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From dust to a must

Investigating the social barriers to farmers' adoption of soil conservation practices in Hungary, with recommendations for an effective information-based soil governance

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Köszönöm.

Abstract

Soil as a fundamental, conditionally renewable natural resource is increasingly under threat from unsustainable farming practices in a changing environment. In Hungary, expansive areas of land are susceptible to soil degradation, while only a small percentage of farmers currently applies soil conservation practices (SCPs). Degraded soils have an impact on food production, climate adaptation, climate regulation, clean water, and biodiversity. Introducing soil conserving farming methods is integral to protecting the ecosystem services that soils provide. The primary aims of this research are to provide an overview on existing information-based policies in Hungary for agricultural soil conservation; to provide a more comprehensive and nuanced view on social barriers that hinder farmers' adoption of SCPs; to understand what farmers need in order to adopt more sustainable practices; and to explore how information-based policy instruments can better support a wider uptake of SCPs. The research builds on qualitative data gained from 23 semi-structured interviews and an observed event with stakeholders from ten different stakeholder groups, as well as on quantitative data from an online survey with 83 responding farmers. The research is guided by an expanded version of the Drivers-Pressures-State-Impacts-Responses framework, as well as relevant aspects of the Diffusion of Innovations theory and the Agroecological Transition theory. The research provides an overview on existing information-based policies for soil conservation, and outlines dominating themes, with illustrative examples, on the most common social barriers in the way of widespread adoption of SCPs by Hungarian farmers. With recommendations and best practices, targeting policy makers and relevant authorities, the thesis wishes to contribute to and inspire future steps towards an effective information-based governance for soil conservation, and an improved understanding and cooperation among stakeholders.

Keywords: soil protection; sustainable soil management; conservation agriculture; arable farming; Hungary

"One of the greatest pains to human nature is the pain of a new idea. It makes you think that after all, your favorite notions may be wrong, your firmest beliefs ill-founded. ... Naturally, therefore, common men hate a new idea, and are disposed more or less to ill-treat the original man who brings it."

— Walter Bagehot

"Ideas confine a man to certain social groups and social groups confine a man to certain ideas. Many ideas are more easily changed by aiming at a group than by aiming at an individual."

— Josephine Klein

"Building trust in one another and developing institutional rules that are well matched to the ecological systems being used are of central importance for solving social dilemmas. ... A core goal of public policy should be to facilitate the development of institutions that bring out the best in humans."

— Elinor Ostrom

"The soil is the great connector of lives, the source and destination of all. It is the healer and restorer and resurrector, by which disease passes into health, age into youth, death into life. Without proper care for it we can have no community, because without proper care for it we can have no life."

— Wendell Berry

Executive Summary

Problem definition and research questions

Soil is a fundamental, conditionally renewable natural resource which plays an essential role in food security, protecting groundwater, supporting biodiversity, nutrient cycling and in climate regulation, as well (Defra, 2009). Certain agricultural practices, such as conventional tillage, leaving soil surface bare during winter, and growing monocultures have long been named as major factors behind soil degradation and soil carbon loss (Adger & Brown, 1994; Borrelli et al., 2020). While the quality of agricultural soils in Hungary is generally considered to be good, several adverse effects have had a negative impact on soil resources since the 1950s, the most important ones being soil erosion, physical degradation and soil compaction, acidification and salinisation (Greenland et al., 1994).

The uptake of sustainable land management practices by farmers is often hindered by various social, economic, or technological factors. On the social barriers that affect Hungarian farmers' decision-making, existing literature has been fragmented and is rarely based on input from stakeholders, a notable exception being a recent EU project that, through a Hungarian case study, investigated the barriers and drivers of a transition towards agroecological farming practices (Balázs et al., 2019). The findings of this case study, however, suggested that utilising additional methods, involving further stakeholder groups, and investigating the problem from different perspectives, can potentially result in a more nuanced, more comprehensive view on the matter.

While the amount of previous and current research on soil science and soil management is abundant, the study of soil governance, that is the policies related to the management, conservation, and restoration of soils, is surprisingly underrepresented and neglected. The primary aims of this thesis were to provide a better understanding and a more comprehensive picture of the social barriers that hinder the uptake of soil conservation practices by farmers in Hungary, and highlight how information-based policies can potentially help overcoming these barriers. The research therefore attempted to contribute to better future Hungarian policies and their effective implementation for agricultural soil conservation, as well as to improve understanding and collaboration between different stakeholder groups.

The scope of this research was limited to the challenge of physical soil degradation in arable lands that is strongly affected by certain farming practices. While exploring barriers to the uptake of soil conservation practices by farmers, emphasis was placed on social factors.

The below table provides an overview on the research questions and the data collection- and analysis methods that the thesis built on:

Research questions	1. What are the most relevant existing information-based policies in Hungary that aim to influence farmers' soil management practices? a. What do relevant stakeholder groups consider to be the strengths and weaknesses of these policies for agricultural soil conservation?	2. What are the most common social barriers to the adoption of soil conservation practices by farmers in Hungary? a. What do farmers need in order to adopt or continue applying soil conservation practices?	3. How can information-based policies achieve a wider uptake of soil conservation practices? a. What role do 'trust' and 'participation' play in such policies?
Data collection methods	Literature review Semi-structured interviews Event observation Online survey		
Data analysis methods	Document analysis Reflexive thematic analysis with manual coding Thematic manual coding Descriptive analysis; Comparison of cumulative results along different factors		

Figure 0-1. An overview of research questions, data collection- and data analysis methods

Research design and methodology

The thesis followed an exploratory sequential mixed methods research approach: starting with qualitative data collection and analysis, followed by the collection and analysis of quantitative data. For the interpretation and understanding of the collected data, a modified and extended version of the DPSIR (Drivers-Pressures-State-Impacts-Responses) framework by the European Environment Agency (1999) was adopted and complemented with elements of relevant theories, using a conventionalist approach. The theories utilised in the thesis, are the Diffusion of Innovations theory, and to a lesser extent, the Agroecological Transition theory.

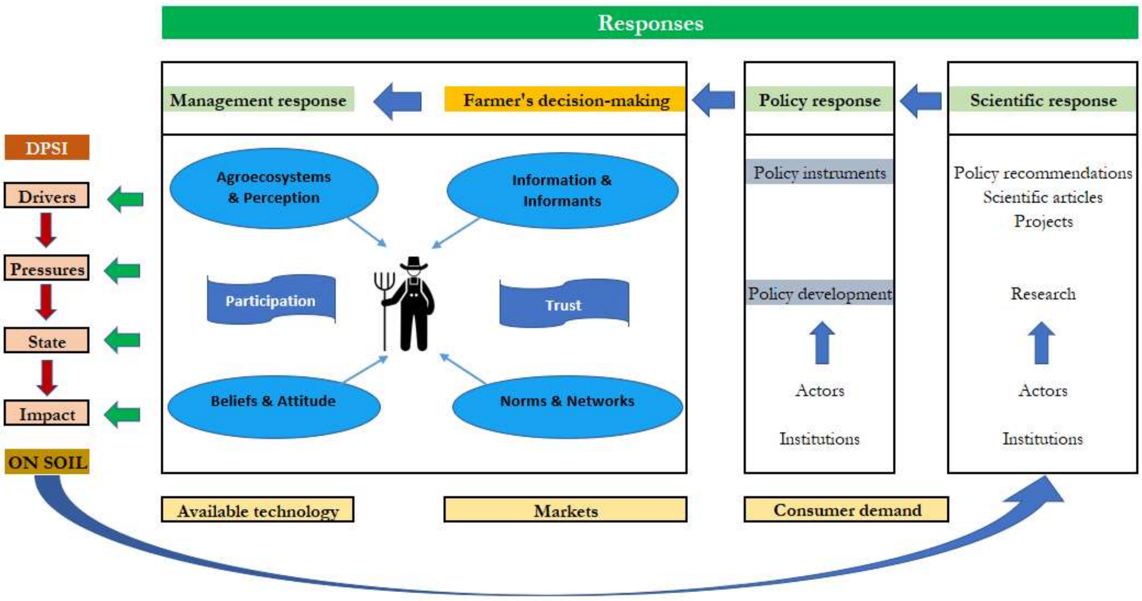

Figure 0-2. Conceptual framework

In order to investigate the social factors that can affect farmers' decision-making on the use of soil conservation practices, the research was guided by four pre-determined categories, suggested by the identified theories of relevance and reviewed literature, and two more general aspects, 'participation' and 'trust':

1. Agroecosystems & Perception
2. Information & Informants
3. Beliefs & Attitude
4. Norms & Networks

Primary qualitative data was collected from 23 semi-structured interviews and from the observation of ten presentations at a virtual event on the future of soil conservation farming in Hungary. The interview subjects and the presenters came from altogether ten different stakeholder groups. Secondary data was collected from relevant academic and grey literature, as well as from various documents. The thematic content analysis process included familiarisation, the thematic coding of hand-written notes and manual transcriptions of the recorded interviews, generating themes, reviewing themes, defining, and naming themes, and finally producing the report. Manual coding was chosen by the author because it allowed for a deeper immersion, and familiarisation with the collected data and also supported a continuous learning process on a complex topic.

Findings

In response to **RQ1**, the thesis provided an overview on the main characteristics and objectives of the most relevant existing information-based policies for soil conservation including the Good Soil Conservation Practice handbook, the Soil Information and Monitoring System, the Farm advisory service, requirements for a soil conservation plan, the Soil Degradation Subsystem (SDS), and the Soil Conservation Action Plan (SCAP).

Collected stakeholder views mostly concerned the farm advisory service and the suitability of the newly accepted Soil Conservation Action Plan (SCAP). Identified factors leaving room for improvement for existing policies dominated the collected results, the main pieces of criticism being: the lack of a prepared, available, and independent advisory system, lack of available and usable data on soils, and the voluntary nature of the new Action Plan. Among the strengths, stakeholders mentioned the strong legislative foundations for soil conservation in Hungary, and the potential of developing policies, such as the national CAP strategic plan.

Answering **RQ2**, the dominating themes for common social barriers that have been formulated, as a result of the empirical study, are the following according to the pre-determined categories of the conceptual framework:

Agroecosystems and perception: Farmers' lack of knowledge and understanding of their soils; Application of SM practices that are unfit to the conditions; Inadequate perception of a changing environment
Information and informants: Outdated advice from advisors who are overwhelmed with administration; Lack of trust in information sources; SSM is not adequately covered in the school curriculum/farmers' training
Beliefs and attitude: Farmers tend to stick to using what they have always used (e.g. ploughing); Avoiding risk taking for uncertain gains; Economic factors outweigh long-term thinking
Norms and Networks: Copying the practices of predecessors; Imitating peers or fearing their criticism; Certain regulations create a competitive situation between farmers, resulting in lack of trust

Participation: Ad-hoc nature of government/authority-initiated consultations*;* No follow-up on given feedback to farmers
Trust: Post-political-system-change individualistic behaviour of farmers (lack of cooperation)*;* Lack of trust between stakeholder groups

Based on the interviews with and the survey of farmers, the thesis identified their primary needs for adopting or continue applying SCPs, that information-based policies could and should address. These needs include, among others: tailored guidance and advice; a strong and prepared farm advisory service; access to the latest research results; and a knowledge platform or other opportunities to share and exchange knowledge and experience with other farmers.

In response to **RQ3**, the thesis found that information-based policies have a greater chance for successful implementation if they are integrated in a set of other, for example, regulatory or economic policy instruments. Encouraging collaboration and supporting greater interaction among farmers, as well as between farmers and advisors; rewarding beneficial practices instead of penalising farmers for damaging practices are also proven to be beneficial. Enabling and supporting farmers' participation in policy development, implementation, and even analysis processes, can contribute to the long-term sustainability of measures. Using evaluation criteria in policy analysis that are integral to democratic values (e.g. social acceptance, transparency, participatory rights) can contribute to the effectiveness of policies that aim to achieve long-term behavioural and attitude change. The independence of both research and farming advice, policies' sensitivity to local conditions and their long-term reliability, the education of consumers, and using the right framing for the cause of soil conservation (e.g. soil security) are all among those key aspects that can enable the successful implementation of information-based policies.

Conclusions and recommendations

This thesis provided insight into a complex issue from the viewpoint of ten different stakeholder groups by integrating their knowledge, perceptions, and experience. The dominant themes formulated from the analysis of gathered data, provide a more comprehensive, refined insight into stakeholder perspectives and relations, as well as into the policies that aim to influence the adoption of soil conservation practices.

Recommendations targeting policy makers and relevant authorities call for a novel approach to both farmers and the promotion of SCPs in Hungary, that is based on cooperation, participatory processes, independent advice, and a general attitude of trust and partnership among relevant stakeholders. The thesis also provided a list of international best practices for information-based soil governance, among them the establishment of Living Labs and Lighthouses to demonstrate the work of soil conservation pioneers; catchment-level community-based soil conservation; no-till research and extension groups; the co-production of knowledge in soil governance; and participatory natural resource management by multi-stakeholder actor networks.

The thesis concludes by emphasising that sustainably managed soils and the application of soil conservation practices can not only contribute to the environmental sustainability and resilience of agroecosystems, but they can potentially improve the social and economic sustainability of the rural community, as well. This research wishes to contribute to and inspire future steps towards an effective information-based governance for soil conservation, and an improved understanding and cooperation among various stakeholder groups.

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Abbreviations

AM - Ministry of Agriculture (Hungary)

CAP - Common Agricultural Policy

EU - European Union

FAO - Food and Agriculture Organization of the United Nations

FSCP - Farmers' Soil Conservation Programme

GAEC - Good agricultural and environmental conditions

NCA - National Chamber of Agriculture

NFCSO - National Food Chain Safety Office

RDP - Rural Development Programme

SCAP - Soil Conservation Action Plan

SC - Soil conservation

SCP - Soil conservation practice

SDG - Sustainable Development Goal

SDS - Soil Degradation Subsystem

SM - Soil management

SOM - Soil organic matter

SSM - Sustainable soil management

SIMS - Soil Information and Monitoring System

1 Introduction

1.1 Problem definition

Soil is a fundamental, conditionally renewable natural resource which not only provides a growing medium to 95% of global food supplies, but also plays an essential role in protecting groundwater, supporting biodiversity, nutrient cycling and by being the largest terrestrial storage of carbon, in climate regulation, as well (Defra, 2009; Fowler, 2019). The degradation and erosion of this vital resource have been receiving an increasing level of scientific and political attention, especially since the loss of soil carbon and other forms of agricultural greenhouse gas (GHG) emissions are being proven to be significant contributors to global warming (Adger & Brown, 1994; Reay, 2020). The deteriorating health of agricultural soils and the transformation of natural habitats into farmlands have gradually directed the attention to certain agricultural practices and land use change as potential culprits behind soil degradation and soil carbon loss (Adger & Brown, 1994; Borrelli et al., 2020).

As soils' potential role in mitigating climate change by carbon sequestration is increasingly recognised (Dignac et al., 2017; Minasny et al., 2017), certain sustainable, "climate-smart" farming practices, such as the use of cover crops, reducing tillage and chemical use, and increasing the number of biodiverse landscape elements on farmlands have gradually become part of the discussion (Food and Agriculture Organization of the United Nations, 2014). Various agri-environmental policies aim to halt the degradation of agricultural soils by encouraging land management practices that benefit their conservation and restoration, while others aim to regulate and limit farming practices that can damage agricultural soils (Prager et al., 2011). In the frame of environmental protection, soil conservation aims to preserve the essential functions of soil, both those that it provides in natural ecosystems and those that it delivers in ecosystems cultivated by man (Stefanovits, 1977).

While the quality of agricultural soils in Hungary is generally considered to be good, several adverse effects have had a negative impact on soil resources since the 1950s, the most important ones being soil erosion (on almost 40% of the country's arable land), physical degradation and soil compaction, acidification and salinisation (Greenland et al., 1994). According to the 2016 agricultural census in Hungary, over 85% of the total area of arable land is cultivated with the use of conventional tillage methods, while only on the remaining approximately 15% do farmers use other cultivation methods that are more beneficial to soil health, such as conservation tillage, direct seeding (no-till) and the use of multi-annual cover plants (Hungarian Central Statistical Office, 2016).

The uptake of sustainable, soil-friendly land management practices by farmers is often hindered by various social, economic, or technological factors (Napier, 2010). On the social barriers that affect Hungarian farmers' decision-making, existing literature has been fragmented and is rarely based on input from stakeholders, a notable exception is a recent EU project that, through a Hungarian case study, investigated the barriers and drivers of a transition towards agroecological farming practices (Balázs et al., 2019). The so far published results of the case study were a good starting point to this research, as they provided insight into different stakeholder group's evaluation of existing policies relevant for agricultural soil conservation, their recommendations for improved future policies, and identified multiple economic, social, and contextual or systemic barriers. The findings of the case study, however, have also gave the impression that utilising additional methods, involving further stakeholder groups, and investigating the problem from different perspectives, can potentially result in a more nuanced, more comprehensive view on the matter.

Improving existing policy instruments for soil conservation can benefit from having a clear view on the factors that hinder farmers in adopting soil-benefitting practices over conventional, often damaging farming techniques, and how current policies intend to achieve positive change (Napier, 2010). While the amount of past and current Hungarian research in soil science and soil management is abundant, the study of soil governance, that is the policies related to the management, conservation, and restoration of soils (agricultural and other types), is surprisingly underrepresented and neglected.

This thesis aims to identify the most common social barriers to farmers' adoption of soil conservation practices in Hungary, as well as the needs that farmers have in order to integrate sustainable practices. The research explores and aims to gain a better understanding of the factors that have an influence on farmers' decision-making on soil management. The thesis also aims to provide an overview of existing information-based policy instruments that intend to influence farmers' soil management practices. While the findings of the empirical study shed light on key stakeholders' views on the strengths and weaknesses of these policies. Furthermore, integrating the recommendations provided by interviewed, observed, and surveyed stakeholder groups, the author provides recommendations for the future improvement and development of effective information-based soil governance in Hungary. The thesis builds both on information gained from the review of relevant academic and grey literature, and data collected from a practitioner-oriented empirical study.

1.2 Background and significance

In Hungary, about 83,6% of the country's 9,3 million hectares of land area is suitable for agricultural use, of which 62,2% is agricultural land (Stankovics et al., 2020). Hungary is an outstanding case when compared to other European countries due to its exceptionally high share of arable farming (81% of all agricultural land) and low share of grasslands (14,2%) (European Commission, 2019). The soils of Hungary are increasingly threatened by a decline in soil organic matter, compaction, decreasing biodiversity and salinisation. Such threats are mainly addressed by regulating agriculture and its relative impacts (Ronchi et al., 2019). Threats on agricultural soils, however, are more than an environmental concern. According to the data of the Hungarian Central Statistical Office, the percentage of the population employed in the agricultural sector was relatively high, 10,97%, in 2017. In 2017, 3,3% of the GDP was realised by agricultural production (Kertész & Křeček, 2019).

Hungary is culturally and historically proud of its agricultural heritage. The 'New Hungary Rural Development Programme' describes arable land as "*a vitally important resource of the country, and thus one of the fundamental factors of production*" (Ministry of Agriculture and Rural Development, 2011). There have been multiple well-known and internationally recognised Hungarian figures in soil science and agricultural science over the course of history, with long-standing reputable scientific institutions dedicated to the research and development of soil science (Várallyay, 2009). There is a unique *Soil Information and Monitoring System* (SIMS) in place in Hungary, operating since 1992 on over 1200 sampling sites (Hidvégi, 2008). As a result of the SIMS, other long-term observations, soil surveys, analytical and mapping activities on diverse scales, there are large amounts of soil information available in Hungary, that György Várallyay, one of the most prominent figures of Hungarian soil mapping, explains with the relative small size of the country (93 000 km^2), the great importance that agriculture and soils possess in the national economy, and "*the historically 'soil-loving' character of the Hungarian people, and particularly the Hungarian farmers*" (Greenland et al., 1994, p. 472).

Hungary's *Soil Conservation Action Plan* (SCAP), adopted in January 2021 by the Ministry of Agriculture, sets three strategic objectives for the protection and sustainable use of agricultural soils in Hungary: 1. Effective soil conservation, 2. Soil conservation knowledge management, and 3. Modern core infrastructure. The action plan is unique in multiple sense: it places the farmer, as the guardian of land, in the centre of its targeted actions, it aims to build on better information, improved exchange of knowledge and experience, and raising awareness on the significance of soils and that of soil conservation farming practices (National Food Chain Safety Office, 2021d). With this rather novel governmental perspective of building a long-term partnership between land-users and authorities, it is ever more integral to understand the barriers that hinder Hungarian farmers' adoption of soil conservation practices. For better-targeted future policies that aim to achieve positive and long-term behavioural change, their current views, attitudes, and beliefs need to be better understood. The action plan primarily proposes information-based policy interventions to address social barriers that currently prevent farmers from integrating more sustainable land management practices.

Information-based policies, such as awareness-raising campaigns, advisory services, labels, certifications, trainings, and knowledge sharing may all potentially influence behavioural factors behind the decisions that farmers make about the use of different soil management practices on their lands. Such factors are, for example, environmental concern or sensitivity, targeting and developing which with the right policy instruments are more likely to result in a long-term environmentally friendly behaviour based on inner conviction than achieving change solely by regulation or economic incentives that may seize to exist with the change of government or the fluctuation of market prices. This is especially true in democratic societies with a market economy (Takács-Sánta, 2008). Information-based policies can potentially contribute to positive behavioural change as stand-alone policy instruments, in combination or complementing other instruments, such as economic and regulatory policies (Mzoughi et al., 2005).

Discussing national policies for soil protection is especially relevant in 2021 and the coming years, as multiple directly or indirectly soil-related European Union (EU) frameworks are being currently updated or are about to be created. These include the new EU Thematic Strategy for Soil Protection, the Zero Pollution Action Plan for Air, Water and Soil (under the EU Biodiversity Strategy), the new EU Nature Restoration Law, the Carbon Farming Initiative (under the Farm to Fork Strategy), and of course, the Common Agricultural Policy (European Commission, 2020). When new or updated EU policies are adopted, Member States will be required to construct their own national frameworks aligned with EU requirements. The EU has also recently provided a long-term vision for European soil protection with its '*Caring for soil is caring for life*' initiative, aiming to ensure that 75% of European soils are healthy by 2030 (European Union, 2020). The potential role of agriculture and soil protection is also featured through multiple actions for climate change drawdown, among them, regenerative agriculture, pasture cropping, agroforestry, crop rotation, intensive silvopasture, farmland restoration and permaculture (Hawken, 2017). Protecting agricultural soils by better farming practices, that are supported by an improved and effective soil governance is a crucial step towards establishing a sustainable and low-carbon food production. Finally, healthy soils and sustainable land use are essential preconditions to achieving multiple Sustainable Development Goals (SDGs), among them, most notably, SDG 2 (Zero hunger), 3 (Good health and well-being), 12 (Responsible consumption and production), 13 (Climate action) and 15 (Life on land) (European Environment Agency, 2019). According to Gonzalez Lago et al. (2019) "*From an anthropocentric perspective, the soil is an increasingly impaired public good that should be protected to ensure intergenerational equity, a central tenet of sustainability*" (p. 98).

1.3 Aim and Research Questions

Building on extensive empirical data collection from a diverse set of stakeholder groups, the primary aims of this thesis are to provide a better understanding of the social barriers that hinder the uptake of soil conservation practices by farmers in Hungary and highlight how information-based policies can potentially help overcoming these barriers. The research therefore attempts to contribute to better future Hungarian policies and their effective implementation for agricultural soil conservation, as well as to improve understanding and collaboration between different stakeholder groups. Better future dialogue and policies can then potentially serve the greater objectives of food security, the protection of soil as an essential natural resource, and ultimately, the resilience of agroecosystems and rural communities.

The above objectives have led to three research questions for this thesis: the first one is descriptive in nature as it aims to provide an overview of the most relevant information-based policies currently in place that aim to or potentially can influence the adoption of soil conservation practices; the second question aims to investigate and present the most common social barriers to the adoption of soil conservation practices by farmers; and finally, the third question is prescriptive in nature as it intends to bring about change by recommending practical interventions for an effective information-based soil governance. There is one sub-question complementing each research question.

The research questions (RQs) are as follows:

RQ1: What are the most relevant existing information-based policies in Hungary that aim to influence farmers' soil management practices?

a. What do relevant stakeholder groups consider to be the strengths and weaknesses of these policies for agricultural soil conservation?

RQ2: What are the most common social barriers to the adoption of soil conservation practices by farmers in Hungary?

a. What do farmers need in order to adopt or continue applying soil conservation practices?

RQ3: How can information-based policies achieve a wider uptake of soil conservation practices by farmers in Hungary?

a. What role do 'trust' and 'participation' play in such policies?

1.4 Scope and delimitations

The scope of this research is limited to the challenge of physical soil degradation in arable lands that is strongly affected by certain farming practices. While exploring barriers to the uptake of soil conservation practices by farmers, emphasis was placed on social, and to a lesser extent, institutional factors. As far as the discussion on existing policies is concerned, currently in-place information-based policies were primarily considered that target the conservation or restoration of agricultural soils through sustainable land management practices. Particular policies were not evaluated or assessed as part of this research, only the objectives and basic features of the policies were outlined. Policy recommendations were partly guided by the critical review of the recently adopted *Soil Conservation Action Plan* and its feasibility in the current socio-political landscape. The research did not intend to assess or discuss the effectiveness of particular soil conservation practices. The research scope, with regard to discussed policies and practices, is geographically limited to Hungary. While the online survey targeted only farmers who are actively involved in arable farming in two Hungarian counties: Fejér and Somogy counties.

1.5 Ethical considerations

The research did not receive funding from any external organisation and there were no external actors who could influence the analysis or the conclusions of this study. The author holds a position as policy officer at a Budapest-based regional (Central and Eastern European) non-governmental environmental organisation (NGO). Her employer, however, does not formally support or influence the research and will not use the findings of the thesis. Interviews, surveys and all thesis-related research were conducted solely in the author's capacity as a university student. There are no external expectations of any kind from the author to conduct her research in any particular way other than how she, as a university student, sees it fit.

All contacted subjects could voluntarily decide whether to participate or refuse to participate in any interview or the survey. Responses to the questionnaire were anonymous, personal data was requested only on matters, such as: gender of respondent, age interval, county within Hungary, size of farm, level of education. These data do not make it possible to identify respondents. Individual responses to the questionnaire or recorded interviews will not be shared with third parties. In case of the interviews, all subjects were asked explicitly whether they consent to indicating their name and/or position, affiliation in the research. The subjects' preference was naturally respected and accepted in the research process. Participants did not suffer any disadvantage or damage during the research process.

Any sensitive information or data collected during the research process are stored on the author's laptop hard drive to which access is restricted by password, allowing only the author of the thesis to access it. Passwords or access paths are not shared with third parties. With regard to any other ethical aspects, the author follows the instructions and recommendations identified by Blaikie & Priest (2019).

The research design has been reviewed against the criteria for research requiring an ethics board review at Lund University and has been found to not require a statement from the ethics committee.

1.6 Audience

The intended audience for this thesis includes policy-makers, soil conservation authorities, national and sub-national decision-makers, and the representatives of farmers'- or farm advisory organisations, who wish to gain a better understanding of the various factors that lay behind farmers' decision-making on adopting soil management practices for the sustainable use and conservation of arable soils. The findings and recommendations of this thesis can be beneficial to all relevant stakeholder groups, both governmental and non-governmental, whose aim is to improve the development and implementation of future policies and so better support farmers' transition to sustainable farming practices. The thesis can also provide value to researchers in fields related to sustainable agriculture and soil conservation, highlighting novel approaches and new areas for further research.

1.7 Outline

The thesis follows the below structure:

Chapter 1 - 'Introduction' presents the environmental and policy challenge addressed in the thesis, and the general background and significance of the research topic. The chapter furthermore identifies the aim, scope, delimitations, and research questions, and describes the intended audience of the thesis.

Chapter 2 - 'Literature review' presents an analysis of the immediate field of study by the review of relevant academic and grey literature, outlining current knowledge related to the topic and the research questions in particular. It furthermore provides an overview of the relevant theories and the conceptual framework that this thesis builds upon.

Chapter 3 - 'Research design, materials and methods' presents the research design, detailing data collection and analysis methods, and the types of materials and sources used for the research and the empirical study.

Chapter 4 - 'Findings and Analysis' presents the main findings and interpretation of the empirical research, highlighting the dominating themes with examples; guided by the conceptual framework.

Chapter 5 - 'Discussion' provides an overview on the significance of the findings of the thesis, and reflects on the methods and limitations of the study.

Chapter 6 - 'Conclusions and Recommendations' summarises the empirical and policy conclusions of the thesis and highlights areas for future research. The chapter also provides a list of practitioner-oriented recommendations as formulated in response to the third research question.

2 Literature review

This section provides an overview on the most relevant pressures, state, and impact from unsustainable farming practices on the arable soils of Hungary, as well as the societal responses provided to them from the side of soil conservation practices and information-based policies. The literature review, furthermore, provides an overview on the existing body of knowledge on the most common social barriers that hinder Hungarian farmers' wider uptake of soil conservation practices.

2.1 Arable farming and the degradation of arable soils

Before zooming in on the issue of soil degradation in Hungary's agricultural lands and the various management and policy responses given to it, it is beneficial to put into context and, for a better understanding, to take a closer look at the main characteristics of arable farming and the farming community in Hungary.

Arable farming in Hungary

As briefly mentioned in the *Introduction*, almost 85% of Hungary's total land area is suitable for some kind of agricultural activity (including forestry), the exact extent is largely dependent on the fertility of the soil. The physical condition of Hungarian farmlands, such as quality of land, soil type, and climatic conditions are generally considered to be favourable for agricultural productions, although there are some regional differences within the country (Bozsik & Koncz, 2018).

Based on the terminology used in the 2016 Agricultural Census and the ones before, carried out by the Hungarian Central Statistical Office, we can differentiate, on the basis of legal form, between two main types of farms in Hungary: agricultural enterprises that are units with legal entity, and private holdings that have no legal entity. Within both groups, we find multiple sub-categories depending on the purpose of production. These sub-types are: Specialist holdings - animal production; Specialist holdings - crop production; Mixed holdings; and Non-classified holdings. Looking at the area of holdings (in hectares, according to the 2016 Hungarian agricultural census) in *Table 2-1* by the two main legal forms, arable land constitutes by far the greatest share of agricultural area in Hungary (Hungarian Central Statistical Office, 2017).

Table 2-1. Area of holdings by agricultural land use categories and legal forms

	Agricultural area	Arable land	Kitchen garden	Vineyard	Orchard	Grassland
Agricultural enterprises						
Total	1 945 917	1 673 874	477	14 584	19 801	237 182
Private holdings						
Total	2 724 350	2 156 512	7 995	48 861	58 460	452 522
Total						
Total	4 670 267	3 830 386	8 472	63 445	78 261	689 704

Source: Hungarian Central Statistical Office (2017)

In addition to the above indicated agricultural area, productive land area in Hungary also includes forests (1 335 131 ha), reed (21 752 ha) and fish ponds (25 557 ha), making the total productive land area of the country 6 052 706 hectares. The average area used for arable farming is 251,1 hectares per holding in case of agricultural enterprises and 9,4 hectares in case of private holdings. (Hungarian Central Statistical Office, 2017)

According to Eurostat's 2018 edition of 'Agriculture, forestry, and fishery statistics', 81,4% of Hungarian farms are under 5 hectares in size, so they, similarly to the two-thirds of farms in the EU, constitute as small farms. However, between 2005 and 2016, the number of farms above 10 hectares increased in Hungary (Eurostat, 2018).

The sown area by group of crops (See *Table 0-1* in *Appendix 1*) shows that cereals (mainly wheat, maize, and barley) and industrial crops (in highest quantities, sunflower, rape and soya-been) dominate arable crop production in Hungary. The dominance of crops like maize and sunflower has relevant implications for soil conservation, since traditionally, with their shallow roots, greater row width, and thus greater uncovered soil surface, the area where they are produced is often more prone to soil erosion, especially in case of sloped fields. (Finke et al., 1999; Fujisao et al., 2020).

Looking at the characteristics of the labour force in Hungarian agriculture (See *Table 0-2* in *Appendix 1)*, we can see that 31,3% of private farm holders are above the age of 65, while only 21,3 % of Hungarian farmers are under the age of 45. In the EU, "*for every farm manager under 40 in 2016, there were three farm managers over 65*" (European Commission, 2021a). These numbers indicate a tendency of an aging farming community and a slow generational renewal of farmers and landowners in Hungary, as well as in the EU. According to the European Commission's 2021 report evaluating the impact of the CAP on generational renewal, Hungary is the only EU Member States with a dedicated young farmers' sub-programme, as part of its Rural Development Programme, and yet, the percentage of young farmers is still rather low (European Commission, 2021a).

According to the 2016 Eurostat data on the gender ratio of farm managers: in Hungary, 27% of farms is managed by a woman, which is only one percent below the EU average (28%). Member State-level ratios are spread between the highest, 45% share of farms managed by a woman in case of Austria and the lowest share, 5% in case of the Netherlands (Kovačiček & Franić, 2019).

