Adopting sustainable soil management – the role of socio-economic factors[1]

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Abstract

The sustainable management of soils is crucial to enable the long term use of the various soil functions. Although soil degradation caused by agriculture is a process defined by technical, climatic, and bio-physical factors, there is recognition that the underlying causes are to be found in the socio-economic, political and cultural context in which farmers operate. In Europe, farmers' decision-making on farm management is strongly influenced by agricultural policies and economic incentives.

This paper aims to review and summarize findings of existing studies on the role of socio-economic factors that influence farmers and other land managers' adoption of soil conservation practices with a focus on the European situation.

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In order to provide a structured overview we classified factors derived from previous studies into four groups (environmental/ technical, personal, economic and institutional), and added a time dimension by considering the *process* of adoption. There is no evidence in the studies that either economic factors or social factors are superior in explaining adoption decisions. Rather, it is always a mix of personal, socio-cultural, economic, institutional and even environmental variables that explain behavior.

Across the studies reviewed for the European context we found that there are three distinct pathways for the adoption of soil conservation practices: (1) an individual adopts a practice on their own initiative; (2) an individual enrolls in an agri-environment scheme or soil conservation program and receives compensation (incentive payments); or (3) an individual complies with legislation and conservation requirements. A mixture of these may apply but there are distinct differences how these pathways determine the set of socio-economic factors that play a role in the adoption decision. These pathways will also decide whether an investigation of adoption factors will focus on personal motivation, learning and experiences, on scheme characteristics that facilitate participation, or on compliance and enforcement of legislation.

Keywords: adoption factors, soil and water conservation, farmers, land managers, acceptance process, behavior, sustainable farming

Soil Degradation and Agriculture

Soil degradation can have serious negative impacts on agricultural production and the environment. However, it is only since the 1980s that awareness on the negative impacts of agricultural intensification on water and soil resources has been expressed in agricultural policies and soil conservation interventions (see Louwagie et al., 2010). Although in some regions soil conservation practices have been applied for centuries (e.g. olive terraces in the Mediterranean), in other regions (in particular in Northwest Europe) soil conservation practices are only recently introduced through agricultural policies. For example, only in the late 1990s attention was given for the first time to protecting soil quality and controlling soil erosion in the 'Code of Good Agricultural Practice' in the UK (Boardman, 2003).

Until the 1980s, agricultural policies in Europe were based on a productivist paradigm; governments supported agriculture with subsidies and technical advice to increase domestic food production for food security reasons. By the early 1980s, however, concern about over-production, burgeoning costs of support, and environmental damage associated with intensive farming, questioned the validity of continuing the predominantly productivist regime. A new paradigm emerged which focused on the multi-functionality of agriculture and the importance of non-market environmental goods and services associated with agriculture (Banks and Marsden, 2000). The problems associated with intensive agriculture such as overproduction, diffuse pollution, soil degradation and loss of wildlife, as well as the World Trade Organization negotiations, have led to a reconsideration of agricultural policies in Europe. The Common Agricultural Policy (CAP) reform in 2003 puts more emphasis on environmental impacts, while it also tries to decouple financial support from agricultural production. Other new policies and

EU directives, such as the Water Framework Directive (WFD) and the Soil Thematic Strategy, also reflect a growing commitment to improve the sustainability of land and water management in rural areas (Posthumus and Morris, 2010).

Although soil degradation caused by agriculture is a physical process defined by technical, climatic, and bio-physical factors (e.g. tillage practices, rainfall, topography, soil type), there is consensus that the underlying causes are to be found in the socio-economic, political and cultural context in which farmers and other land managers operate (Blaikie, 1985; Boardman et al., 2003; Enters, 1999; Stocking and Murnaghan, 2001). Farmers' decision-making on farm management is strongly influenced by agricultural policies and economic incentives (Boardman et al. 2003; Evans 1990). However, the introduction of new policies and uptake of agri-environment schemes does not automatically guarantee success in ecological and environmental outcomes (Kleijn and Sutherland, 2003; Wilson and Hart, 2001). It is therefore important to understand what factors influence farmers' adoption of agri-environmental measures in general and soil conservation practices in particular.

This paper aims to review and summarize findings of existing studies on the role of socio-economic factors that influence farmers' adoption of soil conservation practices with a particular focus on the European situation. The main emphasis will be on soil conservation but bearing in mind that the way soils are managed has a direct or indirect impact on water as well. Soil conservation efforts that control runoff also contribute to flood risk management or a reduction in water pollution (e.g. Posthumus et al., 2008), although these effects cannot be labeled as water conservation as such. We will focus on farmers although we are aware that not

all land is managed by farmers or for farming purposes. However, most of our discussion should be transferable to other land manager operators.

Theoretical Approach

An investigation of socio-economic factors in adoption decisions is intrinsically linked to the specific conservation practice[2] and the physical, chemical and biological processes that are affected by a given practice, as the environmental benefits and the profitability of a practice will vary from place to place according to the bio-geo-physical conditions. In addition, the decision of a farmer to adopt a soil conservation practice is not only determined by factors relating to the farm and its management but also by exogenous institutional and social factors beyond the farm gate, so there is evidently a need to identify those factors beyond just farm finances and farmer characteristics that explain adoption. It is therefore common in adoption studies to distinguish the following four categories of factors (e.g. Ervin and Ervin, 1982; Stonehouse, 1997): environmental / technical, personal, economic and institutional.

We assume that any adoption decision is a result of the combined influence and interplay of these four groups of factors. In order to explain which factor comes into play at which stage, how it interrelates with other factors, and what its relative importance is this we draw on adoption theory.

[2] For ease of reading, we will refer to soil conservation practices in the remainder of the paper. They include technologies such as precision farming and wide tires; specific cropping/tillage measures such as no tillage, intercrops, undersown crops, contour tillage, mulching, crop rotation; and long term technical measures such as strip cropping, subsoiling, change of field pattern and sizes, retention ponds, and bench terraces.

Three main paradigms can be distinguished in the theory on adoption of soil conservation practices: the economic constraint paradigm, the innovation-diffusion-adoption paradigm and the adopter perception paradigm (Adesina and Zinnah, 1993). Each focuses on particular elements of adoption, e.g., the individual characteristic, the adoption process, the transactions and institutions. Table 1 summarizes the three main paradigms for adoption.

The economic constraints paradigm assumes that individuals strive for profit or utility maximization, but resource endowments are asymmetrically distributed amongst individuals, determining the observed patterns of adoption (Adesina and Zinnah, 1993; Negatu and Parikh, 1999). The strength of the economic paradigm is the recognition of the importance of profitability and economic constraints (e.g. availability of assets, learning costs associated with innovation, or risk) to explain adoption behavior, but it fails to recognize less tangible factors such as personal motivation or peer pressure. The innovation-diffusion-adoption paradigm is based on the innovation-diffusion theory of Rogers (1995). According to this paradigm, access to information is the key factor determining adoption decisions. The strength of the innovation-diffusion-adoption paradigm is the recognition that adoption is a multi-stage process of collecting information, revising opinions and reassessing decisions (Feder et al., 1982; Marsh, 1998), but it fails to take individual characteristics of the adopter into account. The adopter perception paradigm argues that the adoption process starts with the perception that there is a need to innovate. This perception is determined by personal factors (e.g. human values, education and experience) as well as physical factors of the land and institutional factors (e.g. raising awareness through extension) (Ervin and Ervin, 1982; Lynne et al., 1988).

