Assessing farmers' intention to adopt soil conservation practices across Europe

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Abstract: During the past decennia, soil conservation practices (SCPs) have been developed in order to maintain or restore soil health which is essential to the resilience of the farm. However, the adoption rate in practice is rather low. Amongst other reasons, these practices might lack on-farm compatibility, or farmers may lack confidence in the proposed measures. To increase the adoption rate of SCPs, capturing farmers' opinions, given their specific farming context, can aid future strategies to get the SCPs implemented. Therefore, the aim of this study is to identify and compare different barriers and drivers towards the adoption of SCPs across 25 major farm type agri-environmental zone combinations in 8 European countries. To unravel farmer's motivation and ability to implement a certain SCP, we applied a sequential mixed method approach based on the theory of planned behavior, a socio-psychological framework to predict human behavior. Qualitative semi-structured interviews with farmers reveal a first indication of possible barriers and drivers. These serve as the basis for a broad quantitative survey in each of the 25 major farm type zones, all characterized by their own soil, climate, regulatory and socio-economic context. Due to this context, the selected SCPs in the questionnaire differ among the major farm type zones, although with cover crops and reduced and/or non-inversion tillage, two wide-spread practices, were included across nearly all farm type zones. An EU-wide comparison between different regions allows us to better relate differences in barriers, motivators and farmers' intention to differences in bio-physical, economic, institutional, social and regulatory conditions. To obtain a correct interpretation and clarification of the most striking results, we organize regional focus groups with experts and farmers. The results will offer valuable insights to advice EU policy, extension and scientific research. They will be able to take into account the specific context of the different major farm types when developing strategies to increase the adoption rate of SCPs.

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Introduction

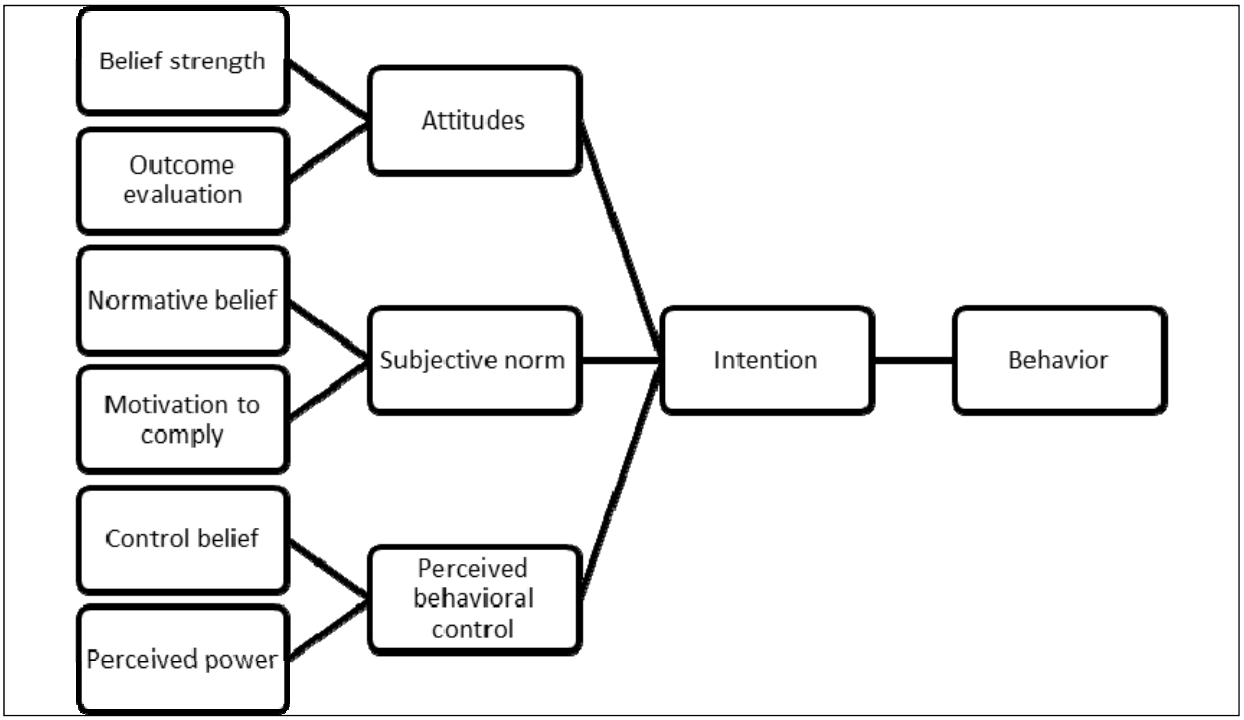
During the past decennia, soil conservation practices (SCPs) have been developed in order to maintain or restore soil health which is essential to the sustainability and resilience of the farm. Nevertheless, compared to other regions in the world, the adoption of conservation practices by European farmers is lagging and varies among different countries and even among different regions within a country (Derpsch, 2005; Lahmar, 2010). Adoption rates are dependent on the specific context of a region or a country, consisting of biophysical, economic, social but also regulatory and institutional conditions (Stonehouse, 1995). With respect to European farmers, it has been suggested that they are generally not strongly affected by the consequence of soil degradation and therefore unlikely to adopt some conservation practices compared to other regions in the world (Vandeputte et al., 2010). However, adoption rates also fluctuate in time caused by e.g., some unforeseen problems after uptake of a new management practice or changes in economic conditions (Lahmar, 2010). In this respect, the fundamentally changing EU's common agricultural policy accompanied by an increased social pressure, might increase the potential adoption of conservation practices in Europe (Vandeputte et al., 2010). Nevertheless, to raise the uptake of conservation practices, we need a better understanding of country and region specific differences in adoption rates of SCPs. Therefore, it is necessary to investigate why farmers refrain from implementing practices that have proven to increase soil quality and sustainability. Hence, the objective of this study is to investigate farmers' barriers in adopting soil conservation practices across Europe. Attitude and behavior towards new technologies, including soil conservation practices, have been extensively studied in agriculture. While some studies described the distribution of benefits and costs of adopting a management practice, other researchers studied correlations between the adoption of conservation practices and a number of potential independent variables such as age, land tenure, farm size, education level, etc. (Knowler and Bradshaw, 2007). However, a meta- analysis to integrate these variables into universally significant correlations revealed no causal impact of variables such as farm size and land tenure on the adoption of conservation practices (Knowler and Bradshaw, 2007). Farmers' attitudes towards specific conservation practices have also been investigated in a socio-psychological manner by using a behavioral approach, which refers to studies that employ actor-oriented quantitative methodologies for the investigation of decision making (Burton, 2004, Edwards-Jones, 2006, Wauters et al., 2013). Behavioral approaches made their entry in attitudinal research when one started to question the notion that decision making is not purely performed on an economically rational basis. However, due to the dominance of qualitative techniques such as participant observation and discourse analysis, the behavioral approach has not fully permeated attitudinal studies in the agricultural research area (Burton, 2004). However, compared to the qualitative research techniques, the behavioral approach offers a repeatable methodology, which is very valuable for performing a comparative analysis in a wider European context. Therefore, this study applies a behavioral approach to identify barriers and drivers in adoption of conservation practices across Europe.