As far as the agricultural qualification of Hungarian private farm holders is concerned (See *Table 0-3* in *Appendix 1)*, the farming community is overwhelmingly (73%) dominated by holders whose agricultural knowledge comes primarily from practical experience, with about 10% having secondary level agricultural qualifications, and only 3,4% percent has college or university education (Hungarian Central Statistical Office, 2017).

Another characteristic with relevance for the theme of this research is the types of farms as per tenure. On average, about 42% of agricultural lands in Hungary is farmed by tenant, with significant differences between land use categories. The share of agricultural land area farmed by tenant is the highest (55%) in case of arable lands, while only 21% in case of vineyards and orchards (Szabó, 2020). According to the 2010 Hungarian Agricultural Census, the percentage of agricultural land of total utilised agricultural area farmed by tenant was even higher (49,9%), while 43,5% of lands was farmed by owner and 6,5% was described as shared farming or other modes (Hungarian Central Statistical Office, 2011). With regard to soil management, these are relevant factors from multiple perspectives. Oftentimes, due to short-term contracts, tenants will not be necessarily incentivised or motivated enough to invest in the necessary soil conservation technology or know-how that would bring measurable benefits only in the medium or long run; carrying even the risk that once the contract between tenant and landowner is terminated, the new tenant or the owner would simply go back to conventional farming (K-Monitor, 2020).

In Hungary, there is also a growing tendency of large-scale investors, such as bankers and other businessmen, purchasing arable lands of thousands of hectares, and then leasing them for the financial benefits (both from area-based and other types of agricultural subsidies and from the selling of crops and other products). Such landowners do not necessarily have an educational background or practical experience in agriculture and so, it is rare, though not without good examples, that they would be willing to make long-term investments in new technologies that are more favourable to the state and health of the soil (Domaniczky, 2021). Another relevant negative consequence of this increasing tendency of business-focused land concentration is that farming subsidies are paid to the landowner and not to the tenant who actually farms the land. This way, even if the farmers themselves were open or committed to the application of soil conservation practices, they will not be the ones who receive financial incentive or support to invest in such technologies (Domaniczky, 2021; K-Monitor, 2020).

In the past decades, the area used for food production is gradually decreasing in Hungary, due to the increasing level of "land-take", that is the withdrawal of agricultural lands (often with good-quality soil) from cultivation and transforming them to roads for transport and infrastructure, or construction sites for other developments. Along with the degradation of agricultural lands used for food production, land take constitutes a major threat to soils (Bozsik & Koncz, 2018).

The degradation of arable soils in Hungary

Soil degradation is described by Várallyay (2015) as a complex process that usually involves several factors that contribute to and result in unfavourable changes in soil processes and soil properties. Such changes can be, for example, the loss of or decrease in soil fertility and consequently, productive capacity; limitations in normal soil functions; and/or the deterioration of the different environmental functions of the soil. Soil degradation may be the result of natural factors and/or human activities (Várallyay, 2015). Kertész and Krecek (2019) also highlight the negative effects that the reduction or loss of biological productivity can have on the healthy functioning of the land and related ecosystems.

This thesis primarily focuses on practices that can potentially provide solution to different forms of physical soil degradation. Physical soil degradation, according to Gliński et al. (2011) comprises of different processes through the deformation of the inner soil structure by:

- compaction, caused by the use of heavy agricultural machinery on land;
- erosion by water and wind;
- the formation of crusts at the soil surface;
- chemical impacts such as salinisation and alkalinisation.

There are varying levels of soil degradation on about 40% of all agricultural lands, which is approximately 2,6 million hectares. Around 34,8% of the soils are sensitive to degradation and compaction, 13,9% are non-sensitive 23% are slightly sensitive, while 28,3% have moderate sensitivity (Birkás et al., 2012).

Large areas of Hungary are exposed to wind erosion, and about one-third of the country is furthermore exposed to water erosion, as well. *Table 2-2* provides an overview of the main types of degradation affecting agricultural soils in Hungary.

Table 2-2. Main types of degradation in the agricultural soils of Hungary

Type of degradation	Value	Unit
Water-logging damaged	0,3 – 0,5	million ha
Compaction problems	1,9	from total area, million ha

Soils, sensitive to degradation and compaction	34,8	%
Soils, non-sensitive to degradation and compaction	13,9	%
Soils, slightly and moderately sensitive to degradation and compaction	51,3	%
Area affected by water erosion	2,31	from total area, million ha
Area affected by wind erosion	1,4	from total area, million ha
Acidification, severe	0,65	from total area, million ha
Acidification moderately, weakly	3,9	from total area, million ha
Salinisation problems	0,946	from total area, million ha
Salinisation in deeper soil layers	0,245	from total area, million ha

Source: Adapted from Birkás et al. (2012)

According to Kertész & Křeček (2019), certain agricultural activities, such as the application of heavy machinery on intensively cultivated fields are among the main triggering factors of physical soil degradation processes. The long-continued use of heavy machinery on arable land frequently results in the compaction of the soil into permanent furrows. These furrows then can act as water channels, resulting in decreased absorption and increased erosion. After years of continued heavy machine-use and resulting soil compaction, a so-called 'plough pan' or 'plough sole' is formed, which is basically a layer of compacted subsoil below the level of soil that is turned over in the process of tillage, inhibiting root growth and by trapping water, it also leads to waterlogging (Goering et al., 1993). Soil compaction and resulting 'plough sole' formation can be especially damaging when the depth of tillage is constant and continued for a long time, as well as when heavy machinery is used on wet ground (Goudie, 1981).

The below map of Hungary displays areas in different colours where soils are to some degree susceptible to physical degradation.

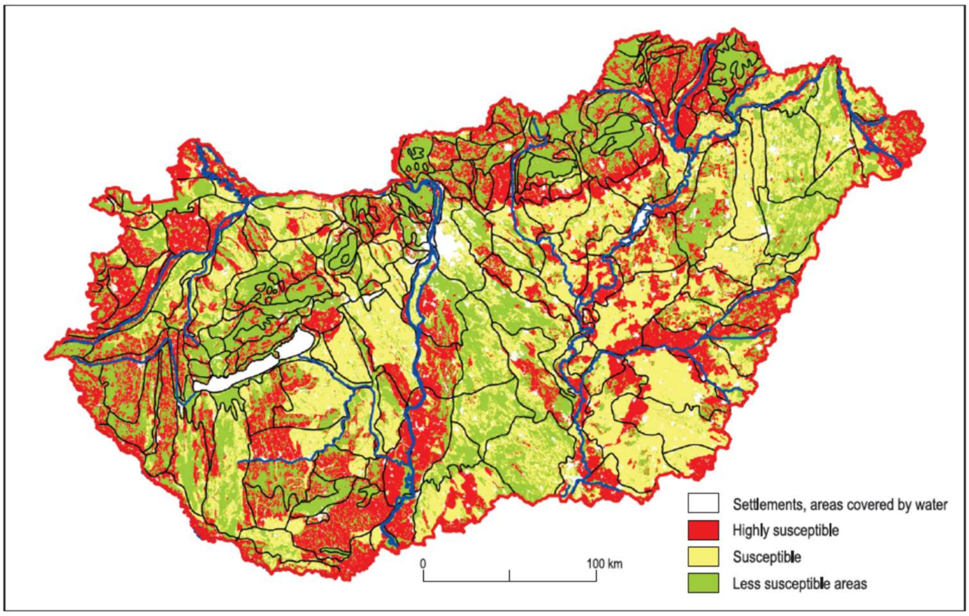

Figure 2-1. Areas in Hungary that are susceptible to physical soil degradation

Source: Kertész and Křeček (2019)

According to the 2017 Environmental State of Hungary report, approximately 25% of the soils of Hungary are degraded by water and wind erosion. The average annual soil loss from degradation constitutes 40 t/ha in mildly eroded areas, 70 t/ha in areas affected by medium-level erosion and 90-100 t/ha in heavily eroded areas. As a result of increasingly frequent severe summer downpours, the level of soil degradation can even be as high as 500-700 t/ha (*Magyarország Környezeti Állapota 2017*, 2018).

The loss of fertile topsoil to wind and water erosion in European farmlands, is significantly higher than the natural rate of soil formation. Usually, the most fertile soil erodes first which then results in reduced yields and crops becoming prone to drought, various diseases, and pest damage. Eroded soils are also lower in organic matter and are less able to hold moisture (Goering et al., 1993).

Salinisation is an important soil degradation process in Europe, with heavily affected areas in Hungary. Salinisation is the accumulation of water-soluble salts near the soil surface. Salinisation, either as a result of the natural soil formation process or as a consequence of human activities (secondary salinisation), for example, inappropriate irrigation practices, can lead to unproductive soils and other environmental problems. Especially in the lowland areas of Hungary, salinisation is a widespread soil degradation process (Kertész & Křeček, 2019). The main agricultural activities that can result in soil salinisation are rising groundwater levels as a result of improper irrigation and inappropriately designed irrigation systems.

Although this thesis is not specifically discussing the issue of soil contamination and pollution, it is important to point out that about two thirds of Hungary is exposed to potential nitrate pollution susceptibility. Overall, however, significant diffuse or point source water pollution of agricultural origin is relatively rare in the country (Birkás et al., 2012).

Hungary's climate is continental, but in recent decades, extreme weather events are more and more frequent in the country, with an impact to agriculture, as well (Birkás et al., 2012). Unequal rainfall distributions as a result of climate change often lead to drought or floods. According to Kocsis et al. (2020), droughty periods not only occur more often, but their impact on agriculture is also increasing, negatively influencing, albeit to different levels, the fertility of agricultural soils. In addition to the growing extent of aridity, increasing mean temperature can also result in higher levels of drought sensitivity in soils (Kocsis et al., 2020).

Soil resilience, however, is a relevant factor in preventing, eliminating or at least moderating soil degradation processes that emerge as a result of weather extremes. But, according to Várallyay (2011), this is possible only with "*permanent control and widely adopted soil (and water) conservation technologies, as indispensable elements of sustainable site-specific precision soil management*".

2.2 The application of soil conservation practices

Sustainable agriculture, according to Pretty (2002), starts with the soil with the aim to reduce soil erosion, to improve the physical structure of the soil, as well as its organic matter content, water-holding capacity and nutrient balance. There are multiple agricultural approaches that integrate soil conservation practices: conservation agriculture, regenerative agriculture, integrated food production, ecological or organic agriculture, or agroecological farming. A common feature of all these is the sustainable management of soils. In the *Voluntary Guidelines for Sustainable Soil Management* by the Food and Agriculture Organisation (FAO) of the United Nations, "*soil management is sustainable if the supporting, provisioning, regulating, and cultural services provided by soil are maintained or enhanced without significantly impairing either the soil functions that enable those services or biodiversity. The balance between the supporting and provisioning services for plant production and the regulating services the soil provides for water quality and availability and for atmospheric greenhouse gas composition is a particular concern*" (FAO, 2017b).

Conservation agriculture builds on the below three main principles for associated objectives, while being adapted to reflect local conditions and needs:

Table 2-3. The main principles and objectives of conservation agriculture

	Principle	Objective
1	Minimum mechanical soil disturbance (i.e. no tillage) through direct seeding or fertiliser application.	to reduce soil erosion and to preserve soil organic matter
2	Permanent soil organic cover (on at least 30% coverage) with crop residues and/or cover crops.	to suppress weeds, preserve soil moisture, avoid soil compaction and to protect the soil from extreme weather patterns
3	Species diversification through varied crop rotations and plant associations involving at least three different crops.	to promote good soil structure, to foster soil biodiversity for improved nutrient cycling and plant nutrition, and to prevent pests and diseases

Source: Adapted from FAO (2017a)

Soil health can be further improved through the use of legumes, green manures, the application of compost and animal manures; and where required, the use of inorganic fertilisers (Pretty, 2002). The previously mentioned FAO guidelines provide a detailed overview of those characteristics that are generally associated with sustainable soil management (See *Table 0-4* in *Appendix 2*).

Although, soil erosion and other forms of soil degradation are influenced by various factors that farmers cannot really change, such as soil type, or the slope of the land, sustainable management practices can effectively contribute to building healthy soils and so, improve the physical structure, biological activity, and other properties of the soil (Bowman et al., 2016). The below figure displays the main levels of soil health degradation with their distinctive characteristics and effects to various soil functions (on the righ-side bulleted list), like organic matter content, soil structure, water-holding capacity, productivity, or resilience to diseases. While in the left-side arrows, examples to adequate interventions by farmers are provided that can offer remedy at different levels of soil degradation in order to restore soil health.

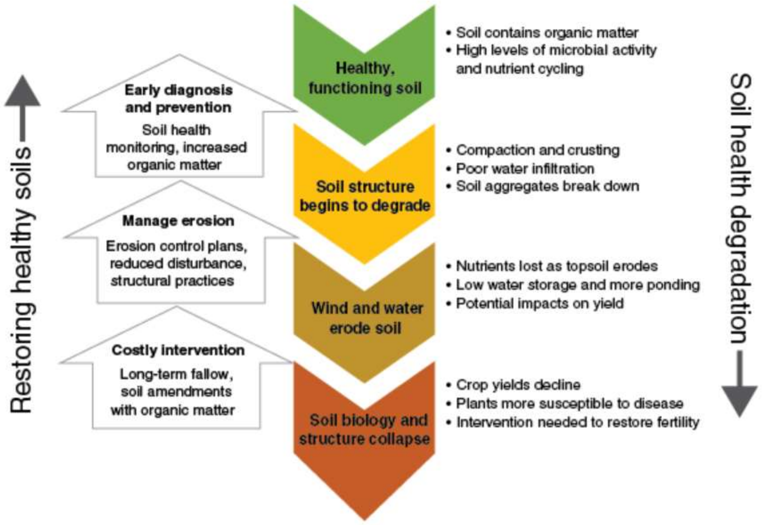

Figure 2-2. The process of soil health degradation and restoration through farmer's interventions

Source: Bowman et al. (2016)

The interventions range from preventive measures to more costly and drastic interventions, suggesting that intervening at an earlier stage of soil degradation is more beneficial to the farmer with regard to invested effort and finances, than postponing action and intervene only when the developed situation forces the farmer to take more radical action.

In order to make the right decision for intervention, soil health can be assessed using a variety of indicators not only by scientists in a laboratory, but also by farmers in the field. The indicators in *Figure 2-3* are able to provide relevant information to both farmers and laboratory personnel, on the physical, biological, and chemical aspects of soil health. Various in-field and scoring systems can help farmers gain a better understanding on the health of their soil, while for more complex analyses, they can still send soil samples for laboratoty testing. Healthy soils are generally known for having high levels of microbial activity, organic matter content, and a good soil structure. Soil organic matter (SOM) in particular provides several important benefits, such as improved water-holding capacity and nutrient cycling, while it is also a good indicator of soil structure and function. An additional benefit is that farmers can measure it relatively easily and see for themselves how the SOM of their soil changes over time (Bowman et al., 2016).

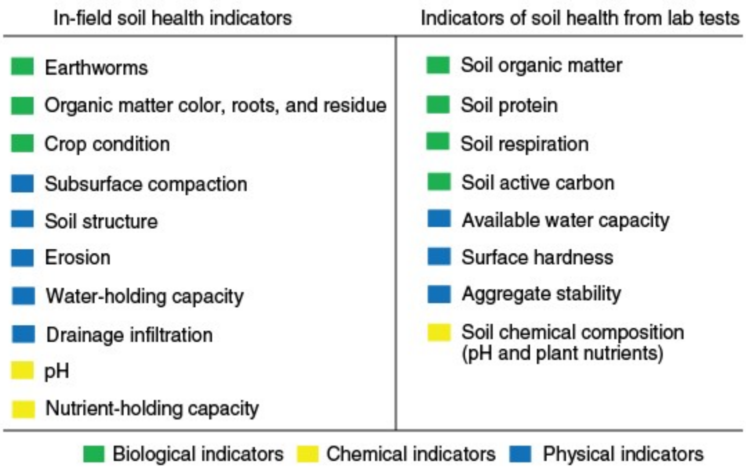

Figure 2-3. Indicators to assess soil health in the field and in a laboratory

Source: Bowman et al. (2016)

In the Hungarian-language literature and everyday language, various terms are used to describe arable agriculture that builds on sustainable soil management, these include: "*talajkímélő gazdálkodás*" (in direct translation to English: "soil-sparing farming"), "*talajvédő gazdálkodás*" (soil conservation or soil protection farming), "*talajmegújító gazdálkodás*" ("soil regenerative farming").

Birkás (2017) distinguishes between the below soil management approaches, that can improve the impact of soil interventions, in a book called "*Talajművelési ABC*" (in English, "Soil Management ABC"):

Table 2-4. Soil-improving management approaches

	Name of soil management approach	**Objective**
1	Adaptable/Adaptive soil management	to improve and preserve soil quality in harmony with the land, machinery, and management conditions; the achieved soil condition is able to mitigate harmful climate effects

2	Energy-efficient soil management	to establish a soil condition fit to the needs of the grown crop and tailored to the conditions of the land with as few interventions and costs as possible
3	Sustainable/Sustaining soil management	to preserve and improve the soil condition to become favourable from the aspect of crop production, as well as the environment; adapting to field and economic conditions; controlling physical, biological, and chemical load; mitigating climate sensitivity
4	Soil-sparing soil management	to spare the physical and biological state of the soil; avoiding and mitigating damages for the security of crop production
5	Climate damage-reducing soil management	to mitigate the climate sensitivity of the soil by controlling the water and carbon cycling as required; retaining moisture and protecting soil structure and organic matter

Source: Adapted from Birkás (2017)

Birkás et al. (2017) provides a historical overview, in *Table 2-5*, of the development of soil tillage in Hungary, and on the main characteristics of each era that had an influence on the particular type of tillage practice. She even attempts to have optimistic and hopeful projections about the future, stating that the years around or after 2020 will be described as the "Soil and environment conservation period", characterised by the progressive recognition of sustainability principles and increased efforts made for soil quality improvement.

Table 2-5. Soil tillage development in Hungary

Eras of soil tillage development	Main characterization of the era*
1. Early (–1700)	Lack of tools and expertise (–)
2. Introduction of low intensity farming techniques (1700–1800)	Challenges in crop production (±)
3. Multi-ploughing systems (1750–1900)	Soil structure deterioration (–)
4. Reasonable tillage (1860–1920)	Adoption to soil state (+)
5. Conventional tillage (1900–1988) *5.1. Classic, based on draught animal (1900–1960)* *5.2. Temporary, partially mechanized (1920–1970)* *5.3. Technology focused, fully mechanized (1960–1980)*	High dependence on weather conditions (–) Adaptability to soil state (+) Crop focusing efforts, deterioration in soil quality (–)
6. Energy saving and soil conservation tillage (1975–1988	Soil quality focusing tillage (+)
7. Modern adaptable tillage (1988–) *7.1. Declining period (1988–2000)* *7.2. Period of transition (2000–2015)* *7.3. Soil and environment conservation period (?2020–*	Deterioration in soil condition (–) Climate threats (–); New challenges in soil conservation (+) Recognition of sustainability principles, soil quality improvement (+)

*+ progressive, – regressive, ± both features.

Source: Birkás et al. (2017)

According to the 2016 Hungarian Agricultural Census, in Hungary, the use of conventional tillage (mouldboard plough or disc plough) with a share of more than 85% overwhelmingly dominates the applied cultivation methods in arable lands. In comparison, the use of conservation tillage and no tillage/direct seeding, constitutes only 9 and less than 1% respectively of the applied cultivation methods (See *Table 0-5* in *Appendix 2*).

The presence or lack of soil cover by some kind of vegetation has serious implications for not only the moisture and organic matter content of the soil, but also to the erosion risk of a particular land area (Kertész & Křeček, 2019). Alarmingly, in Hungary, over 42% of arable lands are left bare during the winter months, while on the remaining land, some level of vegetation cover is provided by normal winter crops, cover crops, plant residues or by multi-annual plants (See *Table 0-6* in *Appendix 2*) (Hungarian Central Statistical Office, 2017).

Crop rotation plays an important role in optimising nutrients in the soil, combatting harmful pests and weeds, and thus eventually its use improves soil health (FAO, 2017a, 2017b). In this regard, largely as a result of related regulatory policies and recommendations, according to statistical data, Hungary performs relatively well. In case of about 74% of the total arable land area of Hungary, the share of arable land included in the crop rotation is between 75 and 100% (See *Table 0-7* in *Appendix 2*) (Hungarian Central Statistical Office, 2017). Generally, the bigger the farm, the higher the share of the area that is in the crop rotation. On farms below one hectare, 49% of the outdoor arable area is not included in the crop rotation, while on farms above 300 hectares, on 79% of the arable area, the share of crop rotation is between 75 and 100% (Patay, 2018).

With regard to nutrient management, it is worth pointing out that while the use of synthetic fertilisers is gradually increasing, the rate of area in Hungary that is treated with organic manure has decreased by 21,5% between 1994 and 2005, while the quantity of manure used has dropped by nearly 25,5% (Ministry of Agriculture and Rural Development, 2011). The use of organic manure and/or otherwise integrating livestock in crop production, as in mixed farming systems, can potentially optimise resource efficiency on a farm-level, while limiting negative environmental impacts, and improving SOM content and soil fertility (EIP-AGRI, 2017).

Agroecology as an alternative, sustainable and holistic farming approach, has gained great momentum with increased scientific and policy recognition in Hungary, as well (Balogh, 2021; Ujj et al., 2020). Several elements of soil conservation farming are part of the agroecological approach, too, such as crop rotation, the use of green manure (cover crops), mulching and animal manure, and soil management that aims to preserve or increase the SOM content, and intervenes only if or to a level that is required (reduced or no tillage) (Bezner Kerr et al., 2021). Agroecological farming and the transition from intensive crop production to agroecology are supported and advocated for by several Hungarian organisations, from the side of research, civil society, and to some degree, governmental institutions (Ujj et al., 2020).

2.3 Social barriers to farmers' adoption of soil conservation practices

Birkás et al. (2017) in their overview of the history and emerging challenges of soil tillage in Hungary, identified the below factors with either a limiting or enabling influence on farmers' adoption of new, more sustainable soil management methods (in this case, meant mostly for conservation tillage). Social factors are marked with (S).

Table 2-6. Factors influencing the adoption of conservation tillage

Barriers/Limiters:	Enablers:
• (S) traditions stuck to the multi-ploughing practice • (S) outright refusal or rejection of adopting or even trying any other soil management practice different from traditional ploughing • (S) lack of knowledge on soil and plants • (S) "blaming the weather instead of recognising soil structure defects" • (S) "insisting on applying the same old routines instead of learning and adopting new techniques" • (S) general poor view of soil conservation tillage techniques	• (S) increased research and experiments on alternative soil management practices • increase of fuel prices • dry seasons • economic pressures • (S) "a new appreciation of expertise and recognition of the need for soil preservation" • greater variety of available tillage equipment on the market • (S) farmers/landowners with up-to-date knowledge on soil management • weather extremes

• "in the 1950s, farmers had an obligation applying deeper (more than 20 cm) ploughing, which was considered to be the guarantee for higher yields" • (S) outdated beliefs • (S) during wet periods (especially during autumn) farmers tend to return to conventional tillage methods • (S) over-estimation of crop-requirements • inadequate draught power of farming machinery • (S) traditional attitude towards farming methods	• crust formation on the topsoil • soil depletion • threats of climate change • (S) interest in novel approaches to soil management from abroad • (S) landscape- and crop production research institutions were established or reactivated • low yields on soils degraded by improper tillage • foreign publications and results on reduced tillage

Source: Adapted from Birkás et al. (2017)

A recent Horizon 2020-funded project (UNISECO) with a Hungarian partner organisation and a case study focused on '*Sustainable resource management to increase economic viability in mid-sized arable grain-protein-oil cropping farms in Hungary*' to some degree investigated barriers of relevance to this research and even provided various recommendations for more effective policy interventions in order to overcome such barriers. Both the identification of barriers and the formulation of recommendations built on a participatory approach and so the active involvement of relevant stakeholders, which further increased the relevance of the project findings to this thesis.

The Hungarian case study of the UNISECO project aimed to explore different transition strategies which address the barriers and drivers of soil conservation farming. The case study considered the adoption of soil conservation practices to be the first step in market oriented arable farming systems towards an agro-ecological transition. Within social barriers, the case study differentiates between cognitive and normative barriers: cognitive ones referring to the traditions and customs of arable farming, in which, for example, most farmers regard tillage or ploughing as an essential and inherent part of soil cultivation; while normative barriers refer to the low level of social capital among Hungarian farmers as a result of a culture of individualism that appeared after the collapse of the socialist regime, generally characterised by inefficient or non-existent cooperation among farmers (UNISECO, 2021b). *Table 2-7* contains further barriers identified in the case study. For more aspects, see *Section 2.4* and the stakeholder views on existing policies.

Table 2-7. Identified social barriers in the Hungarian case study of the Horizon 2020 UNISECO project

UNISECO (2021)	• lack of knowledge and openness to alternative practices and technologies • negative farmer attitudes towards agro-ecological farming • low social capital • lack of specific agro-ecological advisory services • lack of available and meaningful data from a soil monitoring system to farmers • intergenerational conflicts between older and younger farmers on "how things used to be done" versus "how things should be done" • financial aspects outweigh the importance of soil conservation • individualistic thinking, lack of cooperation or information/experience-sharing among farmers

Source: Adapted from UNISECO (2021) and Balázs et al. (2019)

Based on the assumption that the main kinds of social barriers to the adoption of sustainable soil management practices can show similarities around the world, this research also integrated the findings of academic studies that investigated such barriers in a geographical context other than Hungary. The reviewed studies provide, mostly in the context of the United Kingdom, a helpful insight into the main factors that affect farmers' choice of land management practices; as well as into the methods, theories, and approaches that these studies used.

Looking beyond the technical, climatic and bio-physical factors resulting in the degradation of agricultural soils, various underlying causes emerge in the wider socio-economic and political context in which farmers operate (Deeks, 2014). When it comes to farmers' decision-making on farm management, agricultural policies, available information, and economic incentives play important roles. The introduction of new policies, however, does not automatically guarantee the uptake of encouraged farming practices, nor successful ecological and environmental outcomes (Napier, 2010). In order to understand what social factors influence farmers' adoption of agri-environmental measures in general and soil conservation practices in particular, we need to look at personal and institutional factors. *Table 2-8* provides an overview of the most common social barriers identified by reviewed literature.

The reviewed papers use varying data, methods and build on different theories in their quest to identify the most relevant barriers, social and others, to farmers' uptake of soil conservation or other sustainable farming practices. Napier (2010) draws on various adaptation theories to explain how different factors affecting farmers' decision-making relate to each other. In its approach on social factors in the adoption of soil conservation practices, the study distinguishes between the 'Innovation-diffusion-adoption paradigm' and the 'Adopter perception paradigm'. While the former states that the key factor that determines what decisions are made on adopting new practices is access to information, the later argues that it is the perception that there is a need for innovation which drives the adoption process. In this second paradigm, personal factors, such as education, experience and human values also play a crucial role, just like institutional factors and aspects related to the land itself (Napier, 2010). Although knowledge often appears as a significant factor in decision-making processes about adopting new practices, Napier (2010) concludes that it is surpassed by institutional and personal factors at the cognitive level.

Ervin & Ervin (1982) agrees with Napier's statements on several points, in fact, almost 30 years before Napier's paper, they also built on a similar theoretical approach in their research. The 1982 paper applies the so-called "innovation-diffusion theory" to the adoption of environmental practices, like soil conservation. The theory distinguishes between three explanations of adoptive behaviour: psychological innovativeness, profitability orientation, and orientation to farming as a way of life. The study also provides a historical perspective by pointing out that surveys carried out in the 1970s connected level of education, farm size and gross income to the number and diversity of practices that farmers apply on their farms, arguing that the lower the level of these factors, the lower the number of applied land management practices (Ervin & Ervin, 1982).

Prager et al. (2011) identified relevant social barriers, presented in *Table 2-8*, by building on the findings of ten case studies with the aim to understand how various types of policy measures can contribute to encouraging farmers' adoption of effective soil conservation practices. The study describes the analytical framework and methodology that the case studies use, while Prager et al. (2011) itself uses a common framework, the 'Institutions of Sustainability' framework, as guide that takes the interdependencies between ecological and social systems into consideration.

Deeks (2014) in her PhD dissertation, argues that the central factors influencing farmers' management decisions are their individual personalities, environments, and specific circumstances. She also emphasises that the information sources that farmers use also play an important role, thus referring to farm advisors as integral actors in shaping the uptake of various agricultural management practices by promoting agri-environmental schemes (Deeks, 2014).

Another PhD dissertation by Ingram (2005) puts advisory services rather than farmers in its focus of investigating social barriers to the greater uptake of sustainable soil management practices. She argues that the knowledge, skills, and approach of farm advisors, as well as the often-changing governance structure of farm advisory services in a particular country both heavily impact farmers' transition towards more sustainable farming practices.

A policy brief by the Horizon 2020-funded Soil Care project highlights the building of social capital for farmers as a major enabler and recommended area of intervention for policy makers, mentioning various factors that can easily become barriers to the adoption of sustainable farming practices, such as norms, trust, connectedness and power, and the lack of these (Rust et al., 2020).

Table 2-8. Social barriers identified by reviewed literature, in a foreign context

Source	Identified social barriers
Napier (2010)	no access to information; no perception of need for innovation; uncertainty about effectiveness of new practice; lack of problem perception; lack of personal motivation; missing example or peer pressure; lack of awareness or education of land users on the consequences of soil degradation and the benefits of soil conservation
Ervin & Ervin (1982)	soil erosion not considered as an imminent problem; no available information on costs and benefits; reluctance to change familiar practices
Prager et al. (2011)	lack of ability or willingness to cope with complex application procedures to agri-environmental schemes; trade-off between long-term commitment and short-term benefits
Rust et al. (2020)	lack of trust towards advisors and institutions providing information; the lack of connectedness to a wider farmers' community network; lack of power in landlord-tenant relationships
Deeks (2014)	soil management seen as a complicated issue; confidence in own knowledge and practices; lack of specialised knowledge on soils; high reliance on modern technologies (intensification)
Ingram (2005)	lack of advisers' competence and skills in knowledge intensive soil best management practices; farmers preferring slight alterations in current practices to whole system changes; farmers' reluctance to share knowledge with peers to retain competitive advantage; unfamiliarity of environmental problems and technical solutions; privatisation of advisory services results in reduced trust and loss of publicly funded service

Based on these findings and the theories that the reviewed studies applied, social barriers identified in reviewed literature can be roughly categorised as follows:

Table 2-9. Main categories to which identified social barriers from reviewed literature belong

	Categories
1	Knowledge on agroecosystems and the perception of problems affecting them
2	Access to or quality of available information; Trust towards information source
3	Personal beliefs and attitude towards new approaches and practices
4	Norms, peer influence and networks
5	Social capital, owner-tenant power relations
6	Knowledge on and understanding of new approaches and practices

The use of behavioural science for agricultural development

When investigating the human factors, and the institutional or organisational arrangements that may put a constraint on the adoption of certain technologies, practices, or novel approaches for agricultural development, behavioural science might offer a solution (Saint & Coward, 1977; Somerville, 2020). Research from as early as 1977, has critically examined the various ways and theoretical approaches how multidisciplinary studies, involving behavioural scientists, could improve our understanding and later policy responses to social and institutional barriers in the adoption of agricultural technologies. Saint & Coward (1977) discuss how the '*Diffusion of Innovations*' theory by Rogers (1983), which first appeared in 1962, approaches the subject, identifying factors like communication, perceptions, values, local cultures, and motivations playing relevant roles in the adoption or rejection of innovations. The study also explores the potential use of further approaches, such as the '*Limiting Factors Analysis*', which aims to analyse an agricultural production system for those factors that most limit its performance, allowing a behavioural scientist to better understand farmers' perception of risk and their risk-minimising behaviour; in the 'Analysis of Technology Development Systems', technology is viewed as a variable, not something given, with organisational arrangements in technology development, and the generation and dissemination of agricultural knowledge having an influence on the adoption process; and finally, with the use of 'Problem-Specific Typologies', the agricultural population is broken down into farm types as more comprehensible subdivisions, allowing the development of agricultural strategies tailored to different socio-natural situations for maximised effectiveness (Saint & Coward, 1977).

Somerville (2020), on the other hand, investigates the potential use of behavioural science in the adoption of agricultural technologies through more recent, generally low-cost information-based interventions. The study highlights factors such as age, gender, attitudes, beliefs, ease of use, knowledge of technology and its perceived usefulness with significant influence on farmers' adoption of a technology. The article points to various research showing that cognitive biases, such as heuristics (rules of thumb) and cognitive dissonance (our brain's response to information that competes with our original beliefs) often get in the way of accepting new information or techniques. The study concludes by suggesting that educating farmers about various risks and how technology can help minimising them, providing them tailored information, as well as considering and building on their social networks can all contribute to low-cost policy interventions and effective nudges to encourage technology adoption (Somerville, 2020).