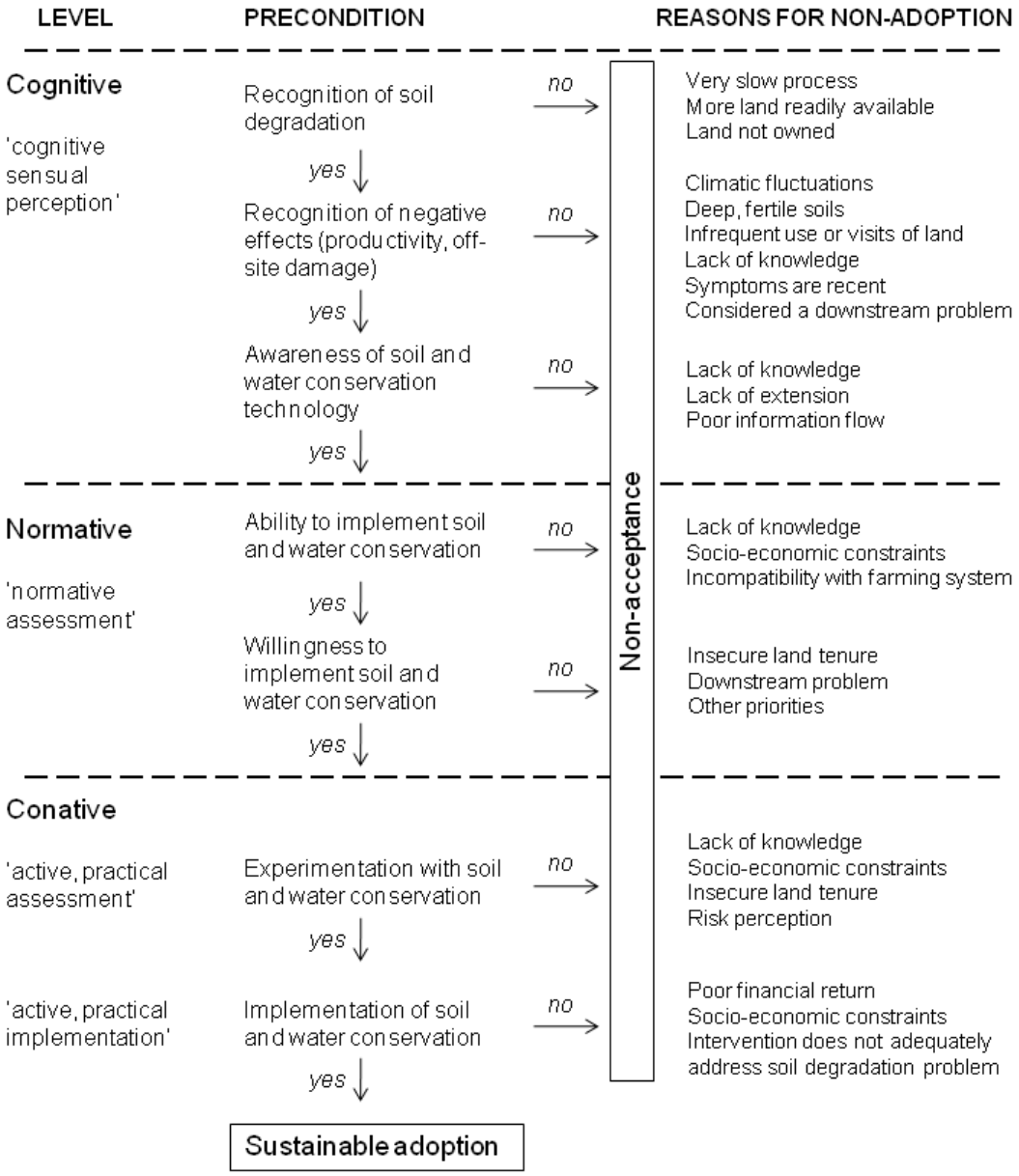
Table 1: Mainstream theoretical models on adoption of soil conservation practices

Theoretical model	**Assumption**	**Decisive factors in adoption behavior**
Economic constraints paradigm	Adoption defined by utility maximizing behavior of farm households	Access to natural resources Access to capital Learning / investment costs Risk attitude
Innovation-diffusion-adoption paradigm	Adoption defined by dissemination of information	Access to information
Adopter perception paradigm	Adoption defined by personal factors in addition to information in utility maximization	Access to information Personal factors: human values, experience, education (Perceived) severity or urgency of soil erosion problem

Source: Posthumus et al., 2010

The adoption of soil conservation practices can be seen as a farmer accepting an innovation (temporarily or permanently) which allows to draw on the acceptance research literature. The adoption paradigms illustrate that adoption, or acceptance of an innovation, is not a characteristic of a person or object, but a process that can be divided into a number of 'levels' or phases (Prager, 2002; Lionberger, 1960). Lucke (1995) introduces a three step model of cognitive, normative and action-oriented (conative) acceptance. Similarly, Erz (1985) recognizes that there are several levels of discrepancies between hearing about an innovation and acceptance: "Said does not mean it's heard – heard does not mean it's understood – understood does not mean it's agreed – agreed does not mean applied – applied does not mean retained" [trans. K.Prager]. Recognizing these phases of acceptance, the model in Figure 1 shows which preconditions are necessary for the successive steps that ultimately lead to sustainable adoption

(Ellis-Jones and Mason, 1999; Graaff, 1996; Lionberger, 1960; Prager, 2002). In addition, examples for reasons that may lead to non-adoption at each stage of the process are given.



Source: based on Ellis-Jones and Mason, 1999; Prager, 2002; Esser, 1999; Graaff, 1996; Lionberger, 1960

Note: The arrows do not imply that one precondition necessarily follows the previous one. Rather, the individual needs to "pass" the group of preconditions at each level and finish positively in order to proceed. In real life, there may be loops, short-cuts, back stepping or interruptions of the process.

Figure 1 Levels and preconditions of the adoption process

Policies, subsidies or regulations can create shortcuts in the adoption process, generally omitting the cognitive phase. For example, financial incentives or legislation may induce a famer to adopt soil conservation practice even though he may not to be convinced that there is a problem and action is necessary, or that the action prescribed by the policy is the best way to tackle the problem. This will affect the sustainability of the adoption decision.

