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RESEARCH ARTICLE

REVISED Social capital factors affecting uptake of sustainable soil management practices: a literature review [version 2; peer review: 1 approved, 1 approved with reservations]

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Abstract

Soil quality is in decline in many parts of the world, in part due to the intensification of agricultural practices. Whilst economic instruments and regulations can help incentivise uptake of more sustainable soil management practices, they rarely motivate long-term behavior change when used alone. There has been increasing attention towards the complex social factors that affect uptake of sustainable soil management practices. To understand why some communities try these practices whilst others do not, we undertook a narrative review to understand how social capital influences adoption in developed nations. We found that the four components of social capital – trust, norms, connectedness and power – can all influence the decision of farmers to change their soil management. Specifically, information flows more effectively across trusted, diverse networks where social norms exist to encourage innovation. Uptake is more limited in homogenous, close-knit farming communities that do not have many links with non-farmers and where there is a strong social norm to adhere to the status quo. Power can enhance or inhibit uptake depending on its characteristics. Future research, policy and practice should consider whether a lack of social capital could hinder uptake of new practices and, if so, which aspects of social capital could be developed to increase adoption of sustainable soil management practices. Enabling diverse, collaborative groups (including farmers, advisers and government officials) to work constructively together could help build social capital, where they can co-define, -develop and -enact measures to sustainably manage soils.

Keywords

sustainable agriculture, sustainable land management, soil management, social capital

Open Peer Review

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Any reports and responses or comments on the article can be found at the end of the article.

This article is included in the Sustainable Food Systems gateway.

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REVISED **Amendments from Version 1**

The revised paper clarifies a number of minor points and considers issues of power in greater depth.

Any further responses from the reviewers can be found at the end of the article

Introduction

There has arguably never been a more important time in history to improve the sustainability of agriculture (Willett *et al.*, 2019). Climate change, a growing human population, an increased demand for (cheap) food, rapid biodiversity loss and a decline in soil and water quality make it increasingly likely that more planetary boundaries will be crossed, triggering abrupt environmental change with potentially catastrophic effects (Steffen *et al.*, 2015). Dynamic interactions between these drivers require new approaches that consider ecological and social processes (Ostrom, 2009). These approaches must consider the sustainability of agricultural production and consumption to secure enough food, feed, fuel and fibre in the coming decades, whilst concurrently ensuring that the environment is protected, as is recognised in the UN Sustainable Development Goals (SDGs) (Griggs *et al.*, 2013).

Soil is the black gold upon which almost all terrestrial life depends, making it the foundation for all crop and livestock agriculture. However, soil quality across the world is in decline, which has repercussions for rural livelihoods and the economy. For example, soil erosion has been estimated to cost $8 billion a year globally (Sartori *et al.*, 2019). Whilst farm management directly impacts soils, underlying drivers of soil degradation are socio-economic, political and cultural (Prager & Posthumus, 2010). Successful agri-environmental policies that incentivise more sustainable soil management must therefore take into account the drivers of human decision-making (Carlisle, 2016).

To understand what, besides policies, contribute to farmer decision-making, researchers have studied the economic, financial, educational, technical, psychological, environmental and demographic factors that influence uptake of sustainable agricultural practices (e.g. Siebert *et al.*, 2006). However, farmer decision-making is often influenced just as much by socio-cultural factors as it is by ecological and economic factors (Burton, 2004; Mills *et al.*, 2017; Rust *et al.*, 2016).

Much of the above research has focused on the behaviour of land managers, where a range of factors explaining (non)-adoption of tillage, best management practices and agri-environmental schemes (AES) are evaluated (e.g. Baumgart-Getz *et al.*, 2012; Knowler & Bradshaw, 2007; Siebert *et al.*, 2006). Many earlier studies from the 1980s–1990s have their roots in theories on adoption of soil conservation practices from North America, where the effect of numerous individual socio-economic farm and farmer factors (e.g. demographic and attitudinal) have been widely studied (Ervin & Ervin, 1982; Napier, 1990; Smit & Smithers, 1992). More recent work from the USA provides further examples showing that a range of factors combine to influence farmer behaviour change. Carlisle (2016), for example, found that uptake of practices to improve soil health were influenced by market forces, psychology, agronomy, environmental, educational and financial constraints. Grover & Gruver (2017) found that barriers to uptake of sustainable agricultural practices on smallholder farms included markets, labour restrictions, environmental factors, regulations, access to information and networks. However, meta-analyses of previous agricultural adoption studies found no universal patterns or determining factors that explain uptake of more sustainable soil management practices, in part due to the range of methods used and also due to the complexity and context dependence of the studies (Knowler & Bradshaw, 2007; Prokopy *et al.*, 2008; Wauters & Mathijs, 2014). The importance of context and complex interactions among various factors can also be found when studying the influence of social capital on the uptake of sustainable agricultural practices. Due to the diverse set of dynamics affecting interactions taking place within farming communities, generalizable findings are difficult to discern.

Underpinning all of the above-mentioned factors is the learning process through which a farmer gains knowledge of the practice and decides to act upon it (Kilpatrick & Johns, 2003; Leeuwis, 2004). This process ranges from uni-directional "knowledge transfer" or acquisition from any number of sources (e.g. media or other farmers) to more multi-directional "knowledge exchange", co-production and social learning, involving interactions with other farmers, advisers and/or other actors (Brunori *et al.*, 2013). Although some of these learning processes are more social than others, a farmer who learns about a new cropping system by reading a magazine will do so in a specific social context with norms that influence how information is interpreted and how knowledge is learned (Bandura, 1977). It is therefore clear that uptake of sustainable soil management practices is inherently a social and a learning process (Schneider *et al.*, 2009; Wynne, 2016). If social learning is defined as "a change in understanding that goes beyond the individual to become situated within wider social units or communities of practice through social interactions between actors within social networks" (Reed *et al.*, 2010), then it can be argued that social learning is a key process through which social capital is built between those who interact in social networks. For example, Farmer Field Schools give groups of farmers opportunities to meet regularly to learn from each other about farming practices, building their knowledge, confidence and capacity to innovate and adapt (Pretty & Buck, 2002). However, much of the literature has conflated social learning and stakeholder participation, providing few insights into the role of learning or social capital in adoption processes (Reed *et al.*, 2010).

