International Journal of Agricultural Sustainability

ISSN: 1473-5903 (Print) 1747-762X (Online) Journal homepage: http://www.tandfonline.com/loi/tags20

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To cite this article: Tatiyana Giomi, Piety Runhaar & Hens Runhaar (2018) Reducing agrochemical use for nature conservation by Italian olive farmers: an evaluation of public and private governance strategies, International Journal of Agricultural Sustainability, 16:1, 94-105, DOI: 10.1080/14735903.2018.1424066

To link to this article: https://doi.org/10.1080/14735903.2018.1424066

INTERNATIONAL JOURNAL OF AGRICULTURAL SUSTAINABILITY, 2018
VOL. 16, NO. 1, 94–105
https://doi.org/10.1080/14735903.2018.1424066

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Reducing agrochemical use for nature conservation by Italian olive farmers: an evaluation of public and private governance strategies

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ABSTRACT

A variety of public policies and private strategies have been implemented to stimulate farmers to implement nature conservation measures. Examples include publicly funded agri-environment schemes (AES) but also eco-labels and Alternative Food Networks; strategies that have been implemented in response to the continuous decline in species abundance and diversity due to agricultural intensification and scale enlargement. Whereas AES as a distinct governance strategy has been evaluated in detail, less is known about other strategies. In this paper, we assess the relative importance of the variety of public and private strategies aimed at enhancing species abundance and diversity in Italian olive farming through a reduction in agrochemical use. In a survey of olive farmers in the region of Tuscany, we found that although farmers are exposed to a variety of public and private strategies, personal motives to reduce agrochemical use are most important. Moreover, having a Corporate Social Responsibility plan or engaging in direct sales to consumers are the only strategies that are related to a reduction in agrochemical use. These findings suggest self-governance is a powerful strategy for enhancing species diversity and abundance in agricultural landscapes. Yet it also means contributing to nature conservation and restoration is a voluntary act. Olive farmers who do not voluntarily contribute to nature conservation by reducing agrochemicals need to be incentivized by showcasing farmers who did reduce their agrochemical use, by critical consumers or by stricter rules in AES or in generic agri-environmental legislation.

KEYWORDS
Nature conservation; agriculture; biodiversity; governance; olive farming; Italy

1. Introduction

Species abundance and diversity (i.e. the number of individuals of one species and the number of species) in agricultural landscapes has decreased substantially in Europe, particularly as a consequence of agricultural intensification (EEA, 2015a; 2015b; Ollerton, Erenler, Edwards, & Crockett, 2014; Stoate et al., 2009). In order to halt the trend of declining species abundance and diversity, governments but also NGOs and private companies have implemented policies and taken initiatives to stimulate farmers to implement nature conservation measures (Runhaar et al., 2017). Agri-environment schemes (AES) are a well-known example. Other examples include cooperation between farmers and NGOs in terms of knowledge exchange and financial support; eco-labels for agri-food products that have been produced in ways that respect biodiversity; Alternative Food Networks that centre round products that are cultivated locally with minimal environmental impacts; and *bonus-malus* arrangements considered or implemented by agri-food companies and that reward farmers who contribute to nature conservation and penalize those who do not (Holloway et al., 2006; Runhaar et al., 2017). Whereas AES have been evaluated intensively (see e.g. Ansell, Freudenberger, Munro, & Gibbons, 2016; Kleijn et al., 2006; Smits,

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Driessen, & Glasbergen, 2008), far less is known about the other public and private strategies aiming to stimulate nature conservation by farmers (Runhaar et al., 2017; see also Fuchs, Kalfagianni, Clapp, & Busch, 2011). In view of the negative ecological trends in many European agricultural landscapes, it is important to have a better understanding of how nature conservation by farmers is governed and how this can be reinforced.

In this paper, we assess the relative importance of a variety of public and private strategies aimed at enhancing species abundance and diversity in Italian olive farming. Olive production is among the main crops in Italian agriculture and is practiced in every region of the peninsula. After cereals and grazing, it accounts for the largest land use in Italian agriculture (FAOSTAT, 2015; ISTAT, 2015). From a biodiversity point of view, olive tree cultivation, particularly if farmed with traditional practices (not only less intensive in terms of agrochemical use but also combining olive production with of other crops, such as legumes, in-between olive groves to enhance soil quality; Calabrese, Tartaglini, & Occhialini, 2012), is considered home to a great variety of habitats and hosts many species of wild fauna, ranging from reptiles to mammals, insects and migratory birds (Camarsa et al., 2010; Tartaglini, Calabrese, & Servadei, 2012). However, over the last decades, the use of inorganic fertilizers, pesticides, herbicides, insecticides and other agrochemicals in order to intensify production has had a detrimental effect on many ground flora and insect populations, reducing their numbers and diversity. This, in turn, has led to a reduction of food accessible to mammals, reptiles and birds (Calabrese, Tartaglini, & Gaetano, 2012; Calabrese, Tartaglini, & Occhialini, 2012; Camarsa et al., 2010; Posta, La Lacirignola, & Mimiola, 2012). Agrochemicals have particularly been used in order to reduce possible insect pests and limit the growth of unwanted plants. Figure 1 depicts their impacts.