Factors Influencing the Adoption of Soil Conservation Practices

In the past 30 years, various studies have been undertaken to better understand the adoption process of soil conservation practices by farmers in Europe. The first studies coincided with the increased awareness of the importance of environmental health for human wellbeing in the 1980s and accompanied the agri-environment schemes first introduced by selected European countries in 1985. In Germany, for example, studies were carried out to investigate the uptake agri-environment schemes and acceptance of soil conservation programs (Wilstacke and Plankl, 1988; Autsch, 1992; Lettmann, 1995; Nolten, 1997). Summarizing the findings of these studies they have in common that they discuss characteristics of (a) the program, (b) the measure/practice and the farm and (c) the farm manager. Most of these studies conclude that economic reasons are decisive for the adoption decision. Important variables are expectation of a positive effect on soil fertility and higher yields, contribution to environmental quality, decreased

costs, confidence in state-governed programs and authorities, knowledge and awareness, flexibility of prescriptions. Among the less relevant variables are age, health, non-farm income, education, future management plans for fields, relationship to the land owner, and reputation in the community. Similar studies in the UK (e.g. Colman, 1994$_a$; Wilson, 1996; Lobley and Potter, 1998; Wilson and Hart, 2001; Walford, 2002) also found that farmers entered agri-environment schemes for financial reasons, but attitude did not necessarily change. As a consequence, some farmers made no changes in their farming practices at all as they were rewarded for activities they were doing anyway, whereas others tried to minimize the impact of these programs on their farm management by adopting the recommended practices on marginalized, less favored areas (Posthumus and Morris, 2010). In a more recent study, Dobbs and Pretty (2008) conclude that the incentive payments were sufficient to enroll English farmers in simple programs but did not succeed to convince farmers to take up programs that required more substantial changes in farming practices, especially since programs competed with high crop and livestock-related payments under the EU's Common Agricultural Policy (CAP).

In other European countries, identification of the adoption barriers to agri-environment schemes was also a research focus (Brotherton, 1991; Falconer, 2000; Barreiro-Hurlé et al., 2008). Many studies analyzed and discussed factors influencing participation or willingness to participate in schemes (Defrancesco et al., 2008; Vaslembrouck et al., 2002; Morris et al., 2000; Wynn et al., 2000; Wilson, 1997; Morris and Potter, 1995). These studies connect the adoption of soil conservation practices with the particular requirements of the schemes, application procedures, contract administration and prescribed measures, all resulting in additional direct and indirect costs for the farmer. Wossink and Van Wenum (2003) found that the production

environment and familiarity with conservation programs better explained participation in conservation programs than farmer characteristics or field characteristics. Kleijn and Sutherland (2003), however, concluded that many evaluation studies of agri-environment schemes in Europe lack robustness and does not allow a general judgment of the effectiveness of European agri-environment schemes. It is therefore controversial whether the enrolment in agri-environment schemes leads to soil conservation benefits and if so, to what degree. This is of particular relevance because most EU agri-environment schemes promote habitat conservation and prevention of water pollution, whereas soil conservation is often a minor objective. It is therefore crucial to distinguish between studies that investigate adoption of soil conservation practices prescribed in an incentive scheme – which might create a bias towards factors relating to incentives – and studies that explore adoption of conservation practices without policy intervention (or at least make the different political-economic contexts explicit).

Mandatory policies, instead of agri-environment schemes, are the other option to approach soil conservation. They apply to all farmers and agricultural enterprises, regardless of their preferences. Winter and May (2001) identified and tested a number of factors that foster compliance with agri-environmental regulations. Their key findings were that farmers' awareness of rules plays a critical role, but normative and social motivations were as influential as calculated motivations in enhancing compliance; and that formalism in inspection can be helpful to a point, while coercion by inspectors can backfire. Literature on the Theory of Regulation emphasizes the importance of the legitimacy ascribed to a regulation in determining the effectiveness with which it can be implemented (Colman, 1994$_b$; Frey, 1997). In this context, Davis and Hodge (2006) reported on farmers' views concerning the perceived legitimacy of

environmental cross compliance as a governance mechanism, identifying two attitudinal variables ('technological beliefs' and 'stewardship orientation') as most influential in determining attitudes towards cross compliance.

Research has also been conducted which focuses on the cost-effectiveness of both voluntary and mandatory soil conservation policies (e.g. Schuler and Sattler, 2010, Schuler et al., 2006, Fox et al., 1995) and Kuhlman et al. (2010) shows how value judgments concerning sustainability influence private and public costs and benefits. Regardless of what 'objective' calculations may say about the cost-effectiveness of individual policies or soil conservation practices, a farmer's final adoption decision will be equally determined by the perceived costs for the adaptation of production processes, handling a conservation scheme, gathering knowledge and making a decision. To what extent the 'hard facts and figures' are taken into account and what weight the perceived costs have depends on the individual's personal experience and preferences.

In recent years, various European studies have been published that tried to determine the decisive factors of the adoption of soil conservation practices in particular, rather than participation in agri-environment schemes. Based on a large-scale survey, Bielders et al. (2003) found that farmers with erosion problems as well as farmers with a higher education level were more likely to take measures to control erosion and muddy floods in Belgium. Wauters et al. (2010) made use of the Theory of Planned Behavior and found that attitude was the most important factor to explain adoption of erosion control measures. It is not unlikely that attitude is largely influenced by the severity of erosion and the education level of the farmers. By studying farmers' 'life-worlds' using qualitative methods, Schneider et al. (2009) found that the adoption

of soil conservation practices by Swiss farmers is largely influenced by their values and the symbolic meaning they attribute to soil conservation. In a case study in north-eastern Germany, it was found that factors such as associated risk, effectiveness and effort required to implement a measure were equally or even more important than financial considerations to explain farmers' willingness to adopt soil conservation practices (Sattler and Nagel, 2010). However, one could argue that risk, effectiveness and effort are economic attributes that determine the level of profitability of these practices. Robinson (1999), on the other hand, found that cost reduction was a more important driver for UK farmers to adopt soil conservation practices than the erosion hazard. Posthumus and Morris (2010) agreed that UK farmers were driven by financial incentives (including agri-environment payments) but also legislation (e.g. the CAP cross-compliance measures) and awareness raising through extension officers. Based on the inventories and assessments of the world-wide initiative KASSA, Lahmar (2010) found that the cultural background and lack of innovation systems prohibited widespread adoption of conservation agriculture in North West Europe. The main drivers of the adoption of reduced tillage in this region appeared to be financial: either subsidies for the adoption of reduced tillage or the farmer's motivation to reduce the costs of machinery, labor and fuel.

We observe that the studies reported here have different, and sometimes contradicting, outcomes, and attribute this partly to differences in cultural context, but also to the differences in methodologies used as each method focused on particular factors that influence adoption decisions. This is in line with Knowler and Bradshaw (2007) who prove that the method of analysis strongly influences the results of the analysis, thus ultimately shaping our understanding of the world. The authors further infer that a few key causal variables in adoption decisions may

simply reflect the influence of the region within which an analysis is undertaken "which points to a need to undertake comparative studies across different contexts". The following section reports on case studies in seven European countries which were carried out using the same methodology.