Knowledge acquisition largely depends on receiving information from another person, be that another farmer, a family member, an agronomist, or someone else (Rose *et al.*, 2018). When presented with a fact, we often look to find out who communicated it and where they got that information from (Carolan, 2006) to assess the validity of the claim. The source

of information is important, as we more easily accept the knowledge that comes from the social networks that we trust (Carolan, 2006; Sutherland *et al*., 2013). Uptake of new agricultural technologies and practices are thus partly dependent on both the social capital of the system and the extent to which it can be said that social learning is occurring between actors in that system (Butler *et al*., 2006; Putnam, 1993). This article thereby focuses on evaluating how social relations influences farmers' willingness to act on new agricultural knowledge by adopting sustainable soil management practices.

Social capital has numerous definitions in the literature but has two dominant conceptualisations: firstly, the ability for an individual to do well in social situations or, secondly, the group-level attributes, like a social network (Glaeser *et al*., 2002). We base our social capital conceptual model on the seminal, somewhat contrasting, contributions to the subject by Putnam (1993) and Bourdieu (1986). Putnam purported that social capital is composed of elements of trust, norms and connections, which are reinforced over time through successive rounds of collaboration that become self-perpetuating (Putnam, 1993). Bourdieu noted that these elements are relational and influenced by the presence and dynamics of power within the network (1986). When it comes to diffusion of ideas between individuals, social capital research has tended to focus on the roles of trust, norms, connectedness and power, especially as they function on a micro-level. These four elements will form the basis of our review.

Proponents of social capital have argued its importance for the proper functioning of effective societies (Grootaert, 1998; Paldam & Svendsen, 2000). Communities with large stocks of social capital have been shown to exhibit better health, less crime, quicker economic growth, and higher support for the government than those with lower stocks of social capital (World Bank (2006) cited in Larsson (2012)). Yet, it is important to note that social capital stands as a contested term, due to the wide variance in its definition and utility within a number of academic fields. Critiques of social capital tend to focus on the conceptual understanding that has been adopted (Harriss & De Renzio, 1997; Ishihara & Pascual, 2009; Poder, 2011). Since social capital is not a generalizable concept, how best to implement a social capital approach depends on contextual factors such as cultural, socio-political, economic, and historical factors that shape power relations within a community. The context may also vary considerably based on spatial and temporal considerations. The confluence of such factors can predispose particular communities in their willingness to engage with stakeholders and the capacity to build social capital (Lasinska, 2013).

In agriculture, social capital has been well studied (e.g. Butler *et al*., 2006; Chloupkova *et al*., 2003; Putnam, 1993), yet it is less clear how trust, norms, connectedness and power each feed into this concept and how these four aspects of social capital affect a farmer's uptake of soil management practices. Evidence is scattered across a wide range of disciplines and literatures and there has been no attempt to synthesise lessons that could be used to promote higher uptake of sustainable soil practices. This is important because without understanding the social capital factors that underpin farmer behaviour change, it may not be possible to fully scale up sustainable intensification of agriculture across national and international contexts to the extent necessary to meet the SDGs (Pretty *et al*., 2018). Equally, it is pertinent to understand whether lessons learnt from how social capital affects agricultural practices more broadly may be applicable to the specific topic of sustainable soil management.

In this review, we examine how social capital and its components of trust, connectedness, norms and power affect uptake of sustainable soil management practices. We define "sustainable soil management practices" as those that improve soil quality (and hence its functions) and that have positive impacts on the profitability and sustainability of cropping systems. We understand adoption/uptake to be a process of adaptation and learning rather than one-off uptake of a technology. We start by looking at studies that have studied social capital as a whole, and then go on to cover studies that focus on the four elements of social capital.

Method

We undertook a narrative review of peer-reviewed and grey literature to understand the social capital factors that influence uptake of sustainable soil management practices. A narrative literature review is an expert-based "best-evidence synthesis" of key literature; it does not seek to capture all literature. Narrative reviews are well-suited to providing critiques or interpretations of issues, especially where it is difficult to identify specific outcome measures for comparison across studies, or where it is based on expert interpretation of key literature. Narrative reviews differ from systematic reviews and meta-analyses that attempt to holistically synthesise literature around more narrowly framed questions and outcomes, often aided by statistics (Greenhalgh *et al*., 2018). Given the broad scope of the review and wide range of potential outcomes, a narrative approach was selected here. Our focus was specifically on agricultural soil management practices in developed nations. However, where literature in the developed world context was scarce but studies from a developing world context were found, these were included. To undertake the narrative review, we searched for articles on Google Scholar and Web of Science using the following Boolean search terms (see Table 1 for number of papers identified and included in the review):

- For trust: trust AND ("soil conservation" OR "soil improving" OR "sustainable agriculture" OR "conservation agriculture") AND farm*

- For norms: ("social norm" OR norms OR culture OR tradition) AND ("soil conservation" OR "soil improving" OR "sustainable agriculture" OR "conservation agriculture") AND farm*

- For power and connectedness: ("social capital" OR (social AND (power OR connectedness)) AND ("soil conservation" OR "soil improving" OR "sustainable agriculture" OR "conservation agriculture") AND farm*

Table 1. Number of publications identified via Google Scholar and Web of Science, and number used in the review.

Search term	Google Scholar search results	Web of Science search results	References used in review
trust AND ("soil conservation" OR "soil improving" OR "sustainable agriculture" OR "conservation agriculture") AND farm*	17,000	38	38
("social norm" OR norms OR culture OR tradition) AND ("soil conservation" OR "soil improving" OR "sustainable agriculture" OR "conservation agriculture") AND farm*	18,200	155	32
"social capital" OR (social AND (power OR connectedness)) AND ("soil conservation" OR "soil improving" OR "sustainable agriculture" OR "conservation agriculture") AND farm*	17,900	27	35

The scope of the study and criteria for filtering papers are defined below:

Sustainable soil management: this is a diffuse concept and here we use the terms soil improving, sustainable agriculture, and conservation agriculture to capture the suite of practices that potentially benefit soil quality.

Language: English

Date range of publication: 1970–2018

Date of search: June 2018 – August 2018

Type of articles: journal articles, book chapters, books, dissertations, policy briefings, monographs, technical reports

Topic: as defined above with the Boolean search terms

The process for searching for relevant articles and analysing texts began with reading the title of the document to check if it was within scope and, if so, to read the abstract and, if still in scope, the entire paper. If, when reading the article, other articles relevant to the research questions were cited in the document, these were also sought and analysed. Additional papers were included where co-authors had knowledge of further relevant research not found within the above search, such as eminent papers on the broader topic of social capital to help contextualise the issue in the wider literature. This process continued until theoretical saturation had been reached and no new themes were emerging from the literature (Glaser, 1965). Results were written by summarising these common themes that emerged from the articles (Denzin *et al*., 2018).

