



Adoption of non-inversion tillage across Europe: Use of a behavioural approach in understanding decision making of farmers



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ABSTRACT

Non-inversion tillage (NIT) is often recommended as a soil conservation measure, protecting soil structure and soil life and preventing erosion. As the adoption of this measure is still below policy targets in many European regions, this study aimed at gaining insights in constraints and drivers of implementing NIT to understand how to stimulate behavioural change. This study uses the theory of planned behaviour as a framework for understanding farmers' decisions on applying NIT. This framework was applied in 8 case studies from 8 Farm Type Zones (FTZ) spread over 4 European countries (Belgium, the Netherlands, Germany and Italy). We used a sequential mixed method, starting with qualitative semi-structured interviews followed by a quantitative survey. Our results show varying adoption rates ranging from 19% to more than 80% across the FTZs. There are large differences between FTZs and even more between countries regarding the number and nature of enabling and hampering factors identified. Although our results do reveal some widely acknowledged advantages and constraints (such as less labour/fuel needs and more weeds), several of them are restricted to one or only some of the FTZs. Some of the conditions favouring or discouraging NIT are related to biophysical characteristics of the FTZs. Besides these biophysical characteristics, agricultural specialization and especially the crops cultivated influence the decision whether or not to plough. Also timing of sowing and harvest of particular crops influences farmers' perceptions on the ease or difficulty to apply NIT. Finally, cultural, political and socio-economic conditions of the regions are influencing adoption behaviour of the farmers, e.g. good results with ploughing, having nice-looking fields, availability of equipment, the existence of subsidies and the opinion of referents influence the decision whether or not to implement NIT in the singular FTZs. These insights in context-specific enabling and disabling conditions are helpful in defining targeted actions to stimulate adoption in a given region. This paper concludes with an overview of how the resulting insights in farmers' behaviour might contribute in addressing effective intervention strategies to increase adoption of NIT.

1. Introduction

Soil degradation processes, such as decline in soil organic matter content and soil erosion, are present in many parts of Europe and are influenced by human activities such as deep ploughing and conversion of pastures into cropland (Jones et al., 2012). In order to decrease soil degradation processes and to ameliorate soil quality and its associated soil functions, alternative cultivation methods have been proposed in the past decades. One of them is the replacement of the traditional

mouldboard plough by conservation tillage aiming at reduced soil disturbance and higher permanent soil cover by residues. Conservation tillage includes multiple tillage techniques ranging from no-till and minimal tillage to non-inversion tillage (NIT) at ploughing depth. Conservation tillage has been shown to have advantages related to soil quality and processes and to the environment, such as reduction in soil erosion (e.g., Holland, 2004; Leys et al., 2010), increased carbon content in the top soil (e.g., D'Hose et al., 2016), increased microbial biomass and increased earthworm number and/or biomass (e.g.,

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D'Hose et al., 2018, 2016; Holland, 2004). Compared to other regions in the world, conservation tillage practices have only been applied to limited extent in European agriculture to date (Lahmar, 2010; Schneider et al., 2012). Vandeputte et al. (2010) speculated that the output-oriented subsidy system by the EU for several decades has not convinced farmers to consider conservation agriculture in general. Moreover, several studies have shown that the adoption process differs across Europe and has been fluctuating over time in several European regions (Lahmar, 2010). In some instances, farmers who had started using conservation tillage techniques, sometimes returned to ploughing because of unforeseen constraints of applying the technique, among which problems of weed, crop residue management and topsoil compaction. Understanding farmers' behaviour and gaining insights in their perceptions on the consequences of adoption, might be valuable for policy makers, farm advisors and researchers to stimulate farmers in the adoption of conservation tillage practices. The overall aim of this study is therefore to get insight in current adoption of conservation tillage across Europe and to understand how the context affects adoption behaviour. By doing this, we aim to offer perspectives for the future implementation of conservation tillage practices. To identify factors affecting adoption and diffusion of conservation tillage across Europe, many adoption studies aimed at identifying 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 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; Wauters and Mathijs, 2014). A first explanation might be the fact that many of the analyses deal with more than one form of conservation tillage, which all vary in the number and depth of tillage practices and the degree to which soil is disturbed. Specifying the tillage practices might be helpful in understanding adoption behaviour, since drivers and barriers might differ according to minor changes in the behaviour itself. Therefore, in our study we have focused on non-inversion tillage (NIT). Another cause is the highly context- and case-specificity of adoption, so much that particular variables do have different influences in different cases (Morris et al., 2010; Wauters and Mathijs, 2014). Context specificity consists of biophysical, economic and social characteristics but also regulatory and institutional conditions. This is confirmed by the study of Schneider et al. (2010), who emphasized the importance of culture in the adoption of conservation tillage in Switzerland. These studies defend the rising interest in socio-psychological methods to understand human behaviour (Gorton et al., 2008; Wauters et al., 2010). Therefore, this study uses a socio-psychological method to gain insights in constraints and drivers of implementing NIT across Europe, taking context specificity into account. Socio-psychological variables reflect people's motivations, attitudes, beliefs, preferences and values that determine the decision-making process. The socio-psychological method applied in this study is based on a behavioural approach, which refers to studies that examine the behaviour of individual decision makers by focusing on constructs such as attitudes, values and goals by mainly employing quantitative methodologies (Burton, 2004; Wauters et al., 2010). These methodologies are characterized as easy to repeat and are therefore very valuable for performing attitudinal research in a wide European context. The behavioural approach used in this study is based on the theory of planned behaviour (Ajzen, 1991). The theory of planned behaviour originated in social psychology and was first used in the human health domain, to explain why people continue unhealthy habits, such as not using a condom (Albarracín et al., 2001). A second area in which it was usefully applied was in environmental psychology, to explain behaviours as the choice of transport mode (e.g., Bamberg et al., 2003), and recycling behaviour (e.g., Tonglet et al., 2004). From there the theory gradually entered the agricultural and rural development domain, and has since been used to explain farmers' conservation behaviour in a number of studies (e.g., Fielding et al., 2005; Wauters et al.,

