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ANALYSING PERCEPTIONS ATTITUDES AND RESPONSES OF WINEGROWERS ABOUT SUSTAINABLE LAND MANAGEMENT IN CENTRAL SPAIN

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ABSTRACT

This study provides a better understanding of the perspective and attitudes of farmers towards sustainable land management (SLM) practices in central Spain. Farmer's willingness to change from conventional tillage to cover crops in vineyards is seen as an indicator for adoption of sustainable agriculture. Two complementary approaches were used: open interviews ($n = 25$) and surveys ($n = 64$). The portrait of these winegrowers is of mature farmers, owners of their lands and conscious of soil erosion problems (81%), although not on their own lands. They observe soil degradation (45%); however, they are more conscious of problems in their vines or grapes (64%). Only 32% would be willing to use cover crops to avoid erosion. The barriers for adoption were mainly related to water constraints, lack of knowledge and inability to accept production decreases. Results indicate an underlying lack of information on SLM. They show confusion or mistakes regarding the relationship between tillage and erosion. Young farmers are more prone to change practices. Scientific results are not effectively communicated; there are no efficient local structures to provide them with knowledge and advice in their work, including guidance on environmental issues. The EU agri-environment payments cover the costs of SLM practices for avoiding erosion or compaction and increasing SOC. In spite of that, participants do not apply for subsidies to compensate the income foregone. Policy makers, extension services and scientists have to face this situation to tackle the limited knowledge transfer revealed in this study. Copyright © 2014 John Wiley & Sons, Ltd.

KEY WORDS: cover crops; land degradation; environmental policy; farmers' perception; erosion

INTRODUCTION

Farmers are small in number (5% of total employment in the EU-27, Archive of European Integration (AEI), 2012); however, they are the most important managers of the landscape: around half of the EU's land is farmed. Farmers' behaviour has a significant impact on environment, and this behaviour can be strongly influenced by their knowledge and perception (Ferguson & Bargh, 2004) of environmental issues. There are many publications regarding soil conservation and degradation, but the points of view of land users are not so frequently addressed (Kelly *et al.,* 2009). Particularly in Spain, little attention has been paid to farmer's environmental knowledge (Oñate & Peco, 2005; Garrido Fernández, 2006; Calatrava *et al.,* 2011). Importantly, the knowledge and attitudes provided by farmers could help in a better-suited implementation of policy measures in agricultural soils. The study of the view or perception of stakeholders is growing as it is the scientific interest on the social, economic and biophysical views of the Earth System, and especially the perceptions of citizens and society (Karltun *et al.,* 2013; Nabahungu & Visser, 2013; Sop & Oldeland, 2013; Pereira *et al.,* 2014; Vila Subirós *et al.,* 2014).

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Agricultural land in Spain is currently threatened by soil erosion (Cerdà *et al.,* 2009), loss of soil organic carbon (SOC), decreased biodiversity and compaction (COM (2006) 231). Particularly, vine farming is one of the agricultural activities that currently puts pressure on Spanish soils. Vineyards cover 963 095 ha of the 7 060 245 ha in the world in 2012 (http://faostat.fao.org/). It is one of the pillars of the economy in many regions in this country.

Vines are resistant to drought and thrive well in poor soils (Van Leeuwen & Seguin, 2006). They are therefore frequently cultivated in marginal lands. Vines can produce grapes for more than a century, although production diminishes after several decades, while wine quality may increase (Robinson, 2006). Because of this longevity, traditional practices based on frequent tillage lead to land degradation because of the resulting large areas and extended periods of unprotected bare soil. As a result, soil degradation has been frequently described in grape producing areas.

One of the most frequently used indicators to assess land degradation and production threat is soil erosion. Cerdan *et al.* (2010) compiled a large database of erosion rates under various land use types in Europe. They found that erosion rates in bare soil were the highest ($15{\cdot}1\,Mg\,ha^{-1}\,yr^{-1}$), followed by vineyards without conservation measures ($12{\cdot}2\,Mg\,ha^{-1}\,yr^{-1}$). In Spain, the next figures of soil loss ($Mg\,ha^{-1}\,y^{-1}$) can be found: 0·3 (Arnáez *et al.,* 2012), 3·3–162 (De Santisteban *et al.,* 2006), 5·9 (Ruiz-Colmenero

et al., 2013), 18–22 (Ramos & Porta, 1997), 25 (Ramos & Martinez-Casasnovas, 2009), 30 (Casalí *et al*., Casali *et al.,* 2009), or 44 (Lorenzo *et al.,* 2002). Therefore, tolerable soil loss, ca. $1\,Mg\,ha^{-1}\,yr^{-1}$ (Morgan, 1995; Verheijen *et al.,* 2009) is frequently surpassed. Consequently, pollution spreading is also an important concern for copper (Fernández-Calviño *et al.,* 2013) or nitrogen (Novara *et al.,* 2013).