2.4 Information-based policy instruments for sustainable soil management

According to the '*Updated Inventory and Assessment of Soil Protection Policy Instruments in EU Member States*' (2017), Hungary has about twenty instruments with a direct impact on soil protection and around seven with indirect impact. Before the adoption of the Hungarian *Soil Conservation Action Plan* (SCAP) in January 2021, Hungary did not have a specific policy that addressed the entire spectrum of soil protection. Although, the SCAP is also rather limited to the protection of agricultural soils, what is unique in it is its emphasis on support and collaboration, as well as on the essential role that information and information sharing are supposed to play in its implementation.

Before taking a closer look at relevant information-based policies, it is worth pointing out that oftentimes, the way how other types of policy instruments frame and treat a subject (in this case, the conservation of agricultural soils) bears great relevance and is an information in itself: with regard to the subject's level of priority, urgency, political support, and integration into other areas of governance. The below table provides an overview of the most relevant regulatory and other strategic policies with an influence on the protection and conservation of agricultural soils:

Table 2-10. Regulatory policy instruments with relevance for the protection of soil and arable land

Name of the policy	Soil-related measures
Act 1994. on Cultivated Soil	• regulates agricultural practices and agricultural land acquisitions by adopting a form of taxation (so-called "*földvédelmi járulék*" in Hungarian) in order to preserve the organic matter of the soil
Act 1995. LIII. on the general rules of environmental protection	• with the overall objective of preserving and protecting the natural heritage, it aims to protect soils and their healthy functions (fertility, structure, air and water balance, biodiversity etc.)
Act 2007. on the protection of arable land	• for the protection of soil fertility and the humus layer, it regulates its preservation when the purpose of an arable land is changed or in case of certain interventions • lists cases when soil conservation plan or permit from a soil conservation authority is needed • lists the tasks of the soil conservation authority (e.g. on soil monitoring) • regulates soil management practices on arable land* • lists cases when the land-user is required to pay a land- or soil-protection penalty
National Environmental Remediation Programmes	• a common strategy for environmental protection, which also addressed the protection of agricultural land, particularly by preserving soil fertility
National Framework Strategy on Sustainable Development (2012-2024)	• mentions arable soil as a Hungarian resource of priority importance • preserving soil fertility and preventing soil degradation are relevant objectives
National Climate Change Strategy of Hungary (2014-2025)	• deals with the role of soils in climate change mitigation, as well as the effects that a changing climate and the variability of weather have on agricultural soils • supports the application of sustainable agricultural practices in order to reduce the detrimental effects of conventional farming on soil fertility and soil quality

Source: Nemzeti Jogtár (2021d, 2021c); Ronchi et al. (2019)

*According to 'Act 2007. on the protection of arable land': the land-user is obliged to apply soil conservation farming that is adjusted to the ecological characteristics of the land. This constitutes, among others:

- (especially on areas that are susceptible to wind- or water erosion) to grow plants for soil cover
- to apply soil management practices that, by protecting the soil structure, can prevent or mitigate soil compaction

  → such practices are: contour farming, covering the soil with cover crops, establishing, and preserving hedge-, grass-, or forest-strips, adjusting nutrient management to the chemical characteristics of the soil, applying 'soil-sparing' management practices, using crop rotation, in order to preserve the organic matter content of the soil: utilising crop residues on the land, applying organic matter, and preserving the humus layer
- to preserve the conditions for soil conservation farming (Nemzeti Jogtár, 2021f)

An additional aim of this research has been to find out why, in spite of the existence of such clear regulations and obligatory soil conservation practices, the percentage of farmers applying soil conservation practices is still rather low in Hungary. The empirical study aimed to gain a better understanding of the reasons from relevant stakeholders.

This thesis primarily focuses on those information-based agri-environmental national policies that, with the objective of conserving arable soils and their healthy functions, as well as the ecosystem services they provide, promote the use of certain soil management practices, while discouraging or otherwise controlling other methods. The below list of various instruments illustrates the variability of information-based policies and the diverse ways in which they aim to achieve change through information:

Table 2-11. Common forms of information-based policies

Common forms of information-based policies

- Communication and diffusion
- Awareness-raising
- Sharing best practices
- Information campaigns
- Advisory or Extension services
- Capacity-building
- Labelling or Certification
- Reporting
- Monitoring
- Access to information and justice rights
- Network creation ('match making')
- Management systems
- Marketing

Source: The author's own elaboration

Now, a brief overview is provided on the most relevant existing information-based policies that can influence farmers' decision-making on soil management practices and soil conservation, as well as the regulations that call for their implementation in Hungary:

Good Soil Conservation Practice

It is an agricultural handbook whose primary aim is to share information with farmers on the soil conservation obligations in particular agricultural support policies. The handbook highlights the most relevant and beneficial practices that are required to establish and sustain "Good agricultural and environmental conditions" (GAEC), the minimum requirements set by the EU's Common Agricultural Policy (CAP). With these practices, farmers can, among others, support water retention on their own land. The publication provides guidance and details on the minimum requirements of multiple regulatory and economic policies, for example: in addition to the already mentioned GAEC requirements, it discusses required practices to satisfy the obligations under the national policy connected to the EU Nitrates Directive and those connected to the minimum requirement framework for "agricultural practices beneficial for the climate and the environment" in the CAP's Greening policy/payments (National Chamber of Agriculture, 2019).

The handbook furthermore illustrates those techniques that aim to preserve or increase the soil organic matter content of soils, as well as the opportunities that can ensure the economic efficiency of nutrient resupply. The promoted practices include the use of cover crops, the establishment of non-productive natural areas on or around farmlands (such as grass or forest strips), reducing the intensity of soil management (e.g. by minimum tillage or direct seeding), and contour farming (National Chamber of Agriculture, 2019). On each illustrated SM practice, the handbook provides practical guidance and highlights the practices' effectiveness and potential limiting factors.

The handbook's objective is to increase farmers' and farm advisors' awareness, and thus, to contribute to the practical realisation of effective soil- and water conservation. It also aims to assist them in applying "soil sparing" methods with which they can ensure efficient and environmentally beneficial farming, the retainment of soils, water and nutrients in place, and the mitigation of erosion-related damages (National Chamber of Agriculture, 2019).

The handbook is distributed among farmers at various events organised by the NCA, or by local village consultants.

Soil Information and Monitoring System

As mentioned before in the *Introduction*, Hungary has a unique and long-time soil information system in place for the monitoring and evaluation of soil quality, the *Soil Information and Monitoring System* (SIMS), which is coordinated by the Hungarian Institute for Soil Sciences, at the Centre for Agricultural Research. This information system is monitoring various changes in soil characteristics on about 1200 observation points around the country, such as acidity, texture, the depth of humus layer, carbonate status, available moisture content, and the content of phosphorous, potassium and different heavy metals (Ronchi et al., 2019). About 800 sampling points are on agricultural land. Some soil parameters are measured annually, others only every 3 and 6 years (Greenland et al., 1994). Soil sampling is carried out by representatives of the county-level soil conservation authorities, while the soil analyses are performed in the laboratories of the National Food Chain Safety Office. This regular soil monitoring activity is regulated by the Act 2007. on the protection of arable land. SIMS data are publicly available and of general interest (National Food Chain Safety Office, 2021a).

Farm advisory service

In relation to the advisory work of agricultural and rural development experts and farm advisors, Decree No. 1/2010. (I. 14.) FVM and Decree No. 16/2019. (IV. 29.) AM details the specific requirements that someone needs to fulfil in order to become an agricultural expert or farm advisor. The two policies also differentiate between the areas in which the expert needs to provide support (e.g. soil and crop analysis, fertiliser and manure application, soil mapping etc.) and the farm advisors, who are registered in the farm advisory database of the National Chamber of Agriculture. With regard to soil conservation, the decree requires particular degrees and/or years of practical experience for anyone working as an agricultural expert or farm advisor (Nemzeti Jogtár, 2021a). In case of the farm advisory service available to farmers through the NCA, the area of soil conservation and nutrient management, belong to the wider category of "Environmental sustainability", together with other sub-themes, such as alternative energy production, water conservation, by-product- and waste-recycling, and circular- and biomass-based economy (Nemzeti Jogtár, 2021b).

Requirements for a soil conservation plan

In addition to the regulations related to relevant agricultural support policies or payments, the detailed requirements that soil conservation experts need to fulfil in order to operate, as well as the instances when farmers need to have a soil conservation plan prepared by a soil conservation expert, are described in the Decree No. 90/2008. (VII. 18.) FVM and the Decree No. 181/2009. (XII. 30.) FVM. The activities include soil improvement interventions, agricultural purpose landscaping, establishing plantations, preserving the humus-rich top soil, recultivation for agricultural purposes, irrigation, the utilisation of liquid manure on arable land, using sewage sludge or sewage sludge compost for agricultural purposes, the water regulation of agricultural fields, technical soil conservation interventions against erosion, and finally, the utilisation of non-hazardous waste for agricultural purposes (Nemzeti Jogtár, 2021c, 2021d).

Soil Degradation Subsystem (SDS)

From the perspective of this thesis, one of the most relevant information-based instruments on the topic of soil degradation is the 'Soil Degradation Subsystem' (SDS), which was commissioned by then Ministry of Rural Development and developed with the leadership of the Centre for Agricultural Research, and within that, the Institute for Soil Sciences (formerly known as Research Institute for Soil Science and Agricultural Chemistry). The subsystem is part of the National Environmental Information System. The aim of the project that resulted in the creation of the SDS has been to develop soil science data and provide the informational background to the data service on environmental load from agriculture and the environmental state of soils. The SDS also aims to support the compliance with the guidelines determined in the EU's Thematic Strategy for Soil Protection. Further objectives of the system are to support the implementation of related national public policies, as well as to publish soil science data and information for the public (Ministry of Rural Development, 2021b). The SDS provides science-based information and soil maps in a relatively plain language on the ways in which agriculture affects the state of soils, providing details related to crop production, soil management, nutrient management, pest control, and irrigation. The brief thematic overviews are accompanied by photos with personal captions about the sampling and inspection process, making the scientific content more personal towards the readers. The SDS website also highlights some policy implications and provides potential tools to manage challenges posed by agricultural soil degradation. Such a tool could be the farm-level environmental performance assessment framework, based on the 'Green-point system', supporting a shift from area-based payments to the 'public money for public goods' approach (Ministry of Rural Development, 2021a).

Soil Conservation Action Plan (SCAP)

In many regards, the SCAP provides a new direction and a novel general approach about the role of authorities and the responsibility of land-users in agricultural soil conservation. The Action Plan in its current state gives, however, more of the impression of a work-in-progress, a 'draft' document that does not fulfil all the formal requirements of an official national policy. Apart from the Hungarian coat of arms on the cover page, there is no mention of a date of publication, or the authors or even the organisation that is responsible for its preparation. The document contains only a few references in support of its statements or propositions. In spite of these formal peculiarities, however, the adoption of the Action Plan was shared and celebrated by multiple media in January 2021 (Agro Napló, 2021; National Chamber of Agriculture, 2021a; National Food Chain Safety Office, 2021d). If one is able to set their reservation aside over the formal irregularities of the document, the content, and the set objectives themselves point to a unique approach, that has not been characteristic of Hungarian agriculture-related policies before.

After discussing the general significance and threatened status of soils, both from a Hungarian perspective and with regard to food supply chain security, sustainable resource use and intergenerational equity, the Action Plan calls for the overall renewal of national soil conservation. By this, the Action Plan refers to objectives, such as a prepared, cooperation-based, supporting role for the soil conservation authorities, instead of the ordinary punitive approach, an extensive communication- and educational campaign on the importance of soil conservation, not only towards land-users, but towards the general public, as well, and the *Farmers' Soil Conservation Programme* (FSCP). The FSCP aims to actively involve farmers, with advisory support, in identifying farm-level soil degradation issues, and with consideration to the geographical and farming characteristics of the particular farm, creating a plan for addressing these issues. The implementation of the FSCP programme will be guided by a centrally developed, but locally adaptable protocol (National Food Chain Safety Office, 2021d).

See *Table 0-8* in *Appendix 3* for more details on the strategic objectives of the Action Plan, with respective actions and expected outcomes.

Multiple other information-based measures on soil conservation are carried out on a project- or contract-basis by various agencies, authorities, and research institutes of the Ministry of Agriculture. These include, the organisation and facilitation of thematic trainings, conferences and farm demonstrations for farmers (e.g. 'Arable land days' by the NCA) (National Chamber of Agriculture, 2021b), the preparation of handbooks and other guidance documents that support farmers' decision-making on soil management and their compliance with the requirements of other (mostly support/payment-) policies (National Food Chain Safety Office, 2021b). There are various civil or bottom-up initiatives, as well, that support a greater awareness on soil conservation and the significance of sustainable farming practices for food security, climate action and biodiversity conservation. These include, for example, a citizen science campaign by the Institute for Soil Sciences (Institute for Soil Sciences, 2021), the annual 'Soil Science Assembly' of the Hungarian Soil Science Society (Hungarian Soil Science Society, 2020), and the occasional awareness-raising campaigns and advocacy activities of non-governmental organisations (MTVSZ, 2016; WWF Hungary, 2020). In the meantime, agricultural input production and machinery manufacturing companies are also becoming more and more active in their mission to win over farmers with their products of actual or assumed benefits for arable soils (Magyar Talajvédelmi Baktérium -gyártók és -forgalmazók Szakmai Szövetsége, 2021; Väderstad, 2021).

Stakeholder views on existing policies for agricultural soil conservation

This section outlines how the representatives of different stakeholder groups who contributed to the Hungarian case study of the Horizon 2020 UNISECO project, on the one hand, evaluated existing Hungarian policies for agricultural soil conservation, and on the other hand, what recommendations they formulated for the improvement of information-based policies for soil conservation. These two sets of information, as part of the existing body of knowledge, have great relevance for RQ1/a. and RQ3 of this thesis.

As part of the Hungarian case study of the UNISECO project, which, among others, investigated the sustainability and potential of agroecological farming systems in multiple EU countries, multiple stakeholders were involved in a qualitative assessment of existing agricultural policies in Hungary. Participants assessed policies along multiple criteria and identified their strengths, weaknesses, as well as the barriers and enablers in the way of soil conservation practices going more mainstream and accepted in the arable farming scene of Hungary.

The below table briefly highlights what Hungarian stakeholders, involved in the UNISECO project, considered to be the strengths and weaknesses of the training and farm advisory services in Hungary, an information-based policy that the case study discussed.

Table 2-12. The strengths and weaknesses of the training and farm advisory services in Hungary, identified by stakeholders in the UNISECO project

Policy instrument	***Strengths***	***Weaknesses***
Training and advisory services	➢ Great potential for mainstreaming SCPs if it worked well ➢ There are highly qualified advisors, too	➢ Limited overall coordination ➢ Lack of trained, professional and independent advisors ➢ Slow generational renewal ➢ Lack of openness to SCPs

		➢ Strong influence by business interests ➢ Price-value gap from farmers' perspective ➢ Critical level for the aspect: 'Low performance-High relevance' ➢ Advisors have insufficient knowledge and awareness on environmental issues ➢ Lack of advisors with specific agroecological knowledge

Source: Adapted from Balázs et al. (2020)

As part of the Hungarian case study of the project, various recommendations were formulated by participating stakeholders, that, with regard to information-based policies, are summarised below, in *Table 2-13*. Most of the recommendations aim for the improvement of the farm advisory services, platforms for exchanging knowledge and experience, as well the education of consumers.

Table 2-13. Recommendations identified by stakeholders in the UNISECO project

Information-based policy recommendations for SC
• Develop and better coordinate advisory services • Ensure independent advisory service for SC • Train advisors and provide them up-to-date knowledge on SSM • Have advisors with specific know-how on agroecological transition • Establish demonstration farms to farmers on SCPs • Provide a knowledge platform to farmers where experience, best practices, research results, up-to-date knowledge, list of independent advisors are shared • Support capacity-building activities • Educate consumers, too • Support cooperation among advisors, farmers and other stakeholders • Share science-based evidence with farmers on the economic viability of SCPs

In order to demonstrate how else information-based policies can support an effective soil governance for conserving this precious resource, the next section will provide an overview on their key aspects, based on reviewed literature.

2.5 Key aspects for effective information-based policies

Information, when we refer to it as an environmental or sustainability-focused policy instrument, aims to alter the priorities and the significance that various agents attach to environmental issues, or challenges of a different nature (Mickwitz, 2006). As mentioned in the previous section, information-based instruments include measures such as trainings, communications campaigns, capacity-building, or extension services. Oftentimes, information policy-related activities are not implemented by governmental institutes directly but by other agents or even organisations from the private sector. Policy-makers often just give the authority or the framework within which the measures should be. As Mickwitz (2006) points out, although "*all other policy instruments depend partly on information, information can also be considered as an independent instrument*" (p. 87), leading to the differentiation between 'information on policy instruments' and 'information as policy instruments'.

Pretty (2002) describes information-based policy instruments as "advisory and institutional measures", when distinguishing between the main types of policy instruments (next to regulatory and economic instruments). But he also acknowledges, that in practice, in order to control environmentally damaging activities and to supply public goods to society, usually a mix of all these three approaches is required, while being integrated across various sectors, for optimal, long-term results.

Integration

With regard to the prevention of agriculture-related damages or pollution, according to Pretty (2002), advisory and institutional measures have played a crucial role in policies for a long time that aimed at internalising costs and so preventing damages or pollution. If such policies are not directly connected to other, regulatory, or economic instruments, then these measures generally rely on the voluntary actions of farmers. For being low-cost and relatively easily adaptable, information-based policies are often favoured by policy-makers. Agriculture-related advice is generally given to farmers, by farm advisors or shared on various platforms, in the form of guidelines or codes of good agricultural practice. Extension agents, in an ideal case, can play a relevant role in technology development within a sector like agriculture by transferring knowledge and guidance on new technologies (Pretty, 2002).

Encouraging collaboration

Talking about the great diversity of institutional mechanisms at hand to achieve positive behavioural change in farmers, Pretty (2002) mentions the potential of such instruments in helping to increase social capital within the farming community, as well as the uptake of more sustainable farming practices. This could happen, for example, by encouraging farmers to work together in local study groups, investing in the improvement of advisory services so that they effectively support a greater interaction between farmers and advisors, and "*encouraging new partnerships between farmers and other rural stakeholders, since regular exchanges and reciprocity increase trust and confidence, and lubricate cooperation*" (Pretty, 2002, p. 70).

Rewarding beneficial practices

Economic instruments can be used to penalise farmers who apply damaging practices and to reward those who adopt sustainable technologies. Information-based policies can potentially build on the policy principle that "*it is more efficient to promote practices that do not damage the environment, rather than spend money on cleaning up after a problem has been created*" (Pretty, 2002, p. 71). Another crucial step on this path could be if payments shifted away from being linked to production or farmed area to supporting and rewarding sustainable practices or the environmental, social performance of production (Pretty & Shah, 1997).

Participation

In addition to the appropriate construction and integration of policy mixes, the participation and involvement of relevant stakeholders, like farmers or consumers, in the process of reform can also have a great influence on the outcome of policies that aim for a reform. For this reason, Pretty (2002) suggests that social and institutional processes should be managed in a way that they encourage farmers to work and learn together. While it is known that integrated cross-sectoral partnerships can increase the chance of success, they are still considered to be rather rare and fragmented when it comes to efforts to make agricultural practices more environmentally beneficial (Pretty, 2002).

Advisors and extension agents have a crucial role in sharing knowledge and skills with farmers, building their capacities, and providing them motivation to act. They can also work with communities and create the conditions for new local associations to emerge with appropriate rules and norms for resource management (Pretty, 2002). Success that is achieved in a community in natural resource management can then easily have a positive impact on both social and human assets. Pretty (2002) argues for a participatory approach in policy-making stating that "*when people are organised in groups, and their knowledge is sought, incorporated and built upon during planning and implementation, then they are more likely to sustain activities after project completion*" (p. 154). For long-term sustainability, it is important to invest in and focus on institutional development and local participation than merely addressing individuals, who are treated as separate from the policy development process.

Influencing attitude

While it is common to use regulations and financial incentives to encourage behavioural change, and they often lead to success, in order to achieve a change in attitude, however, usually more is required. As Pretty (2002) suggests that "*new configurations of social and human relationships are prerequisites for long-term improvements in nature. Without changes in thinking, and the appropriate trust in others to act differently, there is little hope for long-term sustainability*" (p. 154). Without a change in thinking and attitude, farmers tend to return to their old practices when incentives are no longer available or regulations are no longer enforced.

Sensitivity to local conditions

Obviously, every community has its differences, divisions, power dynamics, or existing conflicts, for this reason, appropriate care and sensitivity should be applied when initiating novel forms of cooperation. In developing democracies, or otherwise unjust, hierarchical societies, such noble efforts can fail in spite of the best intention. Before making efforts to strengthen or develop social relations or connectedness within a community, one should be aware of its formal and informal rules and norms, and the possible presence of harmful social arrangements as a result. Such characteristics of a community can easily hinder emerging sustainability, for example, by "*encouraging conformity, perpetuating adversity and inequity, and allowing some individuals to get others to act in ways that suit only themselves*" (Pretty, 2002, p. 155).

Educating consumers and farmers

Information plays a relevant role not only towards farmers, but also towards consumers. Consumers, as well, need to be made aware of the detrimental effects of conventional farming practices and the potential benefits that soil conservation farming may provide both to the environment, food security and human health. An increased consumer awareness can potentially lead to better consumer choices. Farmers, on the other hand, will need to learn new techniques, sustainable, soil-friendly practices, just like the more holistic (science-based) thinking and more detailed aspects to soil conservation. Providing farmers with easy access to reliable information is therefore an important part of any policy to develop a stronger presence for conservation agriculture. This is especially true of providing training at all relevant levels in the agricultural sector, from practical training to universities. Any growth scenario for conservation agriculture, however, needs to take into account the fact that education and training take a considerable length of time (Dabbert et al., 2004).

Independent research - Independent advice

For an emerging technology or approach whose going mainstream largely depends on knowledge-sharing and the awareness of stakeholders, government intervention needs to make sure that research organisations are steered more actively towards the theme of conservation agriculture and the adoption of SCPs in arable farming. For the sake of trustworthiness, it is preferable that such research is financed from sources that are independent from inputs companies or machine manufacturers (Dabbert et al., 2004).

Long-term reliability

With regard to direct financial subsidies paid to farmers who are ready to integrate or convert to soil conservation farming, just like it has been the case for organic farming: for the decision to convert, the long-term reliability of any policy in favour of conservation agriculture is much more important than short-term gains. Since the decision to adopt new practices is a long-term strategic decision for the farm, given the often large-scale investment that purchasing appropriate technology or machinery requires, it is necessary to have attractive support programmes available to farmers (Dabbert et al., 2004).

Democratic values

Stakeholder participation and considering factors that deal with the involvement of stakeholders are important not only in the development of new policies, but also in the assessment and evaluation of existing ones. In addition to the more frequently used evaluation criteria, such as cost effectiveness or environmental effectiveness, for information-based policies, that aim to achieve long-term behavioural and attitude change, it is important to evaluate policies with the criteria of transparency, participatory rights and acceptability or social acceptance, too. According to (Mickwitz, 2006), as information policies generally try to influence the knowledge as well as the attitudes of the target groups, they require both transparency and participation. While it is true that paternalism is inherent in all policy instruments, information-based policies "*deal with the foundations of democracy - preferences and attitudes of individuals and groups as a basis for ideas, deliberation, and choice - therefore paternalism is especially relevant for these instruments*" (p. 39), and so it becomes evident that evaluation criteria should also reflect aspects that are integral to democratic values, such as the aforementioned transparency, participatory rights and acceptability (Mickwitz, 2006).

Framing

Before, however, the case of soil conservation or sustainable soil management gets to the point that the inclusion of the above-described key aspects is even considered, it is of crucial importance that the case first finds its way to decision-makers in a form that engages them. Gonzalez Lago et al. (2019) argue that unlike environmental goals, like halting biodiversity loss, limiting global warming to 2° Celsius, and securing access to food for an increasing population, soil protection is entrenched in a policy vacuum. This happens in spite of the fact, that without healthy, fertile soils, none of aforementioned goals can be achieved.

In order to influence the process of agenda-setting and so, extend the policy focus on soils and their significance, Gonzalez Lago et al. (2019) suggests 're-politicising' them. Earlier, there have been efforts to advocate concepts, such as 'sustainable soils' or 'soil resilience', but they often failed at capturing policy-makers interest to develop coherent and lasting soil policies for safeguarding sustainably managed, well-functioning, healthy soils. By advocating the concept of 'soil security', scientists aim to secure a place for soil protection on the policy agenda, not by emphasising the intrinsic or instrumental value of soils, but rather their interconnectedness to the security of other vital resources, such as food, climate change, water, biodiversity protection and the delivery of essential ecosystem services. In support of their argument for re-politicising soils with the soil security framing, the authors conclude by saying, "*To arrive at a durable policy that is capable of truly sustaining soils and their use, we need a strong narrative created from multiple disciplinary strands and based on multiple forms of knowledge, as well as a shared normative goal*". (Gonzalez Lago et al., 2019, p. 104).

Information-based policies for sustainable soil management, when well-framed and well-constructed, in the right combination with other types of policy instruments can contribute to the overall effectiveness of agri-environmental schemes. As Prager et al. (2011) argue, "*The effectiveness of nearly all mandatory and incentive measures appears to be enhanced if they are supplemented and backed up by advice and technical support, not least because it encourages the buy-in of stakeholders—including farmers, input suppliers and crop purchasers—and stimulates farmer uptake and longer-term behavioural change*" (p. 41).

2.6 The conceptual framework and theories of relevance

For the selection of a conceptual framework to guide this research and to support the clear organisation of findings, the author used a conventionalist approach, as described by Blaikie & Priest (2019). The conceptual framework is based on a modified and extended interpretation of the Drivers-Pressures-State-Impacts-Responses (DPSIR) framework of the European Environment Agency (1999) (See *Figure 0-1* in *Appendix 5* for the EEA's framework applied to soil).

The DPSIR framework reflects a systems analysis view of the relations between the environmental system and the human system (Smeets & Weterings, 1999). According to the EEA's framework to soil, this means, that social and economic developments, such as agriculture and land development, as Driving forces exert Pressure on the environment and, as a consequence, the State of the environment changes, soils degrade and physically deteriorate. This, then, leads to Impacts, that are either direct, by affecting soil functions, or indirect, such as effects on human health, biodiversity, and crop yields. These impacts may elicit a Response, like policies and other measures, from society that, through either adaptation or corrective, restorative action, feeds back to the driving forces, or directly to the state or impacts (European Environment Agency, 1999; Smeets & Weterings, 1999). Although the DPSIR framework provides a rather simplified view on a complex system, in which causal relations are not always so obvious, it can still be useful to describe how the origins and consequences of environmental problems relate to each other and how they are linked. From the perspective of this research, the most relevant aspect of the DPSIR framework is connected to the societal Response given to the Impacts, which, first and foremost, depends on how these impacts are perceived and evaluated by the society (Smeets & Weterings, 1999).

The response from society can take several forms, in this research, three types of responses are considered: 1. scientific response, 2. policy response, and 3. management response. In the context of this research, these responses are given by 1. researchers, 2. governmental institutions and authorities, and 3. farmers/landowners, respectively. This division is based on several assumptions, both with respect to the policy process, as well as to the policy intervention. The author assumes that 1. ideally, policies are informed by scientific results on environmental issues; 2. that there are policies that aim to influence farmers' land management practices, and 3. that farmers' decision-making is influenced by such policies. That soil management then has an effect on the drivers, the state, or the impacts, is more based on scientific results, than on assumptions (See *Sections 2.1* and *2.2*).

In order to investigate the social factors that can affect farmers' decision-making on the use of soil conservation practices, the research was guided by four pre-determined categories, suggested by the Diffusion of Innovations theory, as described by Rogers (1983) and Singer (2016), and the Agroecological Transition theory, as described by Ong & Liao (2020):

1. Agroecosystems & Perception
2. Information & Informants
3. Beliefs & Attitude
4. Norms & Networks

The author, furthermore, added two more general aspects, 'participation' and 'trust', to the conceptual framework, as important elements in the development and implementation of information-based policies, suggested by reviewed literature.

Finally, there are three more elements that are indicated in the conceptual framework: 1. available technology, 2. markets, and 3. consumer demand. They did not constitute the focus of this research, but their possible influence on societal responses, especially on policy and management, are considered to be relevant. Their inclusion is also suggested by the conceptual diagram used by (Ong & Liao, 2020).

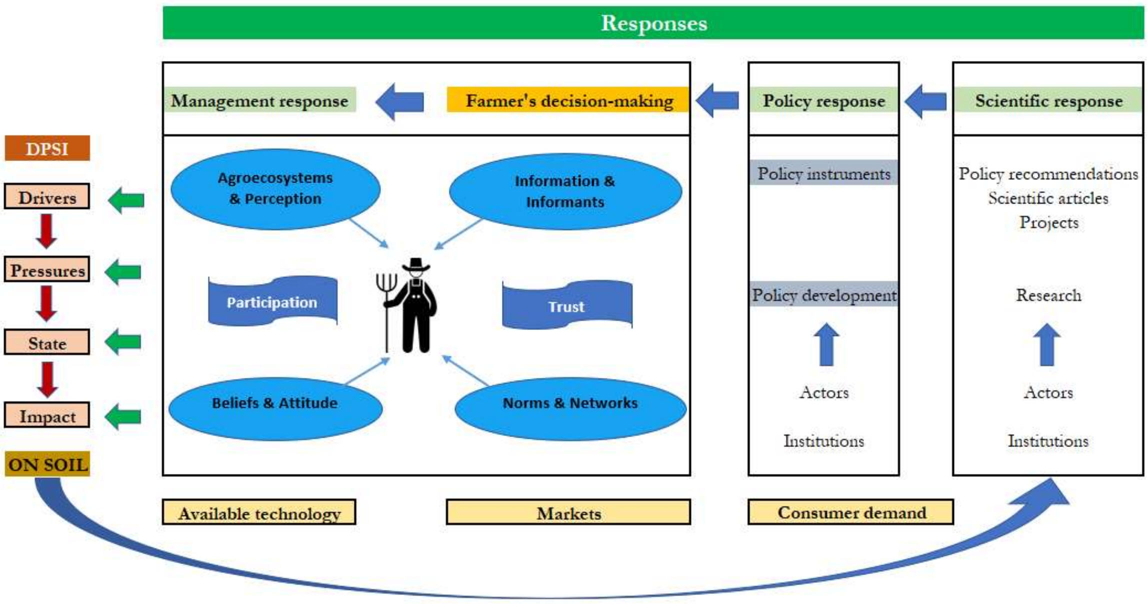

Figure 2-4. Conceptual framework

Source: The author's own elaboration based on European Environment Agency (1999); Ong & Liao (2020); Rogers (1983)

According to the **Diffusion of Innovations theory**, diffusion is the process by which an innovation is communicated through certain channels over time among the members of a social system (Singer, 2016). The theory, first developed by Rogers (1983), can help us better understand why people behave in the way they do and what we can do to influence their behaviour. From the early stages of the theory's application in the United States, it has been used extensively to investigate the development and diffusion of agricultural innovations. According to the theory, the stages by which a person adopts an innovation, and whereby diffusion is completed, include awareness of the need for an innovation, decision to adopt (or reject) the innovation, initial use of the innovation to test it, and continued use of the innovation (Rogers, 1983).

The segment of the theory that is most relevant to this thesis is the Innovation-Decision process, which describes how individuals or groups get from the first knowledge of an innovation, through forming an attitude about it, and then finally, deciding to adopt or reject it. The simplified process is illustrated by *Figure 2-5* below, while *Figure 0-2* in *Appendix 5* provides more details on the factors that can have an influence on the process and alternative scenarios.

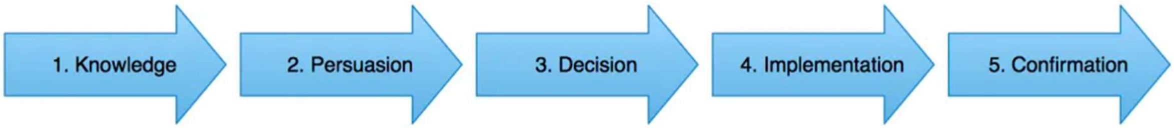

Figure 2-5. The Innovation-Decision process in the Diffusion of Innovations Theory

Source: Adapted from Singer (2016)

'Compatibility' plays an important role in the adoption of innovations. It refers to how much an innovation is perceived to be consistent with the potential adopters' existing values, past experiences and needs (Rogers, 1983). With the help of this theory, we can better understand how factors, such as incentives or the amount and quality of information that a potential adopter has about an innovation influence its adoption. Similar relevant influencing aspects are, furthermore, the complexity, or the trialability of a particular innovation, the "innovativeness" of the adopter, influence from peers in the diffusion network, or the role of the change agent.

The **Agroecological Transition theory**, as applied by Ong & Liao (2020), contributed to identifying relevant perspectives and concepts to be used in guiding the investigation of common social barriers, as well as later to organising the main findings of this research, while aiming to answer RQ2.