Theoretical framework

The theory of planned behavior was chosen as socio-psychological framework since it has been proven to explain a large proportion of the variation in adoption of many behaviors, including soil conservation (Armitage and Connor, 2001; Wauters et al., 2010). Moreover, this theory offers a standardized and repeatable methodology to allow for a comparative study across Europe (Burton et al., 2004). According to the theory of planned behavior, individual beliefs about a behavior or

practice are believed to determine intention and behavior (Ajzen, 1988; Ajzen, 1991). The greater the intention to behave, the more likely one is to actually perform the behavior, provided that the person has actual control over the behavior. The intention of a farmer to implement a certain SCP is determined by the degree to which implementing the SCP is evaluated positively or negatively by the farmer (attitude), the feeling of social pressure from others (called referents) to perform or not perform a certain SCP (subjective norm) and the subjective beliefs about the ease or difficulty of successfully performing the SCP (perceived behavioral control) (Figure 1). According to the theory of planned behavior, attitude is formed by the belief that the behavior will be associated with a set of outcomes (belief strength), weighted by an evaluation of these outcome (outcome evaluation). Subjective norm is thought to be a function of how much we perceive others (called referents) think we should perform the behavior (normative belief), weighted by our motivation to comply with these referents. Finally, perceptions of behavioral control are determined by our beliefs about the factors that facilitate or obstruct the behavior (control beliefs), weighted by the expected impact that these factors would have if they were to be present (perceived power). Combining attitude, subjective norm and perceived behavioral control, results in a positive or negative intention to actually perform the behavior. All these underlying subjective beliefs influence a farmers' intention to adopt a certain SCP, and are acting as cognitive drivers or barriers which encourage or discourage the farmer to adopt a specific SCP.