Accelerated soil erosion could diminish as has been demonstrated frequently in the scientific literature (García-Orenes *et al.,* 2012; Zhao *et al.,* 2013). There are alternatives to conventional tillage that are worth doing. They are known as Conservation Agriculture, a sustainable land management (SLM) promoting agricultural systems involving minimum soil disturbance, permanent residue soil cover and diversified crop rotation (FAO, 2008). One of these alternatives is the use of cover crops in the inter-rows of vineyards. We can find pros and cons in the literature. Erosion control has been confirmed in grassed vineyards (Casermeiro *et al.,* 2004; Durán Zuazo *et al.,* 2004; Lieskovský & Kenderessy, 2014); conservation of soil moisture is not clearly established (Celette *et al.,* 2008), but there is no doubt regarding improvements of physical–chemical soil conditions (Bochet *et al.,* 1998; Ruiz-Colmenero *et al.,* 2013); soil biodiversity, both micro and macro-fauna (Ingels *et al.,* 2005); and vine pest control (Guerra & Steenwerth, 2012). Research on organoleptic characteristics of juice and wine and vine performance in grassed vineyards is being developed and shows promising results (Warner, 2007; Lee & Steenwerth, 2013). However, the use of cover crops entails costs; this includes man power, cost of seeds or new machinery. Policy measures can counteract these drawbacks.

In this context, policy makers are committed to encompassing economic and environmental needs. Since 2000, agri-environment payments have been part of the EU's rural development approach. They are based on two principles: (i) payments are for additional costs and income foregone as the result of agri-environmental commitments and (ii) the decision to apply for it being voluntary for farmers. In 2003, in the framework of the Common Agricultural Policy (CAP), common conditions were established for direct payment, not linked to the level of production, but rather linked to good agricultural and environmental conditions (Council Regulation (EC) 1782/2003). In addition, structural measures for supporting rural development were established (Council Regulation (EC) 1698/2005). Payments were granted only to farmers who make agri-environmental commitments on a voluntary basis (Art. 39). This includes, for example, avoiding erosion and soil compaction, conservation of SOC and conservation of habitats. The current national law concerning these matters in Spain (*Real Decreto* 486/2009) supports the use of vegetation covers in permanent crops (Annex II). Although a case by case study is necessary, the corresponding regional regulation establishes payments for organic vineyards from €266 to $€513\,ha^{-1}$ (producing wine or table grapes respectively). Moreover, those growers working on less favoured areas with sloping lands can obtain a compensatory allowance from €25 to $€250\,ha^{-1}$, with a maximum of €4000 per holding. Are these payments enough? It is worth examining the costs and benefits of vine-growing activity.

Globally, depending on the vine variety and crop density, harvests usually yield between 5 and 20 Mg of grapes per hectare. In Spain, according to a review of production of red wines (Fernández Alcázar, 2011), the yield is approximately $6\,Mg\,ha^{-1}\,yr^{-1}$ on average, and the cost of producing grapes (bush or trellis training systems) is around $€3400\,ha^{-1}\,yr^{-1}$. Costs include fertilisers, pesticides, machinery, depreciation and taxes. The national official prices of most common red grapes range from €0·50 to $€1{\cdot}0\,kg^{-1}$ (BOE No. 13, 15 January 2011). If an average price is considered ($€0{\cdot}75\,kg^{-1}$), the vine grower can obtain a profit of $€1100\,ha^{-1}\,yr^{-1}$.

Cover crops involve additional costs, which derive from the work needed to sow and mow covers, the cost of seeds and the drop in production. The cost of sowing and mowing is neutralised by less tillage, which is carried out only once (before sowing) when using cover crops, instead of three times (at least) in conventional management. The cost of seeds is variable, for example, Ruiz-Colmenero *et al.* (2011) reported different prices ranging from $€49\,ha^{-1}\,yr^{-1}$ ($€0{\cdot}7\,kg^{-1}\,yr^{-1} \times 70\,kg\,ha^{-1}$ of *Secale Cereale L.*) to $€60\,ha^{-1}\,yr^{-1}$ ($€1{\cdot}5\,kg^{-1}\,yr^{-1} \times 40\,kg\,ha^{-1}$ of *Brachypodium distachyon* (L.) P. Beauv.). These authors also found an average drop in grape production of 20% in cover crops treatments. Considering this loss of income, farmers would earn approximately €200 less per hectare yearly.

If the aforementioned figures are taken into account, the subsidies provided for environmental measures – based on additional costs and income foregone – are considerable. In spite of it, vineyards in Spain are mainly managed by tillage, actually, different kinds of tillage. The most common is minimum tillage (66·4%), followed by a so-called traditional tillage, deeper and more frequent (22·8%), and by the use of spontaneous cover, concentrated in humid regions in northern Spain (5·2%). Less than 0·2% of vineyards are managed by sown cover crops (Ministerio de Agricultura Alimentación y Medio Ambiente, 2012).

The aim of this study is to analyse why this SLM in vineyards is not used more frequently. We gathered information on the different management practices of winegrowers in central Spain, as well as their opinions about erosion problems in their vineyards and their willingness to change from tillage to cover crops as a proxy indicator for adoption of SLM.

MATERIAL AND METHODS

Study Area, Natural, Social and Economic Description

The area studied is located in the centre of Spain (Figure 1), in rough outlines it is a semiarid area, with 360–500 mm of annual rainfall, and average temperature ranging from 14 to 15 °C (25 year-average, National Institute of Meteorology). The area corresponds to the Cambisol soil Order, dominated by marls and limestones. These calcareous soils are widely distributed in Mediterranean semiarid climatic conditions.