European Case studies following the same methodology

Comparative case studies are required in order to control for the influence of survey and analytical methods. This section is based on the results of the project "Sustainable Agriculture and Soil Conservation" (SoCo) which was carried out in 2007-2008. Its overall aim was to contribute to the understanding of how policy measures can contribute to encourage farmers to adopt effective soil conservation practices and to assess the effectiveness and efficiency of soil conservation practices in agriculture. Part of the research focused on factors influencing farmer adoption of such practices. The case study areas were located in Belgium, Bulgaria, the Czech Republic, Germany, Greece, Spain, and the United Kingdom (UK). All case studies were based on a common analytical framework and followed the same methodology (Prager, 2010; Prager et al., 2010). Literature and document analyses were complemented with a stakeholder survey in order to generate primary data. The standardized questionnaires were targeted at three groups of actors: (1) farmers, (2) administrative and governmental actors, and (3) civil society actors.[3] The majority of questions were open ended, thus allowing for a qualitative analysis of the responses. Farmers were asked to rate the ease of adoption, costs and benefits of a practice, broader environmental impact, and why they were applying particular practices (expected impact and

[3] On average, 8 farmers, 9 administrators and 8 civil society representatives were interviewed per case study. Full details available in: SoCo Project Team 2008. Final Report on the Project 'Sustainable Agriculture and Soil Conservation (SoCo)'. Joint Research Centre. European Commission. Online resource: http://soco.jrc.ec.europa.eu/

motivation). All three groups were asked to assess soil conservation policies (agri-environment schemes, laws, regulations, advisory services) regarding their flexibility, technical soundness, suitability to local conditions, costs of compliance, support structures, and threat of enforcement action.

In West Flanders, the Belgian case study, decisive factors included awareness of suitable practices and awareness of rules (legislation), awareness of environmental and economic benefits (practices with multiple benefits are preferred), economic feasibility, provision of technical assistance and demonstration sites for complex techniques such as conservation tillage, and flexibility in implementing the measure. Institutional and social factors potentially hinder the adoption of soil conservation practices, e.g. if rules are too stringent and not differentiated by crop and soil, or if farmers disagree with the sampling procedure and the indicator that is measured for enforcement of rules (Verspecht et al., 2008). These findings are consistent with Bielders et al. (2003) who ascertain – for the Walloon Region of Belgium – that the awareness of an erosion hazard contributed to increased adoption rates.

In the Uckermark region (Germany), a sufficient compensation of incurred costs and economic advantage was the most important factor in adoption of soil conservation (Prager et al., 2008). At first glance, this contradicts Sattler and Nagel (2010) who found for the same region that associated risks, effectiveness, or time and effort necessary to implement a measure are equally or even more important depending on the specific situation. However, as mentioned above, risk, effectiveness and effort can be interpreted as economic attributes that determine the level of profitability of conservation practices. The importance of personal and social factors was also emphasized in a qualitative study by Prager (2002). Regarding agri-environment schemes,

farmers perceive the effort to enroll and complete application forms as very high and therefore adoption of voluntary schemes for soil conservation has been low. However, most technical soil conservation measures have become standard practices over the past years, and commonly farmers apply them without compensation (reduced tillage, intercrops) (Prager et al., 2008). This may have been caused by the strong links to several transdisciplinary research and development projects carried out in the region (GRANO, Preagro, Schorfheide-Chorin Project) which often involved field days, seminars, demonstration farms and thus contributed to increased awareness of soil degradation problems and available technologies.

In Bulgaria, which is a characteristic example for a post-socialist country, crucial factors hampering the adoption of practices to mitigate salinization are the lack of financial resources and, even more important, institutional factors. Theesfeld (2008) highlights the ambiguous assignments of property rights that occurred as a result of the formally claimed devolution process of responsibilities to the local level, i.e. “instead of the irrigation sector’s formally claimed devolution process—transfer of responsibilities and authorities from state to local communities—there is a further concentration of decision power with the state authorities by means of legislation breakdown” (Theesfeld 2008, 388). The case study by Penov et al. (2008) in Belozem (near Plovdiv) shows that farmers are aware of the importance of a functional drainage systems and crop rotation, however, direct (individual) benefits are lacking and little or inadequate information on implementation and funding schemes is provided. Farmers were found to be unable to cope with forms and procedures for compensation schemes, but also lacked trust in state agencies.

The Czech Republic is also a former socialist country. However, it joined the EU earlier

than Bulgaria and farmers have more experience with agri-environment schemes and soil conservation related policies originating at EU level. The main motivation for farmers to adopt soil conservation practices is financial and resembles other Western European countries: either positive financial incentives such as subsidies (agri-environment schemes) or negative incentives such as penalties if farmers fail to comply with the cross compliance or national legislation. But similar to Bulgaria, factors related to property rights play an important role. According to results from the Czech case study (Svratka River Basin), the technical feasibility of a practice is often limited because of fragmented land ownership and unclear property rights (e.g. if a farmer has a narrow plot that runs across the contour lines it is not feasible for him to plough along contour lines). Land ownership has been found to influence management decisions because land managers (both family farms and corporate farms) have less motivation for long term considerations related to soil conservation if they do not own the land (Prazan et al., 2008). Inflexible measures, uncertain user rights after the termination of an agri-environment scheme, and the fact that farmers and rural inhabitants are not convinced of the value of soil conservation practices, are inhibiting factors. Continuous advisory and information efforts are required to convince farmers of the benefits of soil conservation in order to ensure that they continue applying the practice (ibid.).

The conclusive statement for the Greek case study in the prefecture of Rodopi (Thraki region) (Skuras et al., 2008) says that price and policy factors dominate all other factors influencing soil conservation decision. It is more attractive to farmers to have two crops in one season rather than maintaining green cover and also market prices for products and prices for fuel determine farming decisions. In addition, the practice must be technically feasible and not

dangerous (e.g. contour ploughing on steep slopes). Lack of awareness of soil degradation and unclear benefits prevent adoption. Regarding agri-environment schemes, bureaucratic efforts and required paper work result in high indirect costs (e.g. paying a consultant to complete forms) which are not compensated by payments. In addition to economic factors, the study found that farmers' mental models are difficult to change, e.g. when they believe that water salinization or soil degradation outside their farms is the responsibility of the government. Similar to the Czech case, land fragmentation in some rural areas restrains coherent management for soil conservation. The low trust in government and farmers' suspiciousness of state and EU interventions is another important factor in adoption decisions (Skuras et al., 2008). Suspiciousness of agri-environmental funding opportunities was also found to be an important issue for Scottish farmers (MacGregor and Warren, 2006).