The goal of this paper is to identify various public and private strategies for nature conservation by farmers, to characterize them and to evaluate their outcomes. We realize that Italian olive production is not representative of European agriculture in terms of its agrobiodiversity, its agricultural production styles and the specific public and private strategies present that promote nature conservation by Italian olive farmers. This case is nevertheless interesting as olive farming is conducted in many other parts in the world and particularly in other parts of Southern Europe where also ecological impacts due to agrochemical use are reported (e.g. Herrera, Costa, Medinas, Marques, & Mira, 2015). The case chosen is particularly interesting because as it allows for the analysis and comparison of a variety of governance strategies, as we will show later.

The remainder of this paper unfolds as follows. In Section 2, we present our analytical framework. In Section 3, the methodological framework is explained. The results are presented in Section 4. Finally, in Section 5 we wrap up with our main conclusions and some reflections.

2. Analytical framework

In this section, we specify our key concepts and variables. A distinction is made between dependent and independent variables. We draw from earlier studies that aimed to explain why farmers do or do not reduce agrochemicals as well as from more general (agri-)environmental governance literature.

2.1. The dependent variable: use of agrochemicals

Agrochemicals are used for pest control and weed control. It is likely that farmers who reduce agrochemical use (whether or not under the influence of public or private governance arrangements) will switch to alternative measures for pest or weed control as the threat still persists. Alternative pest control measures include the use of traditional pest control products such as copper, lime, white oils or Bordeaux mixture (also allowed in organic farming) and to mass-trapping using baits and pheromones or preventive methods such as pruning or focused pesticides treatment (Beaufoy, 2001; Camarsa et al., 2010; Hajjar, Jarvis, & Gemmill-Herren, 2008; Movses & Micheli, 2015). A lower use of herbicide can be achieved through alternative soil management, e.g. permanent or semi-permanent grass cover maintained through mechanical mowing and/or sheep raising or using the understorey to grow other crops (e.g. legumes) (Beaufoy, 2001; Movses & Micheli, 2015; Phalan, Balmford, Green, & Scharlemann, 2011).

2.2. Independent variable: governance strategies

A key concept is 'governance strategy'. Whereas *governance* in our case refers to interventions deliberately initiated in order to prevent, reduce or mitigate harmful effects of agriculture on species diversity and abundance, and to promote positive effects

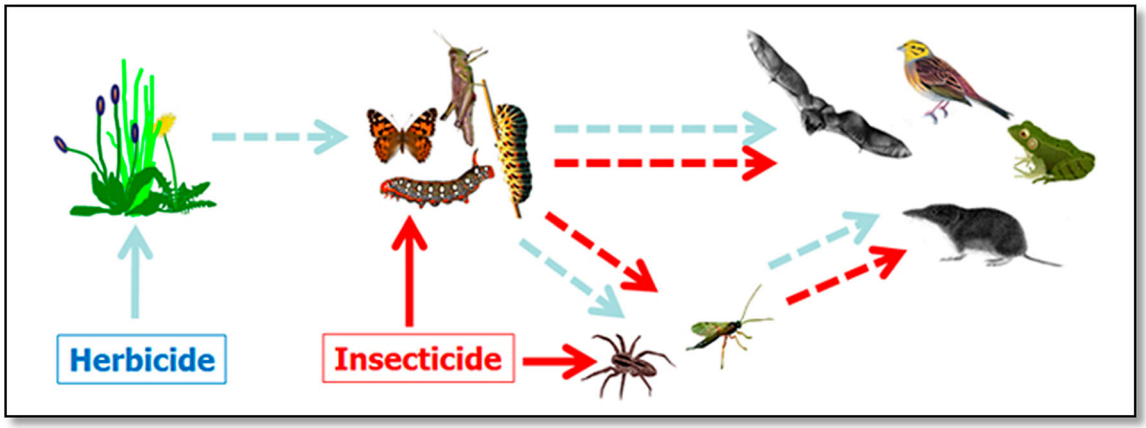

Figure 1. Impact of agrochemicals on ground flora, insect and spider populations, mammals, amphibians and birds. Source: http://www.uni-koblenz-landau.de/campus-landau/faculty7/environmental-sciences/ecotoxicology-environment/research/projects-terr-ecotox.

