine the use of targeted outcome-based elements with existing action-based agri-environment support. This will help us understand stakeholders' attitudes and preferences regarding these new approaches and is crucial to their success (Schroeder *et al*., 2013). In addition, reinforcing bottom-up approaches and tailoring the efforts of the administration to local needs are also essential when it comes to ensuring the efficacy and cost-effectiveness of these schemes.

Finally, it should be emphasized that this result-oriented approach to enhance soil carbon sequestration in olive growing must be part of broader strategic policy objectives. This means that ROAECS would fit well within an agri-environmental policy framework focused on the provision of public goods. Similarly, unlike the current action-oriented payments, agri-environmental measures should no longer be considered a guaranteed source of income.

Acknowledgements

This research was supported by the Andalusian Council of the Economy, Innovation, Science and Employment (CEICE) and the Ministry of Innovation and Competitiveness under grant P11-AGR-7515.

References

Andalusian Government. (2017). *Proyecto Ley Andaluza Cambio Climático.* Available at: http://www.cma.junta-andalucia.es/medioambiente/PAC/Destacados%20Nivel2/inicio/proyecto_ley_cc_bopa.pdf (accessed 4 March 2018).

Armsworth, P.R., Acs, S., Dallimer, M., Gaston, K.J., Hanley, N., and Wilson, P. (2012). The cost of policy simplification in conservation incentive programs. *Ecological Letters,* 15, pp 406-414.

Brunner, A., and Huyton, H. (2009). The environmental impact of EU Green Box Subsidies. In: Meléndez-Ortiz R, Bellmann C, Hepburn J (Eds.), Agricultural Subsidies in the WTO Green Box. Cambridge University Press. Cambridge. United Kingdom.

Carbon Brief (2017).Will the reformed EU Emissions Trading System raise carbon prices? Press release, available at: https://www.carbonbrief.org/qa-will-reformed-eu-emissions-trading-system-raise-carbon-prices (accessed 4 March 2018).

Carbon Market Watch. (2014). *What's needed to fix the EU's carbon market. Recommendations for the Market Stability Reserve and future ETS reform proposals.* Carbon Market Watch Policy Briefing. Available at: http://carbonmarketwatch.org/wp-content/uploads/2014/07/ETS-POLICY-BRIEF-JULY-2014_final_1.pdf (accessed 4 March 2018).

Colombo S., Perujo-Villanueva M. (2017). The inefficiency and production costs due to parcel fragmentation in olive orchards. *New Medit*, 2, pp 2-10.

ECA. European Court of Auditors. (2011). *Is Agri-Environemnt Support well designed and managed?* Special Report 7. Luxembourg. Available at: http://www.eca.europa.eu/Lists/ECADocuments/SR11_07/SR11_07_EN.PDF (accessed 4 March 2018).

EIP-AGRI. *European Innovation Partnership for Agricultural Productivity and Sustainability.* (2014). European Commission. Available at: Http://ec.europa.eu/eip/agriculture/ (accessed 4 March 2018).

European Commission. (2014a) *Agriculture and Rural Development, Agri-environment measures.* Available at: Http://ec.europa.eu/agriculture/envir/measures/index_en.htm (accessed 4 March 2018).

European Commission. (2014b). *Environment. Results-based agri-environment schemes: payments for biodiversity achievements in agriculture.* Available at: http://ec.europa.eu/environment/nature/rbaps/ (accessed 4 March 2018).

European Parliament. (2014). *Measures at farm level to reduce greenhouse gas emission from agriculture. DG for Internal Policies. Policy Department of Structural and Cohesion Policies. Agriculture and Rural Development.* Brussels (Belgium). Available at: Http://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=home.showFileandrep=fileandfil=AgriClimateChange_Policy_Paper_EP_2014.pdf. (accessed 4 March 2018).

European Commission. (2016). *Proposal to integrate the land use sector into de EU Climate an Energy Framework.* Fact Sheet, Available at: http://europa.eu/rapid/press-release_MEMO-16-2496_en.htm (accessed 4 March 2018).

European Parliament. (2016). *Effort sharing regulation, 2021-2030. Limiting Member States' carbon emissions:* Available at: http://www.europarl.europa.eu/RegData (accessed 4 March 2018).

Frelih-Larsen, A., Leipprand, A., Naumann, S., and Beucher, O. (2008). *Climate Change Mitigation through Agricultural Techniques* - Policy Recommendations (Deliverable D11). Ecologic Institute. Berlin (Germany). Available at: http://ecologic.eu/sites/files/publication/2013/PICCMAT%20Policy%20Incentives%20for%20Climate%20Change%20Mitigation%20Agricultural%20Techniques%20-%20Deliverable%20D11.pdf (accessed 4 March 2018).

Glenk, K., and Colombo, S. (2011). Designing policies to mitigate the agricultural contribution to climate change: an assessment of soil-based carbon sequestration and its ancillary effects. *Climatic Change*, 105, pp 43–66.

Glenk, K., Schaafsma, M., Morey, A., Martin-Ortega, J. and Hanley, N. (2014). A framework for valuing spatially target peatland restoration. *Ecosystem Services*, 9, pp 20-33.

Haaren, C., and Bathke, M. (2008). Integrated landscape planning and remuneration of agri-environmental services. Results of a case study in the Fuhrberg region of Germany. *Journal of Environmental Management*, 89, pp 209–221.

Hodge, I. (2011). Beyond agri-environmental policy: towards an alternative model of rural environmental governance. *Land Use Policy*, 18, pp 99–111.