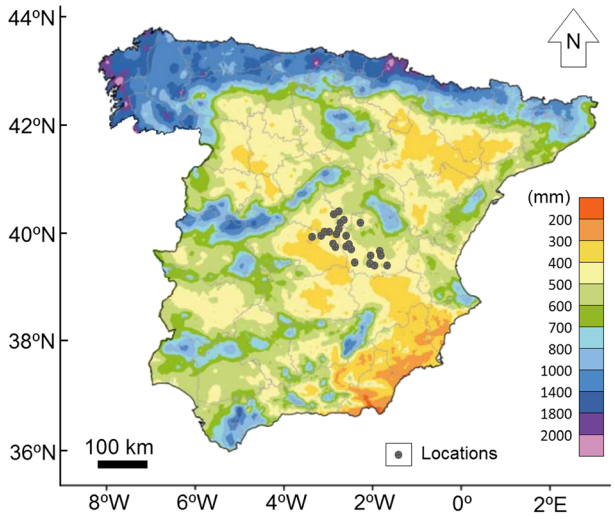

Figure 1. Location of vineyards of respondents, a semiarid area in central Spain. The colours in the figure represent the average total annual precipitation. Map modified from AEMET (in Spanish: Agencia Estatal de Meteorologia). This figure is available in colour online at wileyonlinelibrary.com/journal/ldr.

They are productive soils widely used for cereal, wine and oil production. Vines and olive trees, being more tolerant to shallow soils, are usually displaced towards sloping lands in order to allow flat and better soils for cereal production.

The population density within the study area is between 12 and 69 inhabitants per km^2 in Castilla-La Mancha (CLM) and Madrid regions, respectively. The service sector (60–65%), mining, industry and energy (17–19%) and construction (12–16%) are the areas' principal economic activities, whereas agriculture is carried out by 5–6% of the population.

In Spain, vineyards account for the 5·5% of arable land; in Madrid region, this figure corresponds to the 4·6% and in CLM to 12·6% (Agricultural Census of the Annual Directory of Spain in 2012). The use of cover crops in vineyards in these regions is almost nonexistent: less than 0·1% in CLM and negligible in Madrid (Ministerio de Agricultura Alimentación y Medio Ambiente, 2012). There are ca. 28 000 winegrowers according to the associations of protected designation of origin of Madrid (2759) and CLM (25 098) (Source: Ministry of Agriculture 2010–2011). In this study, vineyards were located in Aranjuez, Arganda del Rey, Belmonte del Tajo, Brea del Tajo, Campo Real, Cenicientos, Chinchón, Colmenar de Oreja, El Herrumblar, Fuenlabrada, Fuente el Saz, Iniesta, Ledaña, Madrid, Morata de Tajuña, Navalcarnero, Paracuellos del Jarama, Peralveche, San Fernando de Henares, San Martín de Valdeiglesias, Serracines, Tielmes, Titulcia, Torremocha del Jarama, Valdelaguna, Valdilecha, Villagarcía del Llano, Villalbilla, Villalpardo and Villanueva de La Jara (Figure 1).

Data Collection

A two-stage process to collect data was carried out. Firstly, 25 winegrowers were contacted amongst those who had previously collaborated with the research team and their acquaintances. This group participated in open interviews. In these long conversations, lasting 1–2 h, the interviewees expressed their opinions about agriculture, soil erosion and land management practices. The information obtained was used to know in depth their points of view on the one side, and to prepare a structured questionnaire on the other side.

In the second-stage, a survey was conducted. A total number of 64 winegrowers, different from the previous 25 interviewees, agreed to answer the questionnaire. They were contacted thanks to the collaboration of winegrower cooperatives and regional extension centres in the area of study. The questionnaire was formed by 23 questions, closed and open ended (Table I). Questions were responded both face by face and by phone. Three categories of information were collected in accordance to Newing (2011): (i) basic characteristics of respondents: personal attributes such as age, location and land tenure; (ii) information on knowledge: opinions about soil erosion, perception of soil or crop degradation or environmental concerns; and (iii) information on behaviour: adoption of conservation farming, terraces, mulching and cover crops. This information was used as a proxy for adoption of SLM.

Data Treatment

Descriptive statistics were used to analyse quantitative data of surveys, and results were presented either as percentages or counts. A chi-square test was used to determine if there were differences between variables. The results were tested for significance at $p \leq 0{\cdot}05$. A multivariate analysis of information gathered from the survey was performed considering all the variables, transformed into categorical responses being 1 as affirmative responses and 0 as negative or not answered. The principal component analysis (PCA) results in an orthogonal subspace after reduction of the dimensions of data sets, which captures the main structure of the data. Analyses were run in STATISTICA 6.0 (Statsoft Inc. Tulsa, OK. USA).

RESULTS AND DISCUSSION

Because of the relatively few number of respondents in this study, the results do not necessarily represent the opinion of winegrowers of the region or the country. Nevertheless, they form a heterogeneous group of varying ages and experience who have similar perceptions, attitudes and responses regarding environmental problems.

The Profile of Farmers, Basic Characteristics of Respondents

The 25 interviewed respondents were all male, in the average age of 50 years old. Their profile or opinions on environmental problems were not analysed from a quantitative point of view; however, some statements deserve attention and are literally included in the results. As mentioned, the total number of winegrowers responding the questionnaire was 64. They were contacted in extension centres and cooperatives in the harvesting period, when they carry the grapes to the cellars. As they were quite busy in that moment, they were also asked to be interviewed by phone later on, but the

Table I. Questionnaire responded by 64 farmers.