(Runhaar et al., 2017), a governance *strategy* refers to a specific way of governing (cf. Mintzberg, 1987). Environmental governance literature often distinguishes between four characteristic strategies based on their 'steering philosophy': regulatory, economic, informational and organizational (Runhaar, Driessen, & Uittenbroek, 2014). Regulatory strategies enforce a specific behaviour and prescribe penalties for non-compliance. In our case, this could be regulations regarding agrochemical use. Economic strategies provide positive or negative economic incentives in order to achieve the desired behaviour (e.g. subsidies/incentives for farmers who switch to biological pest control). Informational strategies aim at behavioural change by the target group by providing knowledge regarding the impact of agrochemicals and the benefits of alternatives (Runhaar et al., 2014; Vedung, 1998). Organizational strategies include procedures and structures that facilitate the incorporation of biodiversity concerns in sectoral policies or in agricultural practices (Mees et al., 2014; Runhaar, 2016). A second way in which governance strategies are often distinguished is according to their 'steering approaches' in terms of the type of interaction between governmental, market and civil society actors: top-down, interactive and self-governance (Driessen, Dieperink, van Laerhoven, Runhaar, & Vermeulen, 2012; Runhaar et al., 2014; Runhaar, 2016).

2.3. Other factors

The use of agrochemicals is influenced by factors other than specific governance strategies that aim to reduce agrochemical use. The use of agrochemicals will depend on the frequency and magnitude of pests, but also on characteristics of the farmers. In other studies, it was found that farmers' willingness to switch to more nature-friendly or environmentally friendly practices (of which reducing agrochemicals is a specific form) is related to personal motives such as their sense of ownership of nature conservation or environmental protection (Lokhorst, Staats, van Dijk, & de Snoo, 2011) but also to commercial interests: e.g. a demand for products based on a sustainable use of pesticides (Costa & Santos, 2016) or the expectation that a lower use of agrochemicals results in lower overall costs (Nave, Jacquet, & Jeuffroy, 2013). In addition, in other surveys it was found that there are several demographic characteristics that affect farmers' decisions regarding production styles (including but not limited to agrochemical use), namely farm size, farmer's age and educational background, intensity of production and location of the farm (Schroeder, Isselstein, Chaplin, & Peel, 2013; van Dijk, Lokhorst, Berendse, & de Snoo, 2015; Wilson & Hart, 2000). The impact of at least part of these factors however is inconclusive, as different studies have reported different impacts (Nave et al., 2013).

3. Material and methods

3.1. Research context

3.1.1. Geographical delineation

We focused on a particular region in Italy, namely Tuscany. Tuscany is one of the nineteen regions in Italy were olives are farmed. About 90% of the

cultivation is localized in hill or low mountain areas, albeit there has been a tendency of abandoning the more remote plantations for valleys or level ground lands (Giunta Regionale Toscana, 2013). The most recent census performed by the Italian Statistical Institute (ISTAT) in 2010 indicated that an area of 91,200 hectares, about 12.2% of the total surface used for agriculture of the region, was used for olive production (ISTAT, 2015). The average land cultivated per agricultural business is 1.83 hectares (Giunta Regionale Toscana, 2013). Most of the Tuscan olive culture fields derive from orchards that were planted between the 1800 and early 1900.

Olive orchards in Tuscany host over 300 different flora species (Calabrese, Tartaglini & Occhialini,2012). The diversity of habitats provided by olive groves also allows a great variety of wildlife including butterflies and other invertebrates, reptiles, mammals and birds. They host numerous species of birds breeding in olive groves in Tuscany such as *Upupa epops* (Hoopoes), *Coracias garrulous* (European roller; a species of conservation concern, *Otus scops* (Eurasian scops owl) , *Athene noctua* (little owl) and various passerines (Calabrese, Tartaglini & Occhialini,2012; Camarsa et al., 2010). Particularly, the centuries-old olive trees farmed with low inputs practices have been recognized above other to have high levels of biodiversity (Calabrese et al., 2015).

Species diversity and abundancy have been threatened by the intensification of olive farming and the incremental increase in the use of agrochemicals. The use of herbicides as well as the clearance of natural vegetation in the understorey has led to a decline into reptiles and invertebrates and small mammals feeding on them which in turn has entailed the loss of nourishment for birds and larger reptiles and mammals. Pesticides are particularly used to control the olive fly, a pest specific for Italian olive farming. This fly decimates crops, impacts the acidity of the oil and makes table olives unsaleable. The occurrence of the olive fruit fly (*Bactrocera oleae*) is particularly high during humid and frost-free periods (Cirio, 1997). Pesticides have perpetuated the trend of declining invertebrate populations and, as a consequence, all species sustaining on them (Calabrese, Tartaglini & Occhialini,2012, 2015; Henle et al., 2008). A reduction in agrochemicals inputs, for instance as a consequence of a switch to organic farming, has been found to have a positive impact on biodiversity in olive orchards, particularly in ancient ones (Calabrese et al., 2015).