Figure 1: Theory of planned behavior, adapted from Ajzen, 1991



Research areas (FTZ) and soil conservation practices (SCP)

This study was conducted in eight EU-member states (Poland, Belgium, Italy, Spain, the Netherlands, Germany, Austria and France). In each country, several farm type zones (FTZ) were targeted. These FTZs are characterized by land use and farm specialization (EC 1985; Andersen et al., 2007) and by agri-environmental zones, defined by slope, soil texture (JRC soil map) and climate zone (Metzger et al., 2005). In total, 25 FTZs were included in this study. The SCPs studied in each FTZ were determined based on expert judgment for their potential contribution to improve soil sustainability in that specific FTZ. Through an inventory of current practices contributing to soil degradation, some additional SCPs were identified as alternative practices to improve soil sustainability. These SCPs were included in this study only if they have additionally

been proven to be beneficial for the farmer in the short or long term based on literature or on experience of extension agents and experts. Although some SCPs were studied in only one or two FTZ, others were subject of research in almost all FTZs. Examples of the latter are non-inversion tillage, cover crops and return of crop residues, mainly straw. An overview of the SCPs studied is shown in Table 1.

Table 1: SCPs investigated and number of FTZs and countries in which each SCP was investigated

Category of SCP	**Subcategory of SCP**	**SCP**	FTZs	Countries
Rotation	Crop rotation	Rotation with legume crops	4	3
		Rotation with cereals	2	2
		Maize-grass rotation	2	2
		Rotation with leys	1	1
		Rotation with legume leys	2	1
		Land exchange	1	1
		Diverse crop rotation	2	1
	Intercropping/green manure	Cover crops	20	7
		Under-sowing of green manure within maize	1	1
		Early maize harvest to enable green manure	1	1
Tillage		Non inversion tillage/reduced tillage/minimum	18	7
		No tillage	7	3
		Controlled traffic farming	2	2
		Reducing soil compaction	1	1
		Sod seeding	2	1
		Direct drilling	1	1
Nutrient management	Organic fertilizer	Compost application	5	3
		Farmyard manure application	4	2
		Adoption of nutrient management plan	6	3
		Digestate application	3	1
		Timing of application (spring)	2	1
		Row application	1	1
		Spatially adapted fertilization	1	1
	Residue management	Return of crop residues	10	4
Crop protection		Patches of natural vegetation	1	1
Grassland management		Rotational grazing	1	1
		Permanent grazing	1	1
Water management	Irrigation	Drip or sprinkler irrigation	2	1

Methodology

We applied a sequential mixed method, by combining qualitative and quantitative research techniques at different stages in time (Cresswell and Clark, 2011). In this study, the predominant quantitative data collection was preceded by a preparative qualitative step. After the major quantitative data collection, focus groups will be applied as a last qualitative step.

First, semi-structured interviews were conducted to identify all behavioral outcomes, normative referents and control factors for each unique SCP in each of the 25 FTZs. The sample of 200 farmers for this qualitative data-collection stage was gathered through extension agents that were asked to select farmers' contacts randomly. The farmers were given a description of the SCP, which was followed by questions to elicit a list of behavioral outcomes, normative referents and control factors for each SCP. Although a total of 200 semi-structured interviews were conducted during this study (Table 2), the spread over 25 FTZs across 8 European countries resulted in an average of about 8 interviews per FTZ. Since this number of semi-structured interviews is rather low for each FTZ, each outcome, referent and control factor was evaluated on its universal accessibility across a specific farm type, even if it was mentioned only once.

Table 2: number of FTZs and semi structured interviews conducted in each of the participating countries

	N° of FTZs	N° of semi structured interviews
Netherlands	4	20
Poland	3	14
Austria	3	24
Belgium	3	22
Spain	3	36
Italy	3	24
France	3	15
Germany	3	15

Based on these lists of outcomes, referents and control factors, resulting from the qualitative step, a first indication of possible barriers and drivers could be revealed. However, to assess whether these outcomes, referents and control factors might influence the adoption of an SCP among a larger population of farmers, a large scale survey has been set up as a second step of the mixed method. As the list of outcomes, referents and control factors were constructed for each FTZ separately, each FTZ obtained an unique questionnaire, reflecting its specific farming conditions. The sampling for this step depended on the availability of a valid sampling frame, i.e., contact details of farmers, in each participating country (Table). The availability of general databases of farmers' addresses allowed random sampling. However, due to privacy concerns, in some countries access to general databases was not possible. In these countries, researchers had to depend on farmers' associations, farmers' extension services or other contacts to distribute the questionnaire. In some countries, questionnaires were distributed online while other countries send them by post. These decisions were based on availability of time, the availability of email addresses and the expected response rate in the country.

