

Behavioural factors affecting the adoption of sustainable farming practices: a policy-oriented review

François J. Dessart*, Jesús Barreiro-Hurlé and René van Bavel
European Commission, Joint Research Centre (JRC), Seville, Spain

Received April 2018; editorial decision February 2019; final version accepted March 2019

Review coordinated by Sophie Thoyer and Raphaële Preget

Abstract

This paper reviews the findings from the last 20 years on the behavioural factors that influence farmers' decisions to adopt environmentally sustainable practices. It also proposes policy options to increase adoption, based on these behavioural factors and embedded in the EU Common Agricultural Policy. Behavioural factors are grouped into three clusters, from more distal to more proximal: (i) dispositional factors; (ii) social factors and (iii) cognitive factors. Overall, the review demonstrates that considering behavioural factors enriches economic analyses of farmer decision-making, and can lead to more realistic and effective agri-environmental policies.

Keywords: environment, sustainability, conservation, farming, agriculture, behavioural sciences, nudge, psychology

JEL classification: D91 Role and Effects of Psychological, Emotional, Social, and Cognitive Factors on Decision Making, Q15 Agriculture and Environment, Q17 Agricultural Policy

1. Introduction

1.1. Context and objectives

Over the last decades, researchers have increasingly studied the factors that influence farmers' adoption of environmentally sustainable practices. Within this literature, there is a burgeoning stream investigating the role of behavioural factors. Previous academic attempts to take stock of the factors influencing farmers' adoption of sustainable practices (Kabii and Horwitz, 2006; Pannell *et al.*, 2006; Knowler and Bradshaw, 2007; Prokopy *et al.*, 2008; Baumgart-Getz, Prokopy and Floress, 2012) did not specifically focus on the role of behavioural factors, often resulting in an incomplete overview and limited theoretical understanding of how and why these factors affect

*Corresponding author: E-mail: francois.dessart@ec.europa.eu

decision-making (Prokopy *et al.*, 2008). These reviews are fragmented across disciplines (Pannell *et al.*, 2006) and, with the exception of Baumgart-Getz, Prokopy and Floress (2012), date back to more than a decade ago. There have been some efforts in policy circles to make an inventory of behavioural factors influencing farmers' adoption of sustainable practices (Dwyer *et al.*, 2007; OECD, 2012), but their disciplinary scope was restricted to behavioural economics and communication sciences.

In this research context, the primary purpose of this paper is to provide a structured, integrative and updated overview of the literature on the behavioural factors that influence the adoption of environmentally sustainable farming practices. We also aim at developing a simple and integrative taxonomy of behavioural factors, and to highlight the mechanisms and biases that explain *how* and *why* behavioural factors affect farmer decision-making.

The paper's second objective is to propose, based on the identified behavioural factors, potential policy options for encouraging farmers to adopt more environmentally sustainable practices. The literature reviews mentioned earlier, on the factors influencing farmers' adoption of sustainable practices, only incidentally proposed implications for agri-environmental policies. However, policy reports at both national (Defra, 2008) and international (OECD, 2012; The World Bank, 2015) levels, as well as the recent inclusion of behavioural evidence in the background documents of the European Union's Common Agricultural Policy (CAP) reform and in the related impact assessment (European Commission, 2017c, 2018a), have acknowledged the relevance of understanding behavioural factors for agricultural policy. There is, however, still room for policy-makers to fully realise the potential of behavioural insights for agricultural policy. Testament to this is the fact that just one of the hundreds of behaviourally informed policy interventions recently reviewed by international organisations in two reports¹ (Lourenço *et al.*, 2016; OECD, 2017) explicitly targets farmers. The pioneering UK Behavioural Insights Team's four annual reports (The Behavioural Insights Team, 2011, 2015, 2016, 2017), which also showcase hundreds of applications of behavioural sciences to policy, include only one explicit mention of agriculture.

The current debate regarding the post-2020 CAP reform may present an opportunity to further consider behavioural factors when designing agri-environmental policies. One of the priorities of the CAP's next reform is 'bolstering environmental care and climate action and contributing to the achievement of EU environmental and climate objectives' (European Commission, 2017b), for which higher, results-based ambitions are set (European Commission, 2017b, 2018b, 2018c). To achieve better results in delivering environmental and public goods, the CAP likely needs to be based not only on regulations and financial incentives (as it is now), but also on

1 The 2015 *World Development Report* (World Bank Group, 2015) does make dozens of references to the application of behavioural insights to agricultural policy, but all of the reported cases concern developing countries and very few cases relate to actual policy-led interventions (as opposed to researcher-led field trials).

incentives leveraging the non-financial, behavioural factors that have a bearing on farmers' uptake of more sustainable practices. Furthermore, the European Commission's proposal (European Commission, 2018c) to create voluntary eco-schemes, together with the existing agri-environment and climate measures, indicates a budgetary shift to more voluntary approaches to incentivise more sustainable practices. Because a behavioural perspective is particularly warranted when motivating voluntary adoption (judging by the burgeoning literature on this topic), this potential increase of budget towards voluntary schemes further justifies the consideration of behavioural factors.

1.2. Approach and structure

This review focuses on farmers' decisions to adopt (more) environmentally sustainable practices. We understand environmentally sustainable practices (from now on, simply referred to as 'sustainable practices') as farming practices whose main expected benefit – relative to conventional practices – is the provision of positive externalities on biodiversity, water, soil, landscapes and climate change. Conservation tillage, crop rotation, reduction of fertilisers, pesticides and fungicides, rotational grazing and landscape preservation are examples of such sustainable practices.² Precision farming and genetic alterations, on the other hand, fall outside the scope of this paper because yield optimisation is usually farmers' main expected benefit from adopting these practices (OECD, 2016; Balafoutis *et al.*, 2017).

The main remit of this review is the voluntary adoption of sustainable practices, regardless of whether it is government-supported or not. This paper generally does not consider farmers' decisions to comply with mandatory environmental regulations (e.g. the CAP's standards of Good Agricultural and Environmental Conditions) because the behavioural factors leading to complying or cheating (Hart and Latacz-Lohmann, 2005) are likely to be different from those leading to voluntary adoption. We focus our review on individual decisions, thereby excluding coordinated efforts between farmers to protect the environment, which are associated with distinct behavioural factors (e.g. see Banerjee *et al.*, 2017).

We use the term 'behavioural factors' synonymously with psychological factors,³ i.e. the cognitive, emotional, personal and social processes or stimuli underlying human behaviour (American Psychological Association, 2018c). Because they do not pertain to the decision-maker's psychology, factors such as farm size, farmer age or level of education are not considered behavioural and

2 When reviewing studies that link behavioural factors to the adoption of sustainable practices, we report them as they were labelled by the authors. In some cases, studies focus on broad combinations of multiple practices (e.g. 'climate change mitigation practices', 'conservation measures'), while others are much more precise (e.g. 'organic farming practices', 'restoring hedgerows').

3 The term 'behaviour' refers, strictly speaking, to action (American Psychological Association, 2018a). For instance, smoking is a documented behavioural factor causing lung cancer. However, in this review, we adopt a broader meaning of the term 'behavioural,' following how it is commonly understood in the behavioural economics literature.

are not covered in this review. The paper does not build on a specific theoretical framework – such as the theory of planned behaviour (Ajzen, 1991) or prospect theory (Kahneman and Tversky, 1979) – to map behavioural factors influencing farmer decision-making, as the lack of a unified theory means that we would inevitably restrict the range of factors considered (Schlüter *et al.*, 2017).

We restrict our review to factors that have been found, over the past two decades, to be statistically significant in predicting the level of adoption of sustainable farming practices. We review findings from economics, psychology and sociology. We also limit our review to studies conducted with farmers or landowners (i.e. not students) to ensure policy relevance, and to studies in relatively developed countries⁴ because behavioural factors and policy objectives in developing nations may be considerably different (Borges *et al.*, 2018). Comparing the effect sizes of these behavioural factors is beyond the scope of this paper. We also do not intend to provide an exhaustive list of papers exploring the behavioural factors influencing farmers' decisions to adopt more sustainable practices. Whereas the review of behavioural factors covers studies conducted in any developed country, our policy recommendations are made in the specific context of the CAP.

The rest of the paper is structured as follows. In Section 2, we outline the main characteristics of farmer decision-making and our taxonomy of behavioural factors. Sections 3–5 present, respectively, the dispositional, social and cognitive factors that influence farmers' decisions to adopt sustainable practices, along with the corresponding policy options for addressing them. Section 6 discusses the contributions of this paper, farmer rationality, general policy implications, research gaps and the role of experimental research, before concluding in Section 7.

2. Farmer decision-making and behavioural factors

2.1. Farmers' adoption of sustainable practices

Farmers' decisions to adopt more sustainable practices, such as organic farming, restoring hedgerows or growing cover crops, have their peculiarities. Originally, behavioural insights, particularly *nudges*⁵ were applied to consumers and citizens, such as their choice of a meal in a canteen, how much energy they consume at home, or whether they ask for a receipt at the restaurant (Thaler and Sunstein, 2008). Relative to these decision-making processes, farmers' decisions to adopt more sustainable practices are primarily business ones, occur less frequently, often have long-term personal and economic consequences, may involve large investments and long-term commitment (e.g. participating in voluntary land conservation programmes) and largely involve the provision of public goods.

4 EU member states and non-EU countries in the top quartile of the Human Development Index.

5 Nudges are defined as 'liberty-preserving approaches that steer people in particular directions' (Sunstein, 2014).

Importantly, compared with the above-mentioned examples of consumer or citizen decision-making, farmers' decisions to adopt more sustainable practices can also be expected to be more controlled and better thought-out (i.e. closer to 'System 2' thinking: Kahneman, 2003). This does not mean, however, that these decisions are free from heuristics and biases nor that the outcome will be rational. Although the assumption of rationality provides a broadly approximate, often statistically valid account of producer choices, it precludes a more nuanced understanding of actual (not hypothesised) behaviour (Troussard and van Bavel, 2018), which would be particularly inappropriate when studying the interactions between farmers and their environment (Feola and Binder, 2010).

These fundamental differences between the original targets of a behavioural approach and farmers mean that not all behaviourally informed interventions used on consumers and citizens will be either relevant or effective in the context of farmers' decisions to adopt more sustainable practices.

2.2. Classifying behavioural factors

We organise behavioural factors conceptually based on their 'distance' from the decision-making in question, a hierarchy frequently used in the health (Alamian and Paradis, 2012; World Health Organization, 2014) and environmental psychology (Raymond, Brown and Robinson, 2011) literatures. Behavioural factors are considered *distal* when they are higher-order, general 'macro' principles, relatively remote from specific decision-making situations. They have general effects and are thus thought to be related to multiple behaviours (Flay, Snyder and Petraitis, 2009). For instance, farmer personality and risk tolerance affect not only whether they adopt a particular sustainable practice, but also whether they vaccinate their livestock (Sok *et al.*, 2018). At the other end of the spectrum, factors are *proximal* when they consist in lower-order, 'micro' variables directly or almost directly related to the focus of the decision-making (Flay, Snyder and Petraitis, 2009). They are, thus, decision-specific and vary case by case. For instance, farmers' perceptions of the benefits and costs associated with a specific agricultural practice are immediately related to the decision-making in question: some practices may be seen as entailing high benefits and low costs, while others may be perceived as less profitable. Importantly, the malleability of behavioural factors – and thus the ease through which they can be altered through policy interventions – increases with their proximity to decision-making (Alamian and Paradis, 2012).

On this distal–proximal spectrum, we distinguish three types of behavioural factors that have a bearing on decision-making: dispositional, social and cognitive. *Dispositional factors*⁶ are the most distal: they are relatively stable, internal variables related to a given individual, such as personality, motivations, values, beliefs, general preferences and objectives (Malle, 2011). They affect many decisions. *Social factors* relate to farmers'

6 In the psychological literature, dispositional factors emerge from attribution theory and are generally set in contrast to situational factors (Malle, 2011). This review, however, does not strictly adhere to this dichotomy, and rather incorporates situational factors in the two other clusters (i.e. social and cognitive).

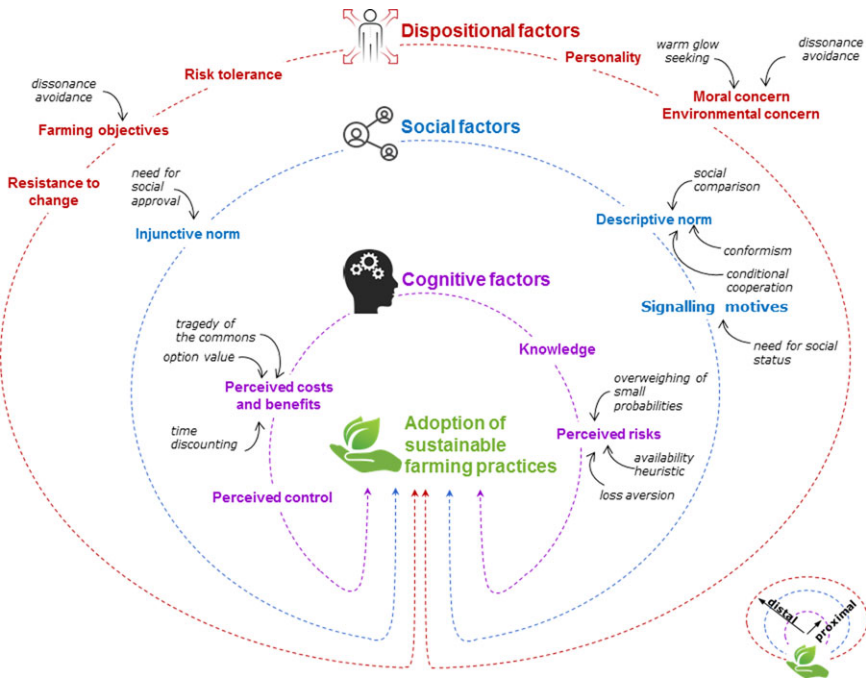


Fig. 1. An integrated framework of behavioural factors affecting farmers' adoption of environmentally sustainable practices. Mechanisms and biases in italics. Within each cluster, behavioural factors are not necessarily situated at the same distance (proximal-distal) to the adoption of environmentally sustainable practices.

interactions with other individuals (e.g. other farmers or advisors) and include social norms and signalling motives. Social factors may be proximal or distal; for instance, injunctive norms (i.e. what farmers perceive others expect from them) may push farmers to adopt a particular practice or more sustainable practices in general. *Cognitive factors* are proximal and relate to learning and reasoning; they include farmers' perceptions of the relative benefits, costs and risks associated with a particular sustainable practice or whether they feel that they are skilled enough to adopt this practice.

Categorising behavioural factors into these three types and along this spectrum may be somewhat arbitrary, and the boundaries between them could be blurred. However, the purpose is to not to offer the final word on behavioural factors, but rather to facilitate thinking about them in an ordered and systematic way. Figure 1 illustrates where these three behavioural factors are positioned in relation to decision-making and the mechanisms and biases that explain how and why these behavioural factors affect the adoption of sustainable practices.

3. Dispositional factors

Dispositional factors relate to an individual's general propensity to behave in a certain way (Malle, 2011). Table 1 presents the studies that found a

Table 1. Literature on the role of dispositional factors on the adoption of sustainable farming practices

Behavioural factor	Authors	Sustainable practice (direction of the effect in brackets)	Farming activity	Operationalisation of dependent variable	Country
Personality					
Extraversion	Austin, Deary and Willock (2001)	Active conservation measures (+)	Livestock and arable crops (various)	Self-reported adoption	UK
Openness	Willock <i>et al.</i> (1999)	Various environmentally oriented practices (+)	Livestock and arable crops (various)	Self-reported adoption	UK
	Austin, Deary and Willock (2001)	Active conservation measures (+)	Livestock and arable crops (various)	Self-reported adoption	UK
	Cruse and Maybery (2004)	Recommended practices in remnant bush and revegetation management (+)	Unspecified	Self-reported adoption	Australia
Conscientiousness	Austin, Deary and Willock (2001)	Active conservation measures (+)	Livestock and arable crops (various)	Self-reported adoption	UK
Resistance to change					
	Sheeder and Lynne (2011)	Conservation tillage (+)	Unspecified	Self-reported adoption	USA
	Hermann, Mußhoff and Agethen (2016)	Investment in organic barn (+)	Livestock (hog)	Self-reported intention to adopt*	Germany
Risk tolerance					
	Gardebreek (2006)	Organic farming practices (+)	Arable crops (various)	Actual adoption	The Netherlands
	Serra, Zilberman and Gil (2008)	Organic farming practices (+)	Arable crops (various)	Actual adoption	Spain

(continued)

Table 1. (continued)

Behavioural factor	Authors	Sustainable practice (direction of the effect in brackets)	Farming activity	Operationalisation of dependent variable	Country
	Kallas, Serra and Gil (2010)	Organic farming practices (+)	Permanent crops (grapes)	Self-reported adoption	Spain
	Läpple and Van Rensburg (2011)	Organic farming practices (+)	Livestock (various)	Actual adoption	Ireland
	Giovanopoulou, Nastis and Papanagiotou (2011)	Nitrate pollution reducing schemes (+)	Unspecified	Actual adoption	Greece
	Mzoughi (2011)	Organic farming practices (+)	Arable (vegetables) and permanent (fruits) crops	Self-reported adoption	France
	Läpple and Kelley (2015)	Organic farming practices (+)	Livestock (various)	Actual adoption	Ireland
	Hermann, Mußhoff and Agethen (2016)	Investment in organic farming (+)	Livestock (hog)	Self-reported intention to adopt*	Germany
	Flaten and colleagues (2018)	Organic farming practices (+)	Livestock (dairy)	Actual adoption	Norway
Concern					
Moral concern	Raymond, Brown and Robinson (2011)	Planting of native vegetation (+)	Livestock (various)	Self-reported adoption	Australia
	Sheeder and Lynne (2011)	Conservation tillage (+)	Unspecified	Self-reported adoption	USA
	Mzoughi (2011)	Organic farming practices (+)	Arable (vegetables) and permanent (fruits) crops	Self-reported adoption	France
			Unspecified	Actual adoption	Sweden

Environmental concern	Johansson, Rahm and Gyllin (2013)	Forest preservation and wetland restoration (+)				
	Michel-Guillou and Moser (2006)	Organic farming, watershed operations, integrated farming (+)	Arable crops (various)	Self-reported adoption	France	
	Toma and Mathijs (2007)	Organic farming practices (+)	Unspecified	Self-reported intention to adopt	Romania	
	Best (2010)	Organic farming practices (+)	Unspecified	Actual adoption	Germany	
	Läpple and Van Rensburg (2011)	Organic farming practices (+)	Livestock (various)	Actual adoption	Ireland	
	Yeboah, Lupi and Kaplowitz (2015)	Filter strips for watershed protection (+)	Unspecified	Self-reported intention to adopt	USA	
	Läpple and Kelley (2015)	Organic farming practices (+)	Livestock (various)	Actual adoption	Ireland	
	Floress <i>et al.</i> (2017)	Practices improving water quality (+)	Arable crops (various)	Self-reported intention to adopt	USA	
	Palm-Forster, Swinton and Shupp (2017)	Best management practices (+)	Arable crops (various)	Self-reported intention to adopt***	USA	
Farming objectives						
Conservation and lifestyle objectives	Greiner, Patterson and Miller (2009)	Best grazing management practices (+)	Livestock (various)	Self-reported adoption	Australia	
	Kallas, Serra and Gil (2010)	Organic farming practices (+)	Permanent crops (grapes)	Self-reported time waited before adoption	Spain	
	Giovanopoulou, Nastis and Papanagiotou (2011)	Participation in nitrate reduction programme (+)	Unspecified	Actual adoption	Greece	

(continued)

Table 1. (continued)

Behavioural factor	Authors	Sustainable practice (direction of the effect in brackets)	Farming activity	Operationalisation of dependent variable	Country
Economic objectives	Greiner (2015)	Participation in biodiversity conservation contract (+)	Livestock (various)	Self-reported intention to adopt**	Australia
	Cruse and Maybery (2004)	Sustainable practices in remnant bush and revegetation management (-)	Unspecified	Self-reported intention to adopt	Australia
	Läpple and Van Rensburg (2011)	Organic farming practices (-)	Livestock (various)	Actual (early) adoption	Ireland
	Mzoughi (2011)	Organic farming practices (-)	Arable (vegetables) and permanent (fruits) crops	Self-reported adoption	France
	Läpple and Kelley (2015)	Organic farming practices (-)	Livestock (various)	Actual adoption	Ireland

*Lab experiment; **discrete choice experiment; ***field experiment.

significant relationship between dispositional factors and farmers' adoption of more sustainable practices. Because they are relatively stable and do not relate exclusively to a specific decision, dispositional factors are relatively distal.