3.1.2. Scope: unit of analysis and time horizon

The single farmer is the targeted population each strategy analysed in this research. Moreover, at farmer level, different strategies might come together and interact or hinder each other (Runhaar et al., 2014). For these reasons, the chosen unit of analysis for the impact assessment performed during this study is the farmer.

We focused on the period between 2010 and 2015 for two reasons: one, the impact of agriculture on biodiversity as well as the number of initiatives towards biodiversity conservation have risen in that period; and two, the period was close enough to the present to avoid lapses of memory from the target group (data were collected in 2015–2016; Calabrese et al., 2015).

3.2. Identifying governance arrangements

Next to an Internet search, we interviewed 12 persons who have a good overview of the Tuscany olive farming sector, to identify the specific governance strategies targeting Italian olive farming. We characterized these strategies in terms of steering approach (top-down, bottom-up or interactive) and steering strategy (regulatory, etc.; see Section 2). We also used these interviews to complement and refine our initial list of independent factors taken from the literature (including personal motives that farmers may have to reduce their use of agrochemicals). See Appendix 1 for the positions of the interviewees and their affiliations.

3.3. Assessing governance arrangements

We conducted a survey in order to be able to assess the relative importance of the variety of public and private governance strategies for promoting biodiverse olive farming in Tuscany. By means of a survey, we hoped to be able to identify general patterns in how the various strategies work. The alternative would have been a case study, in which a limited number of farms is analysed in-depth, which would provide more insight into motivations and limitations at farm-level but which is less appropriate for the purpose of this study because it would not say much about the relative importance of the variety of public and private governance arrangements (Verschuren & Doorewaard, 2010).

We identified olive farmers via the Italian website of the Chamber of Commerce, Registro Imprese, as

categorized by the ATECO code 0126 (Italian classification for economic activities). There are approximately 50,300 olive farmers in Tuscany (Giunta Regionale Toscana, 2013). An interview with a Trade Union representative (one of the 12 persons we interviewed in the above pre-study) however revealed that this population includes many olive farmers who cultivate olive trees as a secondary activity for their own private consumption farms on small plots of land (starting from half a hectare). According to other interviewees, these small plots do not allow a viable economic activity. We therefore decided to focus only on olive farmers who had olive farming as their primary activity. Five thousand seven hundred and thirteen farmers classified as such (Giunta Regionale Toscana, 2013; ISMEA, 2013). Because we did not have access to all (email) addresses, questionnaires were sent to 4057 out of the 5713 farmers using a certified email system ('PEC'; Ministero della giustizia, 2012).

Eventually, we received 309 complete responses, 5.4% of all Tuscany olive farmers and 7.6% of all farmers who were approached by email. One of the possible reasons for the relatively low response rate is the relative novelty of the use of certified e-mails by farmers. Many farmers, as well as businesses in general, use PEC only to receive utilities' invoices and do not often check this email account as we learned after we conducted the survey. In terms of the dependent variable, agrochemical use, the response group is very similar to Italian olive farmers in general; their use of agrochemicals and changes over the last 15 years are very comparable (see Section 4). Regarding the independent variables, we cannot say how representative our sample is in terms of the types of governance strategies they are exposed to. The same applies to general characteristics such as company size, because the national statistics do not differentiate between olive farming as a primary or as a secondary occupation.

3.4. Operationalizations

3.4.1. Dependent variable: (change in) usage of agrochemicals

In order to measure the use and reduction in the use of agrochemicals, we asked three questions. Q1 'In the past five years (between 2010 and 2015) have you used agrochemicals in your olive cultivation?' could be answered with 'Yes', 'No' or 'I haven't used agrochemicals in the past 5 years'. The latter answer overlaps with 'No' but is more specific; we added this category in order to allow us to identify any patterns in agrochemical use; Q 2 'In the same period of time, considering seasonality, have you increased or decreased your use of agrochemicals' could be answered with 'Increased', 'Stayed the same' or 'Decreased'; With Q3, respondents could indicate the degree, in percentage of agrochemicals (volume), to which they reduced the use of agrochemicals. Pre-structured answers varied from 'From 1% to 20%' till 'More than 80%' and 'I'm not using any agrochemicals anymore'.

In order to measure farmers' exposure to the various public and private governance strategies that aim to promote a reduction in agrochemical use, we use pre-structured questions like 'Do you follow the legislation in regards to traceability?' which could be answered by 'yes' or 'no'.