2010; Wauters and Mathijs, 2013). Most of these studies assess how much of the variation in behaviour or intention can be predicted by attitude, subjective norm and perceived behavioural control by regressing these constructs onto the measure used to represent behaviour. The mere knowledge that attitudes influence intention, which influences behaviour, is useful, but not enough to develop potentially effective interventions, with respect to extension and communication, policy and research. As the objective of this study is to shed light on and to better understand reasons behind the implementation of NIT across Europe (8 regions in Germany, the Netherlands, Belgium and Italy), we focus on the cognitive foundations of the socio-psychological constructs influencing farmers' decision to adopt NIT. In the discussion section, our insights in constraints and drivers of implementing NIT are used to propose intervention strategies and actions for policy makers, researchers and extension services to increase adoption of NIT.

2. Theoretical framework

The theoretical framework for this study is based on the socio-psychological **Theory of Planned Behaviour (TPB)**. According to this theory, individual beliefs about a behaviour or practice determine intention and behaviour (Ajzen, 1991; Ajzen and Driver, 1992). The greater the intention to behave, the more likely one is to actually perform the behaviour (i.e. to actually adopt a specific farm practice), provided that the person has actual control over the behaviour. The intention of a farmer to engage in the behaviour is determined by i) the degree to which this behaviour is evaluated positively or negatively by the farmer (attitude), ii) the feeling of social pressure from others (called referents) to perform or not perform the behaviour (subjective norm) and iii) the subjective beliefs about the ease or difficulty of successfully performing the behaviour (perceived behavioural control) (Fig. 1). According to the theory of planned behaviour, attitude is formed by the belief that the behaviour will be associated with a set of outcomes (belief strength), weighted by an evaluation of these outcomes (outcome evaluation). Subjective norm is thought to be a function of how much we perceive others (called referents) think we should perform the behaviour (normative belief), weighted by our motivation to comply with these referents. Finally, perceptions of behavioural control are determined by the belief that a set of control factors that facilitate or obstruct the behaviour are present at the farm (control beliefs), weighted by the expected impact that these factors would have if they were to be present (control power). Combining attitude, subjective norm and perceived behavioural control, results in a positive or negative intention to actually perform the behaviour. All these underlying subjective beliefs influence a farmers' intention to adopt the behaviour, and are acting as cognitive drivers or barriers which encourage or discourage the farmer to engage. To induce behavioural change, these drivers and barriers need to be translated into effective actions by policy makers, extension services and research institutes. Van Woerkum et al. (1999) developed a model depicting a typology of 5 mechanisms to induce behavioural change, which is based on the idea that a combination of actions and communication strategies is needed to induce behavioural change (Leeuwis and Van den Ban, 2004). This model concentrates potential strategies to induce a desired behavioural change into five modes of action, i.e., rules and regulation, education (extension and communication), social pressure, economic incentives and tools (RESET). In this study, the theory of planned behavior is used as analytical framework to identify farmers' beliefs on implementing NIT, whereas the RESET model will only be used as a conceptual framework to structure our discussion in illustrating how our results can be used to identify effective intervention strategies for policy makers, researchers and extension services.

This framework was applied across eight regions in Germany, the Netherlands, Belgium and Italy. In this study, we focus on one specific practice within the range of conservation tillage practices, i.e. NIT. NIT was defined as *'not ploughing for at least an entire year on at least one*

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