In the Guadalentin Basin, the case study area in Spain, scarce water resources are the main concern for farmers. In contrast, they perceive soil erosion and associated economic costs as a minor problem, hence the limited implementation of erosion control practices in the area. Profitability of a practice plays a major role (reduced yields compensated by reduced production costs). Low rainfall is a constraint for the diffusion of no tillage practice (Calatrava et al., 2008). This corresponds with Franco (2009) who found a positive relation between adoption of no tillage and rainfall and fuel price, respectively, but an inverse relation with the price of herbicides. There is a higher rate of adoption for young farmers, for larger farms, irrigation farms, farms on sloping land, for family farms, and if a relative intends to continue farming (Calatrava et al., 2007; Franco and Calatrava, 2008). Some farmers adopted mulching or conservation tillage without policy intervention because they perceived a benefit, but enrolled in

agri-environment schemes once they became available because the marginal cost of participation was small and no further changes in practices were required. Factors hampering the uptake of agri-environment schemes are the lack of technical advice, difficult and time-consuming administrative requirements and insufficient payments (Calatrava et al., 2008).

In the UK case study (Axe and Parrett catchments), the most common soil conservation practices are drainage and hedgerows (both practices have been important features of livestock farming for many decades), and more recently reduced tillage (to reduce production costs because of rising fuel prices), grass strips on field borders (compulsory cross-compliance measure), and cover crops (promoted by agri-environment schemes and catchment advisors). Financial rewards were a major factor explaining the participation of farmers in agri-environment schemes and adoption of soil conservation practices such as cover crops. However, the long-term restrictions on farm management imposed by these schemes were a major barrier for farmers; they feared that they would be constrained to respond rapidly to changing markets or would limit the options for their future successors. Farmers mentioned ‘situational stress’ as another factor influencing adoption of soil conservation practices: farmers who perceive their land to be problematic due to inherent limitations (e.g. soil texture or wetness) are less willing to endorse a governmental defined standard for farming practice. But farmers also suggested that they would be more willing to adopt new practices if they had seen other farmers using them, or if they were financially rewarded for it as an insurance payment against productivity loss (Deeks et al., 2008). This implies that farmers regard soil conservation practices with suspicion as they perceive a great uncertainty on their effectiveness and impact on the farm productivity.

The SoCo case studies showed that there are differences between countries that can be

traced back to cultural and social factors. While financial, or in the wider sense, economic factors are of importance across countries and cultures, mental models play an important role in the perception of soil degradation and mitigation practices, farmers' attitudes towards soil conservation, and their assessment of adequate and feasible measures to tackle degradation. The SoCo case studies did not allow for a comparison of exactly the same practices as the way soil conservation practices are defined and carried out by individual farmers varies between regions and countries. Therefore, the results allow an overview of the relative importance of adoptions factors for soil conservation practices in general.

Synthesis and Discussion: the decisive factors of the adoption process

In Table 2 we have grouped factors that determine the adoption of soil conservation practices as found in the literature. The categories correspond with those used by, among others, Ervin and Ervin (1982), Stonehouse (1997), and Posthumus et al. (2010): "Personal factors" represent the actors, "Environmental factors" represent the bio-physical context, "Economic factors" comprises the technical and financial aspects of the practices, and "Institutional factors" represent the institutions and governance structures. The "Economic factors" can also be seen as a compound of the interactions between the previous elements and characterize the relationships between actors, environment and institutional arrangements. There is overlap however between the factors and the variables they are representing. Production factors could also be considered as part of the environmental situation; and social and cultural factors that have now been grouped with institutional factors are strongly influenced by personal characteristics and attitudes. The third column provides examples and details on how factors are linked and impact on the

decision.

Table 2: Decisive factors in adoption of soil conservation practices

Factor	Examples for variables	Explanation	Examples
Environmental	• Degree of soil degradation/ vulnerability, uncertainty • Climate • Soil type	• Biological, geological and physical factors determine how quickly and severely degradation and its negative impacts become visible. If processes are slow or disguised by fertile soils, or if the impact shows off-farm, the degree of degradation may be misjudged or even overlooked. • Environmental factors determine which technology is suitable, which restrictions are faced and which adaptations become necessary.	Bielders et al., 2003; Ervin and Ervin, 1982; Robinson, 1999; Skuras et al., 2008; Verspecht et al., 2008
Economic	• Characteristics of the technology	• The technology must be available, accessible, and compatible with existing processes and technologies on the farm. • Economic constraints derive directly from the technology if it is expensive to implement, e.g. new machinery must be bought or investments in farm structures made. Access to capital is a precondition for investments. • A technology is evaluated by profitability/ financial return, i.e. either the costs incurred or the costs reduced (e.g. for fuel, fertilizer, labor, time); or by the profit generated by higher yields. Costs for leasing land and externalities may play a role. • The technology must adequately address the degradation problem and show environmental along with economic benefits, i.e. effectiveness.	Lahmar, 2008; Penov et al., 2008; Posthumus and Morris, 2010; Prager, 2002; Prager et al., 2008; Sattler and Nagel, 2010; Skuras et al., 2008; Verspecht et al., 2008
	• Production factors, farming systems	• Labor must be available to carry out the required operation. Family labor may facilitate adoption. • The farming system must be flexible enough to accommodate the new technology/ practice or at least allow for an adaptation without major costs. The less change a conservation practice requires the more likely the adoption.	Feder et al., 1982; Posthumus and Morris, 2010; Prager, 2002; Schneider et al., 2009; Skuras et al., 2008
	• Financial factors	• Access to markets and potential profits that can be made from choosing a certain crop and growing it at a certain time determine profitability. • Incentive schemes compensate for costs incurred by applying soil conservation and may include an incentive payment to cover transition costs. • Indirect costs such as learning costs (gathering information about a scheme) and application costs (time required to complete and submit forms) depend on personal characteristics and institutional factors. Costs for compliance with regulations or non-compliance (fines) apply universally but may be perceived differently.	Wynn et al., 2001; Falconer, 2000; Wilson 1997