3.4.2. Independent variables: strategies and other factors

In order to measure *farmers' motives*, we presented eight possible motives and asked farmers to indicate their importance with regard to a reduction of agrochemicals (if reported). For instance: 'Access to new markets' or 'commercial interest'. Answers could range from 1 'not important', to 5 'extremely important'. Factor analyses showed two sets of motives 'commercial motives' and 'ideological motives', hence we analysed using these two subscales. See for factor loadings and alpha coefficients (Table 2).

We also asked what the main reasons were for farmers who decided to reduce the use of agrochemicals in their olive farms. Farmers could choose one out of three answers: personal reasons (referring to the above motives); public or private strategies aimed at promoting a reduction in agrochemical use; and cost reduction.

The questionnaire contained several background questions to control for factors other than the strategies (see Section 2). Some of these variables were easy to measure, e.g. farm size, farmer's age and educational background, the intensity of production and whether or not farms were organic. Farmers' sense of ownership of environmental stewardship was difficult to measure directly and we therefore decided to ask for the relative importance of nature conservation as an argument to reduce the use of agrochemicals. A similar approach was taken for the relevance of commercial interests and a desire to cut costs. Regarding the independent variable 'farm location', we asked in which province the farmers were located. We did

not find statistically significant differences in responses regarding changes in agrochemical use however, indicating this factor did not play a role. We did ask about the frequency and magnitude of pests by asking whether or not the respondents' farms were located in areas highly affected by the olive fly. Also in this case there appeared to be no statistical correlation between this variable and reported changes in agrochemical use.

3.5. Data analyses

The number of responses was large enough for statistical analysis (and larger than comparable studies; see e.g. Nave et al., 2013) and allowed for a confidence interval of 95% with a standard error of 0.0542 based on 5713 farmers.

We used Chi-square or a Spearman's rho, depending on the type of variable, to test whether there might be a relationship between the dependent variable and the independent variables other than the strategies. This analysis yielded no statistically significant differences except for educational background ($r = .24$, $p < .01$).

To determine the relationship between strategies that governments and other actors employ in order to promote a reduction in agrochemicals, other motives of farmers to reduce their use of agrochemicals and the actual reduction in agrochemicals, we used two methods: first, we asked farmers directly about the importance of their motives and the strategies and second, we measured the dependent and independent variables separately and conducted statistical tests for significant correlations. For the latter tests, we utilized a Spearman correlation coefficient where an ordinal variable was present while we used a Chi-square test if both variables were only categorical (cf. Field, 2009). For our dependent variable, we only used the question which explicitly measured the change in usage. We only included in our analysis those variables which showed variance in answers, namely: participation in AES, participation in farmers' market (i.e. direct sales from farms) and whether or not farmers had developed a corporate social responsibility plan. All farmers indicated to comply with legislation in regards to traceability of products and chemical use and to legislation specifying the 'sustainable use of agrochemicals'. None of the respondents indicated to sell to so-called solidarity purchasing groups: Alternative Food Networks consisting of citizens who jointly purchase food products from small and local producers who produce in a socially responsible and environmentally conscious way (Redazione, 2004). Such purchasing groups may create a stimulus to reduce or eliminate the use of agrochemicals to farmers in search of new markets for their products.

4. Results

4.1. Strategies in use to promote agrochemical use reduction

Based on the 12 interviews, Table 1 summarizes the public and private governance strategies aimed at promoting a reduction in agrochemicals by Italian olive farmers, in order to contribute to habitat restoration and biodiversity. Next to an AES, which takes the form of a Rural Development Programme (RDP), a number of other strategies were identified, classified according to the two dimensions discussed in Section 2 (steering strategy and steering approach). Some strategies aim at providing transparency about agrochemical use, to consumers or other stakeholders (e.g. traceability regulations, eco-labels and information sharing). This is an indirect measure; by trying to influence consumer choice, farmers are stimulated to reduce agrochemical use because consumers want them to do so. Other strategies are more directly aimed at agrochemicals, e.g. the National Plan for the Sustainable Use of Agrochemicals that prescribes training for farmers as a precondition for obtaining a licence to use agrochemicals.[1] Appendix 2 contains more detailed descriptions of the strategies.

Most strategies aim to stimulate farmers to voluntarily reduce agrochemicals, by providing support, economic incentives or information. Some strategies aim to stimulate a reduction in agrochemical use by trying to create consumer demand for more local and more sustainable products. Appendix 3 visualizes the different mechanisms through which the strategies aim to influence farmers.