1. For how long have you been producing grapes? … years	13. (Only for respondents using cover crops) If you use cover crops, are they … ? Three options: spontaneous, planted or artificial and DN/RF
2. How big is your vineyard? … hectares	14. (Only for respondents with sloping lands) Do you receive any institutional aid to control soil erosion? Three options: Yes, No and DN/RF
3. Did you inherit your vineyards? Three options: Yes, No and DN/RF	15. Do you think that tillage is a useful technique to reduce soil erosion? Three options: Yes, No and DN/RF
4. Is your vineyard organic? Three options: Yes, No and DN/RF	16. Would you like to receive information to control soil erosion? Three options: Yes, No and DN/RF
5. Is viticulture your sole economic activity? Three options: Yes, No and DN/RF	17. Do you think that soil erosion may influence wine quality? Three options: Yes, No and DN/RF
6. (Only for those having other activities) Which one is it? Six options: independent professional, tourism, building, retired, other (please explain) and DN/RF	18. In a recent scientific experiment in vineyards in the Region of Madrid, it was established that cover crops increased soil organic matter and efficiently prevented erosion. Nevertheless, they reduced grape production between 15 and 25%. Would you change to cover crop in your vineyard under these circumstances? Three options: Yes, No and DN/RF
7. Did you notice some of these facts or episodes in your vineyard? Eight options: rills or gullies, sediment accumulation, changes in the colour of soil, increase in soil strength or compaction, more stoniness, other (please write), none of them and DN/RF	19. (Only for respondents saying no) If you would not change, could you explain why? (You can choose maximum three options) Eight options: It is too expensive, it reduces production, there is a competition for water, I don't know how to manage it, it needs too much care, there is a risk of weed invasion, other (please explain) and DN/RF
8. Did you notice any of these effects in your harvest? Six options: low production, vines look bad, more fertilisers are needed, other (please explain), none of them and DN/RF	20. Do you think that soil erosion is a problem or it can be a problem in the future? Three options: Yes, No and DN/RF
9. What proportion of your vineyard is in a sloping area? Six options: none, less than one quarter, between one quarter and the half, more than the half, all and DN/RF	21. Who is responsible for soil conservation regarding erosion? (only one answer) Eight options: the farmers, the agricultural technicians, the local government, the regional government, the state government, all of us, nobody and DN/RF
10. (Only for respondents with sloping lands) Do you use terraces in order to control soil erosion? Three options: Yes, No and DN/RF	22. How old are you? … years old
11. Do you use mulch in the inter-rows to avoid soil loss? Three options: Yes, No and DN/RF	23. Where is your vineyard (municipality)? Village: …
12. (Only for respondents with sloping lands) Do you use cover crops in order to control soil erosion? Three options: Yes, No and DN/RF	

DN/RF, don't know or refused to answer.

majority of them declined to participate. Hence, just some 5% of the potential vine growers of these cooperatives were willing to participate in the survey. From the 64 participants, 23 responded *in situ*, filling the questionnaire and 41 responded by phone.

The corresponding χ^2 analysis of the survey between the two studied regions showed that there was just one significant difference: the number of organic farmers that was higher in Madrid ($\chi^2 = 8{\cdot}2$; $p = 0{\cdot}004$; $df = 1$). Nevertheless, other characteristics such as age, sloping areas or land tenure were similar. In spite of this difference in organic management, responses were alike regarding environmental issues.

The mean age of respondents was 46 ± 16 years old. Indeed, 44% of them can be considered young farmers as they are under 40 years old according to the Council Regulation (EC) No 1698/2005 of 20 September 2005. They are not beginners in this business as 43% have been farming for more than 15 years, 37% for 5–15 years, and only 19% are new vine growers, having been harvesting grapes for just 5 years.

Taking the size of their vineyards, some 30% used land measuring less than 10 ha, 64% measuring greater than 10 ha and 6% who did not know or refused to answer.

Most respondents inherited their lands (75%). Nonetheless, this is not their only income source: up to 72% have other work, which diminishes their competitiveness. This second business is generally agricultural: growing cereal, olives or raising livestock (46%). Some others are also involved in activities not related to agriculture (43%). Finally, 11% are retired but continue working their lands. This profile matches the figures provided by the Labour Service Surveys indicating that a very small number of people work in agriculture on a full-time basis. Arguably, this can have an impact on the willingness to protect soil, which can be less important if it is not the main livelihood activity.

Information on Knowledge

From the information obtained in the interviews, farmers were especially concerned about economic returns; this has not changed from previous studies (Garrido Fernández,

2006). Environmental problems were focused to eventual hazards because of pollution. They usually mixed different environmental issues, for example, droughts, climate change, water pollution by fertilisers or pesticides, air pollution by carbon dioxide or urbanisation. Farmers also complained about the lack of knowledge of their own soils, considering that soil analyses are difficult to be obtained and are expensive.

Soil and land problems were identified as loss of fertility; soil loss was barely mentioned on one's own initiative. However, all the farmers had some areas of their lands on slopes, although they were not able to provide their exact gradients. This fact impedes further quantitative analysis in this study, and it may be developed in the future as other studies found the slope gradient to be the main factor to move farmers to change to SLM in olive groves (Franco & Calatrava, 2006).

Considering the 25 interviews, three groups can be differentiated according to their perception of soil erosion as a driving force of land degradation. The first group (six interviewees) had not a clear stance, they declared certain environmental concerns and also lack of knowledge.