3.1. Personality

Personality traits are individual differences in patterns of thinking, feeling and behaving (American Psychological Association, 2018b). Since personality traits consist in habitual patterns of behaviour, they are very distal from specific decision-making tasks. Five clusters of personality traits – coined the 'Big Five' – are usually considered: extraversion, openness to new experiences, agreeableness, neuroticism and conscientiousness (Costa and McCrae, 1992). Of these, extraversion (i.e. the state of primarily obtaining gratification from outside oneself through enthusiasm, gregariousness and assertiveness), openness (i.e. the motivation to seek new experiences through curiosity, preference for variety and creativity) and conscientiousness (i.e. the desire to do a task well and to take obligations towards others seriously) are significantly correlated with farmers' uptake of sustainable practices (Austin, Deary and Willock, 2001; Crase and Maybery, 2004). Personality also influences other behaviour by farmers, such as vaccinating livestock (Sok *et al.*, 2018) and engaging in practices enhancing animal welfare (Austin *et al.*, 2005).

3.2. Resistance to change

Resistance to change has been suggested as a reason that farmers may not adopt more sustainable practices (Burton, Kuczera and Schwarz, 2008). Resistance to change and personality are linked: individuals scoring low on openness to new experiences may be particularly reluctant to change in general (George and Zhou, 2001). The status quo bias, whereby people systematically prefer to keep their current practices because they perceive any change as a loss (Samuelson and Zeckhauser, 1988), is also intrinsically linked to resistance to change. A recent meta-analysis on the role of the status quo bias in agri-environmental policy showed that a high percentage of farmers systematically reject change (Barreiro-Hurle *et al.*, 2018). Because inertia is strong among farmers (Burton, Kuczera and Schwarz, 2008; Rodriguez *et al.*, 2009), it is probably one of the major reasons that more sustainable practices are not adopted. Resistance to change has been found to deter conventional hog farmers from investing in an organic barn (Hermann, Mußhoff and Agethen, 2016) and conventional tillage users from adopting conservation tillage (Sheeder and Lynne, 2011).

3.3. Risk tolerance

Risk tolerance is a key concept in (behavioural) economics. It is not surprising, therefore, that the influence of risk tolerance on farmers' behaviour has

been extensively studied. Risk tolerance⁷ is a relatively stable disposition, closely related to the openness and extraversion personality traits mentioned previously (Frey *et al.*, 2017). As a distal factor, it has been found to influence farmer behaviour across a wide range of areas, such as the signing of crop insurance contracts (Hellerstein, Higgins and Horowitz, 2013) and the adoption of crop diversification (Hellerstein, Higgins and Horowitz, 2013), particular marketing strategies (Pennings and Garcia, 2001) and crop innovations (Ghadim, Pannell and Burton, 2005). Against the backdrop of increased income volatility, high levels of debt, low margins and extreme climate events (European Commission, 2017d), it is not surprising that European farmers are usually considered risk averse (Pennings and Garcia, 2001), leaving them little room for adopting new practices.

Risk-tolerant predispositions are positively correlated with the (early) adoption of organic farming practices (Gardebroek, 2006; Serra, Zilberman and Gil, 2008; Kallas, Serra and Gil, 2010; Laple and Van Rensburg, 2011; Mzoughi, 2011). Some authors suggest that the relationship between risk tolerance and the adoption of sustainable farming practices is not direct (Trujillo-Barrera, Pennings and Hofenk, 2016). Accordingly, risk tolerance moderates the negative link between the perceived financial risks of sustainable practices (see below) and their adoption: the impact of perceived financial risk on adoption is greater for risk-averse farmers than for risk-seekers.

Risk tolerance is at least partly influenced by culture: contrary to lay beliefs, people living in collectivist cultures tend to be less risk-averse than those living in individualist societies (Weber and Hsee, 1998; Hsee and Weber, 1999). Although cross-cultural data on farmers' risk tolerance are scant, evidence from studies among the general population shows that risk aversion is much stronger in some EU countries than in others (Rieger, Wang and Hens, 2014).

3.4. Moral concern and environmental concern

Moral concern refers to a person's conscience, ethical principles and concern for others' welfare (Cushman, 2015). Compared with conventional farmers, organic farmers are significantly more concerned about doing 'the right thing' (Mzoughi, 2011), a proxy for moral concern. Farmers who show relatively high concern for others and score highly on empathy-sympathy are more likely to adopt conservation tillage (Sheeder and Lynne, 2011), to participate in voluntary forest preservation or wetland restoration (Johansson, Rahm and Gyllin, 2013). Moral concern affects other farmers' behaviours, such as adopting practices enhancing animal welfare (Kielland *et al.*, 2010).

Environmental concern relates to the affect associated with environmental problems (Schultz *et al.*, 2005). Compared to other dispositional factors, environmental concern is more proximal to the decision to adopt sustainable practices. Environmental concern influences both pro-environmental behaviour in the general population (e.g. Bamberg, 2003) and farmers' adoption of

7 While we use the term risk tolerance, the literature also refers to this as risk attitudes, risk aversion or risk preference.

sustainable practices (Toma and Mathijs, 2007; Best, 2010; Läpple and Van Rensburg, 2011). For instance, farmers who adopt sustainable practices are more likely than conventional farmers to be worried about water quality (Michel-Guillou and Moser, 2006). Being a member of an environmental organisation, a proxy for environmental concern, leads farmers to accept some of the costs associated with conservation practices, which can mean that they bid below their costs when taking part in conservation auctions (Palm-Forster, Swinton and Shupp, 2017). Feeling emotionally connected to nature is also correlated with conservation behaviour, such as the adoption of native vegetation protection measures (Gosling and Williams, 2010). Environmental concern is driven by the ascription of personal responsibility for environmental damage that, for water pollution, may be low compared with industry and households (Michel-Guillou and Moser, 2006). Farmers may also not feel personally responsible to change their current practices if they consider they are already doing enough to protect the environment.

Moral and environmental concerns influence farmers' adoption of sustainable practices, as people in general seek coherence between behaviour and concern to avoid dissonance (Festinger, 1962). Similarly, people seek to reduce the unpleasant emotions associated with environmental and moral concerns (e.g. guilt) and to experience instead positive emotions of self-satisfaction in what is called the 'warm-glow' process (Andreoni, 1990). Avoiding guilty feelings is one reason farmers adopt organic practices (Mzoughi, 2011), and organic farmers are usually happier than conventional farmers (Mzoughi, 2014). One potential drawback of the warm-glow process is that it can lead to moral licensing (Blanken, Ven and Zeelenberg, 2015), i.e. feeling that one has the right to act in a less environmentally friendly way (or even to be environmentally unfriendly) in other domains. Moral licensing is linked to the well-known rebound effect in energy economics (Berkhout, Muskens and Velthuisen, 2000), which is an unexpected increase in energy consumption following an increase in fuel efficiency. Some qualitative evidence shows that participating in agri-environmental schemes may lead to some moral licensing (Burton, Kuczera and Schwarz, 2008), and theoretical work shows that the rebound effect may hold true for water irrigation (Berbel and Mateos, 2014).

3.5. Farming objectives

Farming objectives are the goals that farmers pursue through their activity.⁸ Farming objectives go beyond economic ones, and may include lifestyle

⁸ Compared with farming objectives, personal values are much more distal from the decision to adopt sustainable farming practices. Personal values consist of representations of abstract goals that motivate action in one's life (Roccas *et al.*, 2002) and transcend specific decision-making tasks. They convey what is important for a person in his or her life (Bardi and Schwartz, 2003), such as tradition, family and self-expression. Although farmers' personal values have been studied (e.g. Emery, 2015), there is little research about how they relate to the adoption of sustainable practices. Generally speaking, farming objectives are better predictors of decision-making than values (Bandura, 1986). Notably, some of the literature cited later in this study uses 'values' to refer to lower-order farming objectives.

(Maybery, Crase and Gullifer, 2005). This dichotomy has also been referred to as an opposition between entrepreneurship and peasantry/conservation (Miira, Vesala and Vesala, 2012). Raymond, Brown and Robinson (2011) reviewed evidence suggesting that the importance farmers give to conservation objectives has grown only marginally since the early 2000s. Importantly, farmers often have conflicting objectives: most of them embrace both conservation and economic objectives but to varying degrees (Gosling and Williams, 2010). Regarding sustainable practices, a common core running through several decades of research is that essentially farmers will adopt such practices if they expect these to help them achieve their objectives (Pannell *et al.*, 2006). The literature on farmers' behaviour is rather consistent in showing that adopting sustainable practices is negatively correlated with economic objectives, and positively correlated with lifestyle and conservation objectives (Greiner, Patterson and Miller, 2009; Kallas, Serra and Gil, 2010; Mzoughi, 2011; Greiner, 2015). This finding may be surprising, considering that some sustainable practices are more profitable than conventional ones (see the section on perceived costs and benefits).

Most research on this topic focuses on the influence farming objectives have on the adoption of unsubsidised sustainable practices. Yet participating in economically incentivised public schemes may well be in line with economic farming objectives (for qualitative evidence, see Mills *et al.*, 2018). A survey carried out in five EU Member States showed that most farmers who participate in paid agri-environmental schemes are motivated by economic gains (Pavlis *et al.*, 2016).

As environmental concern, farming objectives are relatively more proximal to the decision to adopt more sustainable practices than other dispositional factors. They also influence decision-making through the avoidance of dissonance between goals and actions (Festinger, 1962; Bardi and Schwartz, 2003).

3.6. Policy options addressing dispositional factors

Short-term and long-term policy strategies may be designed to address the dispositional factors influencing farmers' adoption of more sustainable practices. Regarding short-term approaches to addressing dispositional factors, one policy recommendation is to segment or target policies according to farmer heterogeneity, i.e. their personality, degree of resistance to change, risk tolerance, level of moral and environmental concern and farming objectives. For instance, it has been suggested that economic incentives should be targeted to farmers who place high value on profit as a farming objective, because farmers with intrinsic motivations to protect the environment may in some cases react negatively to payments (Greiner and Gregg, 2011; Grolleau, Mzoughi and Thoyer, 2015). This (disputable) 'crowding-out effect' may be especially relevant when conservation payments are modest (Andrews *et al.*, 2013).

While segmenting agricultural policies based on dispositional behavioural factors is theoretically interesting, actually implementing this idea is difficult. One issue is that policy-makers cannot directly observe these dispositional factors. Another major barrier is that agricultural policies need to treat all farmers equally. Two potential solutions that could be implemented within the CAP framework are worth pursuing and, to a certain extent, are already being applied.

The first is to design a mix of policies based on voluntary and mandatory adoption of sustainable practices. Voluntary schemes *de facto* target farmers who are relatively open to new experiences, prone to change, risk-seeking and concerned about morality and the environment, as these dispositional factors characterise farmers who willingly adopt sustainable practices. On the other hand, mandatory schemes can be a solution for other groups of more reluctant farmers. In this sense, introducing the greening layer as part of CAP direct payments in 2013 (European Commission, 2016) could be seen as a tool based on the power of defaults to increase the adoption of sustainable practices. However, the high proportion of farms exempt from greening requirements⁹ has limited the impact of these on the adoption of sustainable practices. The enhanced conditionality put forward in the Communication on the post-2020 CAP is an opportunity to further use the power of defaults to overcome behavioural barriers to adopting sustainable agricultural practices. These issues are particularly relevant in the light of the post-2020 CAP, since Member States will have to design appropriate mixes of voluntary and mandatory agri-environmental policies to achieve common EU objectives (European Commission, 2018c).

The second solution is based on the idea that farmers can be indirectly segmented according to more observable variables such as age, sex and country or region, which have been found to be correlated with some dispositional factors. For instance, the literature is rather consistent in showing that young people have a higher degree of environmental concern (Diamantopoulos *et al.*, 2003) and of risk tolerance (Halek and Eisenhauer, 2001), suggesting that it may be more cost-effective to target support for voluntary adoption to younger farmers than to older farmers. To a certain extent, with its specific economic support for young farmers (e.g. policies related to generational renewal), the CAP already segments its direct payments and rural development programmes based on farmers' age, suggesting that it does not breach the rule of law. Perhaps, then, segmenting the environmental components of the CAP, based on sociodemographic variables, is also possible. Designing country- or region-specific environmental policies also takes into account the heterogeneity of farmers. Culture plays a role in shaping the different dispositional factors influencing farmer decision-making. Although there is a lack of

9 Louhichi and colleagues (2018) report that 45 per cent of the farms are exempted and an additional 25 per cent already comply with the greening measures, meaning that only 30 per cent of farms need to change their land allocation to comply with greening. According to the European Court of Auditors (2017), greening led to changes in farming practices on around only 5 per cent of all EU farmland.

cross-cultural evidence regarding the prevalence of each of the identified dispositional factors among farmers, studies among the general population show, for instance, that environmental concern and risk tolerance vary considerably across EU countries (Rieger, Wang and Hens, 2014; European Commission, 2017e). Adapting environmental policies based on these aggregate dispositional factors can be a way to make these policies more efficient: while voluntary schemes may work best in Member States where farmers show a generally higher level of environmental concern and risk tolerance, mandatory schemes may be more appropriate in Member States where farmers show overall high levels of resistance to change. Within the CAP, the expected greater subsidiarity left to Member States to design CAP strategic plans seems in line with this philosophy (European Commission, 2018c).

Another short-term policy recommendation to address dispositional factors involves targeting farmers *when* they are least resistant to change. Proposing a change at the same time as a major life event (such as becoming a parent, moving home or retiring) has been found effective in prompting people to decrease their resistance to change (Schäfer, Jaeger-Erben and Bamberg, 2012). Life events often mean disrupting the environment in which decisions are normally made (Darnton *et al.*, 2011), making people more receptive to new information and more prone to change their behaviour (Verplanken and Roy, 2016). Policies designed to encourage farmers to adopt more sustainable practices – especially those that require a major change, such as converting to organic farming – should be aware of the opportunities afforded by such life events and capitalise on them where possible. If it is not possible to take advantage of major life events, incentivising farmers to make instead small, but incremental changes towards sustainable practices can be an effective option to address resistance to change and risk aversion (Öhlmér, Olson and Brehmer, 1998).

In the long term, policies may attempt to alter the most malleable dispositional factors so as to increase farmers' general willingness to adopt more sustainable practices. By definition, dispositional factors are relatively stable and hard to change. Personality and moral concern are probably the most stable behavioural factors, partly because they may have a genetic component (Pedersen and Reynolds, 2002; Kuhnen and Chiao, 2009). Risk tolerance may be less stable: the CAP, through its direct payments decoupled from production, has increased European farmers' risk tolerance (Koundouri *et al.*, 2009). Policies reducing the volatility of farmers' income may thus indirectly encourage more risk-taking in the form of adopting more sustainable practices. Environmental concern and farming objectives may also be more malleable. Social marketing programmes, including agricultural education and training through advisory services (Cullen *et al.*, 2018) and media campaigns, can, in the long term, raise farmers' environmental concerns and increase the importance they give to conservation as a farming objective. Government-run campaigns are already used to induce farmer behavioural change, for instance to promote more appropriate use of antibiotics (Ministère de l'Agriculture et de l'Alimentation, 2018). However, rather than traditional, isolated top-down

media campaigns, raising environmental concerns requires building long-term, integrated and diversified social marketing programmes involving all stakeholders (Dessart and van Bavel, 2017), therefore fully including farmers in the process (Westerink *et al.*, 2017). For instance, this bottom-up approach has proved effective in reducing the adverse health effects of pesticide exposure among agricultural workers (Flocks *et al.*, 2001).

4. Social factors

Interpersonal relationships influence farmers' decisions to adopt more sustainable practices. Social factors include social norms and signalling motives. Social norms, in their broad sense, represent collective representations of acceptable behaviour as well as individual perceptions of the adoption of a particular conduct by others (Lapinski and Rimal, 2005). Table 2 summarises selected studies that found a significant relationship between social factors and the adoption of sustainable farming practices.

Social factors can be relatively distal (e.g. perceived societal pressure to adopt more sustainable practices in general) or more proximal (e.g. a spouse disapproving of a particular labour-intensive, sustainable practice). Traditionally, the social factors of farmer decision-making have been studied by sociologists and social psychologists (Michel-Guillou and Moser, 2006), but now there is also a burgeoning economics literature investigating them.