Results

Studies on social capital have sought to understand how it affects agricultural management, though less attention has specifically been directed at soil management. We therefore start with a broad overview of studies that have looked at sustainable land management practices (sought through the narrative review search term "sustainable agriculture") and then focus on studies that covered soil management specifically.

In terms of broader land management, social capital has been found to be an important ingredient for effective environmental governance (Pretty & Ward, 2001) and for influencing adoption of more environmentally-friendly practices (Pretty & Smith, 2004). In relation to agricultural management, Sobels *et al*., (2001) noted that government support for social capital was a factor that helped lead to considerable success for Landcare Australia initiative[1]. Regarding uptake of new agricultural practices, a study of young Greek farmers found that those who had higher social capital were more likely to be innovative (Koutsou *et al*., 2014).

When it comes to soil management practices specifically, similar patterns have been found to those above. One study noted that where American farmers were embedded within larger farmer networks (where other farmers were already using practices to improve their soil health), these farmers were more likely to try these practices too (Carlisle, 2016). However, this study also found that whilst the farmer networks promoted soil health practices, this mostly influenced early and middle adopters, meaning that late adopters were harder to reach even in networks with apparently high social capital. Similarly, an Italian study showed that non-adopters of agri-environmental measures were reluctant to seek information from neighbouring farmers, preferring instead to get their agricultural information from input producers and farming magazines, whereas adopters were more willing to seek agricultural information from other farmers (Defrancesco *et al*., 2008). This suggests that how a farmer uses their connections can influence who they trust about where to get agricultural information from. Furthermore, learning in social networks and peer support is particularly important when farmers undertake longer-term systemic changes towards more sustainable systems such as organic, agro-ecological, and conservation agriculture (where soil improvement is a core element) (Ingram, 2010; Schneider *et al*., 2009).

Some of the proposed processes that social capital can facilitate increased uptake of agricultural practices include:

[1] This originated as a community-based organisation focused on agricultural land management, with the main goal of better managing our natural resources. Landcare Australia worked with a wide range of stakeholders to co-develop and –manage their land collectively

- the idea that trust reduces the transaction costs of learning about new information,
- social norms, which are created and maintained that promote adoption behaviour,
- certain network characteristics and power dynamics that promote the wider diffusion of innovations (de Krom, 2017; Pretty & Smith, 2004).

We continue this narrative review by looking at these different dimensions of social capital, starting with trust.

Trust

Trust between individuals can help an individual believe information and turn it into usable knowledge, so this section focuses on how trust functions within a social network and how this can influence uptake of new agricultural practices, especially sustainable soil management. Trust is a key attribute of social capital, as high social capital can promote trust between people, which in turn promotes collective action (Porta *et al*., 1996; Tsai & Ghoshal, 1998); equally, collective action can also promote trust, which leads to higher social capital. People tend to exhibit a higher willingness to accept knowledge that comes from the social networks they trust, especially in instances where risks and uncertainty are high (Carolan, 2006; de Vries *et al*., 2015; Taylor & Van Grieken, 2015). To understand how trust might influence adoption of more sustainable soil management practices, we first reflect on what trust is and how it develops and operates between individuals and institutions.

Interpersonal trust is the trust developed between individuals, including a willingness to accept risk or be vulnerable in the relationship (Mayer *et al*., 1995; Stern & Coleman, 2015; Sundaramurthy, 2008). A distinction is usually made between the trustor (the one trusting) and the trustee (the one being trusted). Trusting someone is not only about being confident that another person has your own interests and welfare in mind, but also relates to whether you will act on the other person's actions and words (Möllering, 2001). Trusting someone tends to mean you believe they are competent, reciprocal, fair, reliable, responsible and dependable (McAllister, 1995). Indeed, an important aspect of social capital is reciprocity, a norm which is closely linked with trustworthiness, and reciprocating builds trust and cements relationships. Trust is based on the success of past interactions as well as social similarity, such as ethnicity or religious background. Trust is not limited to the interaction between two people but also between a person and an institution, such as a government (Luhmann, 1979; Zucker, 1986).

Trust may be formed, maintained and broken in different ways, at different social, spatial and temporal scales (de Vries *et al*., 2015). When trust is violated, the trustor may be less likely to cooperate with the trustee in the future, which can inhibit business productivity (Lewicki & Tomlinson, 2003). Depending on how badly the trust has been violated, the reaction from the victim could range from forgiveness to retribution, or even ending the relationship forever. Trust is specific: someone can trust a person on one specific issue, while distrusting another issue (Lewicki *et al*., 1998). A breakdown of trust could result in a farmer choosing different sources to get agricultural advice from and the social memory of a community can either enhance or inhibit future uptake of sustainable agricultural practices depending on past experiences (Wilson, 2013).

In participatory processes, trust is vital in influencing the process both positively and negatively (DeVente *et al*., 2016; Kelliher *et al*., 2018). Trust has shown to aid individuals to cope with uncertainty (O'Brien, 2001), reduce complexity (Luhmann, 1979) and improve credibility (Ingram *et al*., 2016). Relationships with a high degree of trust can result in a greater degree of exchange between participants, with people being more willing both to share and receive information with others in the group, as well as to absorb other's knowledge (Levin & Cross, 2004; Lyon, 2000; Stobard, 2004). In a farming context, this could mean that, in networks that exhibit a high degree of trust, learning about new practices takes place easier and faster (Schneider *et al*., 2009) and could encourage either quicker and/or more frequent uptake of innovations, such as more sustainable soil management practices.