According to this theory, in agroecological transitions, similarly to many other large-scale shifts to sustainability, it is necessary to understand the ecological and socio-political causes and constraints to change. The agroecological transition theory builds on three different frameworks while analysing the role of relevant factors, such as syndromes of production, agents, barriers, and drivers of change in agroecological transition. These frameworks are: 1. socio-ecological, 2. socio-technological and 3. social norms and networks. See *Figure 0-3* in *Appendix 5* for a conceptual diagram of key agents and interactions in the transformation of food production systems.

Based on Ong & Liao (2020), the socio-ecological framework primarily focuses on farmer to farm interactions, investigating how farm management decisions affect food production and the environment; the socio-technological framework explores those technological and structural lock-ins which prevent shifts to sustainability, like agroecology, this framework investigates how institutional policies and investments influence advances in technology; and finally, the third framework describes how social norms and networks affect agricultural change.

3 Research design, materials, and methods

This section provides an overview on the research design that the thesis research was built on. It provides further details on the data collection and data analysis methods, used for both the collection of primary, empirical data and those used for the collection and analysis of secondary sources.

3.1 Research design

The thesis follows an exploratory sequential mixed methods research approach: starting with qualitative data collection and analysis, followed by the collection and analysis of quantitative data. In the research, the findings of the first, qualitative phase provided a basis for the second, quantitative phase, enabling the author to develop an adequate quantitative data collection instrument that already built on relevant information from stakeholders, both with regard to the sample and the specific questions asked (Creswell, 2014). As qualitative methods better fit a research in which one of the primary aims of the author is to understand individuals' perception of the world they live in, the connection between actions and beliefs, and the factors that influence their decisions, qualitative approach was the dominating method used in this research, while the second, quantitative phase had more of a complementary purpose (Creswell, 2014; Glover et al., 2014).

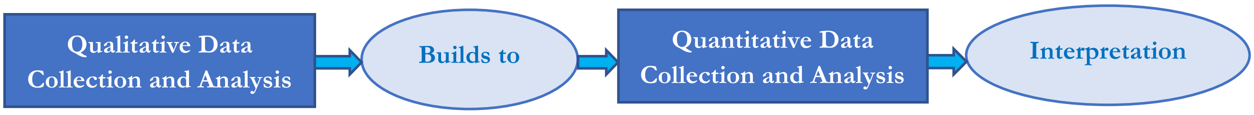

Figure 3-1. Exploratory Sequential Mixed Methods

Source: Adapted from Creswell (2014)

The author followed an inductive logic of inquiry in the research, as the majority of information was gathered from subjects through open-ended questions, which then was analysed. On the basis of the analysed data, themes were formed that allowed the author to identify broad patterns and to critically reflect on them with the help of relevant theories (Creswell, 2014). Qualitative and quantitative data were integrated at different stages of the inquiry.

As described in *Section 2.6*, for the interpretation and understanding of the collected data, a modified and extended version of the DPSIR (Drivers-Pressures-State-Impacts-Responses) framework by the European Environment Agency (1999) was adopted and complemented with elements of relevant theories, using a conventionalist approach. The main theories utilised in the thesis are the Diffusion of Innovations theory and, to a lesser extent, the Agroecological Transition theory.

Building primarily on data that were collected from a diverse set of stakeholders through qualitative methods such as semi-structured interviews and event observation, inevitably comes with the influence of various worldviews, subjective experiences, and normative judgements. In the investigation of social barriers to a phenomenon and stakeholders' perception of relevant matters, this influence is of course, natural and provides the unique, personal side of the research findings. The influence of a particular worldview is certainly true not only of the interviewees, survey respondents and event presenters, but also of the author herself. With the collection of both qualitative and quantitative data during the research, the author primarily utilised a pragmatic worldview with the assumption that collecting diverse types of data can provide a more complete understanding of the research problem (Creswell, 2014).

3.2 Data collection methods

In the research process, in addition to the literature review and document analysis, two qualitative data collection methods were used: semi-structured interviews and event observation, as well as one quantitative method for an exploratory purpose: an online survey. The below figure provides an overview of the data collection methods in relation to the research questions and the objectives of the thesis.

Table 3-1. An overview of research questions, data collection- and data analysis methods

<table>
<tr><td>Research questions</td><td>1. What are the most relevant existing information-based policies in Hungary that aim to influence farmers' soil management practices?

a. What do relevant stakeholder groups consider to be the strengths and weaknesses of these policies for agricultural soil conservation?</td><td>2. What are the most common social barriers to the adoption of soil conservation practices by farmers in Hungary?

a. What do farmers need in order to adopt or continue applying soil conservation practices?</td><td>3. How can information-based policies achieve a wider uptake of soil conservation practices?

a. What role do 'trust' and 'participation' play in such policies?</td></tr>
<tr><td rowspan="4">Data collection methods</td><td colspan="3">Literature review</td></tr>
<tr><td colspan="3">Semi-structured interviews</td></tr>
<tr><td colspan="3">Event observation</td></tr>
<tr><td colspan="3">Online survey</td></tr>
<tr><td rowspan="4">Data analysis methods</td><td colspan="3">Document analysis</td></tr>
<tr><td colspan="3">Reflexive thematic analysis with manual coding</td></tr>
<tr><td colspan="3">Thematic manual coding</td></tr>
<tr><td colspan="3">Descriptive analysis; Comparison of cumulative results along different factors</td></tr>
</table>

In one case, there was a difference between the data collection and analysis methods used for a main research question and its sub-question: while for the main question of RQ1, data was primarily collected from reviewing literature and relevant documents (often following interviewed stakeholders' recommendation in the searching process), for the sub-question of RQ1, the literature review and document analysis process were secondary to qualitative data gained from the semi-structured interviews, the event observation, and to a lesser extent, the online survey.

Literature review and document analysis

With regard to all three research questions, secondary data were collected through an extensive review of relevant academic and grey literature, as well as various other documents. Reviewed literature includes peer-reviewed studies, PhD dissertations, governmental reports, thematic articles, public records, statistical data, and policy documents. Relevant literature was collected with the help of platforms, such as Google scholar, the Library search engine of Lund University, the websites, and databases of relevant organisations, as well as through literature utilised for a pre-study of this thesis. Further literature was recommended to the author during the process of empirical data collection by interviewed stakeholders. The most frequently used search words, both in English and Hungarian, in the online identification of useful sources were: "soil governance", "soil conservation practices", "soil degradation", "information-based policies", "diffusion of innovation", "agricultural policy", "soil conservation", "soil conservation policy Hungary", "farmer behaviour change", and "agricultural advisory service".

In case of academic resources, like PhD theses and peer-reviewed studies, preference was given to sources in which the authors used or built on various qualitative or quantitative methods to collect primary data from farmers. Reviewed literature, therefore, had an influence on the development of questions for the semi-structured interviews, as well as, on the sample selection and questions used for the online survey.

Semi-structured interviews

For the collection of primary data, in parallel with the literature review process, pilot calls were conducted with relevant practitioners acquainted to the author. Contacted practitioners at that stage, included a retired Soil conservation authority representative, who previously worked for several decades at a county-level soil conservation authority representation of the National Food Chain Safety Office; and a Soil scientist, university professor and researcher, who is also a practicing soil conservation expert, with relevant expertise, experience and knowledge on soil degradation and soil conservation. The aim of these initial calls was to gain insight into the wider context, current issues, challenges, practitioners' personal views on the questions that the thesis aimed to investigate and answer. This way collected information highlighted primary issues, particular matters of importance that supported the formulation of more targeted questions for the later semi-structured interviews and the farmers' survey. By following the snowball sampling method, initial calls with first acquaintances resulted in the identification of further interviewees from their networks who were then contacted for the later, more formal, and in-depth interviews. Conducting interviews was chosen as a data collection method for this research because it has the potential to generate rich data to reveal the complexities of the studied topic, and to explore a range of perspectives in order to develop a holistic viewpoint (Glover et al., 2014).

Semi-structured online (Zoom) and phone interviews were conducted with 21 relevant stakeholders and practitioners, while two individuals sent their detailed responses to formerly sent interview questions via email. Interviewees were invited through snowballing and email requests for participation through searching for relevant stakeholders integral to the research topic. Of all the contacted stakeholders, only two individuals did not respond, all others accepted the author's invitation. Interviewed stakeholders were from the below stakeholder groups.

Table 3-2. Interviewed stakeholder groups

Label	**Stakeholder group**	**N° of interviewees**
I-R	Researcher/University professor	4
I-G	Governmental/Authority representative	4
I-F	Farmer/Landowner	6
I-L	Soil laboratory representative	1
I-A	Farm Advisor/Village consultant	3
I-N	NGO representative	1
I-P	Senior project manager	1
I-C	Ecolabel Certifier	1
I-NF	NGO representative and Farmer/Landowner	1
I-RF	Researcher/University professor and Farmer/Landowner	1

For the full list of interviewed stakeholders (including the two who responded by email), their position, organisation, as well as the format and length of the conducted interviews, see *Table 0-10* in *Appendix 6*. Indicated citation labels are used later in the presentation of findings. During the selection of invited stakeholders, the author aimed to have practitioners from diverse disciplines, and to include experts with many decades of experience, even if that meant that they were already retired. With regard to the development of policies and changing trends, attitudes towards soil conservation in Hungary, retired practitioners were expected to be a unique source of knowledge and perspective.

In most cases, interviewees were contacted first via email with a short introduction of the author, a clear explanation of the research motives, objectives of the thesis and how the author envisions the contacted stakeholders could support the research process by sharing their views and experience on certain matters, related to the research problem and the research questions. Out of the 23 interviewees, 2 responded to the interview questions via email, 10 interviews were conducted by phone, and 11 interviews were conducted via the online Zoom platform. All interviews were conducted in Hungarian, and they lasted between 25 and 125 minutes. The targeted length, indicated in the email-invitation was 60 minutes.

The phone interviews were not recorded, instead extensive and detailed hand-written notes were taken by the author, noting down key words, direct quotes, or paraphrased statements, as required, depending on the relevance of the shared thoughts to the topic and the research questions of the thesis. Interviews that were conducted via Zoom were recorded, after the author explicitly asked for and was granted permission to do so. With the exception of one individual, all interviewed practitioners voluntarily and explicitly agreed that their name and position can be included in the thesis.

The author prepared a different set of questions to each of the ten interviewed stakeholder groups. There were common points, but obviously, depending on the profession, expertise, and experience of the interviewees, the questions focused on diverse aspects related to the same topic and research problem. The conversation often deviated from the initial plan or had an iterative nature, and when the author felt it relevant, additional follow-up questions were asked. *Table 0-12* in *Appendix 7* provides an overview of the main areas, example questions and the rationale behind them in the interviews with one stakeholder group (farmers), while below, the general focus areas are briefly outlined that were covered with other stakeholder groups.

In the interviews with practitioners working as farm advisors or village consultants, the author aimed to gain a better understanding on the nature of their work, their background, their collaboration with farmers, how the themes of soil conservation and SCPs appear in their work, how do they evaluate existing Hungarian policies for SC, what do they consider to be the main barriers in the wider uptake of SCPs in Hungary, what role do they think that social, personal and institutional factors play in the low level of SCP-adoption, what policies and other measures do they think could address these barriers, and how information-based interventions could achieve a positive change in the adoption of SCPs. The interviews with researchers, university professors and NGO representatives partly built on the more general questions of the above list, especially those that meant to assess the practitioners' general opinion on particular matters. Researchers and NGO representatives were, furthermore, asked about their involvement or knowledge about projects that dealt with the studied social barriers or possible information-based responses to them, about the current tradition of sharing new research results with farmers, their opinion about the SCAP, and whether they are regularly involved in policy discussions, development or evaluation processes with the government or authorities. And finally, with regard to governmental and authority representatives, the main areas covered during the interviews (in addition to relevant ones from the former two lists) were their views on the SC authority's organisational structure and possible changes over time, the past and present state (political support, coordination, monitoring etc.) of agricultural soil conservation in Hungary, the SCAP and their hopes, and prospects about the future of SSM in Hungary.

Event observation

Participating in an online conference, as a researcher representing Lund University, provided the author the chance to collect relevant data and gain insight into the perspective of ten additional stakeholders, one of whom was interviewed as well at a later date, after the virtual event. The conference was organised by the National Chamber of Agriculture and the Hungarian team of the Horizon 2020 UNISECO project, on '*The future of soil conservation farming in Hungary*' (See *Appendix 8* for the agenda of the event with the topics covered by the presentations). Of the presenters of the conference, five were representatives of the government or other governmental authorities, and five belonged to other stakeholder groups (See *Table 0-11 in Appendix 6* for the list of presenters and their affiliation.)

The virtual conference and all presentations were held in Hungarian via the Zoom platform.

Table 3-3. The event observed for data collection

Nº	Date	Title of Event	Organiser	Format
1	2 Mar.	Conference on the future of soil conservation farming in Hungary	Horizon 2020 UNISECO Project; National Chamber of Agriculture	Zoom

Table 3-4. Stakeholder groups giving presentations at the observed event

Label	Stakeholder group	Nº of presenters
P-G	Governmental/Authority representative	5
P-R	Researcher/University professor	2
P-F	Farmer/Landowner	1
P-C	Certifier/Consumers' representative	1
P-I	Inputs company representative	1

At the time of the registration to the workshop, registering participants had the opportunity to send questions to the organisers of the event. Three out of the six questions sent by the author were asked by the moderator in the roundtable discussion phase of the conference, to which presenters answered in varying detail. With the sent questions, the author aimed to gain a better understanding of how relevant authorities envisioned the implementation of the then relatively newly adopted *Soil Conservation Action Plan*; how they planned to involve farmers and other stakeholder groups for the sake of achieving the objectives of the SCAP; how national measures (e.g. agricultural subsidies, eco-schemes etc.) are planned to be harmonised with the objectives of the SCAP; whether there is a long-term political will or strategy in Hungary for sustainable food production and soil management, based on agroecological principles; and finally, whether the Ministry of Agriculture aims to incentivise farmers in the near future for adopting farming methods particularly to increase the organic carbon- and organic matter-content of soils (carbon farming). Some of the questions were directly connected to the research topic and RQs of this thesis, others were intended to identify possible topics for future research.

Online survey

In addition to the semi-structured interviews and event observation, an online questionnaire was sent out to farmers, as well as to institutions and practitioners who directly work together or support farmers (for dissemination purposes). The targeted sample was farmers who are actively involved in arable farming on at least 0.1 hectare of land in two counties of Hungary

(Fejér and Somogy), who themselves, either as landowners or tenants, make the practical and financial decisions related to soil management (See *Table 0-13* in *Appendix 9* for an overview of the targeted population, based on data from the 2016 Hungarian agricultural census). The main purpose of the survey was exploratory and not explanatory, as it primarily intended to gain insight and a better understanding of the applied soil conservation practices, farmers' perception of certain matters, the factors influencing farmers' decision-making on soil management methods and various other aspects, as well. The additional data collected through the quantitative survey was expected to provide some indication related to the data previously gathered from the qualitative semi-structured interviews and event observation.

The survey was intended to collect relevant quantitative data on soil management practices, personal views, perception of environmental problems, trust towards common information sources on soil conservation and soil management, and the general opinion on matters that are important from a soil conservation perspective (See *Appendix 10* for the complete survey in English translation). The logic and rationale behind the questions was similar to those in the interviews with farmers (See *Table 0-12* in *Appendix 7* for the outline of the interview schedule with farmers.) The author also intended to identify patterns, themes, consistencies or inconsistencies, and possible correlations between farmer characteristics and the choice of soil management practices, revealed by the survey results. The targeted two groups of farmers who were surveyed by the online questionnaire came from two distinctive counties of Hungary: from one where the quality of agricultural soils is generally favourable, the severity of soil degradation and erosion is relatively low (Fejér county), and from another, where the quality of agricultural soils is considered to be more diverse, often poor, with higher levels of soil degradation and other challenges (Somogy county) (Tóth et al., 2015). Such an approach might reveal specific characteristics in the attitude of farmers towards soil conservation practices, depending on the context in which they operate, and how they perceive the characteristics of their surroundings. As the author did not manage to gain direct access to the email-addresses of farmers, experts, advisors and other organisations (e.g. the county-level NCA representations) were contacted and asked to share the survey with the farmers they work with or have access to. Since, unfortunately, these indirect contacts did not reveal with how many individuals they shared the survey, it is not possible to say exactly what the response rate to the survey was. Another challenging factor that led to the decision to regard the survey more as a complementary than a primary source of data, was the time of the year when the survey was conducted (March-April). This period with the intensified work of farmers in the field, made it hard to get responses from a high enough number of respondents.

In addition to the aforementioned main points of interest, demographic data were also collected related to the respondent's gender, age, the county where they farm, the crops that they grow, and their highest agricultural education. Questions were meant to investigate the respondent's perception of the quality of their soil, the level of soil degradation on their land, how important they consider soil conservation, and to what level they perceive the impact of climate change on their land. The above listed factors were considered to be the independent variables of the survey, that would probably cause, influence, or affect outcomes with regard to the later questions on the application or non-application of SCPs (Creswell, 2014). Dependent variables in the survey were, therefore, the applied SCPs, and the items in Question 17, which were meant to measure the level of respondent's agreement with various statements.

For the purpose of the data collection, the following types of questions were used: demographic questions, Likert scale questions, multiple choice questions, and one extra (non-compulsory) open-ended question if any of the respondents wished to share more thoughts with the author on the topic of the survey. Furthermore, in case of multiple-choice questions, the option 'Other' was included, providing respondents the chance to indicate and add if an option that they felt relevant in their case was not included in the list of options. All but one of the 17 questions were mandatory (apart from the last, voluntary field): the question where respondents were asked to indicate the level of trust, they have for certain sources of information was voluntary, this way allowing respondents to rate only those sources with whom they had personal experience, thus avoiding that particular sources are rated without actual experience with them.

In the introduction to the survey, its purpose was briefly described, together with the author's and the thesis topic's short introduction. It was also emphasised that participation in the survey was anonymous, voluntary and could be aborted at any point, while individual answers would not be shared with third party (See the entire survey in *Appendix 10*.).

Altogether, 83 responses were received to the online survey, in an approximately 60-40% ratio distribution between the two counties.

3.3 Data analysis methods

This section briefly describes the data analysis methods used for the analysis of collected qualitative and quantitative data in the research.

Literature review and document analysis

For the organisation of the most relevant collected secondary data from reviewed literature and documents, a synthesis matrix was prepared, including short abstracts, key findings, and, when necessary, direct quotes from the reviewed literature and documents. In the synthesis matrix, references were included to the theories, conceptual frameworks, and methods that the reviewed studies built on. The process of the literature review, as well as the work in the synthesis matrix was an iterative process.

Semi-structured interviews

For the content analysis of collected qualitative data from the semi-structured interviews and the observed presentations, the author followed a slightly modified version of the six-step '*Reflexive thematic analysis*' process developed by Braun & Clarke (2006) and the qualitative content analysis process, as described by Erlingsson & Brysiewicz (2017). This process included familiarisation, the thematic coding of hand-written notes and manual transcriptions of the recorded interviews, generating themes, reviewing themes, defining, and naming themes, and finally producing the report. As the interviews, event presentations, and the survey were all conducted in Hungarian, the data analysis itself was conducted in Hungarian and only the final set of themes and the findings of the empirical study were prepared and shared in English in the final thesis. Manual coding was chosen by the author because it allowed for a deeper immersion, and familiarisation with the collected data and also supported a continuous learning process on a complex topic. The organisation and presentation of the themes followed the three research questions and the pre-defined categories, included in the conceptual framework (developed on the basis of the relevant theories and reviewed literature). The themes identified as a result of the coding process and categorisation, are intended to express underlying meanings on an interpretative level, using a more metaphoric language (Erlingsson & Brysiewicz, 2017).

Event observation

The analysis of collected qualitative data from the observed event mostly followed the above-described steps. During the event, extensive and detailed hand-written notes were taken on each presentation, including noting down direct quotes, when relevant, which provided the data for the later thematic manual coding.

Online survey

The depth and form of analysis of collected quantitative data from the online survey was influenced by the author's original purpose with the survey, that it was meant to be a complementary, not a primary source of data and an additional insight into the perspectives, practices, and decision-influencing factors of a larger group of farmers, than those interviewed. Another relevant factor in the survey analysis was the low number of received responses and the unequal ratio of responses from the two counties. The main purpose of the survey was exploratory and not explanatory. For these reasons, findings are either based on the cumulative results of all 83 received responses, the comparison of responses from the two counties, or the below detailed additional perspective.

In the sample, multiple characteristics turned out to be significantly under- or overrepresented compared to the characteristics of the targeted population, for example, while according to the latest (2016) agricultural census, in Fejér and Somogy counties, farmers (in private holdings) over 65 of age constitute 32% in both counties, in the sample (likely due to the online nature of the survey), they make up only 8 and 21% of the respondents respectively. Similar is the case with farmers who only have practical agricultural experience: while in reality, they constitute 77-78% of all private holders in the two counties, in the sample, only 12 and 9% of respondents indicated practical experience as their highest agricultural education, while, at the same time, those with secondary and especially, with college or university education are massively overrepresented in the sample, with 32% in Fejér county and 64% in Somogy county, while in reality they make up only 3 and 4% of private holders. Respondents from the two counties are represented in an approximately 60-40% ratio in the sample.

At times, when comparing the results from farmers of the two counties to particular questions, a smaller segment of the sample was used. The responses of those farmers, who, in their response to Question 11 of the survey, on regularly applied soil conservation practices, selected at least one of the options provided to each principle of conservation agriculture (See *Table 3-5* below), are looked at more closely, along with those farmers who do not yet follow all three of the below main principles of conservation agriculture in their regularly applied soil management practices. Those respondents who already follow the three main principles of conservation agriculture are of almost equal numbers from the two counties (16-17), see *Table 0-14* in *Appendix 9* for an overview of their demographic characteristics.

Table 3-5. Selection criteria for the narrowed sample of respondents

	Main principles of conservation agriculture	**Related options in the survey** (Q11)
1	Minimum mechanical soil disturbance	• minimum tillage • no tillage/direct seeding • strip tillage
2	Permanent soil organic cover with crop residues and/or cover crops	• use of cover crops/green manure • providing soil cover by e.g., mulching, leaving plant residues on the soil
3	Species diversification through varied crop rotations	• crop rotation

Source: Adapted from FAO (2017a)

For discussing the results of responses given to the Likert scale-type of questions, often the average of the received values is used, and compared.

4 Findings and Analysis

This chapter presents the main findings from the empirical study along the three research questions and, in case of social barriers (RQ2), structured along pre-determined categories based on the conceptual framework (See *Figure 2-4*). In the accompanying tables, the most relevant themes are highlighted, that were formulated as a result of the content analysis, illustrated by quotes or paraphrased statements from interviewed or observed stakeholders as examples to a particular theme. Relevant survey results are presented at the end of each section.

When presenting the findings of the empirical study, references to and the quotes of interviewed and observed stakeholders are presented by their own citation label that can be found in *Table 0-10 and 0-11 of Appendix 6*, along with their name, position, and affiliation.

With regard to the stakeholders targeted by the online survey, *Table 0-13* in *Appendix 9* provides an overview of the demographic data and farming practices of the targeted two groups of farmers in Fejér and Somogy counties, while *Table 0-14* in *Appendix 9* displays the most basic demographics of the 83 farmers who actually responded to the online survey.

4.1 RQ1a: Stakeholder views on existing policies for agricultural soil conservation

While *Section 2.4* provided a brief overview of the most relevant existing information-based policies for agricultural soil conservation, this sub-chapter aims to synthesise stakeholders' views on existing policies, their general sufficiency, as well as their strengths and weaknesses. Focus is on information-based policies, such as the farm advisory service, but views on other types of instruments are also briefly discussed.

4.1.1 Stakeholder views on the state of soil conservation in general

On the general state of soil conservation in Hungary, several interviewed practitioners, especially from the governmental/authority side, emphasised that soil conservation and supporting policies have a 200-year tradition in Hungary (I-G1, I-G2, I-G3, I-G4). The country has always taken pride in being an agrarian nation with good-quality arable soils. Before the political system change of the end of the 1980s-beginning of the 1990s, there were extensive and well-organised governmental programmes for various soil quality improving interventions (I-R-2, I-A3), while farm advisors were generally university- or college-educated professionals, renowned experts who supported farmers with independent advice (I-A3, I-G4). While, from the perspective of legislation and regulations, policies for soil conservation are seemingly strong and ambitious, their enforcement, implementation and monitoring are often lagging behind (I-R1, I-G1, I-R3, I-G4).

Before even mentioning the issue of soil degradation, multiple practitioners pointed out that protecting the quantity of arable soils, that is keeping fertile soils in agricultural production instead of withdrawing them for other (industrial, infrastructural, energy production e.g. solar parks) purposes, should be an absolute priority (I-R1, I-G1, I-G2, I-G4). Short-term economic or political interests, however, too often override the cause of preserving arable soils for food production, and "soils as a national treasure" remain only words (I-G1, I-G4). Four interviewed practitioners highlighted that since 1950, 2 million hectares of arable land have been withdrawn from agricultural production, risking future food security, the competitiveness of our agriculture, and the nation's, especially future generations' own survival (I-R1, I-G1, I-G3, I-G4).

In practice, this means that the value of the withdrawn land (that should be compensated for) is calculated only on the basis of the soil's function for producing crops, its other functions and ecosystem services are not valued (I-R1). Even if soil conservation authorities need to prepare an assessment before land withdrawal decisions are made, it is often ignored because short-term economic interests outweigh it (I-R1, I-G1, I-G3, I-G4). This way, even good quality arable land can be withdrawn from agriculture for the sake of an infrastructural or business investment, if the location of the land is otherwise favourable, for example, it is close to a city (I-R1, I-G1).

According to several practitioners, especially the representatives of authorities, another general trend with a visible impact on soil conservation, is the weakening and damaging effect of frequent top-down institutional/organisational changes and the transformation of SC authorities (I-G1, I-G3, I-G4). Earlier, the areas of crop protection, soil conservation and food chain safety all had their own representations on an authority level, but recently, they have been all integrated under food chain safety, with reduced number of experts, and less available funds (I-G1, I-G4). The harmonisation of these distinctive areas under the theme of food chain safety has not happened yet (I-G4). The fluctuation of personnel at authorities is high, many of the experts with decades-long experience have retired or left the profession (I-G1, I-G2, I-G4). As another consequence of organisational changes and institutional fusions, funds have been often withdrawn from soil conservation authorities, and so, from the cause of soil conservation (I-G4).

Table 4-1. Themes and examples for stakeholder views on the state of SC in Hungary

Theme	Example
Legislation vs. implementation	"The legal environment for soil conservation in Hungary is exemplary." (I-G2) "With regard to, for example, the use of agricultural chemicals, legislation and control in Hungary is stricter and more serious than in the EU." (I-G4) "National policies for soil conservation are good in theory but weak in practice." (I-G4)
Soils' lack of value and appreciation	"Although arable land constitutes a significant part of our national treasure, it is still not valued or appreciated. People take it for granted, not realising that it's finite." (I-G1) "Soil conservation in present-day Hungarian politics is similarly on the side-lines as the case of environmental protection." (I-G1)
Economic interests vs. soil conservation	"Locations for investments and constructions are decided based on availability, their vicinity to an urban area and not on the quality of the soil. Authorities often cannot say no or go against "higher" economic interests." (I-G1)
Threat of land withdrawal	"We are shortening our future with the annual withdrawal of 5000-7000 hectares of arable land from agricultural use." (I-G4)
Downward trends after the political system change	"Compared to the situation before the political system change, the state of soil conservation and agriculture in general, has deteriorated. In the old co-operative system, soil conservation aspects were more respected and complied with." (I-A3) "Before the political system change, liming for soil quality improvement was a regular practice, in the EU, chemical soil improvement is not supported". (I-A3)
Changing institutions - changing priorities	"As a result of a massive organisational transformation, many of the soil conservation tasks and responsibilities were neglected or delegated to county-level representations of the authority. The contracts of many former SC experts were terminated, others left the profession voluntarily as a result of these sudden changes. The importance of SC fell back. The explanation has been the concept of 'the cheap state', making the system more transparent." (I-G4) "Major institutional changes and lack of long-term stability in structure and personnel can hinder the cause of soil conservation." (I-G1)
Lack of funds for SC	"There often are unexplainable anomalies in the distribution of funds, suggesting that economic interests again outweigh the importance of aspects, like

	sustainability, health or environmental protection. More powerful interest groups usually prevail in the policy scene, as well (I-G4)."

4.1.2 Strengths

Discussing the strengths of existing policies for the conservation of arable soils, responses sometimes shifted between highlighting the positive indirect effects of external factors or those of other policies and the potential of new or recently launched policies. In addition to the strong legislative basis, mentioned in the previous section. Researcher and university professor (I-R2) mentioned the government's farmer-friendly, supportive approach which can be a good basis for collaboration and compliance, but sadly does not always benefit soil conservation, if the support is not provided for the right practices. The increase in fuel prices has had both a positive and a negative impact on soil management and thus soil quality: with increased fuel prices, farmers often opt for shallow soil loosening or cultivator application instead of (deep) tillage, which would require more draught force and thus more fuel. The negative consequence is that farmers tend to perform these alternative practices more often than it would be required, causing gradual degradation in soil quality (I-R2).

With regard to the recently adopted *Soil Conservation Action Plan* (SCAP), interviewed practitioners in general acknowledged that the policy correctly identifies the main problems, the objectives, and the needs for intervention (I-G2, I-R2, I-G4). Its objective to protect existing arable lands by limiting green field investments and instead preferring the rehabilitation/restoration of brownfield sites is necessary (I-R2, I-G4). The implementation of the *Farmers' Soil Conservation Programme* can potentially lead to a more informed, prepared, and independent farmers' community. The Action Plan is correct in expecting greater responsibility from land-users (I-R2, I-G3, P-G2). The SCAP is also rightly targeting the establishment of a genuine, supportive, and strong authority, as well as in developing, establishing, and sharing environmentally beneficial technologies and methods for the improvement of soil quality and the preservation of soils' ecosystem services (I-R2).

SC authority manager (P-G2) pointed out as a potential strength of the policy that the SCAP has a 4-year implementation cycle, so it will be reviewed every four years. The *Farmers' Soil Conservation Programme* is supposed to run with advisory support on a watershed level. On the basis of the plan created as a result of an assessment of challenges and needs, the farmer can decide about the required management practices on a field level. The SoilWeb, envisioned by the SCAP, will be a central database of national soil analysis data, in order to support optimal nutrient management (P-G2, I-G4).

In response to the author's questions sent to organisers prior to the virtual NCA-UNISECO conference, a high-level governmental representative emphasised that with the involvement of experts of the National Food Chain Safety Office (NFCSO) in the preparatory work of the thematic (agri-environmental-climate) working group, they wish to make sure that in the national strategic plan of the new Common Agricultural Policy (CAP SP), the objectives of the SCAP are respected and will not be conflicted by new CAP-related policies (P-G4). Representatives of the Agricultural Ministry, furthermore, added that thanks to the 'greener, more ambitious" objectives of the new CAP, knowledge transfer towards farmers and advisory services will have a priority role on a national level, too (P-G1, P-G3, P-G4). With regard to other types of policy instruments, it can have great benefits to soil conservation, that arable land area with valuable non-productive agroecological habitats (such as grass and wildflower strips, hedges and trees) will make the farmer eligible for area-based payments, thereby dissuading farmers and landowners from destroying and ploughing these habitats (as it has often happened before and at present) in order increase the area for financial gain and involve them in agricultural production (P-G4).

The way how the cause of soil conservation and related policies, strategic objectives and research priorities are developing in the EU will certainly have a visible impact on the direction of national policies, their objectives, and priorities on a Member State-level, as well (I-R2, I-R3, I-G4). Hungary is furthermore actively involved in various international activities for soil conservation, such as multiple initiatives of the FAO, the Global Soil Partnership, the newly formed Hungarian network of soil laboratories (HUNSOLAN) which is part of the Global Soil Laboratory Network, as well as multiple research projects and scientific collaborations, such as the European Joint Programme Cofund on Agricultural Soil Management (EJP Soil), and the European 'Soil health and food' mission (Eötvös Loránd Research Network, 2020; European Commission, 2021b; FAO, 2021; National Food Chain Safety Office, 2021c).