4.1. Descriptive norms

Cialdini *et al.* (1990) distinguished norms that concern what other people actually do (i.e. descriptive norms) and norms that describe what people ought to do (i.e. injunctive norms). Regarding the former, farmers' decisions to adopt sustainable practices seem to be influenced by their neighbours' behaviour. Spatial data (Schmidtner *et al.*, 2012; Läßle and Kelley, 2015) suggest that farmers in proximity to each other exhibit similar patterns of organic farming adoption. Having little previous experience of neighbouring farmers with agri-environmental measures is correlated with farmers not adopting these schemes (Vanslebrouck, Van Huylenbroeck and Verbeke, 2002; Defrancesco *et al.*, 2008; Läßle and Van Rensburg, 2011). Being aware that conservation tillage is used by other farmers in one's district positively influences adoption (Llewellyn and Burton, 2008). The descriptive norm has been found to influence other decisions, such as whether to vaccinate livestock (Sok *et al.*, 2016).

A number of reasons may be behind the emergence of such clusters of neighbouring 'converted' farmers. First, a particular natural advantage (Läßle and Kelley, 2015) may create some favourable local conditions for the adoption of sustainable practices such as organic farming. Second, a neighbouring farmer who has adopted sustainable practices may lead to the sharing of information about the real costs, benefits and risks of conversion. Information sharing, and more generally social learning and social capital,

Table 2. Literature on the role of social factors on the adoption of sustainable farming practices

Behavioural factor	Authors	Sustainable practice (direction of the effect in brackets)	Farming activity	Operationalisation of dependent variable	Country
Descriptive norm	Vanslebrouck, Van Huylenbroeck and Verbeke (2002)	Extensification of field margins (+)	Unspecified	Self-reported intention to adopt	Belgium
	D'Emden, Llewellyn and Burton (2008)	Conservation tillage (+)	Arable crop (various)	Self-reported adoption	Australia
	Defrancesco <i>et al.</i> (2008)	Participation in agri-environmental-scheme (+)	Livestock and arable crops (various)	Self-reported intention to adopt	Italy
	Kuhfuss <i>et al.</i> (2016b)	Permanence in agri-environmental scheme (+)	Permanent crops (grapes)	Self-reported intention to adopt**	France
Injunctive norm	Beedell and Rehman (1999)	Sustainable hedge management (+)	Unspecified	Actual adoption	UK
	Defrancesco <i>et al.</i> (2008)	Participation in agri-environmental-scheme (+)	Livestock and arable crops (various)	Self-reported intention to adopt	Italy
	Kallas, Serra and Gil (2010)	Organic farming practices (+)	Permanent crops (grapes)	Self-reported adoption	Spain
	Wauters <i>et al.</i> (2010)	Soil conservation practices (+)	Arable crops (various)	Self-reported intention to adopt	Belgium
	Läpple and Kelley (2013)	Organic farming practices (+)	Livestock (various)	Self-reported intention to adopt	Ireland
	van Dijk <i>et al.</i> (2016)	Agri-environmental management practices (+)	Livestock (dairy)	Self-reported intention to adopt	The Netherlands

Signalling motives	Willock <i>et al.</i> (1999)	Various environmentally oriented behaviours (+)	Livestock and arable crops (various)	Self-reported adoption	UK
	Michel-Guillou and Moser (2006)	Organic farming, watershed operations, integrated farming (+)	Arable crops (various)	Self-reported adoption	France
	Mzoughi (2011)	Integrated protection and organic farming practices (+)	Arable (vegetables) and permanent (fruits) crops	Self-reported adoption	France
	van Dijk <i>et al.</i> (2016)	Agri-environmental management practices (+)	Livestock (dairy)	Self-reported intention to adopt	The Netherlands
	Kuhfuss <i>et al.</i> (2016b)	Permanence in agri-environmental scheme (+)	Permanent crops (grapes)	Self-reported intention to adopt**	France

*Lab experiment; **discrete choice experiment; ***field experiment.

are considered critical to the adoption of agricultural innovations within local farming systems (Marra, Pannell and Ghadim, 2003) and the adoption of agri-environmental schemes in particular (Barreiro-Hurlé, Espinosa-Goded and Dupraz, 2010). Third, if the level of participation of neighbouring farmers reaches a significant threshold, non-adopters may see this as a cue that adoption is the descriptive norm, i.e. the behaviour that most other farmers adopt. As illustrated by Asch (1956), individuals have a strong tendency, especially when they are in the minority, to conform to the majority by adopting their behaviour. This susceptibility to the descriptive norm is culturally grounded: in collectivist cultures, conforming to the social norm is more approved of and more common than in individualistic cultures (Bond and Smith, 1996). Besides conformism, the fact that other farmers adopt sustainable practices may motivate farmers to participate because most individuals are 'conditional co-operators', i.e. they contribute to public goods only if others also do so (Fischbacher, Gächter and Fehr, 2001). People in general are interested in comparing themselves with similar others because they need social comparison (Festinger, 1954), and this also holds true for contributions to public goods (Kurzman and DeScioli, 2008). Farmers' interest in comparing their financial information with that of fellow farmers as part of their participation in mutual funds shows that social comparison also applies to agriculture.

4.2. Injunctive norm

When deciding whether to adopt a more sustainable practice, farmers are also influenced by what they think others expect from them, i.e. injunctive norms, also known as 'subjective norm' in the Theory of Planned Behaviour (Ajzen, 1991). Injunctive norms affect behaviour because individuals need social approval (Talcott, 1951). Farmers who participate in agri-environmental schemes are more likely than those who do not to consider other farmers' and society's opinion as important (Defrancesco *et al.*, 2008). Producers of organic meat say that they follow the opinion or advice of relatives, advisors and the press to a greater extent than do producers of conventional meat (Läpple and Kelley, 2013). Farmers who engage in sustainable hedge management feel greater social pressure than those who are not part of this type of collaborative project (Beedell and Rehman, 1999). Those who adopt soil conservation practices are more likely than non-adopters to consider that important social referents think they should apply these practices (Wauters *et al.*, 2010).

Certainly, (local) citizens and the media put normative pressure on farmers to adopt more sustainable practices, as shown in the latest Eurobarometer on agriculture (European Commission, 2018d). Retailers, and more generally the downstream value chain, may also exert pressure on farmers to adopt more sustainable practices, especially for relatively un-processed food and practices that have received wide media coverage (e.g. pesticides in fruit and

vegetables, antibiotics in meat production – Epices and Blezat Consulting, 2018). However, advisors from agricultural input companies may influence farmers in a different direction. Spouses, relatives and co-workers may also have negative attitudes towards sustainable practices if the latter require more labour on their part (Gardebroek, 2006). Culture also plays a role in the relative importance of social referents. For instance, in pre-2004 EU Member States veterinarians have more influence on young farmers than in new Member States (European Commission, 2015).

4.3. Signalling motives

Consumers are known to choose environmentally friendly products because they seek higher status (Griskevicius, Tybur and Van den Bergh, 2010). For farmers, too, improving local public image and status may motivate them to adopt more sustainable practices (Willock *et al.*, 1999) such as organic farming, watershed operations and integrated farming (Michel-Guillou and Moser, 2006). Farmers who participate in agri-environmental schemes, and those who have adopted organic farming, are more likely than those who do not to value their public image as a farmer (Defrancesco *et al.*, 2008; Mzoughi, 2011). Indeed, adopting sustainable practices has a social identity component, in that it ‘says something’ about farmers (van Dijk *et al.*, 2016). Engaging in sustainable practices may work as a ‘costly’, and therefore reliable, signal of pro-sociality, which has been found to yield status benefits (Zahavi and Zahavi, 1999).

An issue with social signalling, however, is that some sustainable farming practices are invisible to the general public and therefore receive little social praise (Baland and Platteau, 2000). For instance, managing pastures to prevent forest fires is relatively visible (Kuhfuss *et al.*, 2016b), but practices such as carbon sequestration on soils and reducing CO₂ emissions are less so. In addition, citizens who lack the relevant knowledge may erroneously consider some sustainable practices (e.g. spraying pesticides many times in small quantities rather than a few times in large quantities) as unsustainable or simply fail to understand their environmental benefits (e.g. cover crops).

Whereas the need for public recognition from society may drive the adoption of sustainable practices, the dynamic could be different within farming communities; intensive, productive agriculture is often still considered a symbol of ‘good farming’ and competition between farmers is often based on yield rather than on environmental performance (Burton, Kuczera and Schwarz, 2008; Sutherland and Darnhofer, 2012). The desire to produce a visibly tidy landscape, for instance, is at odds with conservation objectives (Schmitzberger *et al.*, 2005). Sustainable farming practices may instead be seen as signals of ‘alternative’ (Gardebroek, 2006) and old-style farming (Läpple and Kelley, 2013). Farmers are less willing to enrol in agri-environmental schemes when these do not allow them to maintain agricultural activity (Espinoso-Goded, Barreiro-Hurlé and Ruto, 2010), probably

because they need to demonstrate their socially expected skills (Burton, Kuczera and Schwarz, 2008).

4.4. Policy options addressing social factors

Several policy recommendations can be made to address the social factors influencing farmers' adoption of sustainable practices. Regarding descriptive norms, the strategy to follow essentially depends on the level of adoption of sustainable practices within a given area. If the level is high, one valuable policy option would be to communicate to farmers that the majority of neighbouring farmers have adopted sustainable practices. A similar approach has been proven effective in motivating consumers to conserve energy (Allcott, 2011). In the context of the CAP, this approach is particularly relevant for voluntary schemes. Recently, Kuhfuss *et al.* (2016b) conducted an experiment on French farmers' willingness to maintain sustainable practices linked to agri-environmental schemes once their contract ended. Informing participants that 80 per cent of other farmers were intending to maintain the sustainable practices even without renewing their contract more than doubled the odds that participants would also maintain the practices. Also Gillich and colleagues (2019) found that farmers would grow perennial crops for bioenergy purposes against a lower compensation premium if their neighbours also grew them. However, another experiment conducted in the USA showed that providing information on the popularity of a voluntary programme had no effect on new or renewed sign-ups (Higgins *et al.*, 2017).

Conversely, if the adoption level is low, communicating this descriptive norm can backfire. In a famous experiment, Cialdini *et al.* (1990) showed that people are more likely to litter when most other people litter, than when most other people do not litter. Applied to our case, this policy 'mistake' implies that, if the majority of farmers in a given area continue to use conventional practices, providing them with information on this descriptive norm is likely to deter, rather than encourage them, to convert to more sustainable practices. For instance, farmers who are informed that they consume less water than the majority of others then tend to increase their water consumption (Le Coent *et al.*, this issue). In areas where the adoption of sustainable practices is particularly low, economic incentives may be more appropriate, precisely to change this self-feeding low descriptive norm.

One documented way of raising farmers' expectations that adoption is the descriptive norm is using collective bonuses for enrolling in agri-environmental schemes (Kuhfuss *et al.*, 2016a). This monetary bonus paid in addition to the agri-environmental scheme premium if a certain adoption threshold is reached increases farmers' expectations about others' participation. As a result, farmers are willing to enrol for a lower subsidy amount, thus leading to greater budget efficacy. However, evidence shows that farmers do not value collective participation in agri-environmental schemes (Rocamora-Montiel, Glenk and Colombo, 2014; Villanueva *et al.*, 2015),

probably because of the resulting lack of perceived control – see the section on cognitive factors below.

Harnessing the power of injunctive norms is also a policy option. Instead of targeting farmers, agri-environmental policies may attempt to persuade their social referents. Here, it is important to identify the most influential stakeholders in order to prioritise working with them to influence farmer decision-making. At a more societal level, policies aimed at educating consumers and citizens about agriculture in general, and about the value of sustainable farming practices, may increase the injunctive norm towards more sustainable practices.

In terms of social signalling, expressing social recognition to farmers for their contribution to protecting the environment may be effective. Farmers who are publicly acknowledged as contributing to environmental protection by participating in agri-environmental schemes are more likely to maintain the practices adopted once their contract ends (Kuhfuss *et al.*, 2016b). Receiving regional stakeholders' appreciation for their agri-environmental work is thought to lead farmers to more long-term pro-environmental commitment (de Krom, 2017). Certification programmes, such as the EU organic label, can give farmers who adopt sustainable practices an opportunity to send a signal of their environmental stewardship to their local community and consumers alike – provided that these programmes are well understood and seen as credible (Stuart, Benveniste and Harris, 2014). An issue here is that many other sustainable practices (e.g. conversion to grassland or wetland, cover crops) have no such certification scheme.

Another option is to give farmers better opportunities to compare their environmental efforts with those of others, a strategy that was found effective for reducing water consumption among citizens (Ferraro, Miranda and Price, 2011) and curbing antibiotics prescriptions by general practitioners (Hallsworth *et al.*, 2016). Social comparison can be achieved either by fostering informal communication and, more generally, social capital between farmers (e.g. through cooperatives), or by making environmental performance information more publicly available through formal channels. For farmers who are heavy consumers of water, letting them compare their individual consumption with the average consumption of neighbouring farmers is effective in reducing their subsequent water consumption (Le Coent *et al.*, this issue).

5. Cognitive factors

The adoption of sustainable practices is influenced by how farmers learn, understand and perceive these practices, particularly the associated difficulties, costs, benefits and risks. These cognitive factors are very specific and, hence, proximal to the decision-making process in question: whereas one type of sustainable practice may be considered risky, costly and difficult to implement, another may be seen as entailing little risk, cost or difficulty. Table 3 presents an overview of studies that found a significant relationship between cognitive factors and the adoptions of sustainable farming practices.

Table 3. Literature on the role of cognitive factors on the adoption of sustainable farming practices

Behavioural factor	Authors	Sustainable practice (direction of the effect in brackets)	Farming activity	Operationalisation of dependent variable	Country
Knowledge about sustainable practices (schemes)	D’Emden, Llewellyn and Burton (2008)	Conservation tillage (+)	Arable crops (various)	Self-reported adoption	Australia
	Kallas, Serra and Gil (2010)	Organic farming practices (+)	Permanent crops (grapes)	Self-reported adoption	Spain
	Läpple and Van Rensburg (2011)	Organic farming practices (+)	Livestock (various)	Actual adoption	Ireland
	Pavlis <i>et al.</i> (2016)	Participation in agri-environmental scheme (+)	Permanent and arable crops (various)	Self-reported intention to adopt	Five EU countries
Perceived control	Michel-Guillou and Moser (2006)	Organic farming, watershed operations, integrated farming (+)	Arable crops (various)	Self-reported adoption	
	Defrancesco <i>et al.</i> (2008)	Participation in agri-environmental scheme (+)	Livestock and arable crops (various)	Self-reported intention to adopt	Italy
	Läpple and Kelley (2013)	Organic farming practices (+)	Livestock (various)	Self-reported intention to adopt	Ireland
	Morgan <i>et al.</i> (2015)	Low-emission practices (+)		Self-reported adoption	Australia
	van Dijk <i>et al.</i> (2016)	Agri-environmental management (+)	Livestock (dairy)	Self-reported intention to adopt	The Netherlands
	Kuhfuss <i>et al.</i> (2016b)	Permanence in agri-environmental scheme (+)	Permanent crops (grapes)	Self-reported intention to adopt**	France
Perceived benefits	Beedell and Rehman (1999)	Sustainable hedge management (+)	Unspecified	Actual adoption	UK

Perceived environmental benefits	Vanslebrouck, Van Huylenbroeck and Verbeke (2002)	Participation in voluntary extensification of field margins (+)	Unspecified	Self-reported intention to adopt	Belgium
	Michel-Guillou and Moser (2006)	Organic farming, watershed operations, integrated farming (+)	Arable crops (various)	Self-reported adoption	France
	Ma <i>et al.</i> (2012)	Participation environmental services programmes (+)	Arable crops (corn, soybean)	Self-reported intention to adopt	USA
	Schulz, Breustedt and Latacz-Lohmann (2014)	Not opting out of CAP greening requirements (+)	Arable crops (various)	Self-reported intention to adopt**	Germany
	Yeboah, Lupi and Kaplowitz (2015)	Filter strips for watershed protection (+)	Unspecified	Self-reported intention to adopt	USA
	Villanueva <i>et al.</i> (2017)	Willingness to accept ecological focus area (+)	Permanent crops (olives)	Self-reported intention to adopt**	Spain
Perceived financial benefits	D'Emden, Llewellyn and Burton (2008)	Conservation tillage (+)	Arable crops (various)	Actual adoption	Australia
	Kallas, Serra and Gil (2010)	Organic farming practices (+)	Permanent crops (grapes)	Self-reported adoption	Spain
	Best (2010)	Organic farming practices (+)	Unspecified	Actual adoption	Germany
	Läple and Kelley (2013)	Organic farming practices (+)	Livestock (various)	Self-reported intention to adopt	Ireland
	Morgan <i>et al.</i> (2015)	Low-emission practices (+)	Unspecified	Self-reported adoption	Australia
	Trujillo-Barrera, Pennings and Hofenk (2016)	Building of sustainable husbandry (+)	Livestock (hog)	Actual adoption	The Netherlands

(continued)

Table 3. (continued)

Behavioural factor	Authors	Sustainable practice (direction of the effect in brackets)	Farming activity	Operationalisation of dependent variable	Country
Perceived risks Perceived financial risks	Kurkalova, Kling and Zhao (2006)	Conservation tillage (–)	Arable crops (various)	Actual adoption	USA
	Pavlis <i>et al.</i> (2016)	Participation in agri-environmental scheme (–)	Permanent and arable crops (various)	Self-reported intention to adopt	Five EU countries
Perceived environmental risks	Trujillo-Barrera, Pennings and Hofenk (2016)	Building of sustainable husbandry (–)	Livestock (hog)	Actual adoption	The Netherlands
	Toma and Mathijs (2007)	Organic farming practices (+)	Unspecified	Self-reported intention to adopt	Romania
	Arbuckle, Morton and Hobbs (2013)	Climate change mitigation practices (+)	Arable crops (corn, soybean)	Self-reported intention to support	USA

*Lab experiment; **discrete choice experiment; ***field experiment.