Potential detrimental effects from excessive or insufficient levels of trust are often overlooked (Lacey *et al*., 2017). Such effects can be a tendency of 'blind faith' between parties, which can lead to complacency (Gargiulo & Ertug, 2003), a lack of objectivism or favouritism (Stevens *et al*., 2015) or even a halt to pursuing new innovative ideas (Stern & Baird, 2015). For instance, farmers may trust their agronomists, and the advice they share, because of the long-term relationship they have built up over time (Sutherland *et al*., 2013), which could result in overuse of chemicals if this is what their agronomist recommends. In countries without government agricultural extension officers, agronomists can be independent or work for an agricultural distribution company; if the latter, they could push the company's agenda, which may lower trust in the information shared. Independent agronomists are in a better position to build trust with farmers due to being seen as impartial, which can build agronomists' credibility, reliability and respect. Thus, trust in both the information itself and the information bearer affect farmer decisions to act on that information (Knowler & Bradshaw, 2007; O'connor *et al*., 2005).

Trust in institutions is different to trust in people. Low trust in institutions, such as governments, can reduce uptake of more sustainable farming practices (Hall, 2008; Prager & Posthumus, 2010). One study showed that historical mistrust of regulators contributed to farmers being unwilling to use more sustainable practices but also found that this distrust could be overcome by using third-party knowledge brokers that could build trust more quickly (Breetz *et al*., 2005). Institutional trust is affected by past and ongoing relationships. For instance, a UK study found that distrust of information on bovine tuberculosis provided by the government to farmers was due to the government's past irregular, inconsistent contact with farmers (Fisher, 2013). Higher degrees of trust and confidence in institutions like the government have been associated with increased uptake of sustainable agricultural practices that benefit the soil like

no-till (Swan, 2012; Turpin *et al*., 2017). Trust works both ways between governments and farmers: for instance, governments that trust farmers to undertake actions as being part of agri-environmental schemes spend less money on monitoring farmers' actions for compliance (Falconer *et al*., 2001).

The degree to which a farmer puts trust in others can by influenced by what type of land manager they are. In a study on Australian landowners to understand who they most trusted, all landowners put most trust in their neighbours (Pannell *et al*., 2006). However, this study also found that landowners who farmed predominantly for production reasons had the least trust in the government, whereas hobbyist farmers and landowners who were most interested in conservation put least trust in productionist groups. Similarly, an American study showed that some organic farmers were averse to trusting information from universities as they were suspicious of this type of knowledge generation (possibly due to phenomenological differences), which affected their uptake of integrated pest management practices (Park & Lohr, 2005). Like other social variables, it is important not to assume all farmers act in the same way, making generalisations only possible for situations with the same context.

Given the influence of globalisation and digitalisation, many trust building interactions will need to be developed and maintained over long distances. Insights from social network analysis and diffusion of innovation theory can shed light into the underlying mechanism of developing long-distance trust. The concept of homophily (the degree to which actors associate themselves with similar people; akin to "in-groups" discussed below) plays an important role for trust building over long distances. Homophily is influential if people attribute trustworthiness to others based on the other person's network position or organisational/institutional affiliations, or having the same culture or ethnicity (Rogers, 2003). Based on stereotypes, trust can even be assigned to roles and public figures that one trustee has never met in person (Henry & Dietz, 2011). Whilst long-distance trust building is important, personal face-to-face trust building is the basis for large-scale, long-distance trust building.

Organisational reputation influences trust building, just as trust between individuals can affect organisational reputations (Lacey *et al*., 2017). For instance, a farmer may already trust a farming association that has a good reputation with the farming industry and therefore would be more likely to trust the advice from that organisations' employee. If one individual (or institution) is seen as trustworthy, the people they trust will likely be trusted as well: this is known as transitivity (Henry & Dietz, 2011). For example, if a national farmers union is trusted by farmers, the policy makers that the union trusts are more likely to be trusted by the farmer too, just as uptake of policies can be enhanced when policy administrators are trusted by farmers (Prazan & Dumbrovsky, 2011).

It is therefore apparent that trust is a crucial aspect of social capital and especially as it relates to accepting information when deciding whether to start the transition towards more sustainable soil management practices. We shall now consider the next element of social capital: connectedness.

Connectedness

Connectedness is the configuration of social interactions on a community scale or between networks and is an important part of social capital (Pretty & Ward, 2001; Pretty, 2003). Connectedness relates to both real and perceived connections within a network, as well as their strength. There are three types of structural social capital connections:

- *Bonding* refers to the close, horizontal ties between similar individuals within a network, such as between other farmers;
- *Bridging* refers to horizontal ties between two different networks, such as between farmers and conservationists;
- *Linking/bracing* refers to vertical ties between different hierarchical levels, such as between policymakers and farmers.

Connections between individuals within a network are dynamic and contextual, with the type of social capital linkages within a network being important for how effective knowledge exchange is. For instance, new practices and information are more likely to be shared between people who have weak social ties, going beyond the close ties of their normal network (Granovetter, 1973). This new knowledge is then exchanged with people they trust within their closer network, spreading tacit knowledge (Butler *et al*., 2006). For more efficient knowledge exchange of new agricultural practices such as those that promote sustainable soil management, bridging and linking ties could be important forms of connectedness (Adler & Kwon, 2002; Hall & Pretty, 2008).

Bonding social capital is equally important to farmers. Sociologist James Coleman explains the benefit of bonding social capital to traditional farming in the following way:

- "*In a farming community…where one farmer got his hay baled by another and where farm tools are extensively borrowed and lent, the social capital allows each farmer to get his work done with less physical capital in the form of tools and equipment*" (Coleman, 1990: 307).

However, given that industrial-scale farming is moving away from the above situation, bonding social capital could be waning in these agricultural contexts. As the farming landscape changes physically, culturally and socially with a shift towards contract farming and "megafarms" run by external companies, it is highly likely that the bonding capital in farming communities is being eroded. The evolving sector has also seen traditional set-ups of farmers as farm managers transition to land owners with farm managers bringing in short-term contractors to manage soil-related issues such as tillage. Consequently, the social make-up of the countryside has changed with connections being broken and remade.

Bonding social capital can affect how trust operates in a system. Trust in "out-groups" (i.e. people different to you so bonding social capital is limited) tends to be lower than for "in-group" members (Brewer, 1979). For instance, information providers that are considered as part of the "in-group" (i.e. similar to farmers) are more likely to result in farmers believing what the information provider says and acting on this (Blackstock *et al.*, 2010); indeed, a study of Australian livestock farmers found that "trust in the messenger is more important than the message" (Palmer *et al.*, 2009: 371). This suggests the importance of who the messenger is in relation to how their message will be received. The level of trust decreases as people move further away from their own group (Gallo *et al.*, 2018), with institutional actors and public administration often being perceived as the furthest away (Harring, 2018). In a UK farming context, this has been deemed "rings of confidence" and farmers tend to go to similar people within their network that they trust more than unfamiliar out-groups such as policymakers (AIC, 2018).