Table 4-2. Themes and examples for the strengths of existing policies

Theme	Example
All for the farmers	"Currently, agricultural policy and the Ministry of Agriculture are farmer-friendly. It is important to show trust and support, especially when the price of inputs increases, while the price of crop produce often not." (I-R2)
Great potential of new policies	
The SCAP	"The Action Plan is one of the most significant intellectual products of the last decade in the area of soil conservation. It has a progressive approach, and has great potential for positive change if it gets successfully implemented." (I-G4)
The new CAP and its national Strategic Plan	"An objective of the new CAP SP is to make ploughing a less attractive alternative to farmers than it is now." (P-G4) "The new CAP (and so, related national policies) will give a greater priority to knowledge sharing and advisory services. Effective agroecological transition is not possible without comprehensive knowledge transfer to farmers." (P-G3) "The new CAP has a mechanism incentivising networking, strong advisory services and information sharing." (P-G4) "Thanks to the future eco-schemes, a certain percentage of the arable land will need to be managed without tillage to make the farmer eligible for subsidies. And there will be further incentives for soil conservation, too." (P-G4)

4.1.3 Weaknesses

Interviewed and observed practitioners' evaluation of existing policies overlapped at multiple points, suggesting the existence of some long-standing, rather deeply embedded systemic issues, as well. With regard to the farm advisory services, the lack of generational renewal, not only in personnel but also in the promoted approaches and practices was a frequently mentioned obstacle in the way of achieving a wider adoption of SCPs by Hungarian farmers (I-G2, I-R2, I-A1, I-F6, I-A3, I-G4). A lot depends on the educational background and acquired degree of the advisor and whether he/she is receptive and responsive to up-to-date recommendations on soil conservation (I-R2). Many advisors of the older generation keep recommending conventional tillage, regardless of the needs of the soil or the crop, or even regardless of the openness and financial ability of the farmer to try alternative methods (I-R2, I-F6). Some of the interviewed practitioners were, however, relatively hopeful about the new generation of advisors who are more recently graduating from universities, hoping that they will "*know and understand the new soil conservation principles",* and this will eventually *"lead to the increased effectiveness of the advisory service*" (I-R2). Outdated advise according to university professor and soil conservation expert (I-R1) can be detrimental not only to our soils, but also to our health (e.g. post-tillage floating dust particles with chemical residues in the wind), to ecological/organic food production (often polluted by the chemical residues of adjacent farms). Not to mention, that the soil management practices that worked 50 or 60 years ago, cannot provide an adequate response to our present-day challenges with a changing climate and in a changing environment (I-RF1). Soil management practices that are beneficial to the soil do not always need to be costly, radical interventions, "*conservation farming is often just farming at the right time*" (I-R1).

Multiple practitioners pointed out that even though existing regulatory and other policies require farmers to have their soils analysed and, on the basis of the results, have a soil conservation plan (with instructions for e.g. nutrient management) prepared by an expert, oftentimes, this plan ends up in their drawer and is not followed or even seriously consulted in practice, before various farming decisions are made. Authorities rarely monitor and even less often enforce the use of these plans for the farms' soil management or nutrient management. It is also very rare that a farmer is penalised for not following the recommendations of the soil conservation plan; as long as he/she can show the plan to authorities on a rare but possible check, there will not be any consequences (I-R1, I-G1, I-R3, I-L1, I-A1, I-G4). In spite of this, the county-level soil conservation authorities, who are responsible for checking the existence of the SC plans on a very small sample of farms, are still often seen as a force of punishment and an inflictor of unnecessary administrative burden to farmers (I-G1, I-G4, I-F4, I-F6).

Practitioners frequently find it challenging and impedimental to progress, that in case of certain policies, actions, and initiatives, it is not always easy to identify the official owner, the person or organisation, department who is actually responsible for those instruments. Authors and responsible institutions are often not indicated on otherwise official-looking documents, such as the *Soil Conservation Action Plan* (as already mentioned in *Section 2.4)*. At other times, documents (such as policy evaluations) are not made publicly available (I-P1, I-G3). This can hinder not only other stakeholder group's access to information, but potentially also the policies' implementation, evaluation by other stakeholders, and accountability (I-N1, I-NF1, I-G4).

On the potential weaknesses of the SCAP, a couple of practitioners shared their thoughts: in the Action Plan, it is not mentioned explicitly that before soil management decisions are made, a soil quality/state check or analysis needs to be performed by the farmer (I-R2), this can be an issue since the occasional laboratory-made soil analysis provides information to the farmer only on chemical characteristics of the soil, not the physical features, that should be known before soil management decisions are made. A soil quality check would be able to provide information on the good or bad physical and biological characteristics of the soil in a given time. University-educated farmers are mostly trained on the simple methods with which they themselves can check the state of their soil, but they constitute only a very small percentage of Hungarian farmers (I-R2). It can be another obstacle in the successful implementation of the SCAP's objectives and proposed programmes that the farmers are likely to consider them as another (administrative) burden to deal with, instead of seeing it as something beneficial that is meant to support them and to serve the conservation of their soil (I-R2, I-F1, I-G3). For this reason, it is of crucial importance how the Action Plan is published and disseminated, communicated towards them (I-R2). The SCAP furthermore, provides more of a strategic direction to policy-makers and authorities, and envisions a novel approach to soil conservation, based on information sharing and collaboration. The Action Plan itself does not require farmers to oblige with its proposed measures, other policies will need to secure that (P-G2).

As a result of many former governmental initiatives, projects, and scientific collaborations, a multitude of great documents, guidance, handbooks, awareness-raising materials have been created by various institutions (research institutes, universities etc.). But these documents, similarly to farmers' soil conservation plans, have often ended up in the drawers of the Ministry, its departments, or high-level decision-makers, who might have changed, been replaced, restructured since then and the plans have become forgotten, leaving researchers and scientists frustrated and disappointed (I-R3, I-RF1, I-P1). In addition to the personal side of this experience, these instances are, as well, missed opportunities, with time, effort, knowledge, and money spent partly in vain (I-R3).

When it comes to economic incentives, soil conservation is financially supported only through the cross-compliance specifications of existing (mostly CAP-related) agri-environmental subsidies (I-R1, I-F3, I-F5, I-NF1). Even if a farmer is open to sustainable soil management and SCPs, required machinery (e.g. direct-seeding equipment, or a powerful enough tractor that is able to directly seed into unploughed soils) is an enormous investment for farmers. Progressive and open-minded farmers, who wish to transition to or integrate SCPs, often feel left alone in lack of support (both financial and informational) and they either make the necessary investment from capital, if they can afford to, or give up on their ambition and do only what is financially supported (e.g. the use of cover crops/green manure, ley-farming) (I-F1, I-F2, I-F3, I-F5, I-F6).

Conflicting policies in the wider policy landscape also need to be better addressed so that the SC policies that do exist, do not get impeded by them. Such policies are, for example, the prohibition of organic manure transportation through settlements. The application of organic manure on arable land, without transportation on a longer distance, is possible only to farmers who or whose neighbours are also involved in livestock-breeding. Other farmers are often stuck with the use of synthetic fertilisers which, if not applied optimally, can be detrimental both to the soil and to water bodies (I-G1). Talking of water, in the current policy landscape, farmers are not only not incentivised to retain water (e.g. accumulated after heavy rains) on their lands, but they are more or less forced to remove it as soon as possible, otherwise risking the loss of financial support (I-N1). A likely reason behind this adverse situation is, that agriculture and water management are two separately handled issues, belonging to different ministries, regulated by different rules, and enforced/monitored by different authorities (I-N1).

Table 4-3. Themes and examples for the weaknesses of existing policies

Theme	Example
Outdated advice	"There is still a generation of advisors that keeps suggesting and pushing for environmentally degrading tillage practices, while others are encouraging farmers to sell the straw and corn stalk from their lands, saying 'they just hamper soil management'." (I-R2) "In our farming and soil conservation practices, we are about 20 years behind other European nations." (I-R1) (I-RF1) "I rather educate myself from YouTube videos, than listening to 60-year-old farm advisors advocating for practices that were the trend 40 years ago." (I-F6)
Punitive authority	"At present, soil conservation is forced by the authority on a small area. This leads only to resistance from farmers, but no large-scale improvement in practices or soil quality." (P-G2)
Lack of ownership and coordination	"There used to be various networking events, policy-related roundtables and working groups, but in lack of coordination, these initiatives usually die down. The results of EU projects are not synthesised or shared with farmers. The reason is usually lack of capacity, or conflicting interests." (I-R3)
No survey before new policy	"The creation of the SCAP was not preceded by any survey or formal consultation with farmers…it is rather based on the decades-long experience and expertise of a group of committed soil conservation authority representatives…most of us have since retired." (I-G2)
Conflicting other policies	"Use of organic manure is not always possible, even if it is more beneficial to the soil than synthetic fertilisers, because its transportation is restricted through human settlements". (I-G1)

	"Agriculture and water management are two separate entities, divided in policy, representation and implementation. They are often in conflict with each other…similarly to agriculture and nature conservation." (I-N1)
Lack of expert representation in decision-making	"In the Ministry of Agriculture, the case of soil conservation is not adequately represented, currently there are no experienced soil conservation experts supporting its case." (I-G1)
Plans ending up in drawers	"The SDS is used only by the research institute who created it. This was one of the many demoralising projects ending this way…". (I-R3)
Lack of available soil data in a clear language	"In spite of the huge amounts of soil data collected, there is not enough capacity/personnel to analyse the data. Data is mostly used by researchers. Farmers cannot really make sense of raw data." (I-G1) "It's not sure that making soil science data publicly available helps those who don't even know the soils of their own land." (I-R2) "The SIMS exists but it is not used as it was intended…only researchers, thesis-writers and some experts use it regularly." (I-R3)
Weak enforcement and lack of adequate monitoring	"Regulations are needed, as well as environmental measures…but authorities cannot regulate if they cannot sanction, when required. There are no tools in their hands to properly monitor and enforce compliance." (I-A1)
Lack of legal tools for policies	"The 2007 Act on the protection of arable land does not have an implementing regulation which is a major obstacle in its implementation and enforcement." (P-G2)
Overwhelming administrative burden on advisors	"In the farm advisory service, soil conservation does not get the required attention, due to all the administrative burden of the advisory job." (P-G2) "We, village consultants do not really have concrete soil conservation-related tasks, only in relation to reporting obligations in compliance with the Nitrates Directive…which then we have no capacity to check. We mostly provide administrative support to farmers with their application and compliance with the area-based or other subsidies." (I-A1)
Voluntary measures in the SCAP	"Although according to the SCAP, farmers should be able to determine the most suitable management practice (with advisory help) in the FSCP, the programme in itself will not make it obligatory for the farmer to implement this plan (future policies need to address this)." (P-G2)
Farmers spoiled with subsidies	"Back then, farmers did not get subsidies...and the farm still worked…Now, nothing seems to be enough for them, they always want more. Farmers are spoiled...to any monitoring or sanctioning, their reaction would likely be public outcry." (I-A1) "Someone who cannot farm without subsidies, shouldn't farm at all." (I-F4)

Relevant survey results

In the online survey, respondents were asked to indicate their level of agreement on a Likert scale (from 1 to 5, where 1 meant 'not at all agree' and 5 meant 'very much agree') with various statements in Question 17. Three of these statements were intended to gain a better understanding on their personal feelings about existing policies. The average values of the 83 received responses to the three relevant questions are as follows:

Table 4-4. Survey results for respondents' evaluation of existing policies

Statements (Q17)	Average
Hungarian legislation and policies adequately support the conservation of agricultural soils.	***2,47***
Farmers are sufficiently incentivised and supported to adopt soil conservation practices on their land.	***2,25***

If financial incentives are available to support the purchase of new technology that can potentially improve soil quality on my land, I would apply for it.	***4,11***

The results indicate that although, there is a clear need for and interest in acquiring new technology that can potentially support soil conservation, farmers at present, do not feel that existing policies are able to provide them this support, nor that existing legislation and policy instruments in Hungary adequately support soil conservation itself.

4.1.4 Summary

Stakeholders' general views on existing policies for soil conservation in Hungary centred around the advisory services' lack of ability to keep up with the challenges and potential solutions of our age, both with regard to the knowledge and preparedness of advisors and the training of farmers. The untapped potential in the enormous soil data that is gathered every year is another missed opportunity that, with the required funds, personnel, and expertise, could be an essential tool in developing local policy- and management responses to local problems. While new policies seemingly target a novel and progressive approach towards increasing land-users' and the general public's awareness on soil conservation, as well as supporting farmers in their transition to more responsible, environmentally conscious soil management practices, these instruments will have the potential to succeed only if they are supported by a strong and stable organisational structure, the necessary legal and monitoring tools to ensure their implementation, and an active and constructive collaboration with all relevant stakeholders. Soil conservation policies in Hungary are built on historical traditions and know-how, it would be a shame to let this foundation get weakened by short-term political and economic ambitions. Protecting agricultural soils both in quantity and quality, requires, first of all, the adequate valuation of this essential natural resource, harmonisation with other policy instruments. Such efforts require political will, ownership, and coordination on all levels. Participatory processes should go beyond formal requirements and shall be based instead on a genuine will to work together, utilising the results of science, the feedback and needs of farmers and society at large.

4.2 RQ2: Social barriers to the adoption of soil conservation practices

During the interviews, many of the practitioners, as well as researchers and university professors, were asked whether they were aware of or had ever been involved in any research or survey that was meant to investigate the social barriers to SCPs. None of them seemed to know about such former research, although they shared that farmers' attitude towards various issues were formerly measured in various projects, and of course, the UNISECO project has also shed light on many of the existing barriers (I-P1); while another university professor referred back to their own research that provided a historic overview on tillage development in Hungary and the factors influencing it (See *Table 2-5* in *Section 2.2*) (I-R2).

In the below sections, findings from the interviews, the event observation, as well as the survey, are presented along pre-determined categories, indicated in the conceptual framework.

4.2.1 Agroecosystems and Perception

Multiple stakeholders, among them several farmers, pointed out that farmers often do not know the soil of their own land (I-R1, I-G1, I-R2, I-F6, I-NF1, I-RF1, I-P1). This is why they often do not do the right practice at the right time, causing the degradation of the soil (e.g. ploughing wet soil leads to compaction; ploughing too dry soil results in break-down to dust) (I-R1, I-G1, I-R2). To some level, the characteristics of the land (e.g. if it is long, narrow and steep) have great influence on how it is possible for the farmer to till it. If a steep field is too narrow and the tractor cannot turn without entering the adjacent fields, then the farmer will not be able to plough the land along the contour lines (perpendicular to the direction of the slope), which then can potentially lead to increased risk of soil erosion by water (I-G1). As far as the type of the grown crop is concerned, profitability often takes priority over soil conservation, even if the farmer knows the possible consequences: for example, ignoring crop rotation because actual market prices 'convince' the farmer of sticking to one particular crop on a large area (I-G1, I-A1, I-RF1).

Farmers are also often not aware of the fact that soil quality and soil health are not the same: while soil quality usually refers only to those parameters that are connected to crop production, soil health includes and values all the ecosystem services that soils provide. A fact that requires a greater awareness among all stakeholders for them to value soils more (P-R1).

How farmers perceive the environment and the changes of the agroecosystem that their farm is a part of has a significant impact on how they decide on soil management practices, or how they approach the natural habitats surrounding their land (I-R2, I-RF1). The SCAP itself refers to the issues resulting from farmers' lack of knowledge of their land or lack of perception of the impacts on their land: "*Degrading soil management is often the result of the land-user's lack of knowledge on soil quality […] or using equipment that are not suitable for their particular soil*" (National Food Chain Safety Office, 2021c, p. 6). In fact, the Action Plan mentions the changed environment as one of the reasons why existing legislation needs to be revised and possibly, to be modified. The SCAP goes further and acknowledges that "*since the majority of land-users have little knowledge on soil conservation, they cannot perceive its importance, and therefore, they cannot approach it adequately. This way, the actor who is supposed to play a key role in the practical realisation of soil conservation, cannot value the importance of neither the topic, nor himself.*" (National Food Chain Safety Office, 2021c, p. 12).

At other times, many of the interviewed farmers indicated that although they do recognise the changes in climate, in the environment and on their land, but since they cannot turn to someone with an up-to-date, expert knowledge on how changed conditions need to be addressed, they often feel left alone experimenting, self-educating and finding out for themselves what works and what does not work (I-F1, I-F2, I-F5, I-F6).

A farm advisor and retired university professor (I-A3) pointed out that policies and policy implementation also need to correctly address the needs and changes of agroecosystems and acknowledge that the same SC solution cannot be applied everywhere.

Table 4-5. Themes and examples for agroecosystems and perception

Theme	Example
Not knowing their own soil	"Farmers are not enlightened enough about the basic matters of soil." (I-R1) "A farmer who does not know their soil, cannot think or act in a committed, responsible way." (I-G2)
Changing practices requires seeing changes	"Whether the farmer recognises and acknowledges that weather conditions are significantly different and more extreme from how they used to be even 20 years ago […] this has an impact on whether he/she will do everything to spare and preserve soil moisture or will rather blame all troubles and set-backs on the weather." (I-R2) "Farmers do not draw a conclusion from the visible signs of climate change and therefore do not adapt to them. If done well, cover crops and agroforestry can both help farmers to retain water on their land, reducing the impact of droughty periods… Farmers, however, often want to apply the same solution everywhere and then complain if things get worse." (I-RF1)
Not recognising that SC benefits them	"Farmers need to be influenced and educated in a way that they recognise their soil's and their own importance...and so, they become personally motivated, responsible and willing to actively contribute to soil conservation." (I-G2)

Forced to experiment	"When we do not get the guidance or information we need, we experiment, talk to each other, and see what works…this often comes with risks." (I-F1) "I realised one day that the part of the land which is sandy or loess kept producing worse and worse yields next to conventional tillage…this was one of the reasons why I started experimenting and then transitioned to strip-till and no-till." (I-F6) "The village consultant is always busy with paperwork, even when I had questions…so then, I decided to watch and learn from YouTube videos, or read foreign articles and studies with Google translate." (I-F5)
Different circumstances call for different solutions	"Soil conservation cannot be done in a unified way; the characteristics of the geographical landscape need to be taken into consideration". (I-A3)

Relevant survey results

In the online survey, three questions intended to assess farmers' perception of environmental characteristics related to their land. One of the primary reasons for having selecting the farmers of Fejér and Somogy county to be targeted by the survey was the fact that the two counties are known for relatively different qualities of arable soils. While Fejér county is more known for its soils of a more stable good quality, Somogy county, on the other hand, has more areas with poor soil quality and soils that are heavily susceptible to various forms of soil degradation (Tóth et al., 2015). As the interviewed soil laboratory leader (R-L1) also confirmed, in Somogy county, due to the challenging soil characteristics, farmers are 'forced' to be more motivated to think outside the box and become more open for SCPs, because sustainable practices are more likely to result in visible soil improvement, than, for example in Fejér county, where soils are of a better quality and less susceptible to soil degradation. Obviously, in order to think outside the box, the farmer first needs to perceive the challenge and the need to look for alternative solutions.

In order to assess farmers' perception of the general quality of their soil, the level of soil degradation and the level of climate change impact on their land, in the survey, they were asked to indicate these levels on Likert scales. The cumulative results on each question from farmers of the two counties can be found in *Appendix 12*, while below, the average values are compared.

With regard to the perceived average quality of their soil, on a scale from 1 (poor) to 5 (excellent), the average of farmers' rating was 3,43 in Fejér county and 2,73 in Somogy county, which seems to align with the expectations based on the actual average arable soil quality in the two counties. In Fejér county, respondents chose 3 and 4 both in a 42% rate and only 2 and 6% perceived their soil being in the poor qualities of 1 and 2, respectively. In Somogy county, however, 52% of respondents rated the quality of their soil as a level 3, 33% thought that it is closer to poor (2), 9% perceived their soil as good (4) and only one-one respondent gave their soil the most extreme quality ratings (1 and 5).

How responding farmers perceived the level of soil degradation on their land resulted in a smaller difference between the average of ratings in the two counties: farmers in Fejér county rated the level of soil degradation on their land to an average of 2,80 on a scale from 1 (negligible) to 5 (considerable), while the average perceived level of degradation is 3,04 in Somogy county. The farmers' ratings from the two counties for level 4 and 5 were 16% in case of Fejér county, where no respondent assessed the level of soil degradation threat to be considerable, while in Somogy county, 18% and 12% of the ratings went to the levels of 4 and 5, suggesting that farmers rightly perceive the difference in soils' level of degradation in the two counties. What, however, might come as a surprise is that those who perceived the level of soil degradation on their land to be negligible (1) are 8% of respondents in Fejér and 15% in Somogy county.

With regard to their perception of the impact of climate change on their land, the responses showed much less of a difference between the farmers of the two counties. On a scale of 1 (negligible) to 5 (considerable), the average rating from farmers in Fejér county is 3,43, while in Somogy county, it is only slightly more, 3,46. 16 and 18% of respondents perceived the impact of climate change on their land to be considerable in Fejér and Somogy counties respectively.

With these in mind, farmers' response to the question "How important do you consider soil conservation on the land you farm?" is certainly of interest: no respondent from any of the two counties considered soil conservation to be not at all important (levels 1 and 2), while the rate of those who thought that it is very important to conserve their soil was 48% in Fejér county and 58% in Somogy county, the average value of farmers' rating was 4,03 in Fejér county and 4,33 in Somogy county.

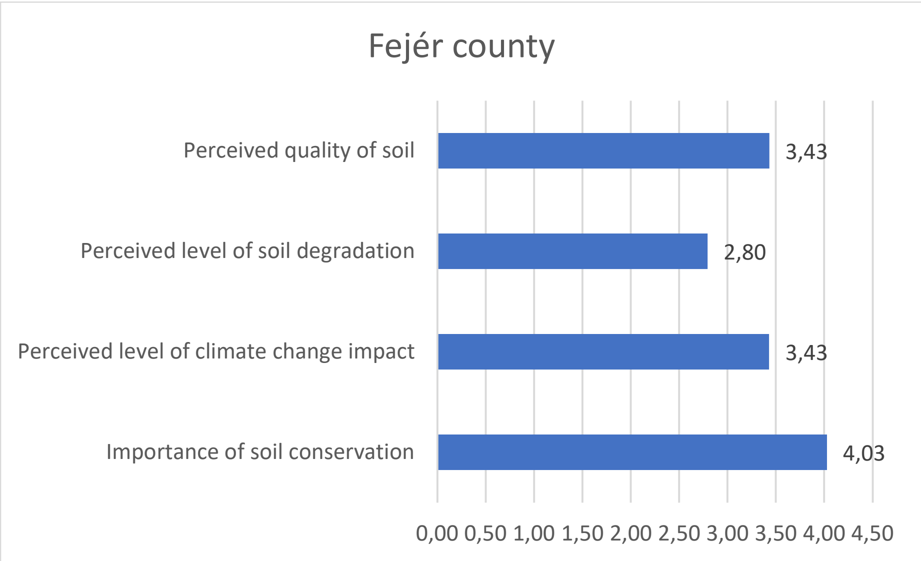

Figure 4-1. Survey results on farmers' perception (Fejér county)

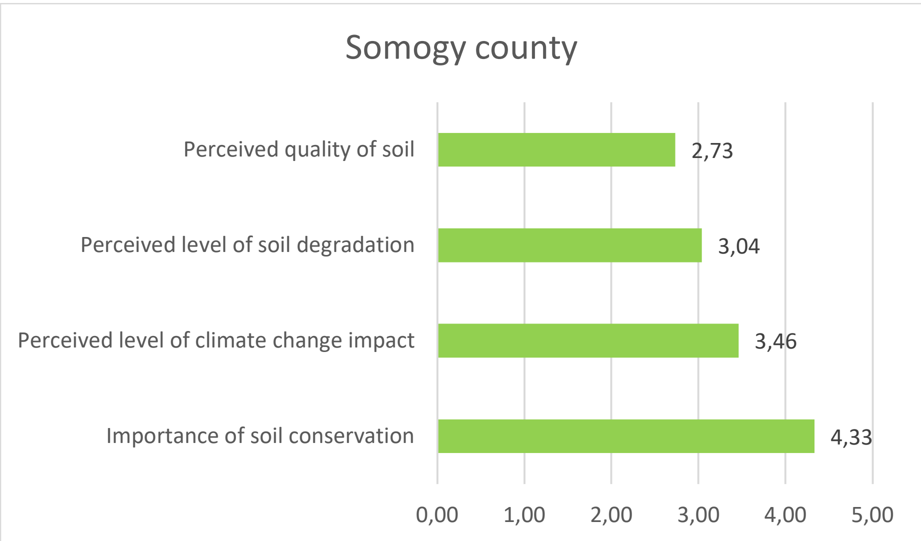

Figure 4-2. Survey results on farmers' perception (Somogy county)

Looking at the results from the narrowed sample of farmers from both counties, who already follow all three principles of conservation agriculture in their regular soil management practices (See *Table 3-5* in *Section 3.3*), the share of respondents is aligned with the level of perception indicated by farmers of the two counties. In spite of the unequal ratio of respondents from Fejér (~60%) and Somogy (~40%) counties, the share of farmers who already follow all three principles of conservation agriculture in their soil management practices is 34% of total respondents in Fejér county, and 48% from Somogy county, suggesting that increased perception of soil degradation and a changing environment can indeed influence farmers' attitude towards soil conservation, as well as their decisions on adopting SCPs.

Although, these results certainly provide valuable information, due to the rather low number of total responses received (83), the unequal (~60-40%) ratio of respondents from the two counties, the significant overrepresentation of certain demographic factors (e.g. college/university-educated farmers), and the underrepresentation of other aspects (e.g. farmers with only practical experience), the above results can be considered more of indications, rather than strong evidence of identified patterns. The results gained from this survey cannot be generalised to the farming community of the two counties, but they still provide a valuable insight into the perceptions of two groups of Hungarian farmers.

4.2.2 Information and Informants

At the virtual conference on the future of soil conservation farming in Hungary, the highest-level representative of the Ministry of Agriculture (AM) started her opening speech by saying that soil conservation is an area where it is important for us to expand our knowledge. She also mentioned that "*while soil conservation is a priority element of regulatory- and agricultural support policy, this is not enough in itself, farmers need to know best practices and they need to be able to follow them on their own farm*" (R-G1).

The source of information on such 'best practices', however, and how they find their way to farmers is rather important. The influence of farming machine and equipment manufacturing companies is increasing, influencing farmers' decisions not always in the right direction (I-R2). Farmers, if persuaded by the company's campaign or field demonstration, e.g. on a foreign visit, will invest in and purchase a machinery that is not suitable for cultivating their soil. There are, though, companies who consider it important to involve experts, like researchers and university professors in their campaigns or machinery demonstrations for farmers, inviting them to such events so that they can share their views on what science and experiments actually confirm as beneficial or harmful with regard to various soil management practices (I-R1, I-R2, I-RF1). Scientific results are, furthermore often shared in printed or online agriculture themed magazines or websites with an educating purpose (I-R2, I-RF1, I-F6).

With regard to the representation of soil science and soil conservation in future farmers' formal education, interviewed university professors indicated that at present, they are only minimally included in the school curriculum, and it is not emphasised enough in agricultural higher education either. People can easily become farmers without the required knowledge on soils and how soils work, how farming practices influence the state and health of soils, while soil should be the basis of agricultural education (I-R1, I-R2, I-R3, I-RF1).

On conflicting, potentially damaging information, a university professor shared that there are many unprofessional, harmful ideas emerging that need to be better handled on higher levels, for example, the assumption that burning crop residues (like straw) produces green energy. While in reality, this takes away an important soil cover and source of nutrition from arable lands, leading to a decreased level of soil organic matter, increased sensitivity to climatic phenomena, as well as to increased fuel/energy consumption (because of the compacted, hardened soil) of the uncovered land. "*A produced energy cannot be considered green if it results in increased fossil fuel consumption elsewhere*" (I-R2).

Others emphasised that farm advisors and village consultants could have a crucial role in informing and educating farmers on the needs of soil and how farmers should make soil management decisions on the basis of these needs, if they themselves possessed the required, up-to-date knowledge on soil conservation, and of course, if next to all the administrative tasks of their job, they had the time to talk to farmers about such essential matters (I-R1, I-F5, I-F6, I-RF1).

On potential fora for sharing knowledge and information with farmers, practitioners mentioned the provenly effective role that 'Living Labs'[1] and 'Lighthouses'[2] play in awareness-raising, knowledge transfer, and sharing experience through e.g. demonstration farms and agricultural best practices (P-R1, P-R2). It needs to be an important goal that researchers and farmers shall expand their knowledge together. Living labs can also be a part of methodological experiments in a farm context, in cooperation with farmers, involving them in solving local problems and challenges (P-R2). In Hungary, at present, there is only one Living Lab (the Research Institute for Organic Agriculture) where new approaches and farming practices are demonstrated and shared in a coordinated way (I-R2). According to multiple stakeholders, average farmers are generally not keen on demonstrating their own best practices (I-R2, P-F1, I-RF1).

Farmers do not have access to the latest research results and the education does not provide a hands-on, reliable knowledge on soil conservation practices either (P-F1). For this reason, farmers are afraid of taking risks, and so they continue doing what they have always done: conventional farming with tillage (P-F1, I-F5, I-F6, I-RF1).

Several practitioners emphasised that in addition to targeting farmers with the right information on threats and possible solutions, consumers also need to be targeted for awareness-raising and educational purposes (P-C1, P-G2, P-G3). Consumers need to be made conscious, involved, and educated about the importance of soil conservation and the benefits of conservation agriculture, not only to the soil and the environment, but also to their health (P-C1, I-R1, P-G1, P-G2).

Table 4-6. Themes and examples for information and informants

Theme	Example
SC and SCPs not adequately included in education	"Earlier, soil science was a fundamental subject at agricultural universities, but not anymore." (I-R3) "In the past, good farmers used to read and learn, educate themselves…now, anyone can purchase land after completing a 4-5-month training. I think maximum 1-2% of farmers actively look for and read publications on the latest research results." (I-RF1)

[1] "Living Labs are interactive innovation ecosystems in which users co-create new solutions, integrating research and innovation processes in real life settings" (Beigel, 2019). In the framework of the EU mission 'Caring for soil is caring for life', Living Labs are defined as "spaces for co-innovation through participatory, transdisciplinary and systemic research, that allow stakeholders to work together to develop solutions and identify gaps in the knowledge on soil health" (EIP-AGRI, 2021).

[2] Lighthouses are places for demonstrating solutions, training and communication. Lighthouse farms could play an important role in promoting soil health, by demonstrating beneficial farming systems such as agro-ecological and organic farming practices, conservation agriculture, high nature value farming and land management, carbon farming, and sustainable and adaptive forestry. (EIP-AGRI, 2021).

Lack of sufficient and up-to-date information	"Conventional soil management is the rule of thumb for farmers that they find hard to change because they lack sufficient information on new research and soil conservation practices." (I-C1)
Universities' influence	"Students of agricultural/crop production studies take home what they have learnt in a 50-50% ratio with success (and later adoption of what was taught) or in vain…As a university educator, I'm always glad to hear about the successes that farmers gained while adopting no-till practices that I introduced them to." (I-R2)
Overwhelmed advisors and consultants	"There is no one to whom we can turn with questions or ask for support. Farm advisors and village consultants usually help only with paperwork." (I-F3)
Educating consumers	"A consumer doesn't even necessarily know that soil is a living medium." (P-G5) "The average consumer has expectations maximum for food to be chemical-free…it is not typical that they expect a certain method of soil management…even if it does have an impact on their food. Consumers need to be addressed with targeted messages." (P-C1)
Communicating the message	"In our world today, the narrative means everything. We need to target information in the right way to achieve change in thinking…both towards farmers and the general public. They need to understand that soil is not merely a growing medium for our food, it is an essential environmental element for climate regulation, flood mitigation, detoxication etc. Soil conservation needs to become a part of the public's thinking." (I-G2) "Calling farmers' attention to shocking facts could help, I think…as it was with the mass dying of bees and the ban on certain chemicals as a result. They need to know what harmful management does to their soil, how much fertile soil is lost as a result and especially, how much time it takes for fertile soil to regenerate. Shocking news with a future impact on them might change their thinking, make them care about the future and change their soil management practices. People need to be scared to start caring." (I-A1)

Relevant survey results

In the online survey, the information sources that most responding farmers indicated as their regular sources on soil management and soil conservation were the following (See also the result to Question 14 in *Appendix 12*). Respondents were allowed to select maximum five sources out of a list of 16 options.

1. Other Hungarian farmers (44)
2. Magazines, books, and studies (39)
3. Online agricultural farming websites (33)
4. Conference/farm demonstration (32)
5. Farm advisor (32)

When it comes to farmers' trust in various information sources, on the basis of the average of values they indicated on a Likert scale from 1 (not at all trust) to 5 (very much trust), the top 5 trusted information sources are the following (See also the result to Question 15 in *Appendix 12*):

1. Soil conservation expert (3,78)
2. Researchers/university educators (3,76)
3. Conference/farm demonstration (3,51)
4. Farm advisor (3,44)
5. Education/training (3,36)

The bottom 5 of least trusted sources of information on soil management and soil conservation were the following:

1. Local farmers' association (2,45)
2. Facebook groups/pages (2,51)
3. Inputs or machine manufacturing company (2,61)
4. Other websites (e.g. YouTube) (2,68)
5. Foreign farmers (2,71)

While this question was not compulsory for respondents to answer in order to avoid that sources are graded in lack of personal knowledge or experience with them, it is still a question whether the sources that were eventually evaluated in some way mirror the farmers' actual personal experience with the source on soil management, or it only reflects their general attitude towards the source. The received results, however, still provide a valuable indication on how soil management- and soil conservation-related information reaches farmers, which are those sources that they trust and which are those that need significant improvements in order to make them trusted sources for future communication towards farmers on SCPs.