Factor	Examples for variables	Explanation	Examples
Institutional	• Policies, legislation, incentive schemes and programs • Land tenure and property rights • Assistance networks, extension and training • Enforcement mechanism and sanctions	• Policies and legislation are used as 'carrot and stick' tools to encourage behavioral change • Information about policies and soil conservation must reach the farmer, therefore extension and access to adequate information are essential. • The ownership of land and the security of land tenure may influence the willingness or ability of the farmer to undertake soil conservation. Shape and location of farm fields influences whether a technology can be applied. • If policies contradict or incentives provided through various schemes compete, the farmer is likely to choose the financially more attractive option. If programs limit the flexibility of (future) land management, farmers are less likely to adopt practices. • The density and frequency of controls and the perceived 'threat' of a law to be enforced is closely linked to personal factors and risk perception. The level of a sanction (e.g. fine) plays out in economic factors.	Arnalds, 2005; Lahmar, 2010; Penov et al, 2008; Posthumus and Morris, 2010; Prager, 2002; Prager et al., 2008; Prazan et al., 2008; Skuras et al., 2008
	• Social and cultural factors	• Peer pressure, land management ethics, traditions are closely linked to personal factors and influence attitudes and values. The reputation of a farmer or the practice applied influences the individual decision. • Trust in government and its administrative authorities, as well as the perceived legitimacy of legislation and government's motifs behind an incentive scheme play a particular role in transition countries. • The presence of young farmers and the guarantee that the farming activity is continued (e.g. by relatives) may have a positive or negative influence on adoption. It can also be considered an economic or an institutional factor.	Calatrava et al., 2008; Franco and Calatrava, 2008; Posthumus and Morris, 2010; Sattler and Nagel, 2010; Skuras et al., 2008
Personal	• Education, age and experience • Attitude towards soil conservation • Risk perception • Emotion, interests • Trust and attitude towards method of change	• Particularly important in the perception and normative assessment phase, where information must reach the farmer to facilitate the recognition of a problem and the awareness of potential solutions (practices, technologies). • Most relevant are knowledge of degradation processes and mitigating practices, perception and attitude towards the soil conservation and environment in general. • The personal perception of social and economic constraints may differ from person to person and changes over time. • Attitude and the assessment of a risk and a technology is based on values which are grounded in social background and experience (variables include age, education level) • If policies are perceived as justified, useful and effective, farmers are more likely to take up prescribed practices.	Bielders et al., 2003; Lahmar, 2008; Posthumus and Morris, 2010; Prager, 2002; Prazan et al., 2008; Sattler and Nagel, 2010; Schneider et al., 2009; Skuras et al., 2008; Wauters et al., 2008

The decisive factors and variables are grouped according to the three different levels of adoption in Table 3. Distinction is also made between adoption without policy intervention and the additional variables that come into play when adoption of a soil conservation practice is influenced by a policy such as legislation, cross-compliance regulations or agri-environment schemes.

Knowledge is an influential variable that appears in every single level. However, it appears that personal, institutional and some environmental factors are more important at the cognitive level; at the normative level the personal, institutional and economic factors are dominant; and at the conative level the institutional and economic factors play the most significant role.

1 **Table 3:** Linking levels of adoption and types of factors

	Environmental	**Personal**	**Economic**	**Institutional**
Cognitive Level – Perception	Climate Slow process Fertile soils Soil type Yield reduction Severity of soil degradation Slope length and angle	Knowledge Education Infrequent visits or use Perception and attitude towards conservation/ environment Risk perception Experience Age Social background Innovativeness	Yield reduction Land availability	Extension Information flow Information access Land tenure Land availability
Normative Level - Decision	Water availability Suitable soils and topography	Knowledge Perception of risk, severity and urgency of the problem Perception of social and economic constraints Other priorities Land management ethics Attitude: downstream problem/ government responsibility	Market prices Economic constraints (debts, income, off-farm income) Compatibility with farming system Availability of machinery, labor, fuel Costs of machinery, labor, fuel, fertilizer and pesticides Undesired effects (e.g. weeds) Yield Access to capital Investment costs Indirect costs (learning costs, administrative costs)	Social constraints Land tenure Property and use rights Location and shape of parcels
Particularities for policies		Congruence with self image Legitimacy of policy Perception of enforcement mechanisms Trust in state agencies	Competition with other incentive schemes Costs for application and compliance Fines for non-compliance	Farmer's right to decide Contradiction with other policy/ legislation Opposition or conflict with land owner Subsequent restrictions on land Flexibility Density of controls
Conative Level – Effort	Conducive conditions Visibility/ Observability of results: soil quality increase	Knowledge Perception of social constraints, peer pressure, recognition Perception of benefits	Fit with other technology, production procedures and farming system Yield stable or increased Financial returns/ long-term profitability Learning and adaptation costs	Social constraints Traditions Availability of appropriate extension and training Reputation in community Land tenure Property and use rights
Particularities for policies		Trust in state agencies		Predictability of policies

Summary and Conclusions

This paper aimed to review and summarize findings of existing studies on the role of socio-economic factors that influence farmer participation in soil conservation efforts, i.e. their adoption of conservation practices, with a particular focus on the European situation. In order to provide a structured overview we combined four groups of factors derived from previous concepts (Ervin and Ervin, 1982; Stonehouse, 1997) with the factors that influence the process of adoption (see model of acceptance in Figure 1). There is no evidence in the studies that either economic factors or social factors are superior in explaining adoption decisions. Rather, it is always a mix of personal, socio-cultural, economic, institutional and even environmental variables that explain behavior.

Across the studies reviewed for the European context, we noted that there are several ways in which farmers or other land managers can participate in conservation efforts. We found three distinct pathways for the adoption of soil conservation practices:

1) an individual adopts a practice on their own initiative
2) an individual enrolls in an agri-environment scheme or soil conservation program and receives compensation (incentive payments)
3) an individual complies with legislation and conservation requirements.

In a particular case a mixture of these may apply but there are distinct differences how these pathways determine the set of socio-economic factors that play a role in the adoption decision. A farmer may not consciously make the choice to take a certain pathway – in case of the third pathway, the choice is made externally. These pathways will also decide whether an

investigation of adoption factors will focus on personal motivation, learning and experiences, on scheme characteristics that facilitate participation, or on compliance and enforcement of legislation.

We infer that each pathway has a main driver. In the first case, the main driver is the personal motivation based on problem perception or intrinsic motifs and, if in a group, peer pressure. In the second case, the main driver is the incentive payment which must outweigh all other costs associated with program uptake and implementation of the measures in order for it to become effective. In the third case, the main driver is the threat of possible consequences of non-compliance such as a fine, loss of payments or reputation. For each pathway, a farmer considers the costs and benefits of soil conservation when deciding whether to adopt conservation practices or not. However, these costs and benefits go beyond direct costs and benefits associated with the practices and for some it may be difficult to quantify them (e.g. reputation, satisfaction, learning costs, costs associated with uncertainty on impact). Furthermore, the costs and benefits are determined by the environmental and economic context, institutional structures, and personal characteristics and they will thus differ between farmers and farms. Although based on a different sample (statistical analyses from regions in Africa and North and South America for conservation agriculture) we strongly support Bradshaw and Knowler's (2007, 25) claim that there are few if any universal variables that regularly explain the adoption of soil practices and their conclusion that efforts to promote soil conservation in agriculture "will have to be tailored to reflect the particular conditions of individual locales."

References

Adesina, A.A., and M.M. Zinah. 1993. Technology characteristics, farmers' perceptions and adoption decisions: a Tobit model application in Sierra Leone. Agricultural Economics 9: 297-311.

Autsch, J. 1992. Wirkungen und Akzeptanzen von landwirtschaftlichen Förderprogrammen mit umweltgerechter Zielsetzung - dargestellt an einem Beispiel im Saarland. Giessen: Wissenschaftlicher Fachverlag Fleck.

Banks, J., and T. Marsden. 2000 Integrating agri-environment policy, farming systems and rural development: Tir Cymen in Wales. Sociologia Ruralis 40(4): 466-480.