Being connected to a network is important for transfusion of ideas and practices, but it is not clear what type of network creates the biggest utility. Some successful networks consist of lots of farmers living geographically close to each other, whereas others include looser affiliations in a diverse network. For instance, one study showed that using social networks to gather information was associated with more interest by farmers in wanting to use more sustainable agricultural practices (Jussaume & Glenna, 2009). Strong bonding social capital can influence others within a farmer's network to follow their lead. For instance, in a study of British farmers, a high level of bridging social capital between farmers and vets meant that farmers trusted information from vets, which led to knowledge transfer and was encouraged by regular, long term, consistent contact (Fisher, 2013). This study concluded that bonding social capital between different farmers helped to spread knowledge but also led to tight-knit exclusive groups that led to distrust between groups. The study also found that low levels of linking social capital between farmers and the government caused mistrust and a lack of confidence in the information given by government outreach officers, demonstrating the relationship between connectedness and trust. However, too much bonding social capital within a network can have negative consequences if the group is very insular (Browning *et al.*, 2000), which can inhibit knowledge transfer.

Besides bonding social capital, bridging social capital can enhance uptake of more sustainable soil management practices. A meta-analysis of American studies that looked at adoption of best management practices, including aspects related to soil improvement, showed that bridging connections between farmers and other groups (such as government agency personnel and watershed groups) was one of the biggest influencers on adoption (Baumgart-Getz *et al.*, 2012). Diverse networks involving bridging and linking social capital, whilst encouraging networks with strong bonding linkages, could therefore be useful when it comes to spreading uptake of more sustainable soil management practices.

If an individual is more attached to their community, they may be more likely to be socially responsible, as well as have better access to information. A study of Georgian farmers found those who were more involved with their community were also more likely to adopt environmentally-friendly practices (Breetz *et al.*, 2005). Furthermore, an Australian study which looked at uptake of climate adaptation strategies by farmers showed that connectedness, as it related to feeling a sense of community, affected uptake (Brown *et al.*, 2016). Equally, being open to making new connections can influence willingness to adopt new practices. In a UK study, farmers who were more open to professional and non-professional contacts were more likely to take part in an agri-environment scheme (Mathijs, 2003). This suggests that farmers with strong bonding ties but a lack of bridging or linking ties could reduce adoption of more sustainable soil management practices.

Connected, diverse farming networks can enable better exchange of knowledge but this is also influenced by the social norms around whether farmers prefer to adhere to the status quo (Inman *et al.*, 2018). This leads us on to the next aspect of social capital that we will discuss as it relates to uptake of sustainable agricultural practices: norms.

Norms

Norms establish behavioural standards that set expectations and guarantee predictability of social relations within a network (or community). A norm is a degree of consensus within a community and is an element of social capital. Norms can give people the confidence to take part in group action if there is the expectation that others will too (Gómez-Limón *et al.*, 2014). Social norms, traditions and peer pressure can help to shape environmentally sustainable behaviour (Reimer *et al.*, 2014). As mentioned above, the norm of reciprocity, where favours done now will be returned in the future, has been argued as one of the most important social norms for building social capital as it allows people to gauge trustworthiness over time and creates a memory of collaborative work (Ashby *et al.*, 1998). Norms and trust are closely linked because norms can be thought of as the basis for developing and maintaining trust (Lyon, 2000). Norms are often imposed by powerful actors from the top down, which can increase trust among subordinates (Gelderblom, 2018). To further show the links between norms and trust, Fukuyama (1995: 26) has described trust as:

- *"the expectation that arises within a community of regular, honest and cooperative behavior, based on commonly shared norms on the part of other members of that community. Those norms can be about deep 'value' questions like the nature of God or justice, but they also encompass secular norms like professional standards and codes of behavior."*

Norms have been shown in numerous agricultural studies to be important drivers of behaviour. Research from the US Corn Belt found that norms and social networks both played key

roles in influencing farmers' decisions to adopt conservation practices (Atwell *et al*., 2009). Similarly, wine growers in France were more willing to change their agricultural management if they thought their peers would do too (Kuhfuss *et al*., 2016) and, in Greece, farmers were more likely to participate in environmentally-friendly farming measures if their neighbours or relatives did (Damianos & Giannakopoulos, 2002). Furthermore, active adopters of agri-environmental practices in an Italian study were more sensitive to what they thought society thinks about farming (i.e. a social norm) than non-adopters (Defrancesco *et al*., 2008).

Farmers can face social barriers that hinder uptake of certain practices, which can cause a "lock in" within the community, with community members resisting change due to past negative experiences (Marshall & Stokes, 2014). For instance, conventional farmers can be highly critical and judgemental of practices that go against the norms of that group (Burton & Paragahawewa, 2011), such as organic farming (Morgan & Murdoch, 2000) and reduced tillage (Ingram, 2010). In a Swiss study to understand what affected a farmer's decision to turn organic, a significant barrier was the social norm to be productive as it was assumed that organic farming is less productive (Home *et al*., 2015). Like other aspects of social capital, it is not necessarily true that having a community with strong norms will automatically create the opportunity for change. Rather, it is whether there is a norm that encourages innovative thinking and adaptiveness.

Norms can therefore hinder uptake of more sustainable agricultural practices. For instance, farmers might not adopt a new, beneficial practice if it is thought to go against the status quo; in some contexts, it can be more important for farmers to change to practices that make their farms look aesthetically pleasing to other farmers, conveying that they are good land stewards, rather than using practices that may be more sustainable (Carlisle, 2016). For instance, the social norm of having a farm look neat was a factor inhibiting Spanish farmers from trying methods to reduce soil erosion, and, in Iceland, farmers would not try such methods because of ingrained traditional agricultural practices that were found hard to change (Caspari *et al*., 2017). Likewise, in a US study, there was a strong cultural norm among farmers to tidy up "weeds" which inhibited some farmers from adopting sustainable agricultural practices that were deemed "untidy" (Carolan, 2005). Another American study showed that farmers were not willing to use manure as a natural fertiliser because they were worried about the smell that would dissipate to their neighbours (Battel & Krueger, 2004). Similarly, early adopters of conservation tillage practices mentioned the practice of not cultivating when neighbours were cultivating was difficult for the early adopters as this went against the norm within the community (Coughenour & Chamala, 2000).