4.2.3 Beliefs and Attitude

Farmers often tend to stick to conventional tillage in the (unsupported) belief that it is a necessity for weed control and that plant residues need to be turned in the ground by ploughing (I-R2, I-F6, I-RF1). This results in the regular practice of tillage with no regard to the actual condition of the soil, for example its wetness. Ploughing the wet soil with heavy machinery is both unnecessary and detrimental to soil quality, leading to compaction and loss of moisture (I-R1, I-R2, I-F6).

Oftentimes, farmers' attitude towards soil conservation or restoring degraded land (when required by policies) is affected by the fact that, at present, the farmer needs to bear the cost of any such interventions on their land (P-G2).

Table 4-7. Themes and examples for beliefs and attitudes

Theme	Example
Stubbornness	"Hungarian peasants are a stubborn folk, although they can cooperate if someone persuades them that it will be beneficial to all of them". (I-G1)
Risk aversion	"As soon as the risk of the slightest financial loss arises, farmers are out of any progressive initiative." (I-G1)
Homo economicus	"For economic reasons, farmers are not typically known for long-term thinking or sustainable soil management." (P-G2)
Tilling at the right time	"I'm not planning to change the way I till my land. Plants can access nutrients only if organic matter is ploughed into the soil. My goal is to till in an optimal way, at the right time, in the right weather." (I-F4)
Motivation behind practices	"The owner of the land that I farm is open to new things. He keeps on experimenting, trying new things, new equipment. And he does this from his own money, not subsidies…He doesn't even allow me to till the soil in frost, fearing that earthworms might freeze." (I-F2)

4.2.4 Norms and Networks

According to long-time farmer and practitioner of SCPs (P-F1), change needs to happen first in farmers' thinking, otherwise any policy effort is in vain. Financial support can have a great role in influencing their thinking, because they need financial support in order to purchase the required technology/machinery (P-F1, P-G2, I-F5, I-F6). No-till farmers, who are still considered pioneers in Hungary, are often verbally attacked, or ridiculed by other, conventional farmers, saying that no-till fields are weedy, while cover crops are there with the purpose to cover the soil, preserve its moisture content and good state (P-F1, I-RF1). There is frequent tension also with authorities and the hunting lobby, over the damage that wild animals, like deer and boars, cause by eating the cover crops or other crops from the land, with the farmer having no means to protect it (P-F1, I-F6). Either financial support/compensation or sanctions are needed. Currently there is no policy in place to help farmers manage game damage (P-F1).

Farmers with a similar thinking or approach to farming sometimes start bottom-up initiatives, such as the so-called *Soil Regenerative Farming Association* in Somogy county, developed with the aim to share experience, information, research, and results with other farmers who are committed to or open to transitioning to soil conservation farming (P-F1).

In the mainstreaming of conservation agriculture, advocacy has an important role. Professional collaborations need to be harmonised (P-C1). Although, not everyone is a supporter of expanding such networks. According to the highest-level representative of the Ministry, in a small country with a few experts, it is hard to manage many platforms, working in parallel for the same cause (P-G1).

Table 4-8. Themes and examples for norms and networks

Theme	Example
Copying the past	"A farmer's choice of a particular soil management practice greatly depends on whether he/she feels the need to perform appropriate soil analysis on his/her field before making the decision, or he/she rather follows the tradition, relying on how his/her grandfather or great grandfather used to do." (I-R2)
Copying peers	"What is important is whether the farmer wishes to become better than his/her neighbour or he/she is only copying what the neighbour does on the field." (I-R2)
Fearing peers	"I believe in no-till, but it drives me mad when I see in spring that the conventionally farmed neighbour's maize has more leaves out than mine." (I-F5) "As the American saying goes, 'No one is rewarded for how his maize looks in May'…what matters is the harvest. No-till crops tend to be a bit behind, but in the end, they deliver a good yield." (I-F6)
Policies' harmful effect on networks	"The Act on the protection of arable land gives local landowners an advantage and a pre-emptive purchase right on land…I guess, originally, they wanted to avoid the threat of foreign investors, this way. But this law creates tension among local farmers, they become each other's competitors. It certainly doesn't encourage trust or cooperation among them." (I-F6)

4.2.5 Participation

In spite of the proven effectiveness and essential role of a participatory approach in the development and implementation of information-based policies (See *Section 2.5*), in present-day Hungary, this aspect is often limited to the level of formal requirements (e.g. by the EU) and ad-hoc requests for feedback and input, which then are not followed up. With regard to shifting to more sustainable practices, policies that encourage voluntary participation, instead of the use of coercive measures, can help motivate such transitions. Furthermore, by building a new social norm and enhancing community understanding and the collaboration of various stakeholder groups have the potential to further motivate sustainability transition (Ong & Liao, 2020).

Table 4-9. Themes and examples for participation

Theme	Example
No follow-up	"I used to send my opinion on certain support policies to the government's open consultation…but then, I never hear anything about it again, the results are not shared with us or they're just hidden away somewhere." (I-F6)
Only when they must	"We are usually invited for policy-related consultations to the Ministry when they are required to do so in order to comply with an EU obligation for public participation." (I-N1, I-NF1)

4.2.6 Trust

According to several interviewed and observed farmers, sharing knowledge and experience with other farmers, and becoming open to new ideas is very much a matter of trust (P-F1, I-RF1, I-F5, I-F6). In the Hungarian case study of the UNISECO project, it was revealed as a potential barrier to the adoption of SCPs that as a result of the political system change of the 1990s and all the radical changes (e.g. privatisation, the ceasing of farm co-operations) that followed, made farmers more individualistic, less likely to cooperate with other farmers (Balázs et al., 2019; UNISECO, 2021b). *Section 4.3.4* on 'Norms and Networks' has briefly shown through a farmer's example, which in the interviews were brought up by three further farmers (I-F5, I-F3, I-NF1), how a policy can affect behaviour and trust within a network with the creation of tension and competition among farmers. Some farmers explained that this is one of the main reasons why, for example, farmers often do not trust local farmers' associations. Though, there are good and successful examples for local farmers' cooperation and networking around a common objective or interest (such as the *Soil Regenerative Farming Association* in Somogy county), it is not unusual that farmers look for opportunities to collaborate and exchange views beyond their direct network, for example, in a farther part of their county, where tension from competing for the same land is less likely (I-F5, I-F6).

Trust among farmers is, however, not the only trust that needs to be improved and addressed in order to create the basis of a future Hungarian agriculture in which soil conservation practices play a greater role. Both the interviews and the observed event shed light on latent or more explicit tension among different stakeholder groups. This tension can manifest in the range from ignorance, constant criticism, to hostility (I-R1, I-R3, I-N1, I-NF1, I-RF1, I-P1). In relation to the mainstreaming of sustainable farming practices, such harmful oppositions are the ones between the government and NGOs, as well as the government and the scientific community. Researchers' constructive criticism or recommendations for the improvement of policies are sometimes met with a threatening display of power (P-R1), or ignorance and a lack of consideration of research outputs (as briefly described in *Section 4.2.3*), or the lack of coordinated and genuine involvement of scientists in policy-related discussions (I-R1, I-R3). NGOs on the other hand are often accused of harming the reputation of farming and even the future of agriculture with their criticism (by e.g. highlighting agriculture's contribution to climate change or to biodiversity loss) (P-G1, I-N1, I-NF1, Németh, 2020). As the highest-level representative of the Ministry put it during the roundtable discussion of the observed virtual event on the future of soil conservation farming: "*The weakest link is the communication towards society which has resulted in the bad prestige of agriculture, turning the youth away from farming*" (P-G1).

4.2.7 Farmers' needs for adopting soil conservation practices

Based on the findings from semi-structured interviews with eight farmers, the observation of an event presentation by an early adopter and potential change agent of SCPs (P-F1), and the results of an online survey with 83 responses from two Hungarian counties, the below table provides an overview of the primary needs that farmers identified for adopting or continue applying soil conservation practices in arable farming. The needs are presented along three types of policy instruments: information-based, economic, and regulatory policies, while also indicating the source(s) of a particular need. In case of factors that were identified in response to the online survey, the number in brackets refers to the number of farmers who selected a given factor as one of their top five needs.

Table 4-10. Policy-related needs identified by farmers to adopt or continue applying SCPs

Identified needs	Source
Information-based	
Tailored guidance and advice	I-F1, I-F3, I-F5, I-F6, I-RF1, Survey (30)
Strong and prepared farm advisory services	I-F3, I-F6, I-NF1, Survey (32)
Access to the latest research results	P-F1, I-F5, I-F6, I-RF1, Survey (17)
Education curriculum which provides an appropriate training and up-to-date knowledge to future farmers on soil science, soil conservation and SCPs	P-F1, I-F1, I-F3, I-F6, I-NF1, I-RF1
Research and the educational system should be partners in the mainstreaming of farming practices that are sustainable in the long run	P-F1, I-F5, I-F6
A knowledge platform or other opportunities to share and exchange knowledge and experience among farmers	P-F1, I-F1, I-F3, I-F5, I-F6, I-NF1, Survey (42)
Indicators and tools to measure progress in improving soil quality	P-F1, I-RF1, I-F6, Survey (28)
Information on the proven effectiveness of SCPs	I-F1, I-F5, I-F6, Survey (51)
Economic	
Financial support to purchase equipment/machinery suitable for SCPs	P-F1, Survey (45)
Financial reward for soil conservation	Survey (26)
Financial compensation for game damage on lands with cover crops	P-F1, I-F6
Financial support to enable a continues soil cover on arable lands	P-F1
Regulatory	
Where the level of soil degradation requires, conventional tillage should be sanctioned	P-F1, I-RF1, I-NF1, I-F6
The application of SCPs (at least on degraded lands) should be required, monitored, and enforced by regulation	P-F1, I-NF1, Survey (6)

4.2.8 Summary

In its effort to identify the most common social barriers to farmers' adoption of soil conservation practices, this research built on the input from altogether 116 stakeholders, gained with the help of two qualitative and one quantitative data collection methods. The dominant themes that were formulated as a result of the content analysis, as well as the results of the online survey were organised around four pre-determined categories and two additional aspects of interest. The study has revealed that a major limiting factor in the uptake of sustainable practices is if the land-user does not know or cannot measure himself the basic characteristics of the soil of their own land. In order to be able to provide a different, ideally more effective response to the increasing pressures, deteriorating state and threatening impacts of our changed environment, the land-user first needs to be able to perceive the change around them.

Knowing the right response to a particular problem or challenge, however, calls for a well-informed and prepared land-user. The way how information gets to farmers and the quality, clarity and suitability of that information are crucial. Timely management response requires timely and up-to-date, tailored advice. Regardless of whether the necessary information and guidance are gained through an educational institute, a fellow farmer, or a farm advisor, the information needs to be reliable, and the source of the information easily available. The study revealed those sources that (albeit suggested by a small sample) regularly provide farmers with information on soil conservation and soil management. On the basis of the level of trust that farmers indicated towards particular sources, places to intervene can be identified. Information should not be limited to land-users, however, consumer can also play an integral role in influencing farmers' SM management practices, if only they know how different practices can affect them. Changing consumer demands, again, requires changing consumer perception by targeted information.

Dominant themes regarding the influence of norms and networks on farmers' decisions and behaviour revealed the influence of some mimetic drivers or in this case, rather mimetic barriers to change: copying peers. There was hardly any interviewed farmer who did not mention the influence of peers on farmers' practices. Usually, the bad example or pressure came from members of the older generation. The possible critical opinion or actual verbal criticism from other farmers on anything yet unknown to them, was a returning aspect. But it is not always external influences that affect behaviour, farmers' own beliefs and attitude can be a major barrier, too. Whether it is stubbornness, personal conviction, avoiding risks, or believing unsupported claims, beliefs and attitudes are probably the hardest to change. But again, the right information from the right sources may help.

And finally, the two aspects of which one's potential is so far more supported by literature than practical experience or demand in Hungary: participation or the lack of it, was more often mentioned by stakeholder groups such as NGO representatives and researchers, some farmers were of the opinion that they have no time for it, or have no trust for it. The two aspects, participation and trust are deeply intertwined and this is true for both sides: the one who initiates a participatory approach, and the other who either rejects or accepts the invitation. According to Rogers (1983), if users are allowed, invited to participate in making key decisions, then they will have a sense of control and potentially contribute to the diffusion of innovative ideas and practices, instead of waiting for the same from a centralised system. For farmers, on the other hand, the notion of 'co-opetition' could potentially be of help: encouraging competitors to collaborate and exchange information to help all participants of a system or community to improve their competitive advantage and efficiency (Glover et al., 2014).

4.3 RQ3: Stakeholder recommendations for an improved soil governance

Based on the analysis of collected qualitative data from the semi-structured interviews and the observed presentations, the below list provides an overview of the dominating themes of stakeholder recommendations for improved soil governance in Hungary, illustrated with relevant examples. Based on the inputs from stakeholders and the key aspects of effective information-based policies outlined in the literature review, a separate list of policy recommendations is provided in *Chapter 6*.

Table 4-11. Themes and examples for stakeholder recommendations for an improved soil governance

Theme	Example
Long-term planning and political commitment	"Future policies for soil conservation need to plan for the long run, need to be committed to the improvement of the quality of our nation's soils, and need to make sure that all interventions raise awareness about this need, while enforcing and monitoring/controlling the implementation." (I-R2) "High-level political power needs to give the green light to soil management practices that conserve the soil, its moisture, and organic matter." (I-R2)
State support to the SC authorities	"The state needs to help, support, incentivise and monitor the implementation of the SCAP objectives through the soil conservation authority." (I-R2)
Soil-friendly product certification with benefits to farmers	"For a future SC-based labelling/certification programme to work, farmers need to be nudged and persuaded to participate, to be willing to spend extra time and money on such efforts. This is only possible if farmers see practical benefits for themselves in it, for example, if the market was ready to pay more for these soil-friendly products or if subsidies could incentivise farmers who participate in this certification scheme." (I-C1)
Adjusting EU targets to the national context	"Proposed EU targets for soil conservation cannot always be achieved on all types of soil: national strategies and indicators are required for the right adjustment. Along the EU objectives, it is the responsibility of all Member States to develop a regulatory and support policy framework that can effectively support soil conservation within the national context." (P-R1)
Shift to a performance-based approach	"Regulations and support policies need to transition from the current area-based approach to a performance or soil quality/soil health-based approach." (P-R1, I-F6, I-N1, I-NF1, I-RF1, I-P1)
Collective action	"In addition to generally encouraging collective action in agriculture, professional collaborations for soil conservation should be harmonised." (P-C1)
Local response to local problems	"Establishing local working groups that are able to develop local responses to local issues, while considering local characteristics." (P-R2)

4.3.1 Summary

In addition to the previously identified policy needs by farmers, these general policy recommendations formulated by interviewed and observed stakeholders aimed to address the more basic aspects of public policy, in addition to some novel ideas. Stakeholders call for a policy development and decision-making process that are ready to make long-term commitments for soil conservation, supported by strong political will. Political support is required for those authorities, as well, who implement, enforce, and monitor many of the existing policies and who are appointed to realise the ambitious objectives of the *Soil Conservation Action Plan*. For a potential future food certification programme that aims to label food products that come from soil-benefitting conservation agriculture, a relevant factor to address is how the idea is sold to farmers as something that they will find beneficial. And finally, the importance of adjusting EU targets to the national context is emphasised, along with the importance of collective action and providing local responses to local challenges.

5 Discussion

Reflecting on the significance and potential contribution of this study

This thesis aimed to provide a better understanding of and a more nuanced insight into those social aspects that influence farmers' decision-making on the adoption of soil conservation practices in arable farming. Building on the concepts, theories and approaches of existing literature, this research intended to integrate rich qualitative data from a diverse group of Hungarian stakeholders, who either directly as arable farmers, or indirectly as advisors, researchers, governmental-, and civil society representatives, and educators are in some way connected and/or committed to the objective of conserving agricultural soils.

The research integrated stakeholders' knowledge, perceptions, experience, and expertise and from the analysis of gathered data, formulated dominant themes that can provide a more comprehensive, refined insight into stakeholder perspectives and relations, as well as into the policies that aim to influence the adoption of SCPs. The used approach and pre-defined categories can be potentially used for the study of other types of innovation adoption, sustainability transition and policies targeting attitude change for environmentally conscious behaviour.

The study, furthermore, placed the investigation of social barriers and information-based policy responses into the wider context and with the use of the DPSIR-framework, highlighted those aspects of arable farming, and soil degradation in Hungary, as well as the key aspects of information-based policies, that can potentially influence the adoption of sustainable soil management practices by farmers.

This thesis provided insight into a complex issue from the viewpoint of ten different stakeholder groups. It explored social barriers to innovation adoption for soil conservation from perspectives (e.g. perception, information sources, attitude, trust) that have rarely been used in a Hungarian research context on agriculture. The research utilised three different methods for the collection of empirical data from altogether 116 individuals. In the context of sustainable agriculture and soil conservation, the work outlined key aspects of information-based policies that can potentially improve their effectiveness. The thesis, furthermore, demonstrated, albeit on a small sample, how the quality of soils in a particular geographical region can potentially influence farmers' perceptions and attitude towards soil conservation. It introduced an adapted and expanded conceptual framework that can potentially be used for the studying of similar research problems (e.g. natural water retention on farmlands, the protection of natural habitats on farmlands). Finally, this research revealed farmers' level of trust towards various information sources and thus provided possible areas to intervene for more effective diffusion of innovations.

Reflecting on the methods and limitations of the study

Although the used methods for data collection have resulted in a rich collection of primary data, for a study and research period of this length, the use of fewer methods or fewer sources would have been more beneficial, and would have allowed for a more in-depth analysis, and the critical discussion of more of the results (in this case, especially, the survey results).

The exploratory sequential mixed methods approach is a good choice for researchers of complex topics that they are not closely familiar with. The first conducted qualitative data collection has provided a useful insight into the more specific aspects and issues of the research topic, allowing the author to better formulate the questions of the later tool for quantitative data collection.

For the studying of agriculture-related (more theoretical) issues, using the periods between November and March for data collection is certainly recommended, otherwise, the researcher might risk a low response rate. Furthermore, especially in countries/regions where computer literacy may be relatively low for people above 60-65, face-to-face interviews are a better choice (if resources and travel restrictions allow), otherwise in the survey results, practitioners above a certain age might be underrepresented, while those of a younger generation will be overrepresented, leading to results that are not representative of the targeted population.

The used theories provided a useful framework for guiding the research and the focus areas for both the literature review and the empirical data collection. There were, however, differences in the usability of the selected theories: the Agroecological Transitions theory proved to be useful merely in providing the key concepts and themes to build the investigation of this study on, while the Diffusion of Innovations theory was more suitable in its overall approach and compatibility with the research topic, even if its more systematic, comparative application fell beyond the scope of this thesis.

The research questions were legitimate and the research was able to provide the answers to them that the author was interested in on the outset of the research. The concept of 'participation' and the investigation of potential participatory approaches in policy development, have not provided the depth of data that the author was hoping for.

With the low level of received responses to the online survey and the over- and underrepresentation of certain variables, the results of the survey cannot be generalised to the originally targeted population, the received results, however, still provide insight and indication for certain patterns for a better understanding of the investigated issues.

As mentioned before, the general approach and the conceptual framework could be potentially utilised in a different geographical or sectoral setting, as well as with different stakeholder groups.

6 Conclusions and Recommendations

With the aim to provide a context for the study of the research topic, the thesis first investigated and in the literature review, provided an overview on those factors that play a role in the degradation of agricultural soils in Hungary, particularly with regard to the general context and characteristics of arable farming in Hungary, and the applied soil management practices. These factors included, among others, the extended areas where soils are susceptible to various forms of soil degradation, the dominating ratio of conventional and intensive farming methods, an aging farming population and the increasing impact of climate change, especially extended periods of drought.

Regarding **Research Question 1**: 'What are the most relevant existing information-based policies in Hungary that aim to influence farmers' soil management practices?

The thesis provided an overview on the main characteristics and objectives of the most relevant existing information-based policies for soil conservation, including the Good Soil Conservation Practice handbook, the Soil Information and Monitoring System, the Farm advisory service, the requirements for a soil conservation plan, the Soil Degradation Subsystem (SDS), and finally, the Soil Conservation Action Plan (SCAP).

Collected stakeholder views on current policies mostly concerned the farm advisory service and the suitability of the newly accepted Soil Conservation Action Plan. Identified factors leaving room for improvement for existing policies dominated the collected results, the main pieces of criticism being: the lack of a prepared, available, and independent advisory system, lack of available and usable data on soils, and the voluntary nature of the new Action Plan. Among the strengths, stakeholders mentioned the strong legislative foundations for soil conservation in Hungary, and the potential of policies that are currently being developed, such as the national CAP Strategic Plan.

With respect to **Research Question 2**: 'What are the most common social barriers to the adoption of soil conservation practices by farmers in Hungary?

The dominating themes for common social barriers that have been formulated, as a result of the empirical study, are the following according to pre-determined categories:

When it comes to *Agroecosystems and perception*, the adoption of soil conservation practices is often hindered by farmers' lack of knowledge and understanding of their soils, their inadequate perception of a changing environment, which often results in the application of SM practices that are unfit, since unadjusted to local conditions, furthermore, farmers often do not recognise soil conservation's benefits.

With regard to *Information and informants*, this research found that outdated advice from advisors, who are generally overwhelmed with administration, and farmers' lack of trust in information sources are major barriers in the way of adopting sustainable practices. The increasing influence of inputs companies and machine manufacturing businesses, the weak coordination for demonstrating best practices, and farmers' lack of access to the latest research results can similarly lead to decisions that do not serve soil conservation. Further relevant factors are the inadequate coverage of SSM in the school curriculum and farmers' practical training, as well as the low level or lack of consumer awareness on the importance of soil conservation and how food choices can potentially affect it.

While investigating how *Beliefs and attitude* influence farmers' decision-making on soil management practices, the thesis found that farmers often have a lack of openness to new approaches and practices, as they tend to stick to using what they have always known and used (e.g. ploughing), while avoiding taking risks for uncertain gains. Their openness to innovation can be further hindered by unsupported beliefs on their soils' or crops' needs, the fact that economic factors often outweigh the potential benefits of long-term planning, and that they tend to prefer minor adjustments to major changes.

Norms and Networks can play an important role in the choices that farmers make as they often copy the practices of their predecessors, while imitating peers or fearing their criticism can strongly affect their farming practices, too. In Hungary, relations and trust within farmers' networks can be further weakened by the competitive situation between farmers that certain agricultural or land acquisition regulations create.

Finally, with respect to the two additional aspects of the investigation, this research found that *Participation* and participatory policy development processes are generally hindered by the ad-hoc nature of government- or authority-initiated consultations, the lack of follow-up on the feedback that farmers provide in response to rare consultations, and the lack of coordination behind these processes. *Trust* both among farmers and between different stakeholder groups tends to be at an alarmingly low level. On the one hand, this can be explained by farmers' gradually formed individualistic behaviour after the political-system-change in Hungary that often results in a lack of cooperation among individuals, on the other hand, various stakeholder groups tend to approach each other with a certain level of suspicion and sensitivity to criticism.

In relation to **Research Question 3**: 'How can information-based policies achieve a wider uptake of soil conservation practices by farmers in Hungary?

Based primarily on the literature review, as well as informed by the input from interviewed, observed, and surveyed stakeholders, this research found that the following key aspects are likely to increase the potential of information-based policies to become effective. Information-based policies have a greater chance for successful implementation if they are integrated in a set of other, for example, regulatory or economic policy instruments. Encouraging collaboration and supporting greater interaction among farmers, as well as between farmers and advisors; rewarding beneficial practices instead of penalising farmers for damaging practices are also proven to be beneficial. Enabling and supporting farmers' participation in policy development, implementation, and even analysis processes, can contribute to the long-term sustainability of measures. As far as effective policy implementation and the role of policy analysis are concerned, using evaluation criteria that are integral to democratic values (e.g. social acceptance, transparency, participatory rights) can contribute to the effectiveness of policies that aim to achieve long-term behavioural and attitude change. As the below list of recommendations will also suggest, the independence of both research and farming advice, policies' sensitivity to local conditions and their long-term reliability, the education of consumers, and using the right framing for the cause of soil conservation (e.g. soil security) are all among those key aspects that can enable the successful implementation of information-based policies.

6.1 Recommendations for practitioners

In addition to the recommendation included in *Sections 4.2.7* and *4.3*, a collection of ten good examples for effective information-based measures for soil conservation are included in *Table 0-18* of *Appendix 13*. Based on both the literature review and the empirical data collection, further recommendations are provided below, addressing various stakeholder groups. Recommendations are more of a fundamental, general nature, calling Hungarian stakeholders' attention to essential factors that are required for making information-based soil governance truly effective and its results long-lasting.

To policy makers and relevant authorities

- Policy responses should be diversified with regard to societal level, target audience, and used measures;
- Agricultural education and the training of future farmers should be updated and developed in a way that it provides adequate, up-to-date knowledge on soil dynamics, soil conservation and sustainable soil management;
- Opportunities and diverse fora should be created for knowledge and experience-exchange, on local and sub-national levels, among farmers; e.g. utilising the concepts of Living Labs and Lighthouses;
- Encourage the co-production of knowledge and ideas between various stakeholder groups (farmers, researchers, consumers, authorities, educators, etc.);
- Create opportunities and fora for stakeholder groups (farmers, advisors, researchers, NGOs) to share and demonstrate best practices, share, and reflect on lessons learnt, and inspire others with positive examples;
- The work and efforts of local communities, civil society- and grassroots organisations should be supported;
- With various sensitive interventions, contribute to restoring trust within essential networks (e.g. farmers) and between stakeholder groups;
- Collaborative relationships between formal and informal networks/institutions should be encouraged and enabled for managing soil resources sustainably;
- Improve farmers' social capital by strengthening trust and engagement in different bonding, bridging, and linking networks;
- Policy makers, advisors, educators, authorities, and researchers should be open to learn from farmers, and utilise/integrate their hands-on, local knowledge;
- Both policy- and land management solutions should be able to be adjusted to local needs and conditions, with the required flexibility and tool set;
- Agricultural advice and support to farmers should be independent from corporate interests;
- Farmers' independent decision-making on soil- and land management should be supported and encouraged by providing them the right training, tools, and indicators, so that they are able to adequately assess challenges, needs on their land and then, select the right response (method, intervention) to address them;
- The transparency of policy development processes should be increased, relevant stakeholders should be involved and consulted, especially before new policies are developed; public consultations should be a genuine and coordinated process to gain valuable input and feedback from stakeholders; policy evaluations, proposals should be made publicly available;
- A new norm should be built in policy development, implementation, and evaluation, based on a participatory approach;
- Policies for soil conservation should also be evaluated along value criteria that are linked to the functioning of democracy, such as acceptability or social acceptance, transparency, participatory rights, and equity;
- Communication- and education campaigns should raise awareness and increase consciousness, especially when targeting farmers and consumers;

- Both farmers and consumers should have access to science-based information, so that, to varying levels, they are aware of the underlying ecological processes and principles in agroecosystems (e.g. soil dynamics);
- Myths around soil conservation should be demystified, build education, communication campaigns on facts based on science and farmers' experience;
- Consumers should be educated and encouraged to ask questions, so that they can make informed choices about their food, with consideration to how the food was produced;
- Consumers' connection to the source of their food should be established or restored by education, awareness raising, field visits, farm demonstrations etc.;
- A label/certification for food products coming from soil conservation farming should be considered, accompanied by awareness raising and communication campaign, both to incentivise farmers to get involved and motivate consumers to consider new aspects when making choices about food;
- The funding of translating influential foreign literature (books, articles, videos etc.) to Hungarian on soil conservation in arable farming should be considered;
- Similarly to independent farm advice, research on soil conservation and SSM should also be independent from corporate interests, while scientific/project results should be adequately utilised and disseminated to stakeholders;
- The right framing should be chosen for targeting the right stakeholder group, e.g. soil or food security when aiming to include soil conservation in agenda setting by decision- and policy makers, land stewardship and farm resilience/sustainability when addressing farmers, health, food security and intergenerational equity when targeting consumers, etc.;

To farmers

- Crops and cultivation methods should be diversified for increased resilience;
- Build on lessons learnt and share experience and knowledge with other actors in agroecosystems, so that they are more equipped to anticipate future events, rather than simply reacting to present conditions and challenges;
- Opportunities to exchange knowledge and experience with other farmers should be utilised or created, inspiring others with positive (or at least useful) examples is often more convincing for a cause (such as soil conservation) than waiting for top-down incentives and 'persuasion';
- Build new partnership, local networks, grassroots organisations around a common interest/objective that enable members to exchange knowledge and experience, co-create ideas and support each other in their own efforts.

6.2 Recommendations for future research

This research revealed several areas where future investigation and research can further improve our understanding of the research problem addressed by this thesis, as well as contribute to better policy responses and stakeholder cooperation. Recommended activities in further research include:

- Investigating current practices and possibilities for co-creating knowledge;

- Integrating behavioural science when investigating the adoption of new/sustainable agricultural practices by farmers in Hungary;
- Large-scale surveying of farmers' decision-making on soil conservation practices (practices, influences in decision-making, sources of information, barriers, trust in information sources, level of perception etc.)
- A large-scale assessment of farmers' needs, practices, sources of information and trust in informants on soil management practices. Statistical analysis of results with the purpose of explaining patterns and identifying areas to intervene.
- Critical examination of online and magazine articles published by thematic agricultural/farming websites on how the framing and general views on soil conservation and associated practices and approaches changed through time.
- Piloting participatory policy analysis with value criteria of transparency, participatory rights and acceptability or social acceptance.

Healthy soils, diverse crops, farmland habitats and cultivation practices all contribute to the resilience of agroecosystems. From a social perspective, self-organising stakeholder groups, shared learning, reflecting and building on past experience, and sharing knowledge with other actors, add to the adaptive capacity of social-ecological systems (Cabell & Oelofse, 2012). Sustainably managed soils and the application of soil conservation practices can not only contribute to the environmental sustainability of the agroecosystem, but they can potentially improve the social and economic sustainability of the rural community, as well, which largely depends on the resilience of the given agroecosystem.

As a result of the devastating *Dust Bowl* [3] in the United States of the 1930s, the government passed the Soil Erosion Act which then led to the establishment of the Soil Conservation Service. Farmers were given technical assistance to set up soil conservation programmes on their lands (Miller & Spoolman, 2012). In Hungary, the Soil Conservation Action Plan, that was adopted by the Ministry of Agriculture in January 2021, proposes a similar measure, the Farmers' Soil Conservation Programme. The Action Plan is an important first step towards building the foundations of an information-based governance for soil conservation. The author hopes that this research, with its findings, formulated recommendations and collected best practices, can contribute to and inspire some of the next steps towards making healthy soils and soil conservation truly a must.

[3] *Dust Bowl* refers to the Great Plains region of the United States of America which experienced severe and prolonged drought and erosion of the topsoil in the late 1920s and 1930s. The phenomenon was caused by a devastating combination of dry weather and over-intensive farming and grazing practices. As a result of the massive degradation of farmlands, thousands of families abandoned their farms and migrated elsewhere (Park & Allaby, 2013).