- '*Land degradation takes a very long time*, *it's difficult to know whether soil erosion has influence on crops*.'
- '*If we use no-tillage we will have to use herbicides*, *and this is worse*.'
- '*Soil is going to be always there*, *but that tree is a pity*, *it has unearthed roots and it's going to fall down*, *it's a pity*.'

The second group of farmers (nine interviewees) was aware of environmental issues and prone to adopt SLM practices. When they were asked about erosion, they exhibited their consciousness about it:

- '*Erosion is evident after big storms*, *you can see the grooves formed after that*.'
- '*Sometimes I see the soil moving from one place to another*.'
- '*Even in less steep lands*, *water creates its own paths*. *Erosion is above all due to water*, *not to wind because it's a clayey soil*.'
- '*Some vines are suffering in bad soils*, *they are smaller and produce less*.'

This group mentioned the influence of the passage of time in the process of land degradation:

- (erosion) '*It is not important in the short run*, *but after generations it must be noticed*, *a lot*.'
- '*Soil erosion is there*, *but changes caused by erosion are not so dramatic to be seen in the short term*, *I'm not going to see them*.'
- '(…) *probably my sons will not inherit this land*, *but I would like to leave it to anyone who may think that someone before him took care of soil*.'

Moreover, they are conscious about the relationship between soils and crops; all these opinions were stated by farmers aged less than 50 years old. They think that wine quality can be linked to soil erosion:

- '*If soil erosion means loss of fertility*, *then*, *nutrient loss must influence wine quality*.'
- '*It must affect the wine because the vines suffering erosion are less productive*.'
- '*The roots of vines are unearthed*, *therefore*, *they cannot obtain nutrients needed for high quality wine*.'
- '*Erosion matters because what happens to soil*, *happens to wine*.'

This concerned group is made of organic winegrowers and owners of cellars who have recently entered in this sector. They declare that they do not need subsidies, as they would use SLM practices even without them:

- '*Honestly*, *in this dry region* (Madrid), *not being organic is a sin*, *it is costless*.'

The third group (10 interviewees) considered that soil erosion is not a problem at all; they represent the knowledge of conventional farmers. The term 'conventional' is used in this study to describe farming relying on highly mechanised and chemical inputs approaches, and as the opposite of organic farming. Their views are illustrated in these words:

- '*Soil erosion is important only because of media pressure*.'
- '*Soil erosion has always existed*, *it is something natural*.'
- '*Soil erosion is not a risk for me*.'
- '*What is important is pollution*, *or the* CO_2, *not the soil loss*.'

One opinion emerges from the last group: soil conservation is not a priority in vineyards, and this is in line with the general belief that best wines are produced through moderate water deficit in soils with limiting factors, such as reduced soil depth, high pebble content and low water holding capacity (Dry & Loveys, 1998; Pellegrino *et al.,* 2006; Van Leeuwen & Seguin, 2006).

These farmers would adopt cover crops to control erosion only if an improvement of wine quality – so price – would be demonstrated. This group thought that there is no relationship between soil erosion and wine quality because

- '*The less soil moisture*, *the higher quality of wine*, *with less production*.'
- '*The worst the soil is*, *the higher quality is obtained for wine*.'
- '*Soil erosion does not influence wine because the roots of vines are deep*.'

Several obstacles were mentioned by conventional farmers for adopting the use of covers: lack of knowledge, lack of tradition for such practices in the region, water competition, weed invasion, fire risk or complex management. For example, they do not want to increase labours for seeding or mowing covers, they would need new machinery, and they think that costs may increase due to seeds, herbicides, pesticides or labours. Possible pests in the vineyard

as a consequence of covers were also brought up, singularly the spider bite (*Tetranychus urticae* Koch). However, demonstrated benefits of cover crops in vineyards as an important component of integrated pest management (Altieri & Al, 1995; Sharley *et al.,* 2008; Danne *et al.,* 2010) were not mentioned.

All these farmers (25) normally obtained the agronomic or environmental information from other farmers, agricultural supply companies, extension agents or technicians from cooperatives. Their opinions regarding information meetings are negative:

- '*If you organise an information meeting with a barbeque you can bring together many farmers in one place. But this is not enough, because motivation is needed.*'
- '*If an expert provides information for farmers, this information is not for the speaker to make an impression. We have to understand that the speech is useful for us, and provides benefits. Speakers have to walk in the farmer's shoes.*'
- '*They are useful if they demonstrate benefit, I only believe what I see.*'

These general ideas were transferred to the questionnaire. When they were asked about problems in their soils (questions 7 and 8, Table I), 55% of respondents did not find any degradation (Figure 2). Those perceiving soil problems reported mainly compaction and rills or gullies, followed by change in soil colour, more stoniness or sediment accumulation.

As mentioned before, sloping topography is usual for vineyards in this study area. In fact, 56% of the respondents affirmed having some or all land on slopes. The winegrowers with sloping vineyards tend to perceive soil degradation more often, 50% of them doing so, instead of 38% for those who have flat vineyards.

Winegrowers are sensitive to changes in their vines or grapes. The percentage of growers observing soil degradation versus observing problems in their vines goes from 45% (Figure 2) to 64% (Figure 3). They describe lower yield, the need for more fertilisers, or poor appearance of their vines.