Barbayiannis, N, K. Panagiotopoulos, D. Psaltopoulos, and D. Skuras. 2008. Sustainable agriculture and soil conservation. Case study report – Greece. Joint Research Centre. European Commission. Online resource: http://soco.jrc.ec.europa.eu/

Barreiro-Hurlé, J., M. Espinosa-Goded, and P. Dupraz. 2008. Re-considering Agri-Environmental Schemes premiums: the impact of fixed costs in sign-up decisions. 12th Congress of the European Association of Agricultural Economists (EAAE).

Blaikie, P. 1985. The political economy of soil erosion in developing countries. Long Development Studies.

Boardman, J., J. Posen, and R. Evans. 2003. Socio-economic factors in soil erosion and conservation. Environmental Science and Policy 6: 1-6.

Boardman, J. 2003. Soil erosion and flooding on the eastern South Downs, southern England, 1976–2001. Transactions of the Institute of British Geographers 28 (2): 176-196.

Brotherton, I. 1991. What limits participation in ESAs? Journal of Environmental Management 32: 241–249.

Calatrava, J., A. Franco, and M.C. González. 2007. Analysis of the adoption of soil conservation practices in olive groves, the case of mountainous areas in Southern Spain. Spanish Journal of Agricultural Research 5(3): 249-258.

Calatrava, J., G. González, and V. Castillo. 2008. Sustainable agriculture and soil conservation. Case study report – Spain. Joint Research Centre. European Commission. Online resource: http://soco.jrc.ec.europa.eu/

Colman, D. 1994$_a$ 'Ethics and externalities: Agricultural stewardship and other behaviour: Presidential address', Journal of Agricultural Economics 45: 299–311.

Colman, D. 1994$_b$. Comparative evaluation of environmental policies; ESAs in a policy context. In: Incentives for countryside management: the case of Environmentally Sensitive Areas, ed. M. Whitby. CAB International, Wallingford. pp 219-251.

Davies, B.B., and I.D. Hodge. 2006. Farmers' preferences for new environmental policy instruments: Determining the acceptability of cross compliance for biodiversity benefits. Journal of Agricultural Economics 57 (3): 393-414.

Deeks, L., H. Posthumus, J. Rickson, I. Fenn, C. Bowyer, D. Baldock, and N. Heyn. 2008.Sustainable agriculture and soil conservation. Case study report – United Kingdom. Joint Research Centre. European Commission.

Defrancesco, E., P. Gatto P, F. Runge F, and S. Trestini S. 2008. Factors affecting farmers' participation in agri-environmental measures: A northern Italian perspective. Journal of Agricultural Economics 59 (1): 114-131.

Ellis-Jones, J., and T. Mason. 1999. Livelihood strategies and assets of small farmers in the evaluation of soil and water management practices in the temperate inter-andean valleys of Bolivia. Mountain and Research Development 19(3): 221-234.

Enters, T. 1999. Incentives as policy instruments: key concepts and definitions. In: T. Enters (Ed.) Incentives in soil conservation: from theory to practice. WASWC, Science Publishers Inc.

Ervin, C.A., and D.E. Ervin. 1982. Factors affecting the use of soil conservation practices: hypotheses, evidence, and policy implications. Land Economics 58(3): 277-291.

Erz, W. 1985. Akzeptanz und Barrieren für die Umsetzung von Naturschutzerfordernissen in Öffentlichkeit, Politik und Verwaltung. Daten und Dokumente zum Umweltzschutz, Sonderreihe Umwelttagung 38: 11-18, Hohenheim University, Germany.

Esser, P. 1999. Akzeptanz – Was steckt dahinter? Überlegungen zur Akzeptanzdebatte in Naturschutz und Landschaftsplanung. Master thesis. Technical University Berlin, Germany.

Evans, R. 1990. Soil erosion: its impact on the English and Welsh landscape since woodland clearance. Soil erosion on agricultural land, eds. In: J. Boardman, I.D.L. Foster, and J.A. Dearing. Chichester, England, John Wiley & Sons: 231-254.

Falconer, K. 2000. Farm-level constraints on agri-environmental scheme participation: a transactional perspective. Journal of Rural Studies 16: 379-394.

Feder, G., R.E. Just, and D. Zilberman. 1982. Adoption of agricultural innovation in developing countries; a survey. Washington DC: the World Bank.

Fox, G., G. Umali, and T. Dickinson. 1995. An Economic Analysis of Targeting Soil Conservation Measures with Respect to Off-site Water Quality. Canadian Journal of Agricultural Economics/ Revue canadienne d'agroeconomie 43(1): 105-118.

Franco, J.A., and J. Calatrava . 2008. Adoption and diffusion of no tillage practices in Southern Spain olive groves. 12th Congress of the European Association of Agricultural Economists (EAAE).

Franco, J.A. 2009. Análisis Económico de la Erosión de Suelos Agrarios, el Caso del Olivar del Alto Genil Granadino. Unpublished Doctoral Dissertation, Department of Agricultural Economics, Sociology and Policy. University of Cordoba, Spain.

Frey, B.S. 1997. A constitution for knaves crowds out civic virtues, The Economic Journal 107: 1043–1053.

Graaff, J. de. 1996. The price of soil erosion. PhD dissertation. Wageningen Agricultural University.

Kleijn, D., and W.J. Sutherland. 2003. How effective are European agri-environment schemes in conserving and promoting biodiversity? Journal of Applied Ecology 40: 947–969.

Knowler, D., and B. Bradshaw. 2007. Farmers' adoption of conservation agriculture: a review and synthesis of recent research. Food Policy 32: 25-48.

Kuhlman, T., S. Reinhard, and A. Gaaff. 2010. Estimating the costs and benefits of soil conservation in Europe. Land Use Policy 27(1): 22–32.

Lahmar, R. 2010. Adoption of conservation agriculture in Europe: lessons of the KASSA project. Land Use Policy 27(1): 4-10.

Lettmann, A. 1995. Akzeptanz von Extensivierungsstrategien. Eine empirische Untersuchung bei Landwirten in Nordrhein-Westfalen. Bonn. Series Forschungsberichte Vol 20.

Lionberger, H.F. 1960. Adoption of New Ideas and Practices. Ames, Iowa: The Iowa State University Press.

Lobley, M., and C. Potter. 1998. Environmental Stewardship in UK agriculture: a comparison of the Environmentally Sensitive Area Programme and the Countryside Stewardship Scheme in South East England. Geoforum 29(4): 413-432.

Louwagie, G., T. Kutter, J. Schuler, K. Helming, S.H. Gay, and K. Prager. 2010. Implementing policies for soil and water conservation in European Union agriculture. In: Napier, T. (ed.):

Human dimensions of soil and water conservation (forthcoming).

Lucke, D. 1995. Akzeptanz: Legitimität in der 'Abstimmungsgesellschaft'. Opladen: Leske & Budrich.