Whilst there may be multiple norms inhibiting a community from changing to more sustainable soil management practices, collective action and the process of developing social capital can work together to help change social norms within a group, thereby fostering more rapid adoption (Cary & Webb, 2000). However, in closely-knit networks with strong bonding social capital, change can be hard because there is often the norm to conform to the status quo (Compagnone & Hellec, 2015). Whilst setting regulations can itself sometimes change behavior, it depends on the norm within the community to abide by the new rules and regulations. For instance, in a study looking at how social factors affected uptake of soil conservation practices in Europe, social norms were found to be as important as individual motivations to comply with the regulations, which together encouraged farmers to use these practices (Prager & Posthumus, 2010).

Norms are therefore crucial aspects of social capital for policymakers and practitioners to consider if they wish to encourage more widespread uptake of soil conservation measures, as norms can either encourage or inhibit farmers to change their agricultural practices. If the norm within a community is to stick to the status quo, it can be very difficult for individual farmers to go against the grain, especially if they have a strong desire to fit in. In this instance, other measures may be useful to help create change, such as working with influential demonstration farmers.

Power

Power is important to consider with respect to social capital as it plays a crucial role in determining who is in a position to gain influence. Putnam's conceptualisation of social capital did not explicitly touch on power, unlike Bourdieu, who was acutely aware of the issues of power within a network. Indeed, Blackshaw & Long (2005: 252) stated that the "value of trust as a form of social capital becomes problematic, because as Bourdieu shows us it will inevitably be exploited for gain, in the practice of symbolic power". Given that most social interactions involve exchanges between people and groups with different power bases, this topic is important to address within an agricultural social capital lens (Chloupkova *et al*., 2003). Power also influences who is included or excluded from a network and therefore relates to trust within that network (Lyon, 2000), as trusting someone often means making yourself vulnerable to someone else. If someone puts trust in another person and the trustee uses opportunism to exploit the trustor, this is exploitation of power. For example, trusting an agronomist to provide accurate agricultural advice puts a farmer in a vulnerable position whereby their profits could decline if the agronomist gives incorrect information. Trust in powerful actors becomes important in contexts of high risk and uncertainty. Whether there is a norm to sanction the exploitation of trust depends on the cultural setting including whether the powerful actor(s) will enforce the sanction, or indeed if it is the powerful actor(s) who are the ones exploiting trust of the less powerful. By trusting someone, you are therefore putting yourself in a vulnerable position and the trustee is often acutely aware of this. Social exchange thus includes components of both trust and power (Bachmann, 2001). Nunkoo & Ramkissoon (2012: 1000) eloquently summarise this by saying "trust and power complement one another to predict social actors' behaviours across different contexts and situations".

When it comes to how the power aspects of social capital have affected adoption of soil management practices, the

narrative review produced limited results, therefore the remainder of this section draws on broader literature on the topic, including (where examples were found) of the topic of power in agricultural settings. Power struggles occur between individuals and groups daily, which affects who controls and gets access to resources and how these resources are used. In situations of power inequalities, risks can be distributed unequally, such as between land owners and tenants (Boardman *et al*., 2017) and farmers and buyers (Hall & Pretty, 2008). Tenancy contracts tend to be short-term, meaning tenants might not be motivated to think about long-term health of soils. Equally, landlords and other powerful food supply chain actors such as supermarkets may stipulate for or against certain land management practices, limiting tenant and land manager power to change. One way to redistribute risk between powerful differentials is to co-create a longer-term contract - although this too can be abused. Ways to demonstrate trust in an unequal power relationship include showing transparency, fairness, and procedural justice (Cook, 2005). With the change in how farms are now run, with external companies and contractors now part of the soil management decision-making process and supermarkets imposing contractual obligations upon the farm managers, the distribution of power in the network has altered too. Farm managers may struggle to have agency over soil management decisions in networks where power is concentrated off-farm.

Power within a network can be abused for personal gain. Szreter (2002) has argued that, when it comes to the connectedness of social networks, it is linking social capital that is the most prone to abuse of power given the nature of the relationship spanning hierarchies. Conversely, associations that already have a certain amount of bridging social capital and are able to build linking social capital tend to be the ones that are more successful at achieving their goals (Szreter, 2002) precisely because they tap into and utilise sources of power for their own ends. This could be a farming community that has successfully built a good relationship with local government officials, for example. However, this tends to only works in more egalitarian societies rather than those that privilege the minority in power, including authoritarian states and those with a strong libertarian market structure. Indeed, Szreter (2002) posits that the tight bonding social capital by the elite in free-market societies could negatively affect natural capital alongside bridging and linking social capital. In agriculture, this has already been seen where companies have formed successful coalitions that fight against regulations to reduce or ban environmentally-damaging chemicals.

Power can be used intentionally or unintentionally to control who gets access to information (Brugnach & Ingram, 2012). It has been argued that power and knowledge go hand in hand, where power is created via the distribution of knowledge and can be used to control others (Foucault, 1980). Therefore, the transfer of knowledge can act as either a process of empowerment or disempowerment depending on how it is enacted (Fazey *et al*., 2013). For instance, some farmers in Namibia have purposefully limited farm worker access to education as a form of subjugation and control (Rust, 2015). Agricultural advisers are in a position of power as they decide what information to share with the farmer and what to withhold. An adviser from a fertiliser company, for example, may share information on the benefits of increased fertiliser usage but refrain from sharing the long-term environmental costs of over-application.

Focusing more on the connectedness of social capital, Blackshaw & Long (2005: 252) state "the poor are geographically constrained and may find it difficult to establish bridging capital through normal day to day contact", meaning that building social capital can be difficult for those with the least power. They conclude that "when [social capital] is good it can be very, very good, but when it is bad it can be horrid" (p 254). It is therefore pertinent to appreciate the role that power in a particular context has in affecting social capital. Regarding uptake of sustainable soil management practices, there is scant literature on power outside developing countries, but it is highly likely that power affects adoption in ways we are only just beginning to understand.