Junta de Andalucía. (2011). *Portal Andaluz del Cambio Climático. Andalusian Greenhouse Gases Emissions; data from 2011*. Available at: Http://www.juntadeandalucia.es/medioambiente/site/pacc/menuitem.acad89bbe95916b477fe53b45510e1ca/?vgnextoid=f460f2bea21f7210VgnVCM1000001325e50aRCRD&vgnextchannel=1b7c1e9604273210VgnVCM10000055011eacRCRD&lr=lang_es (accessed 4 March 2018).

Lal, R. (2006). Enhancing crop yields in the developing countries through restoration of the soil organic carbon pool in agricultural lands. *Land degradation and developments*, 17, pp 197-209.

Matthews, A. (2012). *Understanding the "active farmer" debate.* Available at: Http://capreform.eu/understanding-the-active-farmer-debate/ (accessed 4 March 2018).

Matthews, A. (2014). *Incentivising Soil Carbon Sequestration*. Available at: Http://capreform.eu/incentivising-soil-carbon-sequestration/ (accessed 4 March 2018).

Matzdorf, B., Kaiser, T., and Rohner, M.S. (2008). Developing biodiversity indicator to design efficient agri-environmental schemes for extensively used grassland. *Ecological Indicator*, 8, pp 256–269.

Matzdorf, B., and Lorenz, J. (2010). How cost-effective are result-oriented agri-environmental measures?— An empirical analysis in Germany. *Land Use Policy* 27, pp 535–544.

Mettepenningen, E., Verspecht, A., and Van Huylenbroeck, G. (2009). Measuring private transaction costs of European agri-environmental schemes. *Journal of Environmental Planning and Management*, 52, pp 649-667.

Moragues-Fuas, A.M., and Ortiz-Miranda D. (2012): Governing cooperative quality schemes. *Outlook on Agriculture*, 41, pp 27-33.

Nieto, O.M., Castro, J., Fernández, E., Smith, P. (2010). Simulation of soil organic carbon stocks in a Mediterranean olive grove under different soil management systems using the RothC model. *Soil Use and Management*, 26, pp 118–125.

Nieto, O.M., Castro, J., and Fernández-Ondoño, E. (2012). Sustainable agricultural practices for Mediterranean olive grove. Effect of soil management on soil properties. *Spanish Journal of Soil Science*, 2, pp 281–299.

Per Hasund, K. (2013). Indicator-based agri-environmental payments: A payment-by-result model for public goods with a Swedish application. *Land Use Policy*, 30, pp 223–233.

Potter, C., and Burney, J. (2002). Agricultural multifunctionality in the WTO- legitimate non-trade concern or disguised protectionism? *Journal of Rural Studies*, 18, pp 35–47.

Quick, T., Reed, M., Smyth, M., Birnie, R., Bain, C., Rowcroft, P., and White, A. (2013). *Developing place-based approaches for Payments for Ecosystem Services*, URS London (United Kingdom).

Renting, H., Rossing, W.A., Groot, J.C., Van der Ploeg, J.D., Laurent, C., Perraud, D., Stobbelaar, D.J., and Van Ittersum, M.K. (2009). Exploring multifunctional agriculture. A review of conceptual approaches and prospects for an integrative transitional framework. *Journal of Environmental Management*, 90, pp 193-202.

Rodríguez-Entrena, M., and Arriaza, M. (2013). Adoption of conservation agriculture in olive groves: Evidences from southern Spain. *Land Use Policy,* 34, pp 294-300.

Runhaar, H.A.C., Melman, Th.C.P.F., Boonstra, g., Erisman, J.W., Horlings, L.G., de Snoo, G.R., Termeer, C. J., Wassen, M.J., Westerink, J., and Arts, B.J.M. (2016). Promoting nature conservation by Dutch farmers: a governance perspective. *International Journal of Agricultural Sustainability*. Epub ahead of print 16 April 2017. Doi: 10.1080/14735903.2016.1232015

Schroeder, L.A., Isselstein, J., Chaplin, S., and Peel, S. (2013). Agri-environment schemes: Farmers' acceptance and perception of potential 'Payment by Results' in grassland— A case study in England. *Land Use Policy,* 32, pp 134– 144.

SENDECO2 (2018). Sistema Electrónico de Negociación de Derechos de Emisión de Dióxido de Carbono. Available at: Http://www.sendeco2.com/es/conocenos.asp (accessed 4 March 2018).

Sligo, F. and Massey, C. (2007). Risk, trust and knowledge networks in farmers' learning. *Journal of Rural Studies*, 23, pp 270–282.

Smith, P. (2005). An overview of the permanence of soil organic carbon stocks: influence of direct human-induced, indirect and natural effects. *European Journal of Soil Science*, 56, pp 673–680.

UK-DEFRA, Department for Environment, Food and Rural Affairs. (2013). Developing the potential for Payments for Ecosystem Services: an Action Plan. London (United Kingdom). Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/200889/pb13918-pes-actionplan-20130522.pdf (accessed 4 March 2018).

Van Huylenbroeck, G., and Mettepenningen, E. (2011). The role of institutional arrangements in rural development. Agrarian perspectives: *Proceedings of the 20th international scientific conference*. Prague (Czech Republic), pp 377-386.

Villanueva, A.J., Gómez-Limón, J.A., Arriaza, M., and Rodríguez-Entrena, M. (2015). Assessment of greening and collective participation in the context of agri-environmental schemes: The case of Andalusian irrigated olive groves. *Spanish Journal of Agricultural Research*, 14, pp 142–154.

Wood, P. and Jotzo, F. (2011). Price floors for emission trading. *Energy Policy*, 39, pp 1746-1753.