5.1. Knowledge

If farmers are to adopt more sustainable practices, an obvious prerequisite is that they are aware that such practices exist. Generally speaking, having access to relevant and reliable information is crucial if farmers are to adopt agronomic innovations (Llewellyn, 2007). Regarding sustainable practices, having easy access to information from local agricultural authorities motivates farmers to adopt organic farming (Kallas, Serra and Gil, 2010) and attending cropping extension activities is strongly associated with the adoption of conservation tillage (D'Emden, Llewellyn and Burton, 2008). Those who adopt organic farming use more information and have significantly better attitudes towards information gathering than non-adopters (Läpple and Van Rensburg, 2011). Acquiring information and knowledge about sustainable practices is a highly dynamic and social process (see the Section 4 on social factors).

In addition to information about sustainable practices, having information about policy-supported voluntary schemes is another prerequisite for farmers' participation. In a study carried out in five EU countries, farmers most often said that lack of knowledge about scheme opportunities was the reason they did not participate in voluntary agri-environmental schemes (Pavlis *et al.*, 2016). Indeed, in some areas farmers have little awareness of these schemes (Barreiro-Hurlé, 2016, Dessart, 2019), and lack of awareness can play a significant role in determining whether or not farmers decide to participate (Higgins *et al.*, 2017).

5.2. Perceived control

Another relevant issue is perceived behavioural control (also known as perceived self-efficacy), which relates to farmers' perceptions that they possess the relevant skills and sufficient time to undertake an action. The more a farmer perceives he/she can easily implement the practices associated with a given agri-environmental scheme, the more likely he/she will participate (Defrancesco *et al.*, 2008). Farmers who believe they lack the skills or time to produce organic meat are particularly reluctant to convert (Läpple and Kelley, 2013), and technical difficulties experienced while implementing agri-environmental practices make it less likely that farmers will repeat their participation in schemes (Kuhfuss *et al.*, 2016b). Perceived difficulties are also correlated with the non-adoption of soil conservation practices, especially reduced tillage (Wauters *et al.*, 2010); this factor particularly curtails the adoption of practices that imply a big change (Barreiro-Hurlé, Espinosa-Goded and Dupraz, 2010).

5.3. Perceived costs and benefits

Relative to conventional practices, adopting more sustainable practices may entail both costs to and benefits for farmers. Conservation tillage, for

instance, involves purchasing specialised planting equipment, but also saves time, labour and mechanised machinery and leads to a long-term increase in soil fertility, which overall results in a positive net financial impact (Knowler and Bradshaw, 2007). Cover crops have also been identified as profitable for farmers (Marcillo and Miguez, 2017). Organic farming, on the other hand, reduces the costs of inputs but increases labour costs (Uematsu and Mishra, 2012). If farmers participate in subsidised schemes, then the premium received constitutes another benefit of adopting conservation agriculture. Alongside financial costs and benefits, sustainable practices are expected to bring environmental benefits.

A behavioural approach to costs and benefits will consider farmers' subjective perceptions of these parameters. Farmers' expectations of financial benefits (e.g. labour savings, higher productivity and higher returns, tax benefits) are positively related to their investment in government-subsidised infrastructures that benefit the environment (Trujillo-Barrera, Pennings and Hofenk, 2016). Farmers' perceptions of the benefits associated with conservation tillage (e.g. the ability to sow crops earlier on less rainfall) and low-emission agricultural practices also positively influence adoption (D'Emden, Llewellyn and Burton, 2008; Morgan *et al.*, 2015). Farmers who value the access to economic support and lower input costs associated with organic farming (Kallas, Serra and Gil, 2010) and those who expect higher prices for their products (Läpple and Kelley, 2013) are more likely to adopt organic farming (earlier). As for perceived environmental benefits, farmers who believe that the practices mandatory under the CAP's greening requirements yield no ecological benefits are more likely to opt out of this scheme than those who believe in its benefits (Schulz, Breustedt and Latacz-Lohmann, 2014). Belief in the environmental benefits of filter strips, sustainable hedge management and payment-for-environmental-services programmes is also correlated with adoption (Beedell and Rehman, 1999; Ma *et al.*, 2012; Yeboah, Lupi and Kaplowitz, 2015).

Perceptions of costs and benefits may deviate from objective measures (Michel-Guillou and Moser, 2006), because a number of biases distort them. Time discounting, also known as the present bias, suggests that immediate benefits and costs have a disproportionate weight in decisions than equivalent benefits and costs in the future (Doyle, 2012). The relevance of this bias to farmer decision-making is acknowledged in general settings (Bocquého, Jacquet and Reynaud, 2014), and it may be particularly powerful in the context of sustainable farming practices, because adopting these practices often entails an immediate cost (e.g. investment in machinery, reduced yield in the short term), whereas the benefits (e.g. higher soil fertility, climate change mitigation) tend to occur in further in the future. In a US study, early adopters of sustainable farming practices were found to discount future compensations to a lower extent than late adopters (Duquette, Higgins and Horowitz, 2012).

The 'tragedy of the commons' (Hardin, 1968) may explain a certain distortion in the relative importance given to personal financial costs and public environmental costs: the costs of sustainable practices are borne by individual

farmers, whereas the benefits are diluted among other farmers and society in general. This phenomenon may account for the importance farmers place on personal benefits, relative to environmental benefits, when deciding whether to adopt conservation tillage (D'Emden, Llewellyn and Burton, 2008).

5.4. Perceived risks

Research shows that some sustainable practices are somewhat financially riskier than conventional practices. Organic production, for instance, experiences a greater fluctuation in demand and supply than conventional production (Serra, Zilberman and Gil, 2008), and prohibits the use of fertiliser or pesticides, increasing the risk of crop failure (Gardebroek, 2006). The variability of the soil's reaction to sustainable practices and the uncertain efficacy of sustainable practices are seen as major barriers (Rodriguez *et al.*, 2009). The net payoff under conservation tillage is often more uncertain than under conventional tillage (Kurkalova, Kling and Zhao, 2006).

Here again, a behavioural approach will focus on risks as they are perceived by farmers. In general, financial risk perceptions are known to influence a number of farmers' decisions, such as whether to adopt new technologies (Marra, Pannell and Ghadim, 2003), crop innovations (Ghadim, Pannell and Burton, 2005) and crop insurance (Bocquého, Jacquet and Reynaud, 2014). Farmers' perceptions of the financial risks associated with conservation agricultural practices are correlated with their likelihood of adoption (Kurkalova, Kling and Zhao, 2006; Trujillo-Barrera, Pennings and Hofenk, 2016). In view of the high financial risks farmers generally face in their activity (European Commission, 2017b), the perceived financial risks of more sustainable practices may be one of the most important impediments to their adoption.

Farmers' perceptions of environmental and health risks may also influence their adoption of sustainable practices. For instance, organic farmers are considerably more likely than conventional farmers to have a perception of high risks of poor water quality to human health, livestock health and crop quality (Toma and Mathijs, 2007). Farmers who evaluate the risks of climate change to agriculture as high are also more likely to support mitigation practices (Arbuckle, Morton and Hobbs, 2013).

According to prospect theory (Kahneman and Tversky, 1979), farmers' risk perceptions may be distorted because they rely on subjective probabilities (Hardaker and Lien, 2010). In particular, farmers tend to overestimate the likelihood of low-probability extreme events, such as hail, to which they may be extremely sensitive (Bocquého, Jacquet and Reynaud, 2014). The availability heuristics suggest that farmers will tend to think that a risk is more serious when they can easily recall a relevant incident (Tversky and Kahneman, 1974). In contrast, environmental risks are usually relatively uncertain, strongly delayed and occur far away, making it less likely that environmental incidents will be recalled and hence more likely that these risks will be discounted (Gattig and Hendrickx, 2007).

Loss aversion also comes into play where the risks of losses loom larger than the chances of equally valuable gains (Kahneman and Tversky, 1984). In practice, this means that farmers' decisions will be more affected by the risks of yield losses induced by adopting an agri-environmental contract than by possible increases in revenue due to the reduced costs of chemical inputs and higher market value of their products (Bocquého, Jacquet and Reynaud, 2014; Colen *et al.*, 2016). Loss aversion varies across cultures: for instance, in the general population, Asians are more sensitive to the magnitude of potential losses than the Dutch and the Americans (Bontempo, Bottom and Weber, 2006).

Another concept relevant to the perception of risks is the option value of waiting to engage in sustainable farming practices, also called the 'real options approach' (ROA) (Marra, Pannell and Ghadim, 2003; Ihli, Maart-Noelck and Musshoff, 2014). In the face of sunk costs (e.g. money spent on a spraying machine) and uncertainty about the future benefits of new, sustainable practices, a farmer may value the option to postpone an investment decision and retain a certain amount of flexibility to adjust to changing circumstances (Greiner, Patterson and Miller, 2009; Ihli, Maart-Noelck and Musshoff, 2014). ROA has been applied to investment decisions generally (see Dixit and Pindyck, 1994) and to farmers' investment and disinvestment behaviours in particular. For example, a study of dairy farmers' investment in new waste management technology (Purvis *et al.*, 1995) showed that ROA requires a higher potential income stream for an investment to take place than that if the net present value is considered, as suggested by the theory.

5.5. Policy options addressing cognitive factors

Several policy options can address the cognitive factors influencing farmers' adoption of sustainable practices. Regarding the issue of *knowledge*, one policy recommendation is to raise farmers' awareness of these practices. In the context of the CAP, this can be channelled through the extension or advisory services. To avoid knowledge asymmetry regarding the existence of compensated voluntary schemes, competent national or regional administrations must ensure that all farmers are provided on time and, at the same time, with the relevant knowledge to enable them to apply. Providing relevant information to farmers already participating in voluntary schemes would also seem valuable; experimental evidence in the USA shows that sending reminder letters to farms with expiring contracts is effective in encouraging them to re-offer land under the Conservation Reserve Programme (Higgins *et al.*, 2017).

There are two possible avenues for addressing farmers' perceptions that they lack *control* or that it is difficult to implement sustainable practices. One is to equip farmers with the necessary skills. The agricultural European Innovation Partnership (EIP-AGRI) and the Farm Advisory System (FAS) are relevant CAP policy tools for this. The other is to avoid complex agri-environmental schemes (Defrancesco *et al.*, 2008).

To decrease the *perceived risks* of adoption, an appropriate design of subsidy schemes is crucial. Schemes based on management guidance are preferable over those based on outcomes, as the latter entails a high and uncontrollable perceived risk of non-compliance (Latacz-Lohmann, Schilizzi and Breustedt, 2011). Making fixed – rather than irregular – payments can increase the adoption rates of nature conservation programmes (Engel *et al.*, 2015), as some farmers tend to view payments as a tool for reducing the perceived risks inherent to the transition to more sustainable practices (Hermann, Sauthoff and Mußhoff, 2017). Increasing participation rates can be achieved through more flexible schemes through: letting farmers choose which land they want to enrol in environmental schemes (Ruto and Garrod, 2009; Espinosa-Goded, Barreiro-Hurlé and Ruto, 2010); allowing flexibility in the management of pesticide-free buffer zones and fertiliser use and giving the option to quit a contract from year to year (Christensen *et al.*, 2011); allowing flexible management when growing cover crops (Villanueva *et al.*, 2017) and protecting ground-nesting birds in permanent grassland (Breustedt, Schulz and Latacz-Lohmann, 2013); and proposing negotiable and shorter contracts (Greiner, 2015). Designing flexible, management-based voluntary schemes is going to be a challenge in view of the CAP's new focus on performance. Offering insurance (i.e. protection against yield loss from adopting sustainable practices) and promoting mutual funds (Janowicz-Lomott and Łyskawa, 2014) have been suggested as policy tools to decrease perceived risks, but experimental evidence suggests that this is inefficient if farmers are not confident that they will be paid indemnities (Palm-Forster, Swinton and Shupp, 2017). Another strategy is to reduce the perceived financial risks of adoption by promoting cost-free trialling of sustainable practices, so that farmers can test and learn practices before adopting them (Pannell *et al.*, 2006). The issue of loss aversion can be addressed by combining programmes incentivising sustainable farming practices with risk management tools, such as in the case of integrated pest management in Italy (Codato and Furlan, 2017) or by providing payments unrelated to the area enrolled (Espinosa-Goded, Barreiro-Hurlé and Ruto, 2010).

Regarding the financial *costs and benefits* of adoption, farmers will perceive these as higher if consumers are made better aware of the environmental benefits of these farming practices and are thus willing to pay a price premium. While some (limited) consumer awareness of organic farming has been achieved, thanks to the common label at EU level (Padel, Zander and Zanoli, 2015), less stringent but similarly sustainable practices are largely unknown to consumers (Lefebvre, Langrell and Gomez-y-Paloma, 2015). The issues of perceived costs and benefits can also be tackled through policy design. A first general consideration when designing government-subsidised environmental schemes is how farmers actually perceive these parameters. If the CAP continues to limit agri-environmental scheme payments to compensate only forgone profit or additional costs without taking into account farmers' actual perceptions, the payments may be too small to foster enrolment. In other geographical settings, aligning payments with farmers' perceptions

has been achieved using auctions as an enrolment mechanism (Hellerstein, 2017), while in Europe it has been applied only in pilot exercises (Ulber *et al.*, 2011; Iho *et al.*, 2014). Farmers' perceptions of the costs and benefits of sustainable practices can also be 'de-biased' through education and information (Trujillo-Barrera, Pennings and Hofenk, 2016). To address farmers' tendency to give more importance to immediate costs than to long-term benefits (i.e. their present bias), payments to incentivise the adoption of sustainable farming practices should be made in the initial phases of adoption (Duquette, Higgins and Horowitz, 2012; Grolleau, Mzoughi and Thoyer, 2015; Colen *et al.*, 2016), which is also when farmers face high fixed costs. Finally, focusing agri-environmental schemes on practices for which environmental benefits are real and tangible to farmers is likely to strongly increase participation.

Appropriately framing costs and benefits can also help. Framing the benefits of participating in agri-environmental schemes in terms of environmental conservation (e.g. protection of biodiversity and ground water) yields higher participation rates than framing these as compensation for environmental damage (Broch and Vedel, 2012; Le Coent, Préget and Thoyer, 2017). Conversely, framing the payments made to farmers for participating in agri-environmental schemes as a compensation for incurred opportunity costs (instead of a payment for environmental benefits) may backfire, since this type of framing highlights the costs rather than the benefits (e.g. higher market value) of sustainable farming practices (Grolleau, Mzoughi and Thoyer, 2015). Even simply changing the name of a payment may have an impact on whether farmers adopt sustainable practices (Hermann, Sauthoff and Mußhoff, 2017). Importantly, framing may have different effects on adopters and non-adopters (Andrews *et al.*, 2013). Framing techniques may also leverage loss aversion (Kahneman and Tversky, 1984). For example, if the impact on farm income is kept constant, punishing farmers for using fertilisers is more effective than rewarding them for reducing fertiliser use (Moser and Mußhoff, 2016). A similarly stronger effect of punishment (vs. reward) has been shown to incentivise the cultivation of flowering cover crops (Holst, Musshoff and Doerschner, 2014).

6. Discussion

6.1. Contributions

This paper complements and builds on previous attempts to map the behavioural factors influencing farmers' decisions to adopt more sustainable practices. The previous reviews carried out have had an academic focus (Kabji and Horwitz, 2006; Knowler and Bradshaw, 2007; Prokopy *et al.*, 2008; Baumgart-Getz, Prokopy and Floress, 2012) and a policy perspective (Dwyer *et al.*, 2007; OECD, 2012). This review adds to the former in three ways. First, we addressed the fragmentation of this literature (Pannell *et al.*, 2006) by covering recent and emerging behavioural economic, psychological and, to a lesser extent, sociological research on the topic. This allowed us to

integrate several behavioural factors that were previously not considered in these reviews. Second, in our analysis we systematically included the biases (e.g. present bias, loss aversion) and other mechanisms (e.g. dissonance avoidance, conformism) that explain how and why behavioural factors affect farmer decision-making. Behavioural approaches in policy have indeed been criticised for not sufficiently accounting for this ‘black box’ of behaviours (Marchiori, Adriaanse and De Ridder, 2017). Third, we provided an integrated, structured taxonomy of behavioural factors, along a distal–proximal spectrum, that facilitates their understanding and provides a basis for the short- and long-term policy recommendations.

Regarding our contribution with respect to the above-mentioned policy reports, whereas the focus of Dwyer *et al.* (2007) was the design of communication programmes to influence farmers’ behaviour, our primary objective was to understand the drivers of farmer decision-making. Compared with the OECD’s report (2012), our review covers a wider disciplinary scope (i.e. going beyond behavioural economics), investigates the role of dispositional factors, deepens the analysis of social factors (e.g. injunctive norms and signalling motives) and offers a different, structured taxonomy of behavioural factors.

The exploration of policy options addressing each cluster of behavioural factors, and embedded in the specific yet highly important context of the CAP, also distinguishes this review from previous academic and policy papers investigating this topic.

6.2. Rationality and universality of farmer decision-making

The behavioural factors identified in this review suggest that farmers’ decisions to adopt more sustainable practices are not entirely rational from a neoclassical economic perspective. For instance, a purely *homo agricola economicus* would not be affected by moral concerns leading to the altruistic provision of environmental public goods, by resistance to change, by the behaviours of fellow farmers or by the way the costs and benefits of adoption are framed. A purely rational farmer would also be perfectly informed about sustainable practices and would not be biased in his or her perceptions of risks, costs and benefits.

With so many ways in which farmers can deviate from being rational actors, and considering the abundance of psychological theories underlying the influence of behavioural factors, economists may be reluctant to adopt a behavioural approach. This is a fair point; indeed, the fact that the assumption of rationality has survived in economics for so long proves how useful a simple, if somewhat unrefined, explanation of human behaviour can be. But including behavioural factors in economic and policy analysis does not simply mean introducing more refined variables into economic models. Considering behavioural factors allows moving from a deductive approach to a more inductive one (Lunn, 2013); instead of suggesting what farmer behaviour ought to be on the basis of a number of axioms and assumptions, a behavioural approach sets out to observe it empirically with a more open-minded perspective.

When considering the role of the identified behavioural factors, one should avoid a deterministic stance. This paper identified behavioural factors significantly influencing farmers' decisions to adopt *specific* sustainable practices in *specific* cultural contexts. In other words, the external validity of these behavioural factors, beyond the cultural settings in which they were examined, is not always established. We may thus not conclude whether these behavioural factors apply universally (OECD, 2012). Depending on the context, behavioural factors may indeed be significant or not (Knowler and Bradshaw, 2007; Prokopy *et al.*, 2008). As highlighted various times in this review, cultural factors play a role: culture affects not only the relative importance of behavioural factors (e.g. environmental concern, risk tolerance), but also the mechanisms and biases that underlie the impact of these factors on decision-making (e.g. conformism to descriptive norms, loss aversion).