Lynne, G.D., J.S. Shonkwiler, and L.R. Rola. 1988. Attitudes and farmer conservation behavior. American Journal of Agricultural Economics 40:12-19.

Marsh, S.P. 1998. What can agricultural researchers do to encourage the adoption of sustainable farming systems? SEA Working Paper 98/05. Nedlands, Agricultural and Resource Economics, the University of W.A.

Macgregor, C.J., and C.R. Warren. 2006. Adopting sustainable farm management practices within a Nitrate Vulnerable Zone in Scotland: The view from the farm. Agriculture, Ecosystems & Environment 113 (1-4): 108-119.

Morris, C., and C. Potter. 1995. Recruiting the new conservationists: farmers' adoption of agri-environmental schemes in the UK. Journal of Rural Studies 11: 51-63.

Morris, C.J., J. Mills, and I.M. Crawford. 2000. Promoting farmer uptake of agri-environment schemes: the Countryside Stewardship Arable Options Scheme. Land Use Policy 17: 241-254.

Negatu, W., and A. Parikh. 1999. The impact of perception and other factors on the adoption of agricultural technology in the Moret and Jiru Woreda (district) of Ethiopia. Agricultural Economics 21: 205-216.

Nolten, R. 1997. Implementation von Naturschutzsonderprogrammen. Eine empirische Untersuchung in Nordrhein-Westfalen. Bonn: Series Bonner Studien zur Wirtschaftssoziologie 8.

Penov, I., A. Aleksiev, I. Manolov, and Y. Kavardjiev. 2008. Sustainable agriculture and soil conservation. Case study report – Bulgaria. Joint Research Centre. European Commission. Online resource: http://soco.jrc.ec.europa.eu/

Posthumus, H., C. Gardebroek, and R. Ruben. 2010. From participation to adoption: comparing the effectiveness of soil conservation programs in the Peruvian Andes. Land Economics (forthcoming)

Posthumus, H., and J. Morris. 2010. Implications of CAP reform for land management and runoff control in England and Wales. Land Use Policy 27(1): 42-50.

Posthumus, H., C.J.M. Hewett, J. Morris and P.F. Quinn (2008) Agricultural land use and flood risk management: engaging with stakeholders in North Yorkshire. Agricultural Water

Management 95(7): 787-798.

Prager, K., N. Hagemann, K. Helming, N. Heyn, C. Sattler, J. Schuler, and P. Zander. 2008. Sustainable agriculture and soil conservation. Case study report – Germany. Joint Research Centre. European Commission. Online resource: http://soco.jrc.ec.europa.eu/

Prager, K. 2002. Akzeptanz von Maßnahmen zur Umsetzung einer umweltschonenden Landbewirtschaftung bei Landwirten und Beratern in Brandenburg. Weikersheim: Margraf. Series Kommunikation und Beratung 48.

Prager, K. 2010. Applying the Institutions of Sustainability framework to the case of agricultural soil conservation. Environmental Policy & Governance (forthcoming)

Prager K, Schuler J, Helming K, Ratinger T, Zander P, Hagedorn K. in press. Soil degradation, farming practices, institutions and policy responses: An analytical framework. Land Degradation & Development, Special Issue.

Prazan, J., and M. Dumbrovsky. 2008. Sustainable agriculture and soil conservation. Case study report – Czech Republic. Joint Research Centre. European Commission. Online resource: http://soco.jrc.ec.europa.eu/

Rogers, E.M. 1995. Diffusion of Innovations. 4th ed. New York: The Free Press.

Sattler, C., and U.J. Nagel. 2010. Factors affecting farmers' acceptance of conservation measures – A case study from north-eastern Germany. Land Use Policy 27(1): 70-77

Schneider, F., T. Ledermann, P. Fry, and S. Rist. 2009. Soil conservation in Swiss agriculture – approaching abstract and symbolic meanings in farmers' life-worlds. Land Use Policy (in press)

Schuler, J., and C. Sattler. 2010. The estimation of agricultural policy effects on soil erosion—An application for the bio-economic model MODAM. Land Use Policy 27(1): 61-69.

Schuler, J., P. Zander, H. Kächele, K. Müller, and K. Helming. 2006. Economic frame for soil conservation policies. In: Soil Erosion in Europe, eds. J. Boardman, and J. Poesen. Chichester: Wiley.

Stocking, M., and N. Murnaghan, 2001. Handbook for the field assessment of land degradation. London: Earthscan.

Stonehouse, P.D. 1997. Socio-economics of alternative tillage systems. Soil and Tillage Research 43 (1–2), 109–130.

Vanslembrouck, I., G. van Huylenbroeck, and W. Verbeke W. 2002. Determinants of the

willingness of Belgian farmers to participate in agri-environmental measures. Journal of Agricultural Economics 53(3): 489-511.

Verspecht, A., G. Van Huylenbroeck, A. Van den Bossche, S. De Bolle, B. Moeskops, and S. De Neve. 2008. Sustainable agriculture and soil conservation. Case study report – Belgium. Joint Research Centre. European Commission. Online resource: http://soco.jrc.ec.europa.eu/

Walford, N. 2002. Agricultural adjustment: adoption of and adaptation to policy reform measures by large-scale commercial farmers. Land Use Policy 19: 243-257.

Wauters, E., Bielders, J. Poesen, G. Govers, and E. Mathijs. 2010. Adoption of soil conservation practices in Belgium: an examination of the theory of planned behaviour in the agri-environment domain. Land Use Policy 27(1): 86-94.

Wilson, G.A., and K. Hart. 2001. Farmer participation in agri-environment schemes: towards conservation-oriented thinking? Sociologia Ruralis 41 (2): 254–274.

Wilson, G.A. 1996. Farmer environmental attitudes and ESA participation. Geoforum 27(2): 115-131.

Wilson. G.A. 1997. Factors influencing farmer participation in the Environmentally Sensitive Areas scheme. Journal of Environmental Management 50: 67-93.

Wilstacke, L., and R. Plankl. 1988. Freiwillige Produktionsminderung – Empirische Analyse. Akzeptanz und Wirkungen des niedersächsischen Grünbracheprogramms und anderer Angebote zur freiwilligen Produktionsminderung. Münster/Hiltrup. Series Schriftenreihe des Bundesministers für Ernährung, Landwirtschaft und Forsten A: Angewandte Wissenschaft 357.

Winter, S.C., and P.J. May. 2001. Motivation for Compliance with Environmental Regulations. Journal of Policy Analysis and Management 20(4): 675–698.

Wossink, G.A.A., and J.H. van Wenum. 2003. Biodiversity conservation by farmers: analysis of actual and contingent participation. European Review of Agricultural Economics 30(4): 461–485.

Wynn, G., R. Crabtree, and J. Potts. 2001. Modelling farmer entry into the Environmentally Sensitive Areas Scheme in Scotland. Journal of Agricultural Economics 52(1): 65-82.