Discussion

To date, there has been no in-depth review of the literature to determine how the key four aspects of social capital could influence agricultural soil management. This review therefore fills this gap by examining how trust, connectedness, norms and power affect the adoption of sustainable soil management practices and found the scientific literature to date has not fully explored how social capital directly affects uptake of sustainable soil management practices. This is particularly the case for the topic of power within social capital, suggesting this could be an area worthy of further empirical studies. Findings from studies on adoption of broader sustainable agricultural practices have provided several insights. In many instances, higher amounts of social capital facilitated relationship-building and -maintaining between farmers and the external sources they receive agricultural information from. Knowledge exchange in agricultural contexts may work best in diverse, trusted networks, where the norm of innovation already exists and where less powerful actors can change within the system. Building social capital takes time and the precise way this is done will likely differ depending on context. If a lack of social capital has been established as a source of limited uptake of sustainable soil management practices, strategies to address this would benefit from incorporating measures focused on building bridging and linking social capital, as well as trust between stakeholders.

Whilst we make no claim that understanding the social capital in a farming community can be a silver bullet to entice reluctant land managers to try new practices, we do suggest that social capital is an important factor when it comes to understanding the complex pathway to adoption of sustainable soil management practices. The first – and, some may say, most important – part of social capital is trust, which is a crucial part of this puzzle when it comes to understanding whether someone believes and acts on a piece of information that has been shared. Our review showed how vital it is to develop and maintain trust between the person or institution sharing knowledge on soil management practices and farmers; indeed,

farm advisers have long known the significance of relationship building with their clients. It is therefore imperative that trust be nurtured before attempts are made to influence farmer behaviour.

Connectedness can enhance or hinder uptake of new practices depending on the type of connections; a high amount of bonding social capital can hinder uptake if it is not accompanied with linking and bridging capital. Norms also influence farmer behaviour, sometimes encouraging change in practice and sometimes not. The norm of reciprocity, where present within an environment, can help build trust. Power within the system cannot be ignored because it is omnipresent in all social networks. Power is not an easy force to deal with and, even with the best facilitators in the world, must be handled with care or could cause long-lasting damage to relationships. Whilst power differentials between policymakers and farmers is obvious, there are less obvious power differentials that must be addressed, such as between farm managers and contractors. Power may therefore be the most difficult part of social capital to effectively address, which may be why there has been a paucity of social capital research dedicated to the role of power in agricultural soil management. Researchers following Putnam's conceptualisation of social capital does not include power, which might also explain the lack of focus on this important aspect of social capital. However, given power is present in all forms of social interaction, we recommend power to be included in future social capital studies.

Conclusion

This extensive narrative review has proven the difficulty of drawing general conclusions on how social capital can affect uptake of sustainable soil management. It is important to acknowledge that social capital is highly context specific, which implicates generalizable approaches to critique. This is because of the complex and shifting historical, political, psychological, social, environmental, and economic context in which a farmer, farm manager or contractor is situated that drives them to act in their own unique ways. In attempting to build social capital, it is important to acknowledge at which level the approach is being implemented and to be highly cognizant of the social dynamics within the particular community. Furthermore, whilst social capital can have positive associations, as discussed in the review, there can be unintended negative consequences, which need to be acknowledged and mindful of when implementing a particular strategy.

This review has disentangled the dimensions of social capital and their linkages, whilst providing some theoretical insights into the known benefits of agricultural discussion groups, farmer networks and multi-stakeholder networks in the context of farm management decisions. We have highlighted the importance of influencing social norms to shift farmers' farm management behaviour from the status quo as well as acknowledging the role that power plays in multi-stakeholder networks. Sustainable soil management is a diffuse concept in the literature (Ingram & Mills, 2019) and it has not been possible to sufficiently unpack this term in connection to the elements of social capital covered in this review. The heterogeneity of soils, farming systems and management options, coupled with the changing agricultural landscape towards company-managed farms, absentee landowners and increased reliance on contractors, represented in this study adds a further challenge in terms of determining exactly how social capital impacts uptake of more sustainable soil management practices. However, the review highlights the role of social capital in supporting long-term systemic changes on farm, which require co-learning with the support of trusted peers alongside innovation shared between networks.

With respect to fostering social capital, incentivising cooperation and collaborative approaches in a range of contexts and scales can be effective (Bijman & Iliopoulos, 2014). Although not explicitly addressing social capital, facilitating interactive groups is now an established component of a number of European Union grants, as well as national programmes and advisory systems that address issues of sustainable agriculture. Some initiatives such as the EU Operational Groups on soil topics provide support to enhance connectedness (particularly bonding and bridging with farmers, advisers and researchers working together) and implicitly foster and rely on trust. However, future support for such multi-actor collaboration in the context of improving soil management would benefit from a more nuanced understanding of how these actors interact in building social capital, particularly in relation to norms and power relationships in their design. Power has been much neglected to date in social capital studies on soil management and we recommend this aspect of social capital be addressed more thoroughly not only in research into soil management but also when developing and managing interactive groups between different stakeholders. Addressing power in multi-stakeholder groups requires careful expert facilitation and we therefore recommend the use of trusted, unbiased external agencies to guide the development and management of multi-stakeholder groups working on soil management. If power is not adequately acknowledged in the system, work to build other aspects of social capital may fall short. As the agri-food system changes and power is concentrated more and more within fewer stakeholder groups, this aspect of social capital may, over time, become the most critical factor in determining success or failure of any multi-stakeholder project.

Data availability

Underlying data

All data underlying the results are available as part of the article and no additional source data are required.

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?

Severine van Bommel
School of Agriculture and Food Sciences, University of Queensland, Gatton, Qld, Australia

The article represents a literature review of literature on agricultural soil management practices in developed nations. The authors analysed how trust, norms, connectedness and power feed into social capital to understand how this influences the decision of farmers to change the management of their soils. The article addresses an important and timely topic.

The introduction describes the problem of behaviour change in relation to soil management practices well. It describes the current state of the art - most research has tried to identify factors explaining adoption or non-adoption of new practices - and it discusses that this research is insufficient because no universal patterns can be found. The bridge to learning processes and social capital could be strengthened. How is this different from the approaches that try to identify factors? How will this address some of the shortcomings of the studies so far?

The methods section clearly describes the narrative literature review. As the review included papers that the authors had knowledge of but that were not found within the search as described. This means that the result is not completely replicable. For a narrative literature review, this should not be a problem as narrative analysis is based on different criteria for trustworthiness than traditional positivist research.