6.3. Policy implications

Understanding the behavioural factors influencing farmer decision-making seems warranted to enable more realistic and effective agri-environmental policies. Policies relying solely on economic incentives and based on assumptions of farmer rationality may be insufficient to reduce agriculture's negative environmental externalities. The CAP – which so far has been based mainly on these traditional policy tools – has indeed had a mixed record of achieving environmental objectives¹⁰ (Eurostat, 2018). Assumptions of farmers' rationality may also lead to unrealistic *ex-ante* evaluations. For instance, in the current impact assessment (European Commission, 2018a), the enrolment rate of (voluntary) eco-schemes, which was incorporated in the agro-economic models, was calculated based on pure economic drivers, which led to an assumption that their adoption would be widespread.¹¹ This paper shows that many aspects other than economic are at play, suggesting that adoption rates may not be as high as expected.

Incorporating a behavioural approach in EU agri-environmental policies is, in practice, increasingly advocated and feasible. In the past, *ex-ante* and *ex-post* evaluations of CAP reforms (e.g. European Commission, 2003, 2011) were mainly based on agro-economic models at different scales (partial and global equilibrium approaches, market and agro-economic approaches). The range of tools for designing and evaluating EU (agricultural) policies is broadening and now includes behavioural tools: the European Commission's

10 Looking at the set of 28 agri-environmental indicators that track the integration of environmental concerns into the CAP (Eurostat, 2018), positive trends can be identified, such as the decrease of greenhouse gas emissions (a 20 per cent reduction in 2015 compared with 1990) or the increase of permanent grassland and meadows (a 5 per cent increase from 2005 to 2013). On the other hand, the same data show that the consumption of pesticides increased by 2 per cent between 2011 and 2015 and that the population of common farmland birds decreased by over 30 per cent between 1990 and 2014.

11 When voluntary schemes are assumed (option 3), 'the uptake of the voluntary eco-scheme is simulated at EU level at 98 per cent, varying from less than 90 per cent in Portugal to 100 per cent in Member States with large areas of permanent grassland'.

'Better Regulation Toolbox' (2017a) proposes the use of behaviourally informed instruments to define the policy problem (tool 14), identify policy options (tool 17) and identify and screen impacts (tool 19).

For each of the three clusters of behavioural factors, we provided insights on agri-environmental policy options that could take them into account. Very often, a behaviourally informed policy option will address multiple behavioural factors, meaning that there is not necessarily a one-to-one relationship. Policy problems seldom have one (behavioural) cause, let alone one solution. Behavioural factors may also interact with each other. This means that, instead of using an isolated nudge to tackle one behavioural factor, a holistic approach tackling multiple behavioural factors is needed (Dessart and van Bavel, 2017).

Faced with so many behavioural factors and policy options, policy-makers may, with good reason, wonder where to start. Policy options aiming at encouraging the adoption of more sustainable practices will vary greatly in terms of the likelihood, scope and duration of their effect, according to whether they address distal or proximal factors. Interventions addressing proximal factors may have a powerful effect on the adoption of specific sustainable practices, especially for those farmers that are already considering a conversion (Ma *et al.*, 2012). These interventions are, compared with those targeting more distal factors, relatively easy to implement and may thus constitute a good starting point. For instance, reducing input use may be encouraged by designing agri-environmental schemes that take into account cognitive factors, for instance by properly and timely equipping farmers with knowledge about the existence of these schemes, by making them more salient and flexible and the payments more in line with perceived costs, or even by making enrolment to these schemes the default option. Educating farmers about the real financial and environmental benefits of reduced input use through publications and advisory services may also increase adoption of this specific practice. However, these interventions are unlikely to raise farmers' willingness to adopt more sustainable practices in general. Agri-environmental schemes, although well designed with these behavioural factors in mind, may also not have long-term effects on farmer adoption if they are discontinued (for a review, see Kuhfuss *et al.*, 2016b). Inducing longer-term and more generalisable behavioural change entails addressing more distal factors, such as farmers' environmental concern, the importance they place on conservation as a farming objective and their need for social recognition for the efforts toward the environment. Raising consumers' environmental concern, awareness of agricultural practices and their willingness to buy more environmentally friendly food will address even more distal, societal, 'macro' factors that are critical to encouraging farmers to adopt more sustainable practices. Although policy interventions tackling these distal factors may take more time and have more uncertain outcomes, they are likely to produce more durable behavioural change.

Applying a behavioural approach to motivate farmers to adopt sustainable practices may raise ethical concerns. Are farmers being manipulated? First

and foremost, it is important to acknowledge there is no neutral choice architecture: the way options are presented to farmers will always influence their decisions. The choice that policy-makers face is to either let other forces dictate how the choice architecture is shaped, or take a more active role. Three criteria (Sunstein, 2015, 2016) can be used to assess on a case-by-case basis whether behaviourally informed policies raise ethical concern: do these interventions promote or undermine welfare, autonomy and dignity? First, addressing the behavioural factors that affect farmers' decisions to adopt more sustainable practices generally increases welfare, as this adoption provides environmental benefits for society as well as health and (often) financial benefits for farmers. Second, regarding autonomy, adopting a behavioural approach to encourage voluntary adoption of sustainable practices does not rob farmers of their free will (i.e. they can refuse to adopt). Behaviourally informed agri-environmental policies can also promote autonomy by equipping farmers with the right information (e.g. about the real costs and benefits of sustainable practices), framed in the right way, to allow them to reach better decisions by themselves. The policy options we have presented also do not leverage nudges based on system 1 (i.e. unconscious manipulation), which are the most questionable ones from an ethical perspective (Reisch and Sunstein, 2016). Rather, most of these suggested behavioural interventions appeal to reflection or deliberation. Finally, there is no reason why embedding behavioural insights into agri-environmental policies should compromise farmers' dignity, provided these interventions treat farmers with respect, avoiding infantilisation and stigmatisation. Considering farmers as a key component of the solution to environmental problems is indeed vital (Beretti, Figuières and Grolleau, 2013).

6.4. Proposals for a research agenda

Three overarching directions for research into the behavioural factors affecting farmers' adoption of sustainable practices can be proposed. First, a comprehensive behavioural approach to farmer decision-making, investigating proximal as well as distal factors, requires more cross-disciplinary work. Whereas proximal factors (e.g. perceived costs and benefits) are the traditional territory of (behavioural) economists, more distal factors (e.g. environmental concern, signalling motives) were originally studied by sociologists and psychologists. Integrating all of these factors and understanding the 'black box' of decision-making calls for further cross-fertilisation between these disciplines.

A second general research gap concerns early phases of farmer decision-making. Öhlmér, Olson and Brehmer (1998) identify four phases of farmer decision-making: (i) problem detection (i.e. becoming aware of a problem or an opportunity, such as environmental issues or consumers' willingness to buy organic products), (ii) problem definition (i.e. specifying the problem and identifying alternative actions, such as adopting the more sustainable

practice or pursuing conventional practices), (iii) analysis and choice (i.e. comparing the pros and cons of each alternative and choosing one) and (iv) implementation. It seems that most current research focuses on the phase of analysis and choice, but one needs to understand how farmers do or do not come, in the first place, to consider the possibility of changing practices, as this 'willingness-to-consider' phase is crucial (Ma *et al.*, 2012).

Third, it is important to go beyond individual behaviour and tackle group decision-making at farm level. Farms are usually family businesses, and decisions are rarely made by a single farmer. In contrast, most research cited in this paper tends to consider farmers as individual decision-makers (with the exception of papers examining the influence of injunctive norms). Given the relevance of age to the decision to adopt more sustainable practices (Yeboah, Lupi and Kaplowitz, 2015), the intergenerational aspect of group decision-making at farm level (Trujillo-Barrera, Pennings and Hofenk, 2016) seems particularly relevant.

We now turn to detail specific research gaps related to each of the three identified clusters of behavioural factors. Regarding the influence of dispositional factors, further research is needed to test whether the crowding-out effect applies to payments for environmental services made to farmers who are intrinsically motivated to protect the environment. Given the current low level of EU farmers' income relative to other economic sectors, the existence of this crowding-out effect is debatable and needs more research. Additionally, more research would be welcome to assess whether moral licensing and the rebound effect occur when farmers adopt sustainable practices. The effectiveness of the sociodemographic and geographic segmentation advocated to address dispositional factors should also be further investigated.

Regarding social factors, the potential role of anti-conformism (Brewer, 1991) and independent identity (Emery, 2015) in farmers' decisions not to adopt sustainable practices deserves investigation, as does the effect of social comparison tools on adoption. Furthermore, Le Coent, Preget and Thoyer (2017) provide initial evidence for the relative weight of different stakeholders' opinions on farmer decision-making, but more research on the role of different sources of injunctive norms is needed. The provision of feedback on descriptive norms as a tool to motivate the adoption of sustainable practices deserves more research, especially its potential side effects.

Concerning cognitive factors, the areas that may deserve further attention are farmers' perceptions of the environmental and health-related costs of conventional practices, their beliefs about the market value of sustainable products (considering that farmers' clients are mostly intermediaries in the value chain rather than final consumers) and potential time discounting of the environmental benefits of sustainable practices (Weitzman, 1994) beyond financial benefits (Fisher and Krutilla, 1975). More research is also needed to understand which risks (e.g. financial, environmental, health-related) farmers consider when making their decisions and how these risk perceptions may be misaligned with reality.

From a CAP perspective, we identify three priority research opportunities. The first is to assess the optimal mix of mandatory and voluntary agri-

environmental measures. The latest [European Commission's CAP Communication \(2017b\)](#) states that 'the new delivery model will allow Member States to devise a mixture of mandatory and voluntary measures in Pillar I and Pillar II', including via new 'eco-schemes' ([European Commission, 2018c](#)). Most behavioural research focuses on farmers' voluntary adoption of sustainable practices, but it is unclear how behavioural factors affect farmers' decisions when they are faced with both mandatory and voluntary (i.e. opt-in) schemes.

Second, the new CAP proposals regarding environmental, climate and other management commitments ([European Commission, 2018c](#)) pave the way for Member States to include collective voluntary schemes and results-based payments. Understanding how behavioural factors (e.g. perceived control) might hamper or promote the success of such schemes is a clear research priority. The impact of risk aversion, perceived costs and perceived control will be key to understanding how farmers will respond to this new delivery model.

The third priority research gap concerns the cross-cultural robustness of the behavioural factors identified in the literature. Virtually all of the research reviewed in this paper was conducted in specific national or regional contexts. Assessing the external validity of behavioural factors across countries is warranted because, despite the expected shift towards greater subsidiarity, many EU agricultural policies are still centrally designed. This requires concurrent cross-national behavioural research using identical methodologies, or at least that researchers report the methods they use more completely (e.g. items used in scales for measuring behavioural factors) to allow these to be replicated and when similar allow deriving meaningful conclusions.

6.5. The role of experimental research

The growing interest in using experiments to evaluate the impact of agricultural policies ([Colen et al., 2016](#); [Higgins et al., 2017](#)) goes hand in hand with the increased relevance of understanding the behavioural factors influencing farmer decision-making. Experiments carried out to inform agricultural policies indeed most often include a behavioural component, as the outcome variable generally consists in decisions made by farmers.

Experimental research is called for, both to fill the policy-oriented research gaps identified above, and to address some shortcomings of existing research on the behavioural factors influencing farmer decision-making. In terms of the former, experiments are best placed to evaluate *ex-ante* farmers' choices when they are faced with voluntary versus mandatory schemes and with results-based or collective schemes. Experiments are also the best option to assess the effectiveness of the policy options suggested throughout this paper.

We also believe that experiments can help address three shortcomings of the existing research. First, most of the evidence reported in this paper is correlational (see the column 'Operationalisation' in each table), leading us to

question the validity and direction of the effects. For instance, the perceived environmental benefits associated with sustainable practices are correlated with the adoption of organic farming practices (e.g. [Beedell and Rehman, 1999](#)). However, it may very well be that the adoption triggers a perception of higher environmental benefits rather than the other way around. Experiments are uniquely placed to establish a causal link between behavioural factors and decision-making. Second, experiments can contribute to addressing some of the issues related to self-declared measures, which are largely used in the reported research. Social desirability bias may come into play when directly asking farmers about their motivations and the causes of their decisions, such as how influenced they are by significant others ([Greiner, 2015](#); [Yeboah, Lupi and Kaplowitz, 2015](#)) or the extent to which signalling motives are important to them when adopting sustainable practices ([Pavlis *et al.*, 2016](#); [Trujillo-Barrera, Pennings and Hofenk, 2016](#)). Farmers, like any individuals, may also be unaware of some of the reasons for their decisions ([Nisbett and Wilson, 1977](#)). Moreover, a strategic bias might also be present, whereby farmers voluntarily alter the importance of some factors, such as the amount of compensation for agri-environmental schemes. Experiments, in contrast, allow most of these biases to be avoided ([Colen *et al.*, 2016](#)). In that respect, randomised controlled trials, and more generally extra-laboratory experiments ([Charness, Gneezy and Kuhn, 2013](#)), are especially warranted, as the fact that farmers are not aware of participating in an experiment precludes the introduction of many of the above-mentioned biases. Moreover, between-subject experimental designs are needed to ensure that participants are not aware of the experimentally manipulated variables, thereby reducing strategic bias. We also think that field experiments involving farmers (as opposed to students), thanks to their high contextualisation and high ecological validity, are more likely to be taken into consideration by policy-makers. Experimental research may be particularly relevant for cognitive and social factors; dispositional factors, given that they are very stable, may not be easily experimentally manipulated and may thus benefit less from the added value of experiments.

Experiments can help us to better understand behavioural factors, but the opposite is also true: understanding behavioural factors can contribute to better-informed experiments in agricultural economics. A thorough theory-driven understanding of the behavioural factors, mechanisms and biases influencing farmer decision-making is sometimes lacking in these experiments. Therefore, there is a need to further incorporate behavioural insights and theories into experimental designs and into the interpretation of their results.

7. Conclusions

The main goal of this paper was to provide a structured, integrative overview of the behavioural factors that influence farmers' adoption of environmentally sustainable practices. Our second objective was to propose initial directions

for policy options addressing these behavioural factors within the context of the European Union's Common Agricultural Policy (CAP). We have organised the behavioural factors and the policy recommendations addressing them conceptually around three clusters: dispositional, social and cognitive. These clusters were placed on a distal–proximal spectrum depending on their proximity to the decision to adopt specific sustainable practices.

Dispositional factors refer to farmers' internal propensity to behave in certain ways. Our review shows that extraversion, openness to new experiences, risk seeking, moral and environmental concern, as well as lifestyle farming objectives are associated with higher adoption of sustainable practices. Conversely, being resistant to change and moved by economic objectives makes farmers reluctant to convert. From a policy perspective, this heterogeneity of farmers on these dispositional factors can be addressed by indirectly segmenting them according to sociodemographic and geographic characteristics and by designing appropriate mixes of mandatory and voluntary schemes. A more long-term strategy, with more uncertain but potentially wider effects on farmer adoption, entails increasing farmers' environmental concerns and promoting conservation as a farming objective, as well as boosting consumers' willingness to pay for environmentally friendly food. Social factors concern farmers' interpersonal relationships. Farmers are more likely to adopt sustainable practices when most neighbouring farmers have done so, when they follow the opinion of social referents who support adoption, and when they are willing to gain social status. Communicating the descriptive norm when it indicates a high level of adoption, focusing economic support on areas where adoption is low, providing social recognition of farmers' efforts and informing them of their relative (poor) environmental performance are all promising policy options. Cognitive factors relate to learning and reasoning about specific sustainable practices. Adoption of specific sustainable practices is higher when farmers have sufficient knowledge and competences related to these practices, and when they think these practices bring environmental or financial benefits with limited risks. Policy options to address these cognitive factors will have narrow and vulnerable, but easier-to-obtain effects on farmers' adoption of specific sustainable practices. They include increasing farmers' awareness of sustainable practices, appropriately framing their costs and benefits in order to de-bias their perception, and increasing the flexibility of agri-environmental schemes.

The application of behavioural insights to policy-making began by focusing on consumers and citizens, using nudge approaches targeting System 1 (i.e. automatic) thinking. Leveraging a behavioural approach to design and evaluate policies targeting farmers – who tend to make relatively thoughtful, System 2 decisions when it comes to farming – is, in contrast, still novel. The policy options put forward in the paper deal mainly with general principles to be taken into account when promoting the adoption of sustainable farming practices, as the evidence reviewed here is not specific enough to be more concrete. To address this issue, we have highlighted research gaps that need to be filled, mostly by experimental methods.

Taken together, this review suggests that understanding and considering the role of behavioural factors in farmers' adoption of sustainable practices can help enrich the traditional economic analysis of farmer decision-making. Pre-testing the impact of these behavioural factors on farmer decision-making can, in turn, lead to more effective agri-environmental policies, a crucial challenge in view of the enhanced environmental and climate ambitions for the future Common Agricultural Policy.

Acknowledgements

The authors would like to thank the three anonymous reviewers of this paper, who provided extremely useful feedback on earlier versions, as well as the participants to the coaching workshop gathering the authors of the papers submitted to the present special issue (Montpellier, June 2018) and participants to the second workshop of the Research Network on Economic Experiments for the CAP (Vienna, September 2018) for relevant insights.

Disclaimer

The views expressed in this article do not imply an official policy position of the European Commission.

Copyright

Icons used for Figure 1 were retrieved from Adobe Stock (authors: Rasha Daliyev, Skarin, Napeter, Igarts).

References

- Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes* 50(2): 179–211. [http://doi.org/10.1016/0749-5978\(91\)90020-T](http://doi.org/10.1016/0749-5978(91)90020-T).
- Alamian, A. and Paradis, G. (2012). Individual and social determinants of multiple chronic disease behavioral risk factors among youth. *BMC Public Health* 12: 224. <http://doi.org/10.1186/1471-2458-12-224>.
- Allcott, H. (2011). Social norms and energy conservation. *Journal of Public Economics* 95(9–10): 1082–1095. <http://doi.org/10.1016/j.jpubeco.2011.03.003>.
- American Psychological Association. (2018a). Behavior – APA dictionary. Retrieved from <https://dictionary.apa.org/behavior>
- American Psychological Association. (2018b). Personality. Retrieved April 2, 2018, from <http://www.apa.org/topics/personality/>
- American Psychological Association. (2018c). Psychology – APA Dictionary of Psychology. Retrieved July 20, 2018, from <https://dictionary.apa.org/psychology>
- Andreoni, J. (1990). Impure altruism and donations to public goods: a theory of warm-glow giving. *The Economic Journal* 100(401): 464–477. <http://doi.org/10.2307/2234133>.
- Andrews, A. C., Clawson, R. A., Gramig, B. M. and Raymond, L. (2013). Why do farmers adopt conservation tillage? An experimental investigation of framing effects.