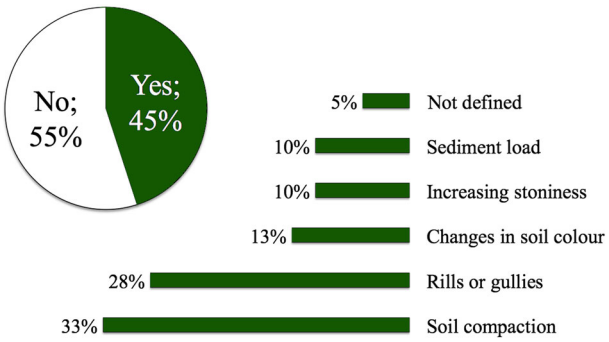

Figure 2. Percentage of farmers perceiving problems in their soils, and how they did notice these problems. Results of survey regarding question 7 ($n = 64$). This figure is available in colour online at wileyonlinelibrary.com/journal/ldr.

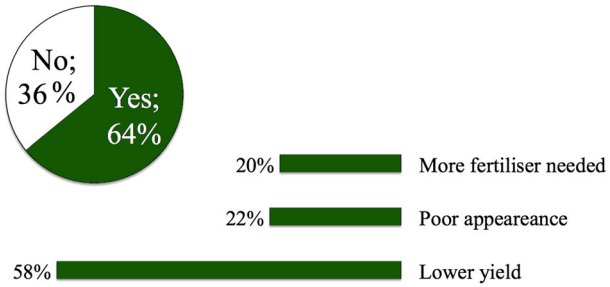

Figure 3. Percentage of farmers perceiving problems in their crops, and how they did notice these problems. Results of survey regarding question 8 ($n = 64$). This figure is available in colour online at wileyonlinelibrary.com/journal/ldr.

With regard to the 56% of farmers having their vineyards in sloping lands, management practices to achieve soil conservation are based mainly in structures such as terraces (33%), the use of cover crops (21%) and mulching (10%) (Figure 4). From the 13th question, the preferred cover crops are spontaneous vegetation, as only one farmer declared the use of seeded crops. Only 3% receive subsidies related to measures to control erosion.

Concerning the 15th question: '*Do you think that tillage is a useful technique to reduce soil erosion*?', 58% responded affirmatively and 18% did not know or refused to answer. Only 24% were aware that soil tillage can contribute to soil erosion. Indeed, this result can be explained by the experience of farmers: as soon as practicable after heavy storms they have to plough their soil to remove rills; otherwise, further rainfalls will deepen the rills and therefore increase soil loss as a result of the increased connectivity caused by rills and gullies (Bennett *et al.,* 2000).

Most of the growers (more than 75%) would like to receive more information about soil erosion and its control. It is also significant that 60% of respondents think that soil erosion can be related to wine quality, even if this cause–effect relationship has not yet been completely established.

Information on Behaviour of Farmers

The most important reason for changing their tillage practices to cover crops is illustrated in this response of

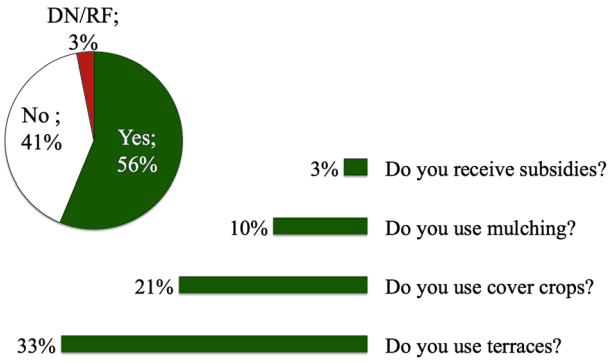

Figure 4. Percentage of farmers working with sloping soils, and what management practices were used to prevent erosion. Results of survey regarding questions 9–16. ($n = 39$) (DN/RF = don't know or refused to answer). This figure is available in colour online at wileyonlinelibrary.com/journal/ldr.

interviewed conventional farmers: '*What's in it for me*?'. When asked about their way to control erosion in sloping vineyards, they mentioned different practices: they use manure to restore depleted soil, they build terraces, they avoid mouldboard plough and they try to avoid ploughing downhill, even if they consider this to be more difficult. Nevertheless, if they have to choose between orientation (north–south is the best one to maximise the hours of light) and slope, they will choose orientation, even if they have to plough in the slope direction. However, in this region, sunlight hours are not a limiting factor. Frequently, the group of conventional winegrowers mentioned their helplessness to avoid soil erosion:

- '*It is really difficult*; *I only try to make contour ploughing in a way and time to avoid runoff*.'
- '*I have no means to do so*.'
- '*We are so short of money that we will not accept any changes if this means cost increases*.'

They also have the feeling that agriculture will last only for a short time, particularly near big cities due to urban sprawl.

Farmer's behaviour is also influenced by their lack of personal motivation:

- '*Actually*, *farmers don't like their work*.'
- '*They do it just because they have no choice*.'
- '*Their sons will not inherit their lands*.'
- '*I only know one farmer really passionate by his job*. *The rest work in agriculture out of sheer necessity*. *They don't like it*. *They come here to exploit*, *just to exploit*.'
- '*Farming is not valued by society*.'

Only two recent winegrowers interviewee were using cover crops to control soil moisture; they tried to reduce tillage, but they did not mention erosion benefits. They said that good farming practices were not especially difficult to follow, but they complained about environmental policy, particularly with regard to the excessive bureaucracy to obtain subsidies. As was observed in other Spanish regions, they apply for subsidies for economic reasons rather than for environmental purposes (Oñate & Peco, 2005; Calatrava *et al.,* 2011).