The large scale survey had two distinctive parts. The first part concerned the accessible outcomes, referents and control factors. First, for the outcomes, farmers were asked to rate the probability of that outcome when implementing the SCP (belief strength). Then, they were asked to evaluate this outcome on a scale from 'extremely bad' to 'extremely good' (outcome evaluation). Second, for each referent, farmers were asked to indicate their perception of whether the referent thinks the farmer should implement the SCP (normative belief) and to what extent the farmer takes into account the opinion of that specific referent (motivation to comply). Third and last, for the control factors, farmers had to rate the extent to which a control factor could hamper the implementa-

tion of the SCP (control belief) and to what extent this control factor was applicable on his own farm (perceived power). All questions were measured on a five point scale from 1 to 5 with extremes as endpoints.

The second part encompassed additional questions related to general farm characteristics and to soil management. For example, farmers were asked how they perceived soil quality on their farm and how they perceived the evolution of soil quality.

General data analysis of the questionnaire was based on descriptive statistics to reveal means, median and frequencies of the prevalence of the subjective beliefs on the outcomes, referents and control factors. Attitude (*A*) was indirectly measured by combining the farmers' belief on the likelihood of occurrence (*b*),of an outcome *i* and by his evaluation of these outcomes (*e*) in the following manner:

$$\mathrm{A} = \sum_{i=0}^{n} b_i e_i$$

In which *n*= the total number of outcomes that were involved in the questionnaire. In a similar way, subjective norms (*SN*) and perceived behavioral control (*PBC*) were determined as follows (Ajzen, 1988, 1991):

$$\mathrm{SN} = \sum_{i=0}^{n} n_i m_i$$

$$\mathrm{PBC} = \sum_{i=0}^{n} p_i c_i$$

In which *n*= the farmers' opinion about what referent *i* wants him to do; *m*= the farmers' motivation to comply with referent *i*; *p*= the perceived ability of control factor *i* to facilitate a particular behavior; and *c*= the respondents' perception of whether control factor *i* is absent or present.

Several studies identified differences in prevalence of the subjective beliefs between adopters versus non adopters and between farmers with positive versus negative intention (Garforth et al., 2006; Wauters et al., 2013). In this study, in order to identify differences in belief structure between adopters and non-adopters and between farmers with a positive versus negative intention, independent samples t-tests were performed. Adopters and non-adopters were identified by measuring behavior as a simple dummy variable, being 1 if the farmer applied the SCP on at least one parcel of his farm. Intention was measured using a latent-variable measurement scale consisting of three items. Each item took the form of a statement, to which the farmers indicated their degree of agreement on a scale from 1 to 5. Internal consistency of the scale was measured by Cronbach's alpha (cut-off value of 0.7). If the median was close to 3, a median split was taken to divide farmers into farmers with positive versus negative intention. If the median was not close to 3, high intenders were defined as those with an intention score higher than 3, and negative intenders were those with an intention score below 3.

Table 3: number of farmers reached and response rate of the questionnaires send either online or by post in each of the participating countries. *no direct access to addresses, **not finalized, NA not available *

	distribution of questionnaires	**N° of farmers reached**	**Response**
Netherlands	online	6800	516**
Poland	post	450	305
Austria	online*	*	**

Belgium	post	3822	762**
Spain	post	NA	248**
Italy	*	900*	285
France	online/phone	1731	118**
Germany	online/post	1587	91**

Preliminary results and discussion

This section shows some first preliminary results from the questionnaires on the barriers and drivers towards implementation of non-inversion tillage (NIT) in two different FTZs in Flanders, Belgium. The FTZs considered are dairy farming on sandy soils with flat slopes where grassland dominates the landscape (FTZ1) and arable farms in Brabant on medium fine soils with nearly level slopes for cultivation of specialized crops (FTZ2). For FTZ1, NIT is applied by 18% (n=186) of the dairy farmers whereas 23% (n=134) of the arable farmers (FTZ2) indicated to implement NIT on at least one parcel of their farm.