- Journal of Soil and Water Conservation* 68(6): 501–511. <http://doi.org/10.2489/jswc.68.6.501>.
- Arbuckle, J. G. J., Morton, L. W. and Hobbs, J. (2013). Understanding farmer perspectives on climate change adaptation and mitigation: the roles of trust in sources of climate information, climate change beliefs, and perceived risk. *Environment and Behavior* 47(2): 205–234. <http://doi.org/10.1177/0013916513503832>.
- Asch, S. E. (1956). Studies of independence and conformity: I. A minority of one against a unanimous majority. *Psychological Monographs: General and Applied* 70(9): 1–70. <http://doi.org/10.1037/h0093718>.
- Austin, E. J., Deary, I. J., Edwards-Jones, G. and Arey, D. (2005). Attitudes to farm animal welfare. *Journal of Individual Differences* 26(3): 107–120. <http://doi.org/10.1027/1614-0001.26.3.107>.
- Austin, E. J., Deary, I. J. and Willock, J. (2001). Personality and intelligence as predictors of economic behaviour in Scottish farmers. *European Journal of Personality* 15(S1): S123–S137. <http://doi.org/10.1002/per.421>.
- Balafoutis, A., Beck, B., Fountas, S., Vangeyte, J., Wal, T., Soto, I., Gómez-Barbero, M., Barnes, A. and Eory, V. (2017). Precision agriculture technologies positively contributing to GHG emissions mitigation, farm productivity and economics. *Sustainability* 9 (8): 1339. <http://doi.org/10.3390/su9081339>.
- Baland, J.-M. and Platteau, J.-P. (2000). *Halting Degradation of Natural Resources: Is There a Role for Rural Communities?* Oxford University Press: Oxford.
- Bamberg, S. (2003). How does environmental concern influence specific environmentally related behaviors? A new answer to an old question. *Journal of Environmental Psychology* 23(1): 21–32. [https://doi.org/10.1016/S0272-4944\(02\)00078-6](https://doi.org/10.1016/S0272-4944(02)00078-6).
- Bandura, A. (1986). *Social Foundations of Thought and Action*. Englewood Cliffs, NJ: Prentice Hall.
- Banerjee, S., Cason, T. N., de Vries, F. P. and Hanley, N. (2017). Transaction costs, communication and spatial coordination in Payment for Ecosystem Services Schemes. *Journal of Environmental Economics and Management* 83: 68–89. <http://doi.org/10.1016/j.jeem.2016.12.005>.
- Bardi, A. and Schwartz, S. H. (2003). Values and behavior: strength and structure of relations. *Personality and Social Psychology Bulletin* 29(10): 1207–1220. <http://doi.org/10.1177/0146167203254602>.
- Barreiro-Hurlé, J., Espinosa-Goded, M., Martínez-Paz, J. M. and Perni, A. (2018). Choosing not to choose: a meta-analysis of status quo effects in environmental valuations using choice experiments. *Economía Agraria y Recursos Naturales – Agriculture and Resource Economics* 18(1): 79–109.
- Barreiro-Hurlé, J. (2016). Evaluación de alternativas para el diseño de medidas agroambientales: asignación de contratos vía subastas y pago por servicios ambientales. *Revista Española de Estudios Agrosociales y Pesqueros* 245: 15–46.
- Barreiro-Hurlé, J., Espinosa-Goded, M. and Dupraz, P. (2010). Does intensity of change matter? Factors affecting adoption of agri-environmental schemes in Spain. *Journal of Environmental Planning and Management* 53(7): 891–905. <http://doi.org/10.1080/09640568.2010.490058>.
- Baumgart-Getz, A., Prokopy, L. S. and Floress, K. (2012). Why farmers adopt best management practice in the United States: A meta-analysis of the adoption literature. *Journal of Environmental Management* 96(1): 17–25. <http://doi.org/10.1016/j.jenvman.2011.10.006>.
- Beedell, J. and Rehman, T. (1999). Explaining farmers' conservation behaviour: why do farmers behave the way they do? *Journal of Environmental Management* 57(3): 165–176. <http://doi.org/10.1006/jema.1999.0296>.

- Berbel, J. and Mateos, L. (2014). Does investment in irrigation technology necessarily generate rebound effects? A simulation analysis based on an agro-economic model. *Agricultural Systems* 128: 25–34. <http://doi.org/10.1016/j.agsy.2014.04.002>.
- Beretti, A., Figuères, C. and Grolleau, G. (2013). Behavioral innovations: the missing capital in sustainable development? *Ecological Economics* 89: 187–195. <http://doi.org/10.1016/j.ecolecon.2013.03.004>.
- Berkhout, P. H. G., Muskens, J. C. and Velthuisen, J. W. (2000). Defining the rebound effect. *Energy Policy* 28(6): 425–432. [http://doi.org/10.1016/S0301-4215\(00\)00022-7](http://doi.org/10.1016/S0301-4215(00)00022-7).
- Best, H. (2010). Environmental concern and the adoption of organic agriculture. *Society & Natural Resources* 23(5): 451–468. <http://doi.org/10.1080/08941920802178206>.
- Blanken, I., Ven, N. van de and Zeelenberg, M. (2015). A meta-analytic review of moral licensing. *Personality and Social Psychology Bulletin* 41(4): 540–558. <http://doi.org/10.1177/0146167215572134>.
- Bocquého, G., Jacquet, F. and Reynaud, A. (2014). Expected utility or prospect theory maximisers? Assessing farmers' risk behaviour from field-experiment data. *European Review of Agricultural Economics* 41(1): 135–172. <http://dx.doi.org/10.1093/erae/jbt006>.
- Bond, R. and Smith, P. B. (1996). Culture and conformity: a meta-analysis of studies using Asch's (1952b, 1956) line judgment task. *Psychological Bulletin* 119(1): 111–137. <http://doi.org/10.1037/0033-2909.119.1.111>.
- Bontempo, R. N., Bottom, W. P. and Weber, E. U. (2006). Cross-cultural differences in risk perception: a model-based approach. *Risk Analysis* 17(4): 479–488. <http://doi.org/10.1111/j.1539-6924.1997.tb00888.x>.
- Borges, J. A. R., Oude Lansink, A. G. J. M., Marques Ribeiro, C. and Lutke, V. (2018). Understanding farmers' intention to adopt improved natural grassland using the theory of planned behavior. *Livestock Science* 169: 163–174. <http://doi.org/10.1016/j.livsci.2014.09.014>.
- Breustedt, G., Schulz, N. and Latacz-Lohmann, U. (2013). Ermittlung der Teilnahmebereitschaft an Vertragsnaturschutzprogrammen und der dafür notwendigen Ausgleichszahlungen mit Hilfe eines Discrete-Choice-Experimentes. *German Journal of Agricultural Economics* 62(4): 244–257.
- Brewer, M. B. (1991). The social self: on being the same and different at the same time. *Personality and Social Psychology Bulletin* 17(5): 475–482. <http://doi.org/10.1177/0146167291175001>.
- Broch, S. W. and Vedel, S. E. (2012). Using choice experiments to investigate the policy relevance of heterogeneity in farmer agri-environmental contract preferences. *Environmental and Resource Economics* 51(4): 561–581. <http://doi.org/10.1007/s10640-011-9512-8>.
- Burton, R. J. F., Kuczera, C. and Schwarz, G. (2008). Exploring farmers' cultural resistance to voluntary agri-environmental schemes. *Sociologia Ruralis* 48(1): 16–37. <http://doi.org/10.1111/j.1467-9523.2008.00452.x>.
- Charness, G., Gneezy, U. and Kuhn, M. A. (2013). Experimental methods: extra-laboratory experiments-extending the reach of experimental economics. *Journal of Economic Behavior & Organization* 91: 93–100. <http://doi.org/10.1016/j.jebo.2013.04.002>.
- Cialdini, R. B., Reno, R. R., & Kallgren, C. A. (1990). A focus theory of normative conduct: Recycling the concept of norms to reduce littering in public places. *Journal of Personality and Social Psychology*, 58(6), 1015–1026. <http://doi.org/10.1037/0022-3514.58.6.1015>
- Christensen, T., Pedersen, A. B., Nielsen, H. O., Mørkbak, M. R., Hasler, B. and Denver, S. (2011). Determinants of farmers' willingness to participate in subsidy schemes for

- pesticide-free buffer zones – a choice experiment study. *Ecological Economics* 70(8): 1558–1564. <http://doi.org/10.1016/j.ecolecon.2011.03.021>.
- Codato, F. and Furlan, L. (2017). Integrated pest management. A successful case study. In *Workshop 'Best practices addressing environmental needs'*. Brussels. Retrieved from https://ec.europa.eu/agriculture/sites/agriculture/files/events/2017/cap-have-your-say/env-clima-workshop/3.2_session_3_furlan_codato.pdf
- Colen, L., Gomez y Paloma, S., Latacz-Lohmann, U., Lefebvre, M., Préget, R. and Thoyer, S. (2016). Economic experiments as a tool for agricultural policy evaluation: insights from the European CAP. *Canadian Journal of Agricultural Economics/Revue Canadienne d'agroeconomie* 64(4): 667–694. <http://doi.org/10.1111/cjag.12107>.
- Costa, P. T. and McCrae, R. R. (1992). Four ways five factors are basic. *Personality and Individual Differences* 13(6): 653–665. [http://doi.org/10.1016/0191-8869\(92\)90236-I](http://doi.org/10.1016/0191-8869(92)90236-I).
- Cruse, L. and Maybery, D. (2004). Personality and landholders' management of remnant bush and revegetation in the Murray catchment. *Australasian Journal of Environmental Management* 11(1): 21–33. <http://doi.org/10.1080/14486563.2004.10648595>.
- Cullen, P., Dupraz, P., Moran, J., Murphy, P., O'Flaherty, R., O'Donoghue, C., O'Shea, R. and Ryan, M. (2018). Agri-environment scheme design: past lessons and future suggestions. *EuroChoices*. <http://doi.org/10.1111/1746-692X.12187>.
- Cushman, F. (2015). From moral concern to moral constraint. *Current Opinion in Behavioral Sciences* 3: 58–62. <http://doi.org/10.1016/j.cobeha.2015.01.006>.
- Darnton, A., Verplanken, B., White, P. and Whitmarsh, L. (2011). *Habits, Routines and Sustainable Lifestyles: A Summary Report to the Department for Environment, Food and Rural Affairs*. London: AD Research & Analysis for DEFRA. [https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=2ahUKEwimjdTNgpXdaHUIJsAKHdxFDfUQFjAAegQIABAC&url=http%3A%2F%2Frandd.defra.gov.uk%2FDocument.aspx%3FDocument%3DHabitsRoutinesSustainableLifestylesEVO502FinalSummaryReportNov2011\(2\).pdf&us](https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=2ahUKEwimjdTNgpXdaHUIJsAKHdxFDfUQFjAAegQIABAC&url=http%3A%2F%2Frandd.defra.gov.uk%2FDocument.aspx%3FDocument%3DHabitsRoutinesSustainableLifestylesEVO502FinalSummaryReportNov2011(2).pdf&us).
- de Krom, M. P. M. M. (2017). Farmer participation in agri-environmental schemes: regionalisation and the role of bridging social capital. *Land Use Policy* 60: 352–361. <http://doi.org/10.1016/j.landusepol.2016.10.026>.
- DEFRA. (2008). *Understanding Behaviours in a Farming Context*. London: DEFRA.
- Defrancesco, E., Gatto, P., Runge, F. and Trestini, S. (2008). Factors affecting farmers' participation in agri-environmental measures: a Northern Italian perspective. *Journal of Agricultural Economics* 59(1): 114–131. <http://doi.org/10.1111/j.1477-9552.2007.00134.x>.
- Dessart, F. J. and van Bavel, R. (2017). Two converging paths: behavioural sciences and social marketing for better policies. *Journal of Social Marketing* 7(4): 355–365. <http://doi.org/10.1108/JSOCM-04-2017-0027>.
- Dessart, F. J. (2019). Farmers' views on EU agri-environmental policies. Contributing to the Common Agricultural Policy Impact Assessment with evidence from focus groups. Publications Office of the European Union, Luxembourg, ISBN 978-92-76-01439-3, doi:10.2760/049327.
- Diamantopoulos, A., Schlegelmilch, B. B., Sinkovics, R. R. and Bohlen, G. M. (2003). Can socio-demographics still play a role in profiling green consumers? A review of the evidence and an empirical investigation. *Journal of Business Research* 56(6): 465–480. [http://doi.org/10.1016/S0148-2963\(01\)00241-7](http://doi.org/10.1016/S0148-2963(01)00241-7).
- Dixit, A. and Pindyck, R. (1994). *Investment Under Uncertainty*. Princeton, NJ, USA: Princeton University Press.
- Doyle, J. R. (2012). Survey of time preference, delay discounting models. *Judgment and Decision Making* 8(2): 116–135. <http://dx.doi.org/10.2139/ssrn.1685861>.

- Duquette, E., Higgins, N. and Horowitz, J. (2012). Farmer discount rates: experimental evidence. *American Journal of Agricultural Economics* 94(2): 451–456. <http://dx.doi.org/10.1093/ajae/aar067>.
- Dwyer, J., Mills, J., Ingram, J., Taylor, J., Burton, R., Blackstock, K., Slee, B., Brown, K., Schwarz, G., Matthews, K. and Dilley, R. (2007). *Understanding and Influencing Positive Behaviour Change in Farmers and Land Managers*. Retrieved from http://www.academia.edu/download/30615275/Final_report_-_main_text_and_exec_summary.doc
- D'Emden, F. H., Llewellyn, R. S. and Burton, M. P. (2008). Factors influencing adoption of conservation tillage in Australian cropping regions. *Australian Journal of Agricultural and Resource Economics* 52(2): 169–182. <http://doi.org/10.1111/j.1467-8489.2008.00409.x>.
- Emery, S. B. (2015). Independence and individualism: conflated values in farmer cooperation? *Agriculture and Human Values* 32(1): 47–61. <http://doi.org/10.1007/s10460-014-9520-8>.
- Engel, S., Palmer, C., Taschini, L. and Urech, S. (2015). Conservation payments under uncertainty. *Land Economics* 91(1): 36–56. <http://doi.org/10.3368/le.91.1.36>.
- Epices, & Blezat Consulting. (2018). *Mobilisation des filières agricoles en faveur de la transition agro-écologique. Etat des lieux et perspectives*. Retrieved from <http://agriculture.gouv.fr/telecharger/90119?token=549d3103699a91d5befd2c94f70f15ec>
- Espinosa-Goded, M., Barreiro-Hurlé, J. and Ruto, E. (2010). What do farmers want from agri-environmental scheme design? A choice experiment approach. *Journal of Agricultural Economics* 61(2): 259–273. <http://doi.org/10.1111/j.1477-9552.2010.00244.x>.
- European Commission. (2003). *Mid-Term Review of the Common Agricultural Policy – July 2002 Proposals*. Retrieved from https://ec.europa.eu/agriculture/sites/agriculture/files/policy-perspectives/impact-assessment/mid-term-review/rep_en.pdf
- European Commission. (2011). *Commission Staff Working Paper. Impact Assessment. Common Agricultural Policy towards 2020*. Brussels. Retrieved from https://ec.europa.eu/agriculture/sites/agriculture/files/policy-perspectives/impact-assessment/cap-towards-2020/report/full-text_en.pdf
- European Commission. (2015). *Needs of Young Farmers*. Retrieved from https://ec.europa.eu/agriculture/sites/agriculture/files/external-studies/2015/young-farmers/final-report-1_en.pdf
- European Commission. (2016). *Commission Staff Working Document. Review of Greening After One Year*. Brussels. Retrieved from https://ec.europa.eu/agriculture/sites/agriculture/files/direct-support/pdf/2016-staff-working-document-greening_en.pdf
- European Commission. (2017a). *Better Regulation 'Toolbox'*. Retrieved from https://ec.europa.eu/info/sites/info/files/better-regulation-toolbox_1.pdf
- European Commission. (2017b). *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. The Future of Food and Farming*. Brussels. Retrieved from https://ec.europa.eu/agriculture/sites/agriculture/files/future-of-cap/future_of_food_and_farming_communication_en.pdf
- European Commission. (2017c). *Modernising and Simplifying the CAP. Background Document: Climate and Environmental challenges facing EU agriculture and rural areas*. Brussels. Retrieved from https://ec.europa.eu/agriculture/sites/agriculture/files/consultations/cap-modernising/env_background_final_en.pdf
- European Commission. (2017d). *Modernising and Simplifying the CAP. Background Document: Economic Challenges Facing EU Agriculture*. Brussels. Retrieved from

- https://ec.europa.eu/info/sites/info/files/food-farming-fisheries/key_policies/documents/eco_background_final_en.pdf
- European Commission. (2017e). *Special Eurobarometer 468 – October 2017. Report. Attitudes of European Citizens Towards the Environment*. Retrieved from <http://ec.europa.eu/comfrontoffice/publicopinion/index.cfm/ResultDoc/download/DocumentKy/83070>
- European Commission. (2018a). *Commission Staff Working Document Accompanying the Document Proposals for a Regulation of the European Parliament and of the Council Establishing Rules on Support for Strategic Plans to be Drawn up by Member States under the Common agricultural policy (CA)*. Retrieved from <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52018SC0301&rid=2>
- European Commission. (2018b). *Communication from the Commission to the European Parliament, the European Council and the Council – A New, Modern Multiannual Financial Framework for a European Union that Delivers Efficiently on its Priorities Post-2020*. Brussels. Retrieved from https://ec.europa.eu/commission/sites/beta-political/files/communication-new-modern-multiannual-financial-framework_en.pdf
- European Commission. (2018c). *Proposal for a Regulation of the European Parliament and of the Council Establishing Rules on Support for Strategic Plans to be Drawn up by Member States under the Common Agricultural Policy (CAP Strategic Plans)*. Retrieved from <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2018percent3A392percent3AFIN>
- European Commission. (2018d). *Special Eurobarometer 473 – Europeans, Agriculture and the CAP*. Brussels. Retrieved from <http://ec.europa.eu/comfrontoffice/publicopinion/index.cfm/ResultDoc/download/DocumentKy/82123>
- European Court of Auditors. (2017). *Special Report no. 21/2017: Greening: A More Complex Income Support Scheme, Not Yet Environmentally Effective*. Retrieved from https://www.eca.europa.eu/Lists/ECADocuments/SR17_21/SR_GREENING_EN.pdf
- Eurostat. (2018). Agri-environmental Indicators. Retrieved July 24, 2018, from <http://ec.europa.eu/eurostat/web/agri-environmental-indicators>
- Feola, G. and Binder, C. R. (2010). Towards an improved understanding of farmers' behaviour: the integrative agent-centred (IAC) framework. *Ecological Economics* 69 (12): 2323–2333. <http://doi.org/10.1016/j.ecolecon.2010.07.023>.
- Ferraro, P. J., Miranda, J. J. and Price, M. K. (2011). The persistence of treatment effects with norm-based policy instruments: evidence from a randomized environmental policy experiment. *The American Economic Review* 101(3): 318–322. <http://www.jstor.org/stable/29783762>.
- Festinger, L. (1954). A theory of social comparison processes. *Human Relations* 7(2): 117–140. <http://doi.org/10.1177/001872675400700202>.
- Festinger, L. (1962). *A Theory of Cognitive Dissonance*, Vol. 2. Redwood, USA: Stanford University Press: Stanford, CA.
- Fischbacher, U., Gächter, S. and Fehr, E. (2001). Are people conditionally cooperative? Evidence from a public goods experiment. *Economics Letters* 71(3): 397–404. [http://dx.doi.org/10.1016/S0165-1765\(01\)00394-9](http://dx.doi.org/10.1016/S0165-1765(01)00394-9).
- Fisher, A. C. and Krutilla, J. V. (1975). Resource conservation, environmental preservation, and the rate of discount. *The Quarterly Journal of Economics* 89(3): 358–370. <http://doi.org/10.2307/1885257>.
- Flaten, O., Lien, G., Koesling, M., Valle, P. S. and Ebbesvik, M. (2018). Comparing risk perceptions and risk management in organic and conventional dairy farming: empirical results from Norway. *Livestock Production Science* 95(1): 11–25. <http://doi.org/10.1016/j.livprodsci.2004.10.014>.