From the questionnaire, we can confirm that in spite of the problems observed in soil and production, the majority is not willing to change their usual practices. In the question 18th, participants were informed about a research project showing the benefits of cover crops on SOC and erosion, but a decline in grape production. Only 32% of respondents were willing to change to cover crop in these circumstances, 20% did not know or refused to answer and 48% were reluctant to change.

Integrated Information: Principal Component Analysis

A multivariate analysis was performed to obtain integrated information of responses obtained from the 64 participants of the survey. Variables placed close to each other influence the PCA in similar ways, which indicates they are correlated. The two principal components of this analysis extracted 30% of the variance. Although this can be considered low, the model is able to separate the main group of respondents saying *Yes* to the question about their willingness to change or not (Figure 5).

The first principal component absorbs the largest variance (17%). The variables defining this component are related to the need for information, the ability to observe soil degradation and the willingness to change (Figure 6). The respondents of this group with steep vineyards tend to think that tillage is a good option to fight erosion. The opinion of young farmers is close to this group. Other authors in Spain found that young farmers were more willing to adopt SLM (Calatrava *et al.,* 2005).

The responses of the older winegrowers (more than 65 years old) working full-time on their land are found on the right side of the first axis; therefore, their willingness to change is weak. According to recent statistics about rural development in Europe (http://ec.europa.eu/agriculture/statistics/rural-development/2012/), elderly farmers account for more than 65% of farm holders in Spain. Their opinion is therefore important, as they are seen as the source of knowledge for new generations of farmers. The results of PCA regarding their attitudes match the conversations with the older winegrowers during the open interviews, because they were reluctant to invest in their vineyards. In their opinion, viticulture has no future, and the land will very probably be transformed for urbanised use. This feeling can be explained by the model of economic development based on new construction in this country (Barbero-Sierra *et al*., 2013).

In the survey, the number of these old winegrowers (>65) was small, constituting just seven (11%). Nevertheless, it is worth mentioning that they have particular opinions about the questions of the survey compared with active younger winegrowers. Only one of these old farmers observed soil degradation, and consequently, he was the only one willing to change to SLM practices.

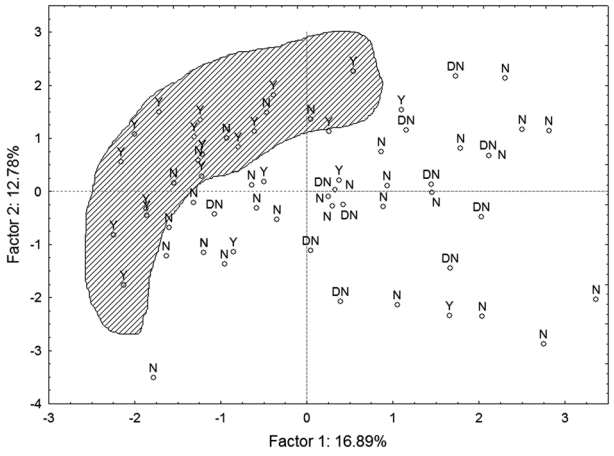

Figure 5. Principal component analysis. Projection of the cases on the factor plane. Results of survey regarding question 18 ($n = 64$; Y = willing to change to cover crops; N = not willing to change; DN = Don't know or refused to answer).

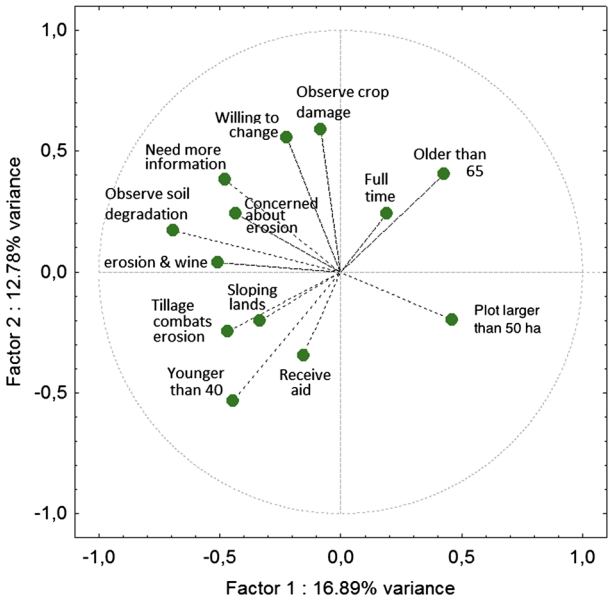

Figure 6. Principal component analysis. Projection of the variables on the factor plane. This figure is available in colour online at wileyonlinelibrary.com/journal/ldr.

In order to determine if the age of respondents was significant, they were divided in two groups: those under versus those above 40 years old (Table II). We found that younger winegrowers (64% of the sample) perceived soil problems better than the older ones (36%). Both have the same opinion about the use of tillage to prevent erosion and the need for more information.