In both FTZs, the main drivers for applying NIT are lower fuel and labour requirement. Although less erosion was indicated as an additional positive outcome in FTZ2, it was not even mentioned as an outcome by the dairy farmers of FTZ1. The higher slope level and higher risk for erosion on parcels of FTZ2 might be a valuable explanation. The soil erosion policy in Flanders provides both financial incentives and obligations to farmers for the implementation of measures, such as NIT, to reduce soil erosion on parcels with risk on erosion. Moreover, arable farmers indicated to experience a labour peak between the harvest of cereals and the sowing of green manure before the 1st of September, which is a precondition to obtain a subsidy for sowing green manures in that FTZ. NIT, perceived as a less labour intensive compared to ploughing offers perspectives to deal with these labour peaks. However, to most of the farmers, these advantages do not outweigh some barriers since adoption of NIT is still rather low. In both FTZs, farmers believe that NIT results in more weeds and in lower yields of the crops, especially when NIT has to be applied on wet soils. The lack of appropriate machinery and the presence of the plough in the barn, doesn't stimulate farmers to implement NIT. Dairy farmers also fear an increased risk of fungi related diseases in maize, as one of the main components of the cows' ration.

These first results indicate the importance of taking into account the very specific context of the farmer by tackling the farm type zones. Soil texture, slope, legislation, the nature of the cultivated crops, etc. all influence the barriers a farmer might perceive to implement NIT. Although some barriers are common between the two FTZs, other barriers are related to the very specific context of the studied FTZ. This finding is of substantial interest to extension services, local and national governmental institutions. They should be aware of these context related barriers and take into account these differences between FTZs. Besides the importance of taking into account the specific conditions of a farmers' context, these preliminary results also show a very broad picture of barriers as has been suggested by previous work (Wauters et al., 2013). Informing the right person or institution is necessary to respond in an efficient way with the ultimate goal of increasing adoption of conservation practices.

Besides obtaining insight into the general belief structure of the respondents in an FTZ, also differences between adopters and non-adopters have been investigated. In both FTZs, the belief that NIT results in more weeds is shared between adopters and non-adopters. However, compared to the adopters, non adopters are more convinced of the negative impact of NIT on crop yields. Non adopters in FTZ1 also fear soil compaction and worse crop development after NIT. In FTZ2, adopters perceive the subsidy as a bigger stimulant to adopt NIT compared to the non adopters and they also seem to have more crops cultivated on hills. Non adopters get good results with ploughing making NIT less attractive. Adopters are not as reluctant to apply a new technique

which might suggest that adopters are less risk averse. Risk aversion of the farmers has been shown to be an important barrier in the adoption of new technology (Willock et al., 1999).

Previous research showed that adopters scored a higher likelihood for most of the positive outcomes of reduced tillage, but also a higher likelihood for the negative outcomes (Wauters et al.,2013). In this study, adopters scored positive consequences higher than non adopters, while negative scores were scored higher by non adopters. This might suggest an overestimation of the negative consequences of implementing NIT. It is a challenge to extension services to understand and reverse these misconceptions that negatively influence a farmers' intention to adopt a specific behavior. Moreover, according to the results on subjective norms, farmers do not feel stimulated by extension services to apply NIT, which raises our interest to further investigate why extension services seem not to promote this conservation practice very often. Is there a lack on the availability of extension services or do they really discourage farmers to implement NIT? This topic might be tackled by the focus groups that will be organized with all stakeholders to inform and discuss the main outcomes and results of the questionnaires, after having finished analyses.

These preliminary results presented in this section are restricted to only SCP for two FTZs in one of the eight participating countries. We intend to extend this analysis to all FTZs where a specific SCP is subject of research, in this case NIT. A similar analysis will be conducted for other SCPs that are widely taken up in the questionnaires. This study will result in an enormous amount of data, that can be valuable in giving advice to local, national and even European extension, governmental and research institutions. When FTZ or SCP specific questions arise, the relevant data might be extracted from this large amount of results. Data collection within a European context allows us to compare different contexts of FTZs and countries and might reveal new insights in the opportunities, possibilities and difficulties in implementation of conservation practices.

Conclusion

This study applied the theory of planned behavior to identify and compare barriers against adoption of conservation practices across Europe. For the data collection, we applied a sequential mixed method, in which the results of the first, qualitative stage, were used to develop the survey questions in the second, quantitative stage. The first preliminary results show the most important barriers and drivers that might influence a farmers' decision to adopt non inversion tillage in two FTZs in Flanders. The study shows the importance of taking into account the specific context of the farmer, when performing adoption studies in the agricultural domain. The results offer valuable insights in terms of effective targeting extension services and communication to governmental institutions at the local, national and even European level.

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