- Flay, B. R., Snyder, F. and Petraitis, J. (2009). The theory of triadic influence. *Emerging Theories in Health Promotion Practice and Research* 2: 451–510.
- Flocks, J., Clarke, L., Albrecht, S., Bryant, C., Monaghan, P. and Baker, H. (2001). Implementing a community-based social marketing project to improve agricultural worker health. *Environmental Health Perspectives* 109(Suppl 3): 461–468. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1240566/pdf/ehp109s-000461.pdf>.
- Floress, K., García de Jalón, S., Church, S. P., Babin, N., Ulrich-Schad, J. D. and Prokopy, L. S. (2017). Toward a theory of farmer conservation attitudes: dual interests and willingness to take action to protect water quality. *Journal of Environmental Psychology* 53: 73–80. <http://doi.org/10.1016/j.jenvp.2017.06.009>.
- Frey, R., Pedroni, A., Mata, R., Rieskamp, J. and Hertwig, R. (2017). Risk preference shares the psychometric structure of major psychological traits. *Science Advances* 3(10): e1701381, <http://advances.sciencemag.org/content/3/10/e1701381.abstract>.
- Gardebroek, C. (2006). Comparing risk attitudes of organic and non-organic farmers with a Bayesian random coefficient model. *European Review of Agricultural Economics* 33(4): 485–510.
- Gattig, A. and Hendrickx, L. (2007). Judgmental discounting and environmental risk perception: dimensional similarities, domain differences, and implications for sustainability. *Journal of Social Issues* 63(1): 21–39. <http://doi.org/10.1111/j.1540-4560.2007.00494.x>.
- George, J. M. and Zhou, J. (2001). When openness to experience and conscientiousness are related to creative behavior: an interactional approach. *Journal of Applied Psychology* 86(3): 513–524. <http://doi.org/10.1037/0021-9010.86.3.513>.
- Ghadim, A. K. A., Pannell, D. J. and Burton, M. P. (2005). Risk, uncertainty, and learning in adoption of a crop innovation. *Agricultural Economics* 33(1): 1–9. <http://doi.org/10.1111/j.1574-0862.2005.00433.x>.
- Gillich, C., Narjes, M., Kringly, T. and Lippert, C. (2019). Combining choice modeling estimates and stochastic simulations to assess the potential of new crops – the case of lignocellulosic perennials in Southwestern Germany. *GCB Bioenergy* 11: 289–303. <http://doi.org/10.1111/gcbb.12550>.
- Giovanopoulou, E., Nastis, S. A. and Papanagiotou, E. (2011). Modeling farmer participation in agri-environmental nitrate pollution reducing schemes. *Ecological Economics* 70(11): 2175–2180. <http://doi.org/10.1016/j.ecolecon.2011.06.022>.
- Gosling, E. and Williams, K. J. H. (2010). Connectedness to nature, place attachment and conservation behaviour: testing connectedness theory among farmers. *Journal of Environmental Psychology* 30(3): 298–304. <http://doi.org/10.1016/j.jenvp.2010.01.005>.
- Greiner, R. (2015). Motivations and attitudes influence farmers' willingness to participate in biodiversity conservation contracts. *Agricultural Systems* 137: 154–165. <http://doi.org/10.1016/j.agsy.2015.04.005>.
- Greiner, R. and Gregg, D. (2011). Farmers' intrinsic motivations, barriers to the adoption of conservation practices and effectiveness of policy instruments: empirical evidence from northern Australia. *Land Use Policy* 28(1): 257–265. <http://doi.org/10.1016/j.landusepol.2010.06.006>.
- Greiner, R., Patterson, L. and Miller, O. (2009). Motivations, risk perceptions and adoption of conservation practices by farmers. *Agricultural Systems* 99(2–3): 86–104. <http://doi.org/10.1016/j.agsy.2008.10.003>.
- Griskevicius, V., Tybur, J. M. and Van den Bergh, B. (2010). Going green to be seen: status, reputation, and conspicuous conservation. *Journal of Personality and Social Psychology* 98(3): 392–404. <http://doi.org/10.1037/a0017346>.

- Grolleau, G., Mzoughi, N. and Thoyer, S. (2015). Les incitations monétaires dans la politique agro-environnementale: peut-on faire mieux avec moins? *Revue d'Etudes En Agriculture et Environnement* 96(02): 241–257.
- Halek, M. and Eisenhauer, J. G. (2001). Demography of risk aversion. *The Journal of Risk and Insurance* 68(1): 1–24. <http://doi.org/10.2307/2678130>.
- Hallsworth, M., Chadborn, T., Sallis, A., Sanders, M., Berry, D., Greaves, F., Clements, L. and Davies, S. C. (2016). Provision of social norm feedback to high prescribers of antibiotics in general practice: a pragmatic national randomised controlled trial. *The Lancet* 387(10029): 1743–1752. [http://doi.org/10.1016/S0140-6736\(16\)00215-4](http://doi.org/10.1016/S0140-6736(16)00215-4).
- Hardaker, J. B. and Lien, G. (2010). Probabilities for decision analysis in agriculture and rural resource economics: the need for a paradigm change. *Agricultural Systems* 103(6): 345–350. <http://doi.org/10.1016/j.agsy.2010.01.001>.
- Hardin, G. (1968). The tragedy of the commons. *Science (New York, NY)* 162(3859): 1243–1248.
- Hart, R. and Latacz-Lohmann, U. (2005). Combating moral hazard in agri-environmental schemes: a multiple-agent approach. *European Review of Agricultural Economics* 32 (1): 75–91. <http://dx.doi.org/10.1093/erae/jbi002>.
- Hellerstein, D. (2017). The US Conservation Reserve Program: the evolution of an enrollment mechanism. *Land Use Policy* 63: 601–610. <http://doi.org/10.1016/j.landusepol.2015.07.017>.
- Hellerstein, D., Higgins, N. and Horowitz, J. (2013). The predictive power of risk preference measures for farming decisions. *European Review of Agricultural Economics* 40 (5): 807–833. <http://dx.doi.org/10.1093/erae/jbs043>.
- Hermann, D., Mußhoff, O. and Agethen, K. (2016). Investment behavior and status quo bias of conventional and organic hog farmers: an experimental approach. *Renewable Agriculture and Food Systems* 31(4): 318–329. <http://doi.org/10.1017/S1742170515000265>.
- Hermann, D., Sauthoff, S. and Mußhoff, O. (2017). Ex-ante evaluation of policy measures to enhance carbon sequestration in agricultural soils. *Ecological Economics* 140: 241–250. <http://doi.org/10.1016/j.ecolecon.2017.05.018>.
- Higgins, N., Hellerstein, D., Wallander, S. and Lynch, L. (2017). *Economic Experiments for Policy Analysis and Program Design: A Guide for Agricultural Decisionmakers* (236). *Economic Research Report*. Retrieved from <https://www.ers.usda.gov/webdocs/publications/84669/err-236.pdf?v=42961>
- Holst, G. S., Musshoff, O. and Doerschner, T. (2014). Policy impact analysis of penalty and reward scenarios to promote flowering cover crops using a business simulation game. *Biomass and Bioenergy* 70(Supplement C): 196–206. <http://doi.org/10.1016/j.biombioe.2014.08.009>.
- Hsee, C. K. and Weber, E. U. (1999). Cross-national differences in risk preference and lay predictions. *Journal of Behavioral Decision Making* 12(2): 165–179. [http://doi.org/10.1002/\(SICI\)1099-0771\(199906\)12:2<165::AID-BDM316>3.0.CO;2-N](http://doi.org/10.1002/(SICI)1099-0771(199906)12:2<165::AID-BDM316>3.0.CO;2-N).
- Ihli, H. J., Maart-Noelck, S. C. and Musshoff, O. (2014). Does timing matter? A real options experiment to farmers' investment and disinvestment behaviours. *Australian Journal of Agricultural and Resource Economics* 58(3): 430–452. <http://doi.org/10.1111/1467-8489.12028>.
- Iho, A., Lankoski, J., Ollikainen, M., Puustinen, M. and Lehtimäki, J. (2014). Agri-environmental auctions for phosphorus load reduction: experiences from a Finnish pilot. *Australian Journal of Agricultural and Resource Economics* 58: 205–222. <http://doi.org/10.1111/1467-8489.12049>.

- Janowicz-Lomott, M. and Łyskawa, K. (2014). The new instruments of risk management in agriculture in the European Union. *Procedia Economics and Finance* 9: 321–330. [http://doi.org/10.1016/S2212-5671\(14\)00033-1](http://doi.org/10.1016/S2212-5671(14)00033-1).
- Johansson, M., Rahm, J. and Gyllin, M. (2013). Landowners' participation in biodiversity conservation examined through the value-belief-norm theory. *Landscape Research* 38 (3): 295–311. <http://doi.org/10.1080/01426397.2012.673576>.
- Kabii, T. and Horwitz, P. (2006). A review of landholder motivations and determinants for participation in conservation covenanting programmes. *Environmental Conservation* 33(1): 11–20. <http://doi.org/10.1017/S0376892906002761>.
- Kahneman, D. (2003). Maps of bounded rationality: psychology for behavioral economics. *The American Economic Review* 93(5): 1449–1475.
- Kahneman, D. and Tversky, A. (1979). Prospect theory: an analysis of decision under risk. *Econometrica : Journal of the Econometric Society* 47(2): 263–291. <http://doi.org/10.2307/1914185>.
- Kahneman, D. and Tversky, A. (1984). Choices, values, and frames. *American Psychologist* 39(4): 341.
- Kallas, Z., Serra, T. and Gil, J. M. (2010). Farmers' objectives as determinants of organic farming adoption: the case of Catalanian vineyard production. *Agricultural Economics* 41(5): 409–423. <http://doi.org/10.1111/j.1574-0862.2010.00454.x>.
- Kielland, C., Skjerve, E., Østerås, O. and Zanella, A. J. (2010). Dairy farmer attitudes and empathy toward animals are associated with animal welfare indicators. *Journal of Dairy Science* 93(7): 2998–3006. <http://doi.org/10.3168/jds.2009-2899>.
- Knowler, D. and Bradshaw, B. (2007). Farmers' adoption of conservation agriculture: a review and synthesis of recent research. *Food Policy* 32(1): 25–48. <http://dx.doi.org/10.1016/j.foodpol.2006.01.003>.
- Koundouri, P., Laukkanen, M., Myyrä, S. and Nauges, C. (2009). The effects of EU agricultural policy changes on farmers' risk attitudes. *European Review of Agricultural Economics* 36(1): 53–77. <http://dx.doi.org/10.1093/erae/jbp003>.
- Kuhfuss, L., Préget, R., Thoyer, S. and Hanley, N. (2016a). Nudging farmers to enrol land into agri-environmental schemes: the role of a collective bonus. *European Review of Agricultural Economics* 43(4): 609–636. <http://dx.doi.org/10.1093/erae/jbv031>.
- Kuhfuss, L., Préget, R., Thoyer, S., Hanley, N., Le Coent, P. and Désolé, M. (2016b). Nudges, social norms, and permanence in agri-environmental schemes. *Land Economics* 92(4): 641–655. <http://doi.org/10.3368/le.92.4.641>.
- Kuhnen, C. M. and Chiao, J. Y. (2009). Genetic determinants of financial risk taking. *PLoS One* 4(2): e4362, <https://doi.org/10.1371/journal.pone.0004362>.
- Kurkalova, L., Kling, C. and Zhao, J. (2006). Green subsidies in agriculture: estimating the adoption costs of conservation tillage from observed behavior. *Canadian Journal of Agricultural Economics/Revue Canadienne d'agroéconomie* 54(2): 247–267. <http://doi.org/10.1111/j.1744-7976.2006.00048.x>.
- Kurzban, R. and DeScioli, P. (2008). Reciprocity in groups: information-seeking in a public goods game. *European Journal of Social Psychology* 38(1): 139–158. <http://doi.org/10.1002/ejsp.443>.
- Lapinski, M. K. and Rimal, R. N. (2005). An explication of social norms. *Communication Theory* 15(2): 127–147. <http://dx.doi.org/10.1111/j.1468-2885.2005.tb00329.x>.
- Latacz-Lohmann, U., Schilizzi, S. and Breustedt, G. (2011). *Auctioning Outcome-Based Conservation Contracts* (51st Annual Conference, Halle, Germany, September 28–30, 2011). German Association of Agricultural Economists (GEWISOLA). Retrieved from <https://econpapers.repec.org/RePEc:ags:gewil1:114523>

- Le Coent, P., Préget, R. and Thoyer, S. (2017). Compensating environmental losses versus creating environmental gains: implications for biodiversity offsets. *Ecological Economics* 142(Supplement C): 120–129. <http://doi.org/10.1016/j.ecolecon.2017.06.008>.
- Lefebvre, M., Langrell, S. R. H. and Gomez-y-Paloma, S. (2015). Incentives and policies for integrated pest management in Europe: a review. *Agronomy for Sustainable Development* 35(1): 27–45. <http://doi.org/10.1007/s13593-014-0237-2>.
- Llewellyn, R. S. (2007). Information quality and effectiveness for more rapid adoption decisions by farmers. *Field Crops Research* 104(1): 148–156. <http://doi.org/10.1016/j.fcr.2007.03.022>.
- Louhichi, K., Ciaian, P., Espinosa, M., Perni, A. and Gomez y Paloma, S. (2018). Economic impacts of CAP greening: application of an EU-wide individual farm model for CAP analysis (IFM-CAP). *European Review of Agricultural Economics* 45(2): 205–238. <http://doi.org/10.1093/erae/jbx029>.
- Lourenço, J. S., Ciriolo, E., Rafael Almeida, S. and Dessart, F. J. (2016). *Behavioural Insights Applied to Policy: Country Overviews 2016*. Retrieved from <http://publications.jrc.ec.europa.eu/repository/bitstream/JRC100547/biapcountryoverviews2016.pdf>
- Lunn, P. D. (2013). Behavioural economics and policymaking: learning from the early adopters. *The Economic and Social Review* 43(3, Autumn): 423–449.
- Läpple, D. and Kelley, H. (2013). Understanding the uptake of organic farming: accounting for heterogeneities among Irish farmers. *Ecological Economics* 88(Supplement C): 11–19. <http://doi.org/10.1016/j.ecolecon.2012.12.025>.
- Läpple, D. and Kelley, H. (2015). Spatial dependence in the adoption of organic drystock farming in Ireland. *European Review of Agricultural Economics* 42(2): 315–337. <http://dx.doi.org/10.1093/erae/jbu024>.
- Läpple, D. and Van Rensburg, T. (2011). Adoption of organic farming: Are there differences between early and late adoption? *Ecological Economics* 70(7): 1406–1414. <http://doi.org/10.1016/j.ecolecon.2011.03.002>.
- Ma, S., Swinton, S. M., Lupi, F. and Jolejole-Foreman, C. (2012). Farmers' willingness to participate in payment-for-environmental-services programmes. *Journal of Agricultural Economics* 63(3): 604–626. <http://doi.org/10.1111/j.1477-9552.2012.00358.x>.
- Malle, B. F. (2011). Attribution theories: how people make sense of behavior. D. Chadee (eds) *Theories in Social Psychology*. Wiley-Blackwell, 72–95.
- Marchiori, D. R., Adriaanse, M. A. and De Ridder, D. T. D. (2017). Unresolved questions in nudging research: putting the psychology back in nudging. *Social and Personality Psychology Compass* 11(1): e12297, <http://doi.org/10.1111/spc3.12297>.
- Marcillo, G. S. and Miguez, F. E. (2017). Corn yield response to winter cover crops: an updated meta-analysis. *Journal of Soil and Water Conservation* 72(3): 226–239. <http://doi.org/10.2489/jswc.72.3.226>.
- Marra, M., Pannell, D. J. and Ghadim, A. A. (2003). The economics of risk, uncertainty and learning in the adoption of new agricultural technologies: where are we on the learning curve? *Agricultural Systems* 75(2–3): 215–234. [http://doi.org/10.1016/S0308-521X\(02\)00066-5](http://doi.org/10.1016/S0308-521X(02)00066-5).
- Maybery, D., Crase, L. and Gullifer, C. (2005). Categorising farming values as economic, conservation and lifestyle. *Journal of Economic Psychology* 26(1): 59–72. <http://dx.doi.org/10.1016/j.joep.2003.10.001>.
- Michel-Guillou, E. and Moser, G. (2006). Commitment of farmers to environmental protection: from social pressure to environmental conscience. *Journal of Environmental Psychology* 26(3): 227–235. <http://dx.doi.org/10.1016/j.jenvp.2006.07.004>.