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Appendices

Appendix 1: Data on arable farming in Hungary

Table 0-1. Sown area by group of crops and legal forms, 2016
[hectares]

	Total	Of which:					
		Cereals	Dried pulses	Root crops	Industrial crops	Forage plants	Vegetables and strawberry
Agricultural enterprises							
Total	1 673 874	948 000	10 545	14 120	416 558	177 857	36 765
Private holdings							
Total	2 156 512	1 334 508	10 638	13 645	488 410	166 260	32 394
Total							
Total	3 830 386	2 282 508	21 183	27 765	904 968	344 117	69 159

Source: Hungarian Central Statistical Office (2017)

Table 0-2. Number of private holders by age bands, 2016
[person]

	Age, age band, years						
	14-24	25-34	35-44	45-54	55-64	65-	Total
Total	2 571	22 562	64 749	85 052	114 906	132 030	421 870

Source: Hungarian Central Statistical Office (2017)

Table 0-3. Number of holders in private holdings by highest agricultural qualification, 2016
[person]

	Highest agricultural qualification					
	None	Practical experience	Basic	Secondary	College, university	Total
Total	30 938	307 573	26 390	42 482	14 486	421 870

Source: Hungarian Central Statistical Office (2017)

Appendix 2. Further information and data on the application of soil conservation practices

Table 0-4. The main characteristics of sustainable soil management

1	Minimal rates of soil erosion by water and wind
2	The soil structure is not degraded and provides a stable physical context for movement of air, water, and heat, as well as root growth
3	Sufficient surface cover (from growing plants or plant residues) is present to protect the soil
4	The store of soil organic matter is stable or increasing and ideally close to the optimal level for the local environment
5	Availability and flows of nutrients are appropriate to maintain or improve soil fertility and productivity, and to reduce the losses to the environment
6	Soil salinisation, sodification and alkalinisation are minimal
7	Water is efficiently infiltrated and stored to meet the requirements of plants and ensure the drainage of any excess
8	Harmful contaminants are below toxic levels
9	Soil biodiversity produces a full range of biological functions
10	The soil management systems for producing food, feed, fuel, timber, and fibre rely on optimised and safe use of inputs

11	Soil sealing is minimised through responsible land use planning

Source: Adapted from FAO (2017b)

Table 0-5. Cultivation methods applied in arable land production, 2016
[hectares]

	Cultivation methods					
	Conventional tillage	**Conservation tillage**	**Direct seeding**	**Areas covered by multi-annual plants**	**Arable land area not cultivated**	**Total**
Total	3 256 562	356 771	37 937	114 729	53 646	3 819 645

Source: Hungarian Central Statistical Office (2017)

Table 0-6. Soil cover in winter on arable land, 2016
[hectares]

	Soil cover methods					
	Normal winter crop	**Cover crop or intermediate crop**	**Plant residues**	**Bare soil**	**Areas covered by multi-annual plants**	**Total**
Total	1 716 950	95 227	283 477	1 609 262	114 729	3 819 645

Source: Hungarian Central Statistical Office (2017)

Table 0-7. Share of arable land in the crop rotation, 2016
[hectares]

	Share of arable area in the crop rotation				
	0%	**1–24%**	**25–49%**	**50–74%**	**75–100%**
Total	257 648	140 374	214 308	377 907	2 829 801

Source: Hungarian Central Statistical Office (2017)

Appendix 3. Objectives of the Soil Conservation Action Plan

Table 0-8. The strategic objectives, proposed actions, and expected outcomes of the SCAP

Strategic Objectives	***Proposed actions***	***Expected outcomes***
Effective soil conservation	Farmers' Soil Conservation Programme (FSCP) Genuine and strong authority that supports farmers in the implementation of good practices	➢ Farmers' increased awareness ➢ Reduced bureaucracy ➢ Risk management ➢ Expanded SC activities ➢ Effective monitoring ➢ Extensive informational activities ➢ Better enforce CAP-related SC requirements
Soil conservation knowledge management	Developing, establishing, and sharing environmentally-friendly technologies and methods that can prevent soil quality degradation and improve soil quality Renewed communicational and informational campaign (with a more robust involvement of media, and a farmer-compatible dissemination of research results etc.)	➢ Updated methodological directives and guidance ➢ Certified nutrient advisory systems ➢ Updated soil conservation list of standards ➢ Mainstreaming the FSCP ➢ Awareness-raising about SC through the media

	Prepared farm advisory system Educated/trained farmers	➢ Well-organised training system for farmers (on SC, SSM)
Modern basic infrastructure	Establishing a central database (SoilWeb)	➢ Publishing results of the annual soil laboratory analyses ➢ User-friendly platform ➢ Map display and visualisation ➢ Supporting SC authorities' tasks and decisions

Source: Adapted from National Food Chain Safety Office (2021b)

Appendix 4. RDP measures for national soil protection

Table 0-9. Relevant measures in the CAP's Rural Development Programme (RDP) to support national information-based policies for soil protection in agriculture and forestry

Knowledge transfer and information actions
Optional: can support vocational training, demonstration activities, information provision, farm and forest management exchanges and visits.
Advisory services, farm management and farm relief services
Obligatory: this measure funds part of the cost of the CAP Farm Advisory System (FAS) which Member States must provide, covering the following: cross compliance; Pillar 1 'Greening' requirements; RDP measures to improve economic performance; obligations under the Water Framework Directive (WFD); requirements for integrated pest management; farm safety; advice for first-time farmers.
Optional: can support additional advisory services helping farmers, forest holders and other land managers to improve the economic and environmental performance as well as climate friendliness and resilience of their holding or enterprise; can also support training of advisors.
Cooperation
Optional: support for a wide range of cooperative activities by different actors and sectors, new clusters and networks; supports the establishment of operational groups linked to the work of the European Innovation Partnership for agricultural productivity and sustainability (EIP-Agri).

Source: Adapted from Frelih-Larsen (2017)

Appendix 5. Figures related to relevant theories and conceptual frameworks

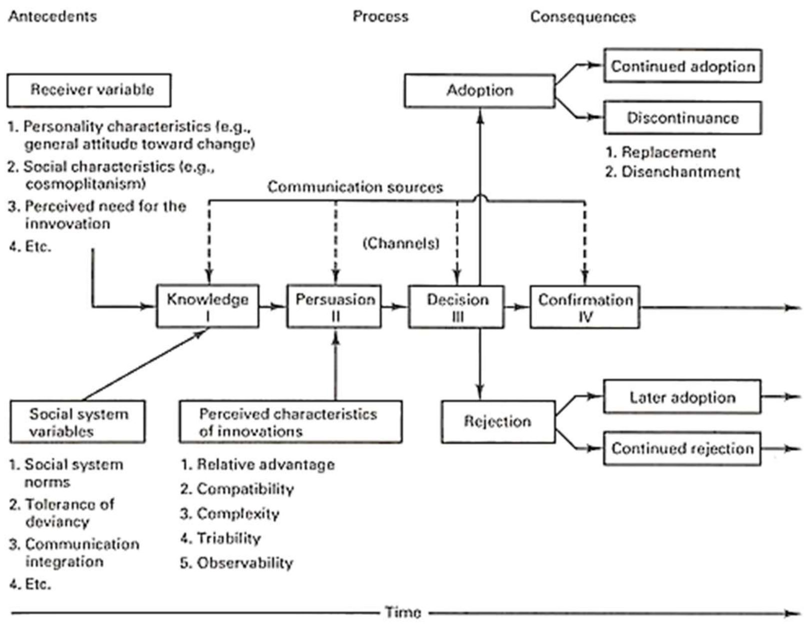


Figure 0-1. The Diffusion of Innovations Theory

Source: Adapted from Rogers (1983)

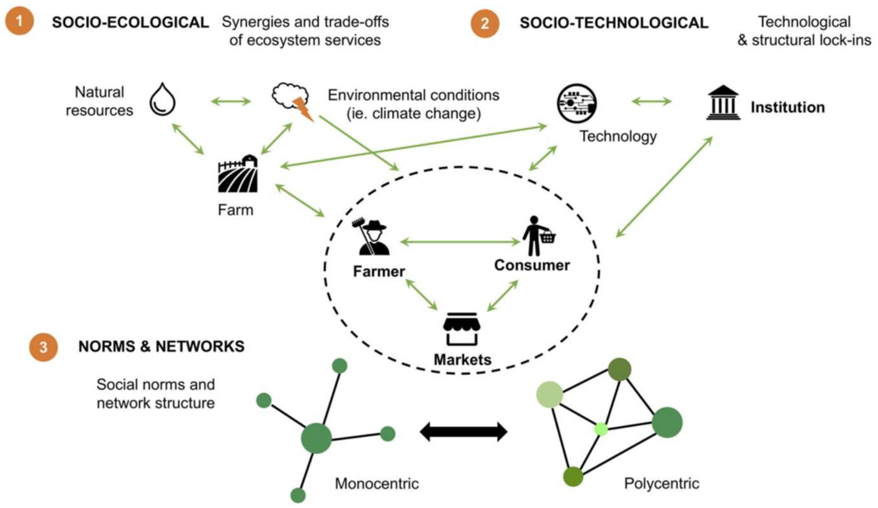


Figure 0-2. Conceptual diagram of key agents and interactions in the transformation of food systems

Source: Ong & Liao (2020)

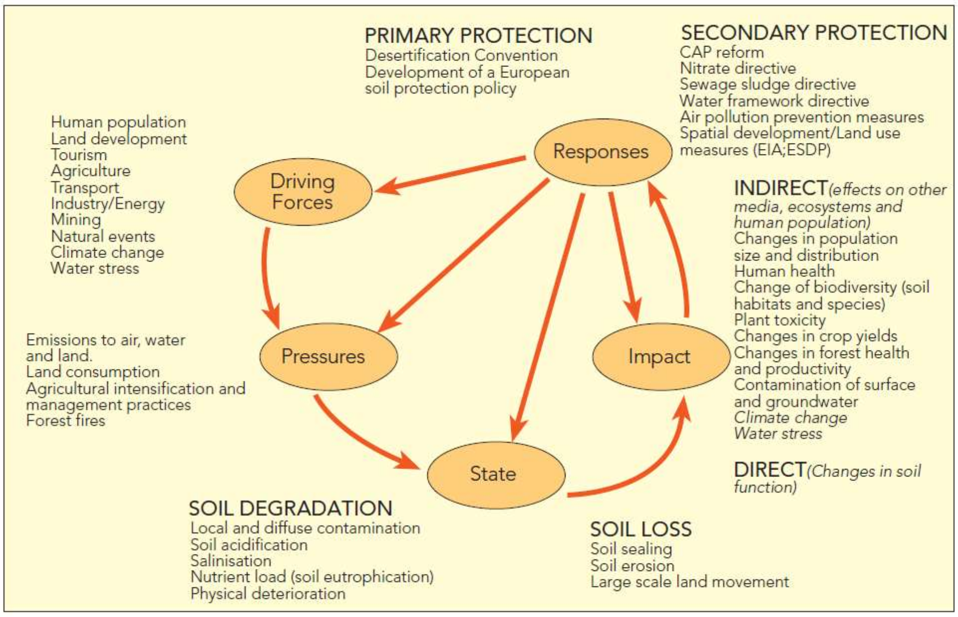


Figure 0-3. The DPSIR Framework applied to soil

Source: European Environment Agency (1999)

Appendix 6: The lists of interviewed and observed stakeholders

Table 0-10. Full list of interviewed stakeholders

Nº	Label	Date	Name	Position and Organisation	Format	Length
1	I-R1	12 Feb.	Prof. Andrea Farsang	Researcher and university professor (soil science) at the University of Szeged; Soil conservation expert	Zoom	60 min
2	I-G1	12 Feb.	Éva Havasné Tátrai	Retired soil conservation authority representative at the Fejér county	Phone	90 min

				governmental representation of the National Food Chain Safety Office		
3	I-G2	5 Mar.	Dr. Sándor Kurucz	Retired soil conservation authority representative at the Baranya county governmental representation of the National Food Chain Safety Office	Phone	75 min
4	I-F1	14 Mar.	László Vida	Farmer/Landowner (Békés county)	Zoom	45 min
5	I-F2	15 Mar.	Respondent 5	Farmer/Landowner (Békés county)	Phone	45 min
6	I-F3	15 Mar.	Zoltán Zámbó	Farmer/Landowner (Fejér county)	Phone	60 min
7	I-F4	17 Mar.	István Heiter	Farmer/Landowner (Fejér county)	Phone	65 min
8	I-R2	19 Mar.	Prof. Márta Birkás	Researcher and university professor (crop production and SM) at the Hungarian University of Agriculture and Life Sciences	E-mail	-
9	I-R3	19 Mar. 23 Mar. 31 Mar.	Péter László, PhD	Researcher (soil mapping, SC) at the Institute for Soil Sciences; Soil conservation expert	Zoom	45 min 68 min 25 min
10	I-L1	23 Mar.	Sándor Kucsera	Laboratory leader at the Velence Soil Conservation Laboratory (Fejér county)	Zoom	55 min
11	I-A1	24 Mar.	Aranka Némethné Apró	Village consultant in Fejér county	Phone	68 min
12	I-F5	24 Mar.	Balázs Czakó	Farmer/Landowner (Fejér county)	Zoom	40 min
13	I-G3	26 Mar.	Erzsébet Sztahura	Soil conservation expert at the National Chamber of Agriculture	Zoom	40 min
14	I-R4	26 Mar.	Dr. Csaba Centeri	Researcher and university professor (SC, landscape ecology) at the Hungarian University of Agriculture and Life Sciences	Zoom	55 min
15	I-A2	30 Mar.	János Nagy	County-level village consultants' coordinator in Fejér county	Phone	33 min
16	I-F6	30 Mar.	Balázs Czvikli	Farmer/Landowner (Fejér county)	Phone	125 min
17	I-N1	6 Apr.	Dalma Dedák	NGO representative at WWF Hungary	Zoom	60 min
18	I-NF1	7 Apr.	Lili Balogh	NGO representative at Védegylet; Farmer/Landowner (Nógrád county)	Zoom	77 min
19	I-A3	7 Apr.	Dr. András Markó	Agricultural advisor and retired university professor	Phone	40 min
20	I-RF1	8 Apr.	Dr. Zsolt Hetesi	Researcher and university professor (sustainability, water- and environmental security) at the National University of Public Service; Farmer/Landowner (Baranya county)	Zoom	96 min
21	I-P1	14 Apr.	Katalin Balázs	Senior Project Manager at Geonardo Environmental Technologies Ltd.; Researcher and former university professor	Zoom	68 min
22	I-G4	16 Apr.	József Hefler	Soil conservation authority representative at the National Food Chain Safety Office	Phone	122 min
23	I-C1	16 Apr.	Katalin Bencsik	Ecolabel certifier at the Herman Ottó Institute Nonprofit Ltd. with a PhD in crop production and a dissertation on SM practices from a SC perspective	E-mail	-

Table 0-11. List of observed presenters at the virtual conference

Nº	Label	Name	Position and Organisation
1	P-G1	dr. Anikó Juhász	Deputy State Secretary at the Ministry of Agriculture
2	P-R1	Prof. Borbála Biró	Researcher and University professor at the Hungarian University of Agriculture and Life Sciences
3	P-G2	Gábor Várszegi	Head of Department at the National Food Chain Safety Office
4	P-G3	Éva Kinorányi	Planning referent at the Department of Support Policy at the Ministry of Agriculture
5	P-G4	István Madarász	Head of the Agricultural Economics Unit at the Ministry of Agriculture
6	P-F1	Ferenc Berend	Farmer/Landowner (Somogy county)
7	P-C1	Zsófia Perényi	Representative of the Conscious Consumers' Association
8	P-G5	Erzsébet Sztahura	Soil conservation expert at the National Chamber of Agriculture
9	P-I1	Rozália Pecze	Head of development at Syngenta Ltd.
10	P-R2	Korinna Varga	Research project leader at the Research Institute of Organic Agriculture

Appendix 7. Outline of interview schedule with farmers

Table 0-12. Overview of the focus areas, example questions and rationale for interviewing farmers

Focus area	Examples of questions	Rationale
Icebreaker/Participant introduction	Please, tell me a bit about yourself, your background/education in agriculture and your work as a farmer.	To get to know the interviewee, find out more about their work and background.
Specifics about farming	On how many hectares do you farm? What are the main crops that you grow? Do you work as a tenant or do you own the land that you farm? *If both:* About what is the ratio of the land you farm as a tenant and as a landowner? Do you make the practical and financial decisions on the land you farm as a tenant?	To get more specific information about the interviewee, and their farm.
Perceptions	How would you rate the average soil quality on the land you farm? How do you perceive the level of soil degradation/the level of climate change impact on your land? How important do you consider soil conservation on your land? What role does environmental sustainability play in your decisions as a farmer (if any)?	To understand how the interviewee perceives relevant factors around him (on the soil, climate) and their general thoughts and attitude towards SC.
SM practices	What SM practices do you regularly apply on your land? What SCPs do you regularly apply? What is your general opinion about them (effectiveness, advantages, limitations etc.)? What factors influenced your decision in case of the adopted SCPs? What factors played a role in your decision on those SCPs that you don't apply on your	To get a clear picture about the interviewee's SM practices, applied SCPs, their opinion about SCPs, the factors influencing their decision on adopting or rejecting certain SCPs.

	land? What do you consider to be the main obstacles or challenges with those SCPs?	
Information sources	Usually, from where or from whom do you get information on SM and SC?	To get to know the main sources that the interviewee gets information on SM and SC from. Or from where such information usually gets to the interviewee?
Trust and advice	Are there information sources that you particularly trust as reliable sources, and sources that you don't really trust? *Follow-up*: How often do you consult with other farmers on SM and SC issues? How do you see the relationship between farmers in general? Do you often ask for support from advisors, experts or consultants? Usually on what topics? Are you usually satisfied with the guidance they give you?	To understand the level of trust between the interviewee and various information sources on SM and SC. To understand how the interviewee evaluates their relationship with farmers. To know more about the interviewee's experience with farm advisory services.
Participation	Are you often asked (e.g. by authorities) to give feedback or recommendations on certain policies, practices or on farming in general? *If yes*: How do you feel about this process, what would you change?	To understand the current processes of farmers' involvement by authorities and how the interviewee thinks about it.
Existing policies	What do you think about the general suitability and effectiveness of existing policies and available subsidies for SC? What would you change in current policies?	To see what the interviewee thinks of existing policies, what would they change to make them better.
Needs and plans	What do you primarily need in order to integrate SCPs more in your everyday work? If there were available subsidies for SCPs, would you consider to apply?	To know the interviewee's needs for adopting SCPs and future plans.
Wrap-up and gratitude	Is there anything else that you would like to share with me? Thank you very much for your time and valuable input, I really appreciate your help.	To wrap-up the conservation and thank the interviewee for their help by participating.

Appendix 8. UNISECO-NCA Conference programme

Conference on the future of soil conservation farming in Hungary

Date:	2 March 2021
Location:	Online - Zoom
Language:	Hungarian
Organiser:	National Chamber of Agriculture; the Hungarian project team of the Horizon 2020 UNISECO project

9:45 – 10:00	Participants enter into the conference platform
10:00 – 10:15	*Welcome* - **Dr. Anikó Juhász**, Deputy State Secretary for Agricultural Economy, Ministry of Agriculture // *Opening* - **Katalin Balázs** Geonardo Kft.
10:15 – 10:30	*The strategic social, economic and environmental importance soils, EU soil strategy, EU Soil Mission* - *Prof. Borbála Biró*, Doctor of the Hungarian Academy of Sciences, Hungarian expert of the EU Mission on Soil Health and Food

10:30 – 10:45	*The Hungarian regulatory environment related to soil-conservation farming and plant protection: risks and costs* - **Gábor Várszegi**, NFSCO - National Food Chain Safety Office
10:45 – 11:00	*CAP Strategic planning in Hungary, possibilities of supporting soil-conservation farming* - **István Madarász / Éva Kinorányi**, Department of Support Policy, Ministry of Agriculture
11:00 – 11:15	*Practices in agricultural production: soil-conservation farming practices, knowledge sharing and role of advisors* - **Erzsébet Sztahura**, National Chamber of Agriculture
11:15 – 11:30	Break
11:30 – 11:45	*Experiences of soil-conservation farming practices* - **Ferenc Berend**, farmer
11:45 – 12:00	*Hungarian participation in the EU Agroecological Partnership networking program (ALL-Ready project) and related opportunities for advancing soil-conservation farming in Hungary* - **Korinna Varga**, ÖMKI - Research Institute of Organic Agriculture
12:00 – 12:15	*Social aspects, health and sustainable food system, the role of environmental education in raising awareness of the importance of soils* - **Zsófia Perényi**, Association of Conscious Customers
12:15 – 12:30	*Agricultural Value Chains and Soil Conservation Farming Practices* - **Rozália Pecze**, Syngenta Hungary
12:30 – 13:15	Break
13:15 – 13:30	*Soil-conservation farming: dream or reality - HU case study results of the UNISECO H2020 project* - **Alfréd Szilágyi / Katalin Balázs**, Geonardo Ltd.
13:30 – 15:00	*Finding the way: domestic status quo and future of soil-conservation farming - round table discussion with the speakers* **-** moderator: **Gergely Papp**, NCA - National Chamber of Agriculture

Source: UNISECO (2021a)

Appendix 9. Overview on the two groups of farmers targeted by the survey

Table 0-13. Main characteristics of the two groups of farmers targeted by the online survey

	Fejér county	Somogy county
Area of arable land [hectares]	Agricultural enterprises: ***120 106*** Private holdings: ***95 978***	Agricultural enterprises: ***118 586*** Private holdings: ***100 398***
Total number of private holders (including arable farmers) [person]	***17 710***	***24 188***
Age of private holders (including arable farmers)	14-24: ***119*** (1%) 25-34: ***891*** (5%) 35-44: ***2759*** (16%) 45-54: ***3382*** (19%) 55-64: ***4898*** (28%) over 65: ***5661*** (32%)	14-24: ***183*** (1%) 25-34: ***1296*** (5%) 35-44: ***3628*** (15%) 45-54: ***4695*** (19%) 55-64: ***6569*** (27%) over 65: ***7816*** (32%)
Gender of private holders	***n.a.***	***n.a.***
Highest agricultural education of private holders (including arable farmers)	None: ***1085*** (6%) Practical experience: ***13548*** (77%) Basic: ***894*** (5%) Secondary: ***1652*** (9%) College/University: ***530*** (3%)	None: ***1055*** (4%) Practical experience: ***18938*** (78%) Basic: ***1235*** (5%) Secondary: ***2073*** (9%) College/University: ***888*** (4%)
Top 3 grown crops/area	Cereals: ***1. maize 2. wheat 3. barley***	Cereals: ***1. maize 2. wheat 3. triticale***

	Industrial crops: ***1. sunflower 2. rape 3. soya-bean***	Industrial crops: ***1. sunflower 2. rape 3. soya-bean***
Cultivation methods applied in arable land production [hectares]	Conventional tillage: ***182 887*** (85%) Conservation tillage: ***25 613*** (12%) Direct seeding: ***1445*** (1%) Areas covered by multi-annual plants: ***5101*** (2%) Arable land area not cultivated: ***632*** (0%)	Conventional tillage: ***184 035*** (85%) Conservation tillage: ***25 654*** (12%) Direct seeding: ***1319*** (1%) Areas covered by multi-annual plants: ***4003*** (2%) Arable land area not cultivated: ***2624*** (1%)
Applied winter soil cover [hectares]	Normal winter crop: ***94 076*** (44%) Cover crop or intermediate crop: ***3853*** (2%) Plant residues: ***17 930*** (8%) Bare soil: ***94 719*** (44%) Areas covered by multi-annual plants: ***5101*** (2%)	Normal winter crop: ***99 823*** (46%) Cover crop or intermediate crop: ***9488*** (4%) Plant residues: ***15 855*** (7%) Bare soil: ***88 466*** (41%) Areas covered by multi-annual plants: ***4003*** (2%)
Share of arable land in the crop rotation	0%: ***2784*** (1%) 1-24%: ***5726*** (3%) 25-49%: ***9083*** (4%) 50-74%: ***21 938*** (10%) 75-100%: ***176 149*** (82%)	0%: ***11 085*** (5%) 1-24%: ***5848*** (3%) 25-49%: ***15 644*** (7%) 50-74%: ***20 622*** (9%) 75-100%: ***164 537*** (76%)

Source: Hungarian Central Statistical Office (2017b)

Table 0-14. Demographic overview of respondents to the online survey

Question	**Fejér**	**Somogy**
Number of respondents	***50***	***33***
Gender	Men - ***36*** (72%) Women - ***14*** (28%)	Men - ***28*** (85%) Women - ***5*** (15%)
Age	14-24: ***4*** (8%) 25-34: ***8*** (16%) 35-44: ***15*** (30%) 45-54: ***13*** (26%) 55-64: ***6*** (12%) over 65: ***4*** (8%)	14-24: ***1*** (3%) 25-34: ***4*** (12%) 35-44: ***8*** (24%) 45-54: ***7*** (21%) 55-64: ***6*** (18%) over 65: ***7*** (21%)
Highest agricultural education	Practical exp.: ***6*** (12%) Basic: ***4*** (8%) Secondary: ***24*** (48%) College/Uni.: ***16*** (32%)	Practical exp.: ***3*** (9%) Basic: ***1*** (3%) Secondary: ***8*** (24%) College/Uni.: ***21*** (64%)

Appendix 10. Online survey for arable farmers in Fejér and Somogy counties

Soil conservation practices in arable farming in Fejér and Somogy counties

Dear Farmer,

I am Orsolya Nyárai, a final-year student at the Lund University of Sweden. In my thesis, I aim to investigate and map those factors that influence farmers' decision-making on the use of soil conservation practices in arable farming.

By filling out this questionnaire, you can help me better understand the personal viewpoint of farmers in Fejér and Somogy counties in connection with various soil management practices. Furthermore, my aim is also to formulate policy recommendations in my thesis that, while taking into account farmers' needs and perspectives, can effectively serve the case of agricultural soil conservation and sustainable food production.

It takes about 10-15 minutes to fill out the questionnaire. Participation is anonymous, individual answers will not be shared in any form with third party. Participating in the survey is voluntary and can be aborted at any time.

The deadline to submit your responses is: 21 April 2021

Thank you for your support!

Orsolya Nyárai

1. **Your gender*:**
   - o Male
   - o Female

2. **Your age*:**

o 14-24 o 25-34 o 35-44 o 45-54 o 55-64 o over 65

3. **The county where you do arable farming*:**
   - o Fejér county
   - o Somogy county

4. **Your highest agricultural qualification*:**

o Practical experience o Basic o Secondary o College, university

5. **Area of arable land under your management*** [in hectares] (where practical and financial decisions on soil management are made by you):
   - o 0.1-4
   - o 5-14
   - o 15-49
   - o 50-99
   - o 100-299
   - o 300-599
   - o 600-899
   - o 900-1499
   - o over 1500

6. **What crops do you grow in the largest quantities? ***
   - ☐ Wheat
   - ☐ Maize
   - ☐ Rye
   - ☐ Barley
   - ☐ Rape
   - ☐ Sunflower
   - ☐ Soya-bean
   - ☐ Other

7. **How do you rate the general quality of the soil on your land? ***
   - o 1 (poor)
   - o 2
   - o 3
   - o 4
   - o 5 (excellent)

8. **How do you rate the level of soil degradation (erosion, deflation, loss of soil fertility etc.) on your land? ***
   - o 1 (negligible)
   - o 2

- 3
- 4
- 5 (considerable)

9. How much do you perceive the impact of climate change on your land? *

- 1 (negligible)
- 2
- 3
- 4
- 5 (considerable)

10. How important do you consider soil conservation on the land you farm? *

- 1 (not at all important)
- 2
- 3
- 4
- 5 (very important)

11. From the below list, which soil conservation practices do you regularly apply? *

- ☐ minimum tillage
- ☐ no tillage/direct seeding
- ☐ strip tillage
- ☐ soil loosening/use of a cultivator
- ☐ use of cover crops/green manure
- ☐ providing soil cover by e.g., mulching, leaving plant residues on the soil
- ☐ use of organic manure
- ☐ ploughing hilly areas along the contour lines (perpendicular to the slope direction)
- ☐ timing and method of soil management is adjusted to soil wetness
- ☐ growing perennial crops
- ☐ optimised nutrient management (e.g. according to soil conservation plan)
- ☐ crop rotation
- ☐ organic crop production
- ☐ preserving/establishing non-productive habitats (grassland, hedges, trees) on the land
- ☐ ley-farming
- ☐ agroforestry
- ☐ Other:

12. In case of those practices that you APPLY on your land, what factors influenced your decision the most? * (select max. 5)

- ☐ cost effectiveness
- ☐ benefits to crop yield
- ☐ benefits to the environment
- ☐ soil quality improvement benefits
- ☐ supported by financial subsidies
- ☐ requirement to other financial subsidies
- ☐ potential saving of resources (e.g., fuel, time, chemical use)
- ☐ good experience shared by other farmers
- ☐ recommended by farm advisor/village consultant/soil conservation expert
- ☐ recommended by inputs/machine manufacturing company
- ☐ long-term planning based on sustainability principles
- ☐ personal conviction towards particular practice/technology
- ☐ convinced by education/training/farm demonstration

- ☐ convinced by article/research study
- ☐ Other:

13. In case of those practices that you DO NOT APPLY on your land, what factors influenced your decision the most? * (select max. 5)

- ☐ soil quality is already good next to conventional soil management
- ☐ lack of funds to purchase technology or machinery
- ☐ additional costs are too high
- ☐ not convinced about the effectiveness or economic benefits
- ☐ soil conservation is not rewarded financially
- ☐ technical solution is not mature enough (additional research/experiment is required)
- ☐ information about the practice is not available
- ☐ criticism/negative experience shared by other farmers
- ☐ potentially emerging challenges (e.g., weeds, pests)
- ☐ biophysical (climate or soil is unsuitable for the practice)
- ☐ Other:

14. From whom/where do you usually get information on soil management and soil conservation? * (select max. 5)

- ☐ farm advisor
- ☐ village consultant
- ☐ soil conservation expert
- ☐ other Hungarian farmers
- ☐ foreign farmers
- ☐ local farmers' association
- ☐ education/training
- ☐ conference/farm demonstration
- ☐ inputs or machine manufacturing company
- ☐ online agricultural/farming websites
- ☐ website of NCA (Hungarian Chamber of Agriculture)
- ☐ website of NFCSO (National Food Chain Safety Office)
- ☐ Facebook groups/pages
- ☐ other websites (e.g., YouTube)
- ☐ magazines/books/studies
- ☐ researchers/university educators
- ☐ Other

15. How much do you trust the below sources when you are looking for reliable information on soil management and soil conservation?

	1 (not at all)	**2**	**3**	**4**	**5** (very much)
farm advisor					
village consultant					
soil conservation expert					
other Hungarian farmers					
foreign farmers					
local farmers' association					
educational institution					
conference/farm demonstration					
inputs or machine manufacturing company					
online agricultural/farming websites					
website of NCA (Hungarian Chamber of Agriculture)					
website of NFCSO (National Food Chain Safety Office)					
Facebook groups/pages					
other websites (e.g., YouTube)					

magazines/books/studies					
researchers/university educators					

16. What do you primarily need in order to start or continue applying soil conservation practices? * (select max. 5)

- ☐ tailored guidance and advice
- ☐ strong and prepared farm advisory services
- ☐ experience- and knowledge exchange with other farmers
- ☐ financial reward to farmers for soil conservation
- ☐ available financial support to invest in new technology/practice
- ☐ requirement by regulation
- ☐ proven effectiveness
- ☐ access to the latest research results
- ☐ indicators and tools to measure progress in improving soil quality
- ☐ Other:

17. To what degree do you agree with the below statements? *

	1 (not at all)	**2**	**3**	**4**	**5** (very much)
Hungarian legislation and policies adequately support the conservation of agricultural soils.					
Farmers are sufficiently incentivised and supported to adopt soil conservation practices on their land.					
I am ready to financially invest from capital in new technologies/practices that can potentially improve soil quality on my land.					
I think it important to protect and restore healthy soil life on my land.					
If financial incentives are available to support the purchase of new technology that can potentially improve soil quality on my land, I would apply for it.					
Environmental sustainability plays an important role in my farming decisions.					
Soil conservation has an important role in climate protection and climate adaptation.					
Soil conservation is necessary for food security.					