Figure 2 shows what strategies Tuscan farmers are exposed to, based on their reports in the survey. All farmers have reported to fulfil the obligations mandated by the regulatory instruments mentioned above, sustainable use of agrochemicals and traceability. To date, no monitoring initiatives have been set out for either legislation in regards to compliance (ISTAT, 2012) and since there was no variance in the reported data we had to exclude both from the below analysis.

Table 1. Strategies in use in Tuscany that aim to promote a reduction in agrochemicals by farmers.

Steering approach steering philosophy	Top-down governance	Interactive governance	Self-governance
Regulatory	Traceability regulations for food farming products National Plan for the Sustainable Use of Agrochemicals		
Economic	Rural Development Programme (RDP)	Eco-labels (EU Organic certification, Agriqualitá)	Farmers market Solidarity purchasing groups (SPG)
Informational	Technical assistance provided by Centres of Agricultural Assistance (CAA)	Technical assistance provided by agronomist, trade associations, consumers associations, farmers associations or Universities	Self-directed trainings Information sharing
Organizational			Corporate social responsibility (CSR)

Table 2. Motives for reducing agrochemical use ($N = 104$).

	Mean	Std. dev.	Factor loading	Factor loading	Alpha/correlation
Ideological motives					
Increase the safety and health of the products	4.26	1.005	.896		$\alpha = .93$
Conservation of the environment	4.12	1.008	.926		
Respect and development of the territory	4.08	1.031	.916		
Conservation of wildlife biodiversity (e.g. pollinators, mammals, reptiles, birds, etc.)	4.01	1.162	.845		
Higher quality of the products	3.95	1.092	.731		
Increase the safety and health of the workspace	3.85	1.283	.819		
Commercial motives					
Commercial interests	2.30	1.253		.831	$r = .70$, $p < .01$*
Access to new markets	2.14	1.318		.781	
Cost reduction					
Reducing costs by using less agrochemicals			n.a.*	n.a.*	n.a.**

*This means that the correlation between the two items was significant at the .01 level.
**No factor analysis or correlation analysis was conducted for this motive as it was asked in one single question.

4.2. Changes in agrochemical use

A majority of the farmers in our sample have not used any agrochemicals between 2010 and 2015. Almost 3% have increased, about 14% have maintained and some 12% have reduced. Of the ones that have lowered their consumption of agrochemicals, more than half have diminished it by at least 40%.

National statistics suggest our sample is fairly representative in terms of the dependent variable, i.e. the reduction in agrochemicals in olive farming. According to ISTAT (2012), 27% of all olive farmers use chemical inputs (which is comparable with the 29.1% in our sample) and that on average, these farmers have decreased their use of agrochemicals by about 54.2% since 2005–2006.

Even though a minority of olive farmers thus uses agrochemicals, their ecological impact apparently is substantial (Calabrese, Tartaglini, & Gaetano, 2012; Calabrese, Tartaglini, & Occhialini, 2012; Camarsa et al., 2010; Posta et al., 2012). Assessing the ecological impacts of the Tuscan farmers using agrochemicals, however, is outside the scope of this paper.

4.2.1. Farmers' motives to reduce agrochemical use

Table 2 shows the reported importance of eight motives to reduce or even stop agrochemical use (this includes farmers who decided to stop using agrochemicals before 2010). Apparently, health and safety arguments (both for farmers themselves and for consumers) and ecological reasons are considered as important (see the scores for the first six motives). Commercial arguments are less important it seems.[2] This also appears from a second test, in which we analysed the correlation between motives and a reduction in agrochemical use; commercial motives appeared not to be related to a change in usage ($r = .087$, ns) whereas the ideological motives were ($r = .3222$, $p < .01$). Reducing costs by using less agrochemicals was mentioned by only 6 respondents (5.8%) as a main motive for reducing agrochemicals.