Figure 6 determines that the low willingness to change is also related to the larger size of vineyards in the PCA analysis. The increase in plot size is convenient for obtaining more production by means of mechanisation of labour. It has been argued that big landowners are usually little concerned by erosion because they may abandon their lands once degraded; furthermore, erosion problems seem to be relatively rare on smallholdings (Roose, 1996). This trend is confirmed in this analysis, although the sample is not big and other studies found different results. In France, big landowners do show interest in no-till techniques in their vineyards, especially because the CAP calls for higher quality, downsizing production and protection of fragile land. In the open interviews, those having cellars or high quality wine producers usually had the opinion that SLM is the best way to achieve long-term profits from the land. This contradiction, between the survey and the interviews, shows the need for further studies to know whether or not the size of lands influences the attitude of winegrowers.

In this study, 87% of respondents have plots smaller than 50 ha. The younger farmers with smaller plots are more prone to change to SLM (Läpple & Van Rensburg, 2011), probably because it is easier for them to observe changes in their soils and crops as was found in this study. Respondents who want more information are at the same time concerned about erosion, to the point where they consider that erosion has an effect on wine quality. In the open interviews, the winegrowers stated that they will assume extra costs, only if this means later economic benefits. This can be achieved only if the relationship between SLM and wine quality is demonstrated.

The detailed reasons for the respondents not being willing to change are frequently based on the lack of water under dry climates for rain fed crops (21%); their lack of knowledge regarding cover crop management (14·8%); their inability to accept a decrease in production (10·6%); the higher costs presumed for the cover crop management (8·5%); the added time spent on this management (8·5%); the possible proliferation of weeds (8·5%); their age, as they are going to retire soon (4·3%); their satisfaction with the present situation of their soil and crops (only 2·1%); and finally, 21·3% are not giving any explanations.

When they were asked in an open question of the questionnaire (21st question), 'Who is responsible for soil conservation regarding erosion?', some of them thought that farmers had an important role (33%), but they also mentioned the state (14%), and the local authorities (8%) or the extension agents (4%) as elements that should be involved in these issues. Yet, most of them thought that this was a shared responsibility of society as a whole (41%).

In this general context, policy makers are involved in the process of implementation of SLM practices through enacting regulations such as environmental payments to avoid erosion, but in the questionnaire, 85% of respondents declared not having applied for any type of aid related to this concept. Only 3% of respondents received this aid (Figure 4), and the remaining 12% did not answer.

Table II. Answers grouped according two groups of age (under and above 40 years old).

	Winegrowers under 40 ($N = 22$)	Winegrowers above 40 ($N = 39$)	Significant differences between two situations. Chi-square 95% confidence ($df = 1$)
Aware of soil degradation	64%	36%	$\chi^2 = 4{\cdot}358$; $p = 0{\cdot}037$*
Aware of damage in production or vines	55%	69%	$\chi^2 = 1{\cdot}316$; $p = 0{\cdot}251$
Think that soil tillage prevents erosion	79%	63%	$\chi^2 = 1{\cdot}498$; $p = 0{\cdot}220$
Receive subsidies for erosion control	8%	0%	$\chi^2 = 1{\cdot}664$; $p = 0{\cdot}197$

The total number of respondents was 64, but three of them refused to answer this question; the information in this table was drawn from 22 + 39 = 61 respondents.
df = degrees of freedom.
*Significant differences.

Policy measures are powerful incentives to farmers for avoiding land degradation (Louwagie *et al.,* 2011), but there are several weaknesses in the successful implementation of environmental measures (Calatrava *et al*., 2011); results show that dissemination of good practices to provide guidance for these farmers seems to be low. 'Farmers are crucial to the success of agri-environmental schemes, and without sufficient understanding and financial incentives, the policy will not be adequately implemented' (ECA, 2011; p. 48). Financial incentives seem to be enough, but in this region, understanding of environmental problems is still a pending issue. Use of SLM is most effective when these are understood, and decisions are rooted in land and resource stewardship and long-term concerns about health of the farm and the soil (Ahnström *et al.,* 2009).

CONCLUSIONS

In spite of the fact that soil is the base of production for farmers, this is not its main environmental concern. This fits in with the little or no intention of changing management practices found in this study. Only 32% of respondents were willing to change to cover crops. This fact may be interpreted as unwillingness to adopt SLM, and, consequently, as a source of concern for policy makers committed to the application of environmental measures of the CAP, and also as a source of frustration for scientists, whose research is not applied.

From a policy perspective, there are two ways to promote SLM: economic support and awareness raising/education. According to the data, the first one seems to be enough, although not sufficiently used by farmers. The second way, education of farmers about environmental issues, is often ignored. The fact that only 24% of respondents be aware of the risks of tillage for soil erosion is worrisome. Efforts must be concentrated to increase the flow of scientific information. There are improvements as farmers declare knowing good farming practices, but they are reluctant to use them if there are no returns. These conflicts between personal profits and general benefits can be mitigated by educational programmes on environmental issues designed for farmers. Local meetings and demonstrations involving farmers are needed, for example, to demonstrate the relationship between SLM practices and quality of products. '*I only believe what I see*' illustrates the importance of these demonstrations. In Spain, the number of extension centres to carry them out has decreased in the past decades and should be relaunched.

A larger survey is currently under way to clarify gaps and weaknesses found in this study concerning the slope of lands or the farm size. Nevertheless, the recruitment of adequate numbers of people to participate is not easy. It is important to emphasise that the willingness of farmers to participate in this kind of environmental surveys is scant. Farmers in this region may still be guided by productivist attitudes and still seeing environmental measures as a threat to their livelihood. These attitudes should push policy makers and scientific community to increase efforts to transfer scientific knowledge and remove barriers between stakeholders with the aim to develop conservation policies.

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