The results describe how trust, norms, connectedness and power influenced social capital in the literature studied. When discussing power, the authors touch upon literature that is quite critical of social capital. It would be good to reflect on the critique to social capital a bit more. If this critique is missing in literature on soil management practices then it is interesting to reflect on why that might be missing.

In the discussion and conclusion, it would be good to draw out more 1) how this approach to social capital is different from the way in which social capital has been addressed in literature so far and 2) what sort of shortcoming in the literature on social capital this approach is addressing. One of the critiques to social capital has been its naivety about power. The approach proposed in this article directly deals with that. Also the link between social capital and trust is interesting and definitely deserves further exploration. It would strengthen the article if the author could draw out these contribution a bit more.

Is the work clearly and accurately presented and does it cite the current literature?
Yes

Is the study design appropriate and is the work technically sound?
Yes

Are sufficient details of methods and analysis provided to allow replication by others?
Partly

If applicable, is the statistical analysis and its interpretation appropriate?
Not applicable

Are all the source data underlying the results available to ensure full reproducibility?
Yes

Are the conclusions drawn adequately supported by the results?
Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Extension, rural development, social learning, interpretive analysis, agriculture, natural resource management.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Reviewer Report 14 April 2020

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Katrin Prager
Geography and Environment, School of Geosciences, University of Aberdeen, Aberdeen, UK

This is a thoroughly researched and well-written review. The paper is very useful to generate the confidence that “the scientific literature to date has not fully explored how social capital directly affects uptake of sustainable soil management practices”. For someone familiar with the social capital concept there will be no surprises because these aspects have been covered in previous studies on adoption of sustainable farming practices. Perhaps it is worth stating why you expect social capital might affect uptake of soil management practices differently than uptake of farming practices more broadly (especially when soil management underpins all agricultural activity apart from special sectors like hydroponics and aquaculture). I particularly like the clear structure of the review around the four components trust, connectedness, norms and power, which is a difficult undertaking given the overlap between the components.

I would like to raise some points for the authors to consider that will hopefully make this review even better.

General
The paper seems to adapt a global stance. However, in the methods you specify that your "focus was specifically on agricultural soil management practices in developed nations" with literature from a developing world context included where literature in the developed world context was scarce. I think this focus should be made clear right from the beginning and in the abstract because I found myself wondering how confident you (or the reviewed studies) are that findings apply equally to smallholders in Europe, subsistence farmers in Africa, agribusiness in the US, etc.
Related, but probably not easy to address, is the question whether a focus on farmers and farming communities is still justified? The farm owner is often no longer identical with the farm manager, and soil management decisions are being made by tenants, contractors or companies that have leased the land from the farmer for a season or two. Given that farming is increasingly undertaken by contractors, farm managers and agri-businesses, I have often wondered to what extent social capital influences these actors, and to what extent they are part of what we conventionally understand by 'the farming community'?
You touch on the issue "However, given that industrial-scale farming is moving away from the above situation, bonding social capital could be waning in these agricultural contexts". Very good point; can you say any more about it?

Abstract
You mention 'effective social capital' twice but this concept is not revisited in the paper. You either need to define this (effective for what? What mix of bonding/ bridging/ linking social capital is the effective kind?) or just stick with 'social capital'.
I'm not sure about "We are now beginning to pay attention to the complex social factors" – some disciplines and interdisciplinary researchers have been paying attention to social factors for quite some time? I'm also not sure we can 'manage power' – would it be more appropriate to talk about how power is perceived, plays out or is used?

Main text
In some cases, you draw on references from a non-farming sector (e.g. "However, too much bonding social capital within a network can have negative consequences if the group is very insular (Browning *et al*., 2000[1]), which can inhibit knowledge transfer.", or the link to "business productivity"). Is there a way to express how confident are you that studies from urban crime, business or organisational studies apply to agricultural soil management?

Please check the reference or amend the text: "For instance, in a study looking at how social factors affected uptake of soil conservation practices in the US, social norms were found to be as important as individual motivations to comply with the regulations, which together encouraged farmers to use these practices (Prager & Posthumus, 2010[2])." This was not a study in the US.

"the known benefits of farmers' collaborating through discussion, farmer networks and multi-stakeholder networks in the context of farm management decisions" – I'm not sure you can collaborate through discussion; should this be 'discussion groups'?

"In this instance, other measures may be useful to help create change, such as financial incentives or regulations." – I understand what you mean but the way it's phrased I'm not sure I agree with this,

especially since you cited Inman *et al*.[ref-3[earlier who said “Simply offering financial incentives or imposing regulatory penalties is unlikely to achieve the desired results”.

You explain trust is as a key attribute/ dimension of social capital, as high social capital can promote trust between people, which in turn promotes collective action. I fully agree but wonder if the reverse reasoning – collective action promotes trust (as it offers opportunity for reciprocating), which leads to high levels of social capital – is also worth mentioning?

Detail on the question answered ‘partly’ on the review form: “sufficient details of methods and analysis provided to allow replication by others”:
The methods for sourcing the relevant literature for the review are appropriately described, however, replication by others will be limited because the review was complemented as follows “Additional papers were included where co-authors had knowledge of further relevant research not found within the above search.”

Minor comments on spelling and phrasing:

- Trust has shown to aide individuals.
- just as uptake of policies goes faster when policy administrators are trusted by farmers.
- "Independent agronomists are in a better position to build trust with farmers due to being seen as impartial, which can build agronomists’ credibility, reliability, respect, competence and empathy”. – I’m not sure about the last two, how would trust with farmers increase the agronomist’s competence or empathy? Might just be a phrasing issue.
- There are a number of statements that are difficult to follow: “Power can be thought of as scalar actor relations” and “Trust in powerful forces becomes important in contexts of high risk and uncertainty” – can you explain what that means?"
- Therefore, the transfer of knowledge can act as either a process of empowerment or disempowerment depending on how it is enacted (Fazey *et al*., 2013[4])” – should this read ‘exchange’?

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Is the work clearly and accurately presented and does it cite the current literature?
Yes

Is the study design appropriate and is the work technically sound?
Yes

Are sufficient details of methods and analysis provided to allow replication by others?
Partly

If applicable, is the statistical analysis and its interpretation appropriate?
Not applicable

Are all the source data underlying the results available to ensure full reproducibility?
Yes

Are the conclusions drawn adequately supported by the results?
Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: farmer adoption of environmentally friendly farming practices, social capital, incentive-based and command-and-control policies, soil conservation practices, agroecological practices

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.