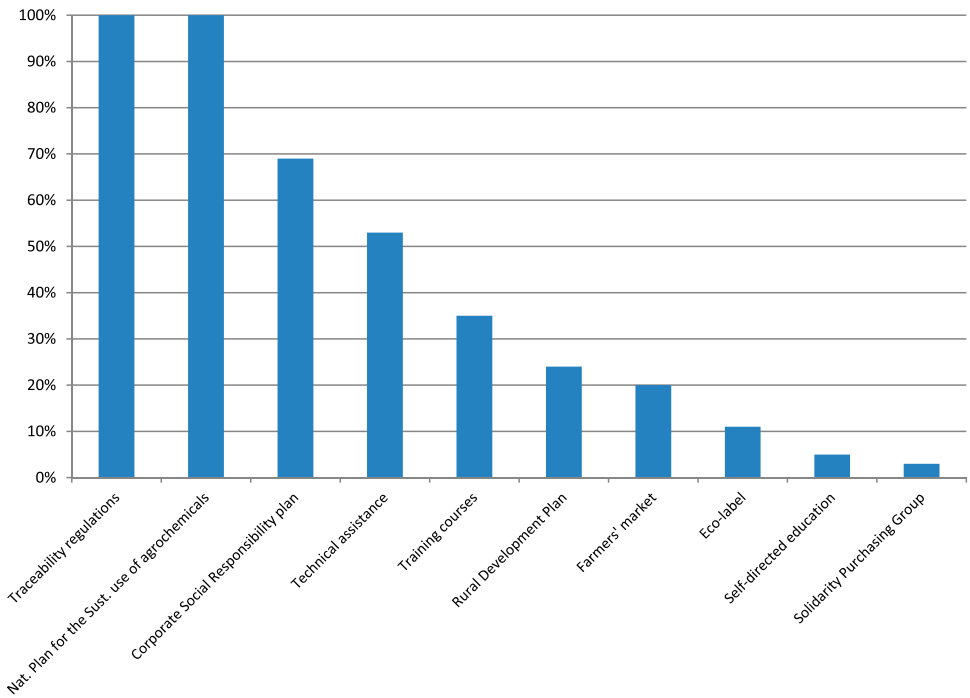

Figure 2. Self-reported strategies Tuscan farmers are exposed to.

4.2.2. The importance of public and private strategies for reductions in agrochemical use

We assessed the importance of the strategies identified in Table 1 in farmers' decisions to reduce the use of agrochemicals in two ways: first, by asking farmers how important these strategies were, and second, by correlating the reported exposure to the strategies with the reported changes in agrochemical use.

The first assessment showed that the presence of a Corporate Social Responsibility plan, i.e. a voluntary plan of farmers to contribute to social values, including environmental protection, is the most important strategy for stimulating a reduction in agrochemical use. This strategy had the highest score (mean: 3.88, sd 1.309). All other strategies had an average score well below 3 (on a five-point scale), suggesting they were not considered very important in farmers' decision to reduce their use of agrochemicals.

Our second assessment of the importance of the strategies showed that only two correlate to a reduction in agrochemicals: again the availability of a Corporate Social Responsibility plan (χ^2 (1) = 7.906, $p = .005$, see also Figure 3) but also participation in farmers' markets (χ^2 (1) = 4.140, $p = .042$; again, see Figure 3).

Both assessments suggest that self-governance is the most effective way of stimulating a reduction in agrochemicals, at least in the case of Tuscan olive farming. Stated differently: strategies employed by actors other than farmers themselves do not seem to contribute significantly to a reduction in agrochemical use. For instance, participation in AES (the RDP) was not found to be related to a decrease in agrochemical usage (χ^2 (1) = .536, $p = .464$). On the one hand, this finding shows the power of self-regulation. On the other hand, it also shows that reduction in agrochemical use, at least in Tuscany, is a voluntary act. Whether or not that is sufficient to reduce the ecological impacts of agrochemicals is to be seen.

4.2.3. Relative importance of personal motives vis-à-vis strategies

The above suggestion that farmers' own motives and strategies play a more important role in their decisions about agrochemical use is also confirmed by farmers' answers on the question what was important to them in their decision-making process: 70.2% chose the option of 'personal reasons' whereas 24% mentioned