- Miira, N., Vesala, H. T. and Vesala, K. M. (2012). Peasantry and entrepreneurship as frames for farming: reflections on farmers' values and agricultural policy discourses. *Sociologia Ruralis* 52(4): 453–469. <http://doi.org/10.1111/j.1467-9523.2012.00572.x>.
- Mills, J., Gaskell, P., Ingram, J. and Chaplin, S. (2018). Understanding farmers' motivations for providing unsubsidised environmental benefits. *Land Use Policy* 76: 697–707. <http://doi.org/10.1016/j.landusepol.2018.02.053>.
- Ministère de l'Agriculture et de l'Alimentation. (2018). Campagne 2018 – « Les antibiotiques, comme il faut, quand il faut ». Retrieved August 28, 2018, from <http://agriculture.gouv.fr/campagne-2018-les-antibiotiques-comme-il-faut-quand-il-faut>
- Morgan, M. I., Hine, D. W., Bhullar, N. and Loi, N. M. (2015). Landholder adoption of low emission agricultural practices: a profiling approach. *Journal of Environmental Psychology* 41: 35–44. <http://doi.org/10.1016/j.jenvp.2014.11.004>.
- Moser, S. and Mußhoff, O. (2016). Ex-ante evaluation of policy measures: effects of reward and punishment for fertiliser reduction in palm oil production. *Journal of Agricultural Economics* 67(1): 84–104. <http://doi.org/10.1111/1477-9552.12114>.
- Mzoughi, N. (2011). Farmers adoption of integrated crop protection and organic farming: do moral and social concerns matter? *Ecological Economics* 70(8): 1536–1545. <http://doi.org/10.1016/j.ecolecon.2011.03.016>.
- Mzoughi, N. (2014). Do organic farmers feel happier than conventional ones? An exploratory analysis. *Ecological Economics* 103: 38–43. <http://doi.org/10.1016/j.ecolecon.2014.04.015>.
- Nisbett, R. E. and Wilson, T. D. (1977). Telling more than we can know: verbal reports on mental processes. *Psychological Review* 84(3): 231–259. <http://doi.org/10.1037/0033-295X.84.3.231>.
- OECD (2012). *Farmer Behaviour, Agricultural Management and Climate Change*. Paris: OECD Publishing, <https://doi.org/10.1787/9789264167650-en>.
- OECD (2016). *Farm Management Practices to Foster Green Growth*. Paris: OECD. https://www.oecd-ilibrary.org/farm-management-practices-to-foster-green-growth_5js00qp1k97f.pdf?itemId=%2Fcontent%2Fpublication%2F9789264238657-en&mimeType=pdf.
- OECD (2017). *Behavioural Insights and Public Policy. Lessons from Around the World*. Paris: OECD Publishing, <http://dx.doi.org/10.1787/9789264270480-en>.
- Öhlmér, B., Olson, K. and Brehmer, B. (1998). Understanding farmers' decision making processes and improving managerial assistance. *Agricultural Economics* 18(3): 273–290. [http://doi.org/10.1016/S0169-5150\(97\)00052-2](http://doi.org/10.1016/S0169-5150(97)00052-2).
- Padel, S., Zander, K. and Zanolli, R. (2015). EU organic logo and its perception by consumers. *British Food Journal* 117(5): 1506–1526. <http://doi.org/10.1108/BFJ-08-2014-0298>.
- Palm-Forster, L. H., Swinton, S. M. and Shupp, R. S. (2017). Farmer preferences for conservation incentives that promote voluntary phosphorus abatement in agricultural watersheds. *Journal of Soil and Water Conservation* 72(5): 493–505. <http://doi.org/10.2489/jswc.72.5.493>.
- Pannell, D. J., Marshall, G. R., Barr, N., Curtis, A., Vanclay, F. and Wilkinson, R. (2006). Understanding and promoting adoption of conservation practices by rural landholders. *Australian Journal of Experimental Agriculture* 46(11): 1407–1424. <https://doi.org/10.1071/EA05037>.
- Pavlis, E. S., Terkenli, T. S., Kristensen, S. B. P., Busck, A. G. and Cosor, G. L. (2016). Patterns of agri-environmental scheme participation in Europe: indicative trends from selected case studies. *Land Use Policy* 57: 800–812. <http://doi.org/10.1016/j.landusepol.2015.09.024>.

- Pedersen, N. L. and Reynolds, C. A. (2002). Stability and change in adult personality: genetic and environmental components. *European Journal of Personality* 16(1): 77–78. <http://doi.org/10.1002/per.443>.
- Pennings, J. M. E. and Garcia, P. (2001). Measuring producers' risk preferences: a global risk-attitude construct. *American Journal of Agricultural Economics* 83(4): 993–1009. <http://dx.doi.org/10.1111/0002-9092.00225>.
- Prokopy, L. S., Floress, K., Klotthor-Weinkauff, D. and Baumgart-Getz, A. (2008). Determinants of agricultural best management practice adoption: evidence from the literature. *Journal of Soil and Water Conservation* 63(5): 300–311. <http://doi.org/10.2489/jswc.63.5.300>.
- Purvis, A., Boggess, W. G., Moss, C. B. and Holt, J. (1995). Technology adoption decisions under irreversibility and uncertainty: an ex ante approach. *American Journal of Agricultural Economics* 77(3): 541–551. <http://dx.doi.org/10.2307/1243223>.
- Raymond, C. M., Brown, G. and Robinson, G. M. (2011). The influence of place attachment, and moral and normative concerns on the conservation of native vegetation: a test of two behavioural models. *Journal of Environmental Psychology* 31(4): 323–335. <http://doi.org/10.1016/j.jenvp.2011.08.006>.
- Reisch, L. A. and Sunstein, C. R. (2016). Do Europeans like nudges? *Judgment and Decision Making* 11(4): 310–325. <http://journal.sjdm.org/16/16202b/jdm16202b.html>.
- Rieger, M. O., Wang, M. and Hens, T. (2014). Risk preferences around the world. *Management Science* 61(3): 637–648. <http://doi.org/10.1287/mnsc.2013.1869>.
- Rocamora-Montiel, B., Glenk, K., & Colombo, S. (2014). Territorial management contracts as a tool to enhance the sustainability of sloping and mountainous olive orchards: Evidence from a case study in Southern Spain. *Land Use Policy*, 41, 313–324. <http://doi.org/https://doi.org/10.1016/j.landusepol.2014.06.016>
- Roccas, S., Sagiv, L., Schwartz, S. H. and Knafo, A. (2002). The big five personality factors and personal values. *Personality and Social Psychology Bulletin* 28(6): 789–801. <http://doi.org/10.1177/0146167202289008>.
- Rodriguez, J. M., Molnar, J. J., Fazio, R. A., Sydnor, E. and Lowe, M. J. (2009). Barriers to adoption of sustainable agriculture practices: change agent perspectives. *Renewable Agriculture and Food Systems* 24(1): 60–71. <http://doi.org/10.1017/S1742170508002421>.
- Ruto, E. and Garrod, G. (2009). Investigating farmers' preferences for the design of agri-environment schemes: a choice experiment approach. *Journal of Environmental Planning and Management* 52(5): 631–647. <http://doi.org/10.1080/09640560902958172>.
- Samuelson, W. and Zeckhauser, R. (1988). Status quo bias in decision making. *Journal of Risk and Uncertainty* 1(1): 7–59. <http://doi.org/10.1007/BF00055564>.
- Schlüter, M., Baeza, A., Dressler, G., Frank, K., Groeneveld, J., Jager, W., Janssen, M. A., McAllister, R. R., Müller, B., Orach, K. and Schwarz, N. (2017). A framework for mapping and comparing behavioural theories in models of social-ecological systems. *Ecological Economics* 131: 21–35. <http://doi.org/10.1016/j.ecolecon.2016.08.008>.
- Schmidtner, E., Lippert, C., Engler, B., Häring, A. M., Aurbacher, J. and Dabbert, S. (2012). Spatial distribution of organic farming in Germany: does neighbourhood matter? *European Review of Agricultural Economics* 39(4): 661–683. <http://dx.doi.org/10.1093/erae/jbr047>.
- Schmitzberger, I., Wrška, T., Steurer, B., Aschenbrenner, G., Peterseil, J. and Zechmeister, H. G. (2005). How farming styles influence biodiversity maintenance in Austrian agricultural landscapes. *Agriculture, Ecosystems & Environment* 108(3): 274–290. <http://dx.doi.org/10.1016/j.agee.2005.02.009>.
- Schultz, P. W., Gouveia, V. V., Cameron, L. D., Tankha, G., Schmuck, P. and Frank, M. (2005). Values and their relationship to environmental concern and conservation

- behavior. *Journal of Cross-Cultural Psychology* 36(4): 457–475. <http://doi.org/10.1177/0022022105275962>.
- Schulz, N., Breustedt, G. and Latacz-Lohmann, U. (2014). Assessing farmers' willingness to accept 'greening': insights from a discrete choice experiment in Germany. *Journal of Agricultural Economics* 65(1): 26–48. <http://doi.org/10.1111/1477-9552.12044>.
- Schäfer, M., Jaeger-Erben, M. and Bamberg, S. (2012). Life events as windows of opportunity for changing towards sustainable consumption patterns? *Journal of Consumer Policy* 35(1): 65–84. <http://doi.org/10.1007/s10603-011-9181-6>.
- Serra, T., Zilberman, D. and Gil, J. M. (2008). Differential uncertainties and risk attitudes between conventional and organic producers: the case of Spanish arable crop farmers. *Agricultural Economics* 39(2): 219–229. <http://doi.org/10.1111/j.1574-0862.2008.00329.x>.
- Sheeder, R. J. and Lynne, G. D. (2011). Empathy-conditioned conservation: 'walking in the shoes of others' as a conservation farmer. *Land Economics* 87(3): 433–452. <http://doi.org/10.3368/le.87.3.433>.
- Sok, J., Hogeveen, H., Elbers, A. R. W. and Oude Lansink, A. G. J. M. (2016). Using farmers' attitude and social pressures to design voluntary Bluetongue vaccination strategies. *Preventive Veterinary Medicine* 133: 114–119. <http://doi.org/10.1016/j.prevetmed.2016.09.016>.
- Sok, J., Hogeveen, H., Elbers, A. R. W. and Oude Lansink, A. G. J. M. (2018). Perceived risk and personality traits explaining heterogeneity in Dutch dairy farmers' beliefs about vaccination against Bluetongue. *Journal of Risk Research* 21(5): 562–578. <http://doi.org/10.1080/13669877.2016.1223162>.
- Stuart, D., Benveniste, E. and Harris, L. M. (2014). Evaluating the use of an environmental assurance program to address pollution from United States cropland. *Land Use Policy* 39: 34–43. <http://doi.org/10.1016/j.landusepol.2014.03.009>.
- Sunstein, C. R. (2014). Nudging: a very short guide. *Journal of Consumer Policy* 37(4): 583–588. <http://doi.org/10.1007/s10603-014-9273-1>.
- Sunstein, C. R. (2015). The ethics of nudging. *Yale Journal on Regulation* 32(2): 413–450.
- Sunstein, C. R. (2016). Fifty shades of manipulation. *Journal of Marketing Behavior* 1(3–4): 213–244. <http://doi.org/10.1561/107.000000014>.
- Sutherland, L.-A. and Darnhofer, I. (2012). Of organic farmers and 'good farmers': changing habitus in rural England. *Journal of Rural Studies* 28(3): 232–240. <http://dx.doi.org/10.1016/j.jrurstud.2012.03.003>.
- Talcott, P. (1951). *The Social System*. New York: Routledge.
- Thaler, R. H. and Sunstein, C. R. (2008). *Nudge: Improving Decisions About Health, Wealth, and Happiness*. New Haven: Yale University Press.
- The Behavioural Insights Team. (2011). *Annual Update 2010–11*. Retrieved from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/60537/Behaviour-Change-Insight-Team-Annual-Update_acc.pdf
- The Behavioural Insights Team. (2015). *Update Report 2013–2015*. Retrieved from http://38r8om2xjhh125mw24492dir.wpengine.netdna-cdn.com/wp-content/uploads/2015/08/BIT_Update-Report-Final-2013-2015.pdf
- The Behavioural Insights Team. (2016). *Update Report 2015–16*. Retrieved from http://38r8om2xjhh125mw24492dir.wpengine.netdna-cdn.com/wp-content/uploads/2016/09/BIT_Update_Report_2015-16-.pdf
- The Behavioural Insights Team. (2017). *Update Report 2016–17*. Retrieved from http://38r8om2xjhh125mw24492dir-wpengine.netdna-ssl.com/wp-content/uploads/2017/10/BIT_Update-16-17_E_.pdf
- The World Bank. (2015). *World Development Report 2015: Mind, society, and behavior*. <http://doi.org/10.1596/978-1-4648-0342-0>

- Toma, L. and Mathijs, E. (2007). Environmental risk perception, environmental concern and propensity to participate in organic farming programmes. *Journal of Environmental Management* 83(2): 145–157. <http://doi.org/10.1016/j.jenvman.2006.02.004>.
- Troussard, X. and van Bavel, R. (2018). How can behavioural insights be used to improve EU policy? *Intereconomics* 53(1): 8–12. <http://doi.org/10.1007/s10272-018-0711-1>.
- Trujillo-Barrera, A., Pennings, J. M. E. and Hofenk, D. (2016). Understanding producers' motives for adopting sustainable practices: the role of expected rewards, risk perception and risk tolerance. *European Review of Agricultural Economics* 43(3): 359–382. <http://dx.doi.org/10.1093/erae/jbv038>.
- Tversky, A. and Kahneman, D. (1974). Judgment under uncertainty: heuristics and biases. *Science (New York, NY)* 185(4157): 1124–1131.
- Uematsu, H. and Mishra, A. K. (2012). Organic farmers or conventional farmers: where's the money? *Ecological Economics* 78: 55–62. <http://doi.org/10.1016/j.ecolecon.2012.03.013>.
- Ulber, L., Klimek, S., Steinmann, H.-H., Isselstein, J. and Groth, M. (2011). Implementing and evaluating the effectiveness of a payment scheme for environmental services from agricultural land. *Environmental Conservation* 38(04): 464–472. <http://doi.org/10.1017/S0376892911000385>.
- van Dijk, W. F. A., Lokhorst, A. M., Berendse, F. and de Snoo, G. R. (2016). Factors underlying farmers' intentions to perform unsubsidised agri-environmental measures. *Land Use Policy* 59: 207–216. <http://doi.org/10.1016/j.landusepol.2016.09.003>.
- Vanslebrouck, I., Van Huylbroeck, G. and Verbeke, W. (2002). Determinants of the willingness of Belgian farmers to participate in agri-environmental measures. *Journal of Agricultural Economics* 53(3): 489–511. <http://doi.org/10.1111/j.1477-9552.2002.tb00034.x>.
- Verplanken, B. and Roy, D. (2016). Empowering interventions to promote sustainable lifestyles: testing the habit discontinuity hypothesis in a field experiment. *Journal of Environmental Psychology* 45: 127–134. <http://doi.org/10.1016/j.jenvp.2015.11.008>.
- 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* 13(4): e0108, <http://doi.org/10.5424/sjar/2015134-7376>.
- Villanueva, A. J., Rodríguez-Entrena, M., Arriaza, M. and Gómez-Limón, J. A. (2017). Heterogeneity of farmers' preferences towards agri-environmental schemes across different agricultural subsystems. *Journal of Environmental Planning and Management* 60(4): 684–707. <http://doi.org/10.1080/09640568.2016.1168289>.
- Wauters, E., Biolders, C., Poesen, J., Govers, G. and Mathijs, E. (2010). Adoption of soil conservation practices in Belgium: an examination of the theory of planned behaviour in the agri-environmental domain. *Land Use Policy* 27(1): 86–94. <http://doi.org/10.1016/j.landusepol.2009.02.009>.
- Weber, E. U. and Hsee, C. (1998). Cross-cultural differences in risk perception, but cross-cultural similarities in attitudes towards perceived risk. *Management Science* 44(9): 1205–1217. <http://doi.org/10.1287/mnsc.44.9.1205>.
- Weitzman, M. L. (1994). On the 'environmental' discount rate. *Journal of Environmental Economics and Management* 26(2): 200–209. <http://doi.org/10.1006/jeem.1994.1012>.
- Westerink, J., Jongeneel, R. A., Polman, N., Prager, K., Franks, J. R., Dupraz, P. and Mettepenningen, E. (2017). Collaborative governance arrangements to deliver spatially coordinated agri-environmental management. *Land Use Policy* 69: 176–192. <http://doi.org/10.1016/J.LANDUSEPOL.2017.09.002>.

- Willock, J., Deary, I. J., Edwards-Jones, G., Gibson, G. J., McGregor, M. J., Sutherland, A., Dent, J. B., Morgan, O. and Grieve, R. (1999). The role of attitudes and objectives in farmer decision making: business and environmentally-oriented behaviour in Scotland. *Journal of Agricultural Economics* 50(2): 286–303. <http://doi.org/10.1111/j.1477-9552.1999.tb00814.x>.
- World Bank Group. (2015). *World Development Report 2015: Mind, Society, and Behavior*. <http://doi.org/10.1596/978-1-4648-0342-0>
- World Health Organization (2014). *The World Health Report 2013: Research for Universal Health Coverage*. Geneva: World Health Organization. http://apps.who.int/iris/bitstream/handle/10665/85761/9789240690837_eng.pdf;jsessionid=143A4F7B3F29CF3F25B62113780787C2?sequence=2.
- Yeboah, F. K., Lupi, F. and Kaplowitz, M. D. (2015). Agricultural landowners' willingness to participate in a filter strip program for watershed protection. *Land Use Policy* 49: 75–85. <http://doi.org/10.1016/j.landusepol.2015.07.016>.
- Zahavi, A. and Zahavi, A. (1999). *The Handicap Principle: A Missing Piece of Darwin's Puzzle*. Oxford University Press: Oxford.