Appendix 11. Survey results for comparison

Sample: All 83 respondents

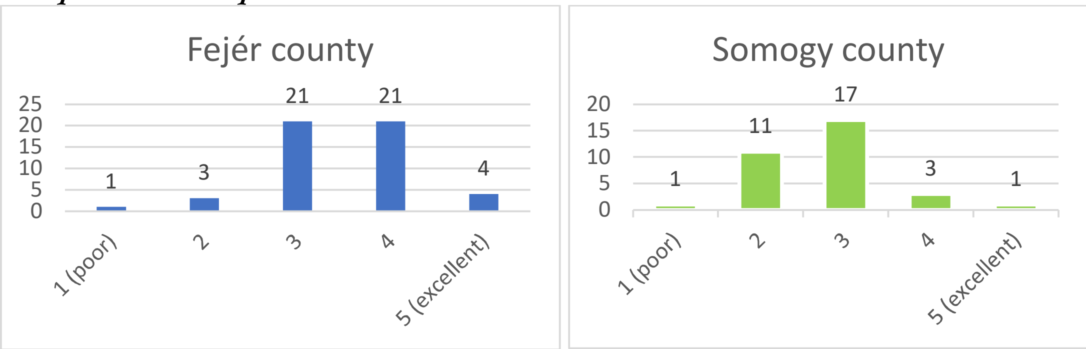


Figure 0-4. How respondents perceived the quality of their soil (Q7)

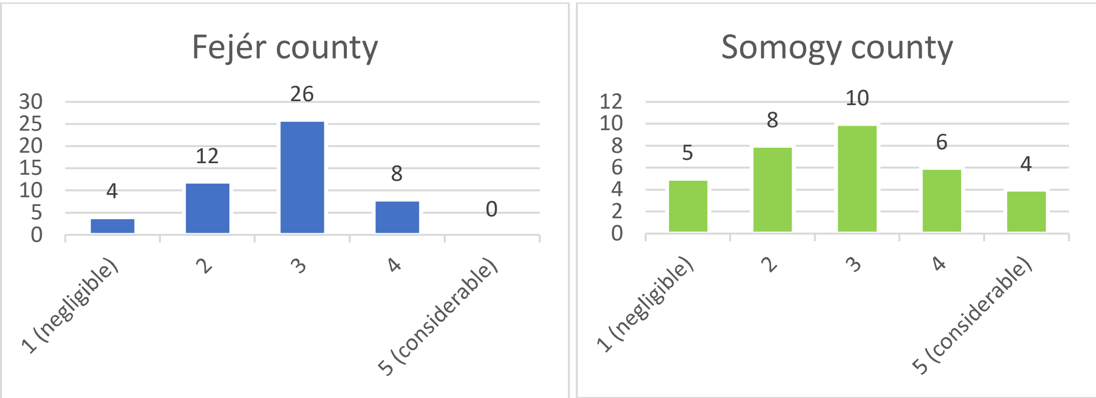


Figure 0-5. How respondents perceived the level of soil degradation on their land (Q8)

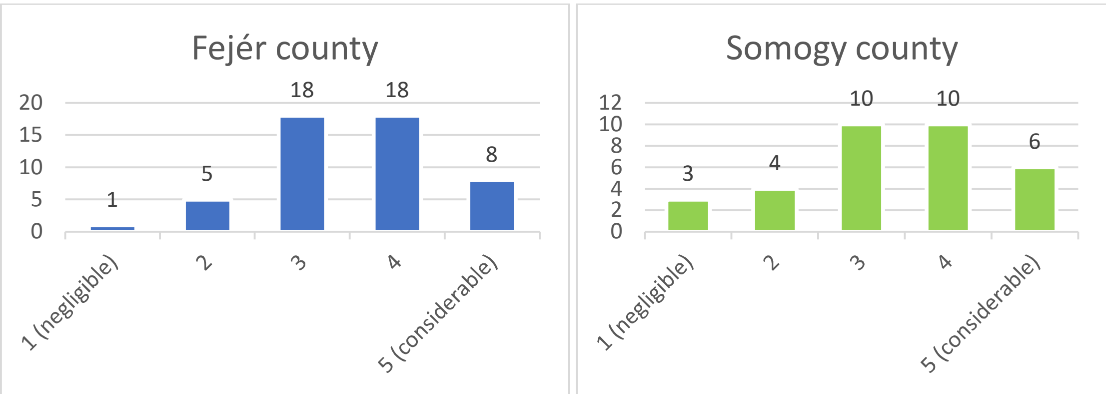


Figure 0-6. How respondents perceived the level of climate change impact on their land (Q9)

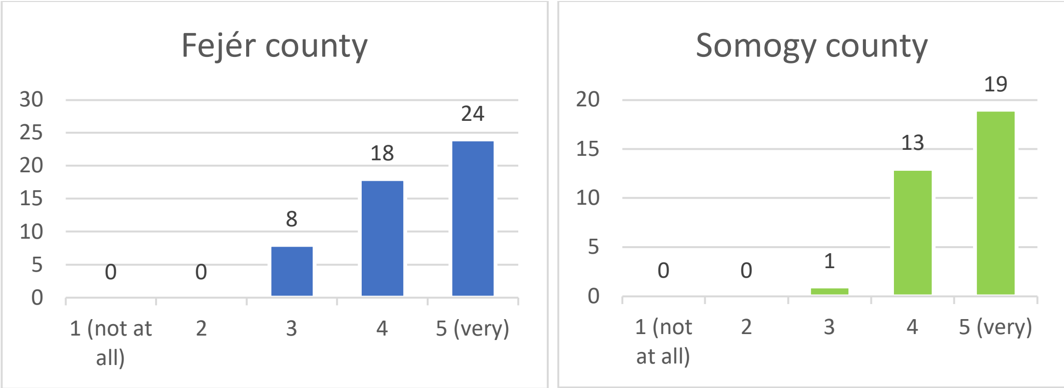


Figure 0-7. How important respondents considered soil conservation on their land (Q10)

Sample: Respondents who regularly apply SCPs in line with the three principles of conservation agriculture

Table 0-15. Respondents who regularly apply SCPs in line with the three principles of conservation agriculture

	Fejér county	**Somogy county**
Number of respondents (in the narrowed sample)	17 farmers 34% of respondents	16 farmers 48% of respondents
Gender	16 men 1 woman	14 men 2 women
Age	14-24: 1 25-34: 3 35-44: 6 45-54: 4 55-64: 2 over 65: 1	14-24: 1 25-34: 2 35-44: 4 45-54: 4 55-64: 3 over 65: 2
Highest agricultural education	Practical exp.: 1 Basic: 3 Secondary: 6 College/Uni.: 7	Practical exp.: 1 Basic: 0 Secondary: 3 College/Uni.: 12
Dominant farm sizes (band)	15-49 ha (4) 50-99 ha (4) over 1500 ha (4)	100-299 ha (4) 600-899 (3) over 1500 ha (5)
Dominant grown crops	Wheat, Maize	Wheat, Maize

Table 0-16. Influencing factors behind applying SCPs
(by responding farmers who already follow all three principles of conservation agriculture)

Farmers who follow the 3 principles of conservation agriculture	***Fejér county***	***Somogy county***
Top 5 influencing factors behind applying SCPs	1. soil quality improvement benefits (13) 2. benefits to crop yield (11) 3. cost effectiveness (9) 4. personal conviction towards practice (9) 5. potential saving of resources (7)	1. soil quality improvement benefits (13) 2. personal conviction towards practice (12) 3. benefits to crop yield (11) 4. cost effectiveness (8) 5. potential saving of resources (7)

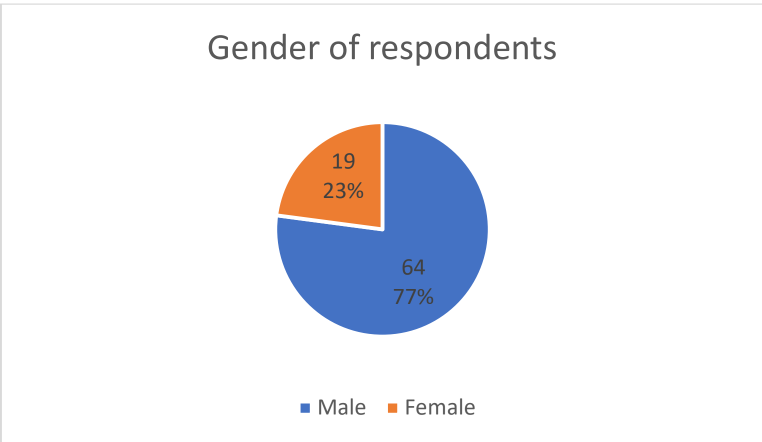
Table 0-17. Influencing factors behind not applying SCPs and the needs for adopting SCPs
(by responding farmers who currently do not follow all three principles of conservation agriculture)

Farmers who do not follow the 3 principles of conservation agriculture	***Fejér county***	***Somogy county***
Top 5 influencing factors behind not applying SCPs	1. lack of funds to purchase technology or machinery (17) 2. additional costs are too high (13) 3. soil quality is already good next to conventional soil management (11) 4. potentially emerging challenges (10) 5. negative experience shared by other farmers (8) 6. climate or soil is unsuitable for the practice (8)	1. lack of funds to purchase technology or machinery (9) 2. potentially emerging challenges (8) 3. soil quality is already good next to conventional soil management (6) 4. negative experience shared by other farmers (6) 5. climate or soil is unsuitable for the practice (6)
Top 5 needs for adopting SCPs	1. proven effectiveness (22) 2. available financial support (20) 3. experience- and knowledge exchange with other farmers (14) 4. tailored guidance and advice (13) 5. strong and prepared farm advisory system (11)	1. proven effectiveness (11) 2. indicators and tools to measure SC progress (9) 3. tailored guidance and advice (7) 4. strong and prepared farm advisory system (7) 5. experience- and knowledge exchange with other farmers (7)

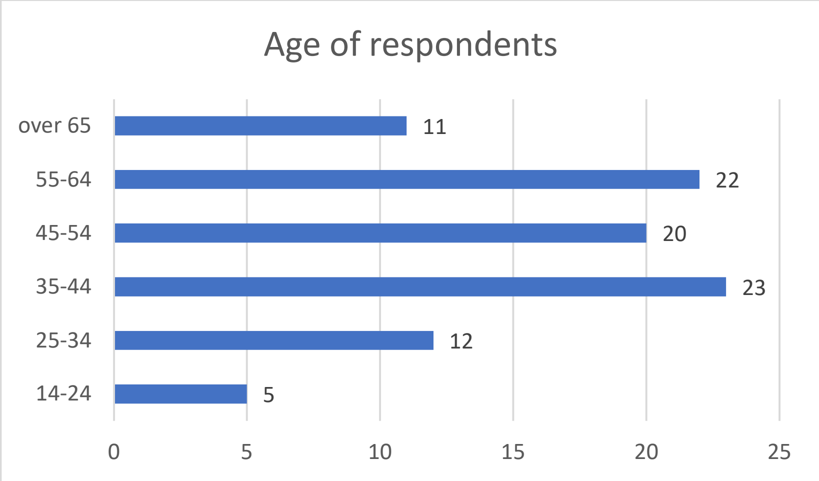
Appendix 12. Overall results of the online survey

(83 respondents)

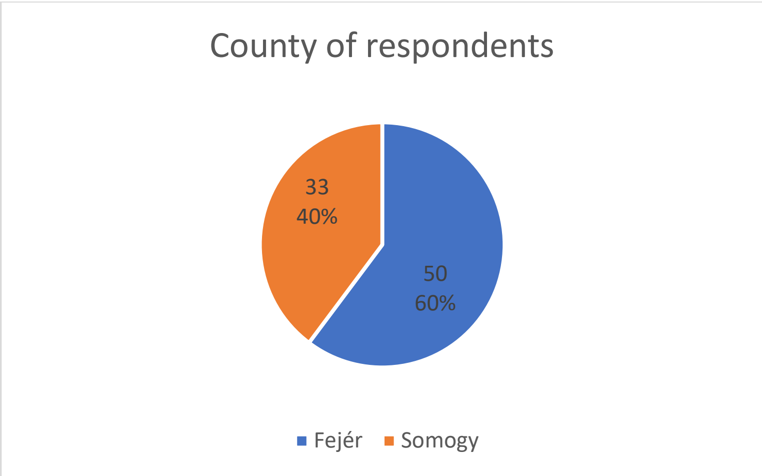
1. Your gender*:



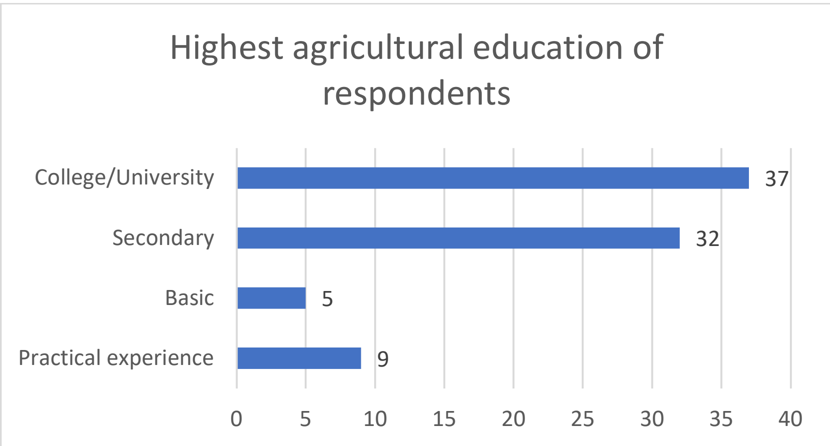
2. Your age*:



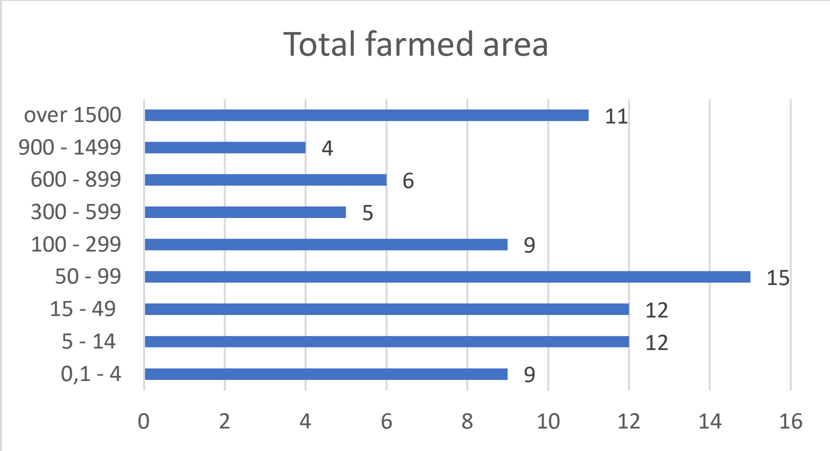
3. The county where you do arable farming*:



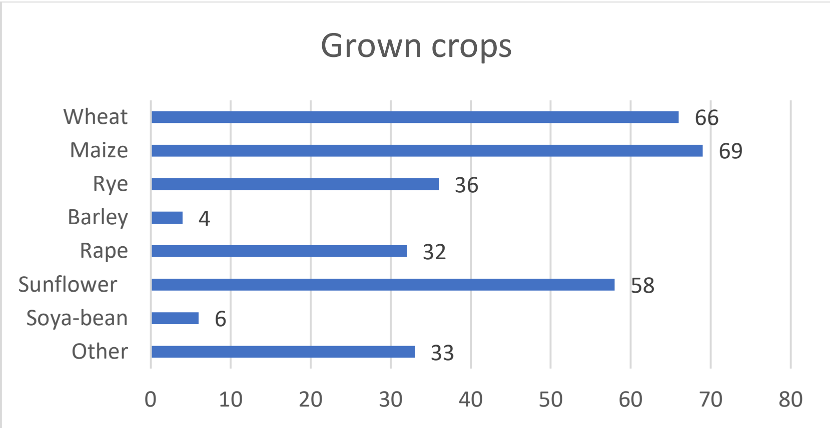
4. Your highest agricultural qualification*:



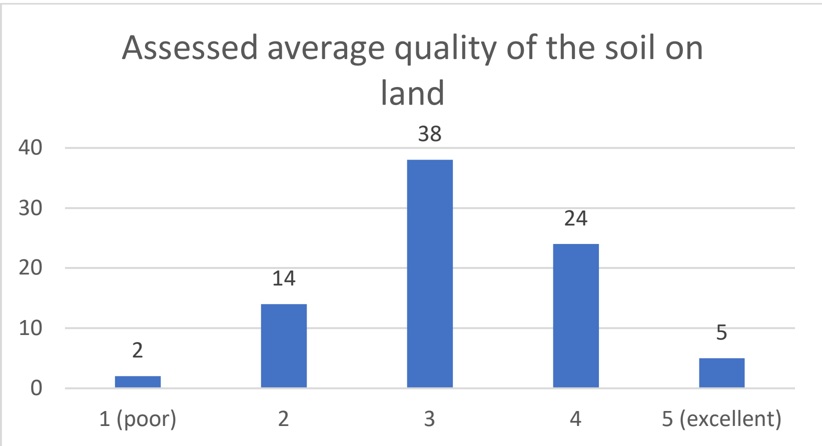
5. Area of arable land under your management* [in hectares] (where practical and financial decisions on soil management are made by you)



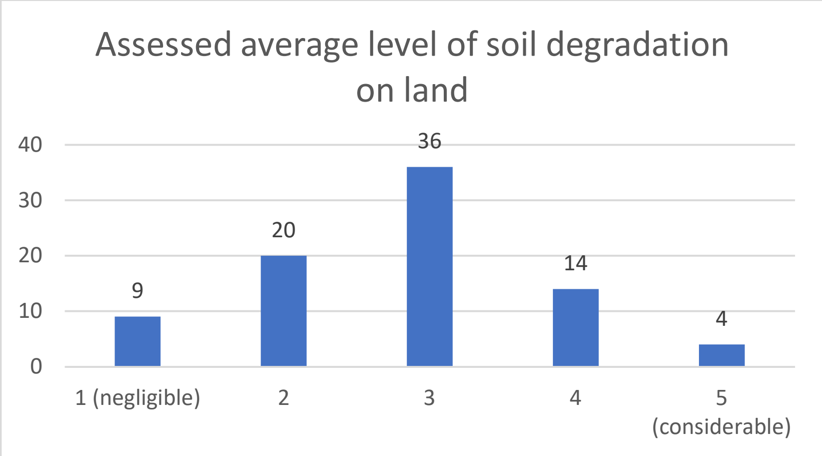
6. What crops do you grow in the largest quantities? *



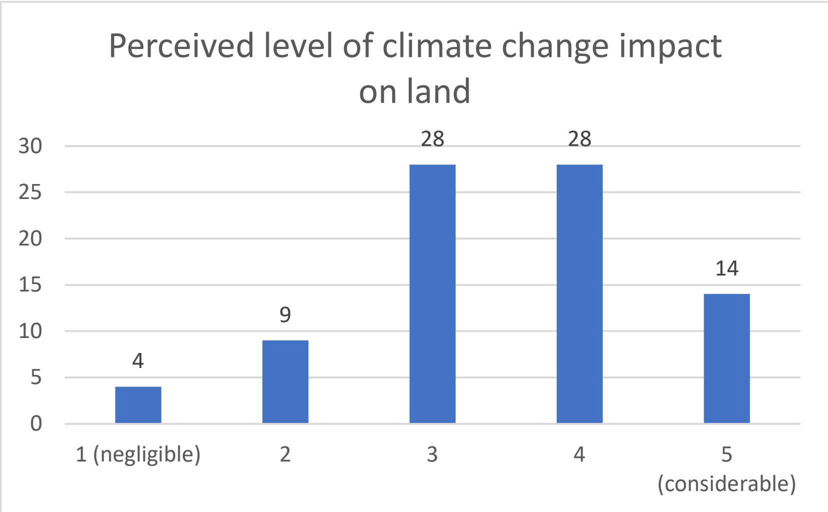
7. How do you rate the general quality of the soil on your land? *
1 (poor) - 5 (excellent)



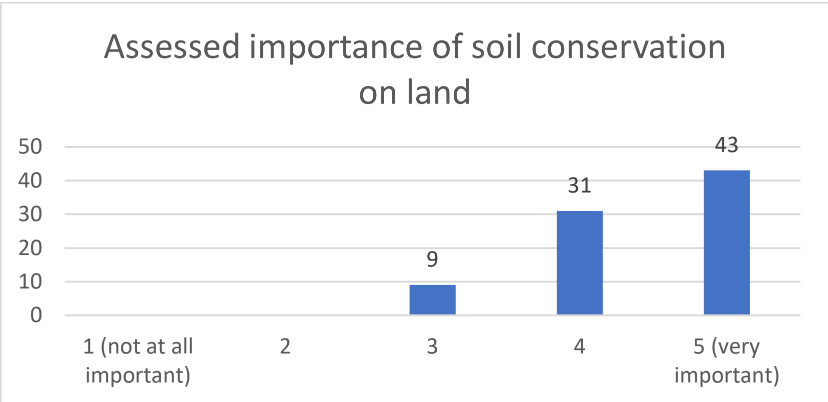
8. How do you rate the level of soil degradation (erosion, deflation, loss of soil fertility etc.) on your land? *
1 (negligible) - 5 (considerable)



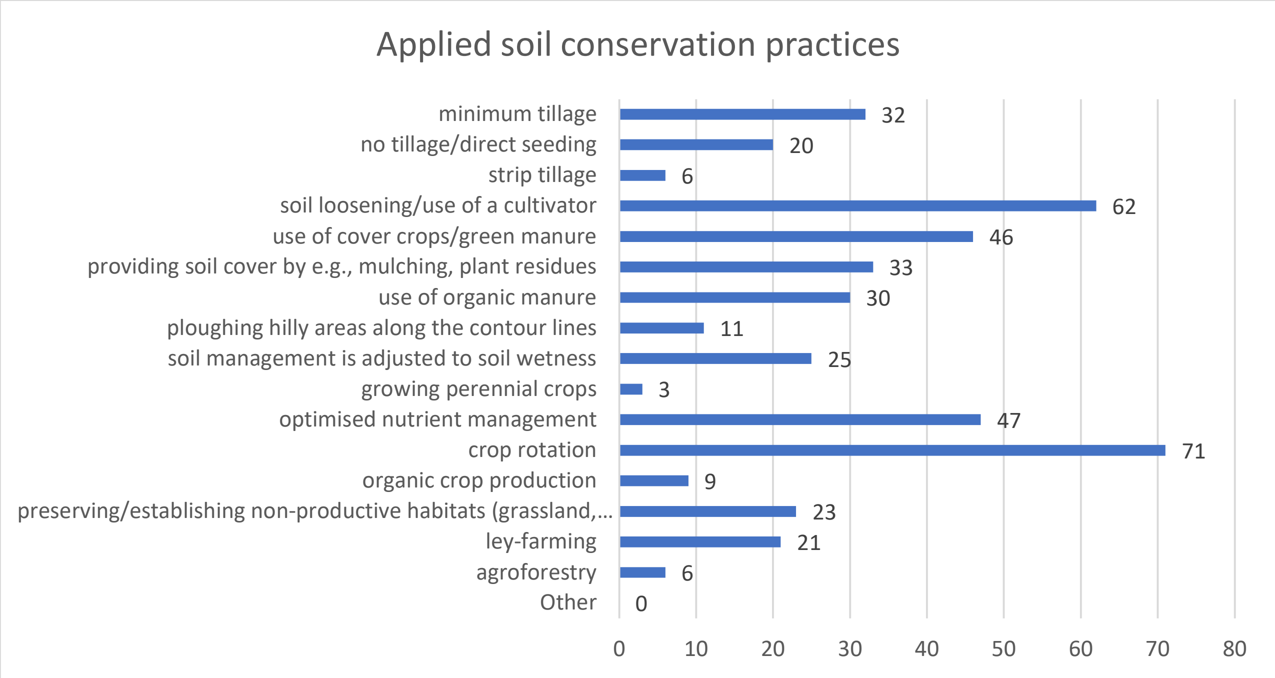
9. How much do you perceive the impact of climate change on your land? *
1 (negligible) - 5 (considerable)



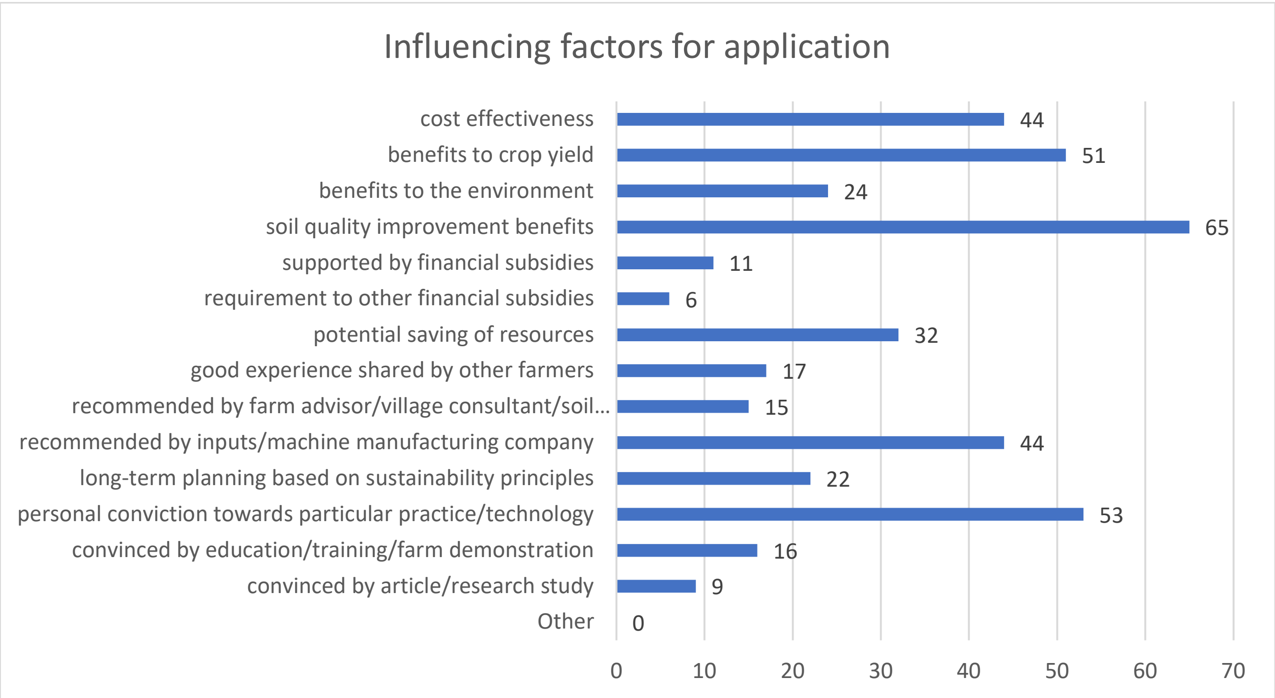
10. How important do you consider soil conservation on the land you farm? *
1 (not at all important) - 5 (very important)



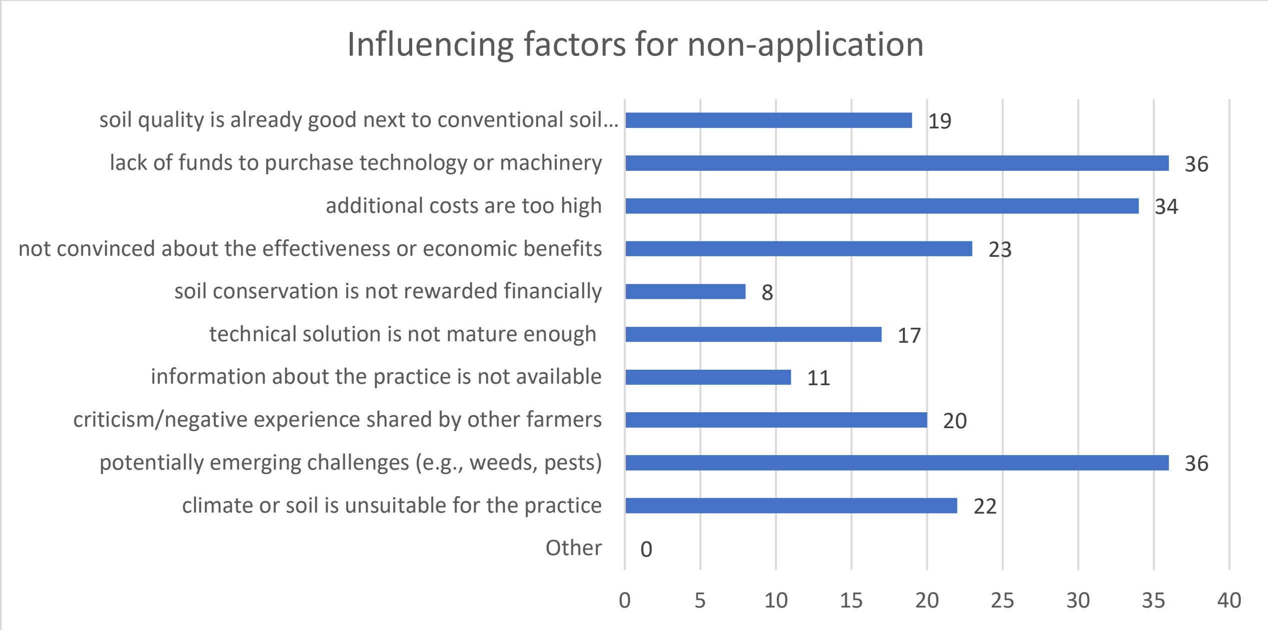
11. From the below list, which soil conservation practices do you regularly apply? *



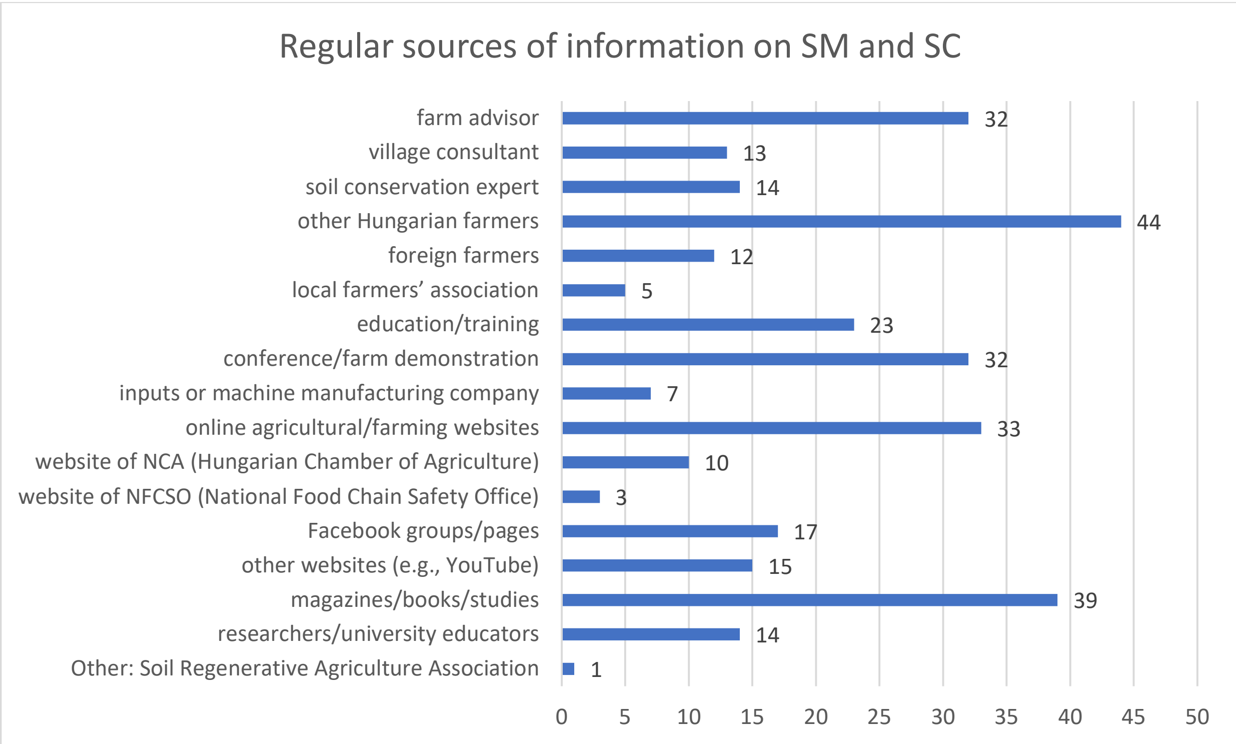
12. In case of those practices that you APPLY on your land, what factors influenced your decision the most? * (select max. 5)



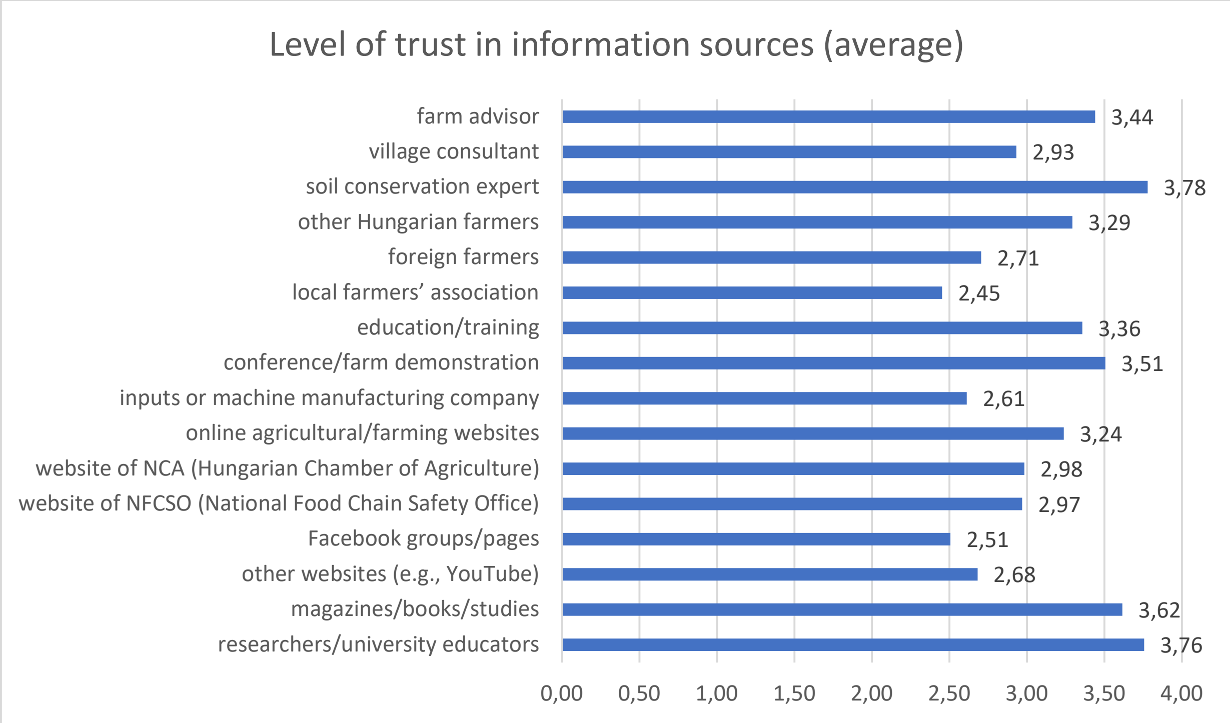
13. In case of those practices that you DO NOT APPLY on your land, what factors influenced your decision the most? * (select max. 5)