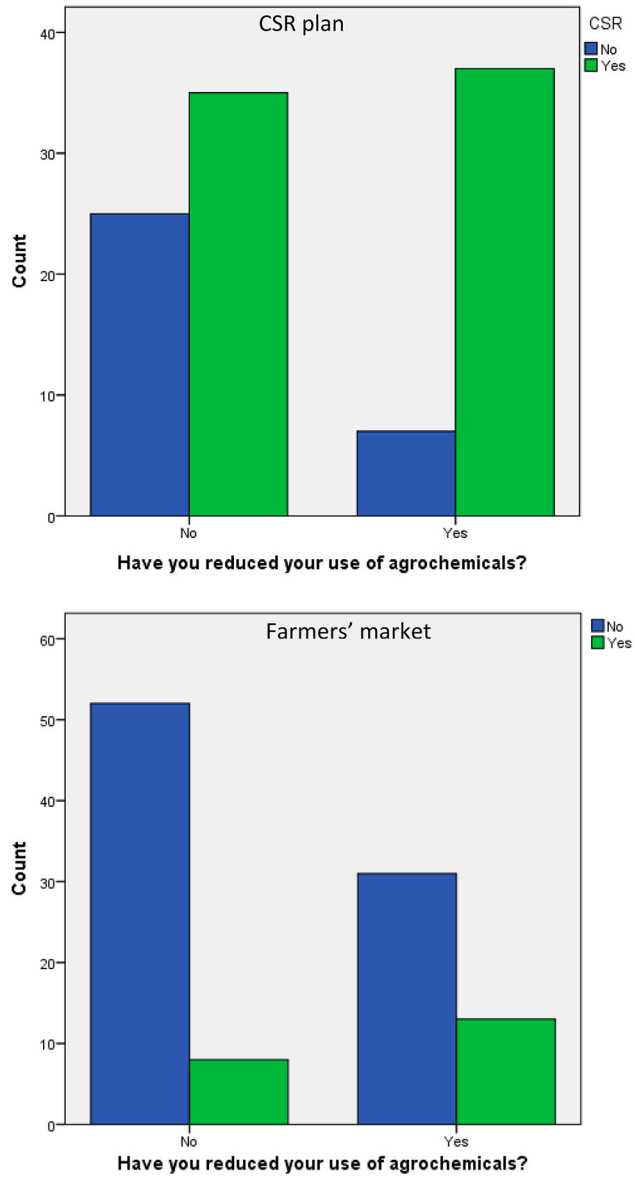

Figure 3. Correlation between agrochemical use reduction and the availability of a corporate social responsibility plan (top) and participation in farmers' markets (bottom).

strategies (including CSR) as being important for having changed agrochemical use.

5. Discussion and conclusions

Farmers can positively contribute to restoring species abundance and diversity in agricultural landscapes, namely by reducing their use of agrochemicals. In this paper, we analysed olive farming in Tuscany, Italy, as a case study. We particularly analysed the importance of public and private strategies that are employed to stimulate farmers to reduce their use of agrochemicals. We also examined the importance of personal motives to reduce agrochemical use.

In our survey, we found that farmers are exposed to a variety of such strategies. Only strategies that they implement themselves seem to be most important for reducing agrochemical use. These strategies include Corporate Social Responsibility plans developed by the farmers voluntarily and direct sales

from farms to customers, which we hypothesize may lead to a reduction in agrochemical use because consumers see how food products are produced and critical consumers ask for more 'nature-friendly' agriculture (cf. Vassalos, Gao, & Zhang, 2017). On a positive note, this means that self-regulation seems a powerful strategy for enhancing species diversity and abundance in agricultural landscapes. Yet it also means contributing to nature conservation and restoration is a voluntary act.

Personal motives to reduce agrochemical use include both concerns about health effects of agrochemicals for farmers themselves and for consumers, and ecological and environmental concerns. These motives are more important than commercial motives and cost savings but also more important than strategies that have been implemented with the goal to stimulate farmers to reduce their use of agrochemicals.

How can other farmers be stimulated to reduce agrochemical use? One way could be to set the farmers who reduced or abandoned their use of agrochemicals as an example for the other farmers. Another way is to raise awareness among consumers and in this way stimulate farmers markets. Interesting lessons can be learned from research on Community Supported Agriculture (e.g. Rossi, Allen, Woods, & Davis, 2017). The current AES apparently is not very effective in reducing agrochemical use, even though reducing agrochemicals is part of the good agricultural practices it prescribes and rewards. This calls for more stringent guidelines regarding payments for reductions in agrochemicals. A strategy of last resort is to implement generic agri-environmental legislation specifying rules for agrochemical use. Whether these interventions will work, in Tuscany and elsewhere, requires further research.

Our study complements studies that have been conducted on farmers' motivations to adopt sustainable farming practices (e.g. Greiner, 2015; Kragt, Dumbrell, & Blackmore, 2017) by putting these in a wider perspective, namely by comparing the relative importance of personal motivations to that of external incentives. Another contribution is that our paper allows for comparing the effectiveness of AES with other, public and private, governance arrangements for promoting agrobiodiversity (cf. Runhaar et al., 2017). Most evaluations of AES do not take into account alternative governance arrangements (e.g. Ansell et al., 2016; Kleijn et al., 2006). Our paper also offers a framework for systematically identifying public and private strategies that are employed in order to stimulate farmers to positively contribute to nature conservation. We encourage other researchers to conduct similar surveys in other agricultural sectors and in other countries, in order to learn about the effective governance of nature conservation by farmers.

Notes

1. This example shows that sometimes it is difficult to classify a particular strategy in terms of steering philosophy; the mandatory character of the training makes it regulatory rather than informational strategy. Same for the technical trainings supplied by the Centres of Agricultural Assistance (CAA) represents an informational strategy, but the CAA themselves could be considered an organisational strategy.
2. Factor analyses showed that we could treat 'Commercial interests' and 'Access to new markets' as one factor; these two items were positively correlated to each other ($r = .70$, $P < .01$).

Disclosure statement

No potential conflict of interest was reported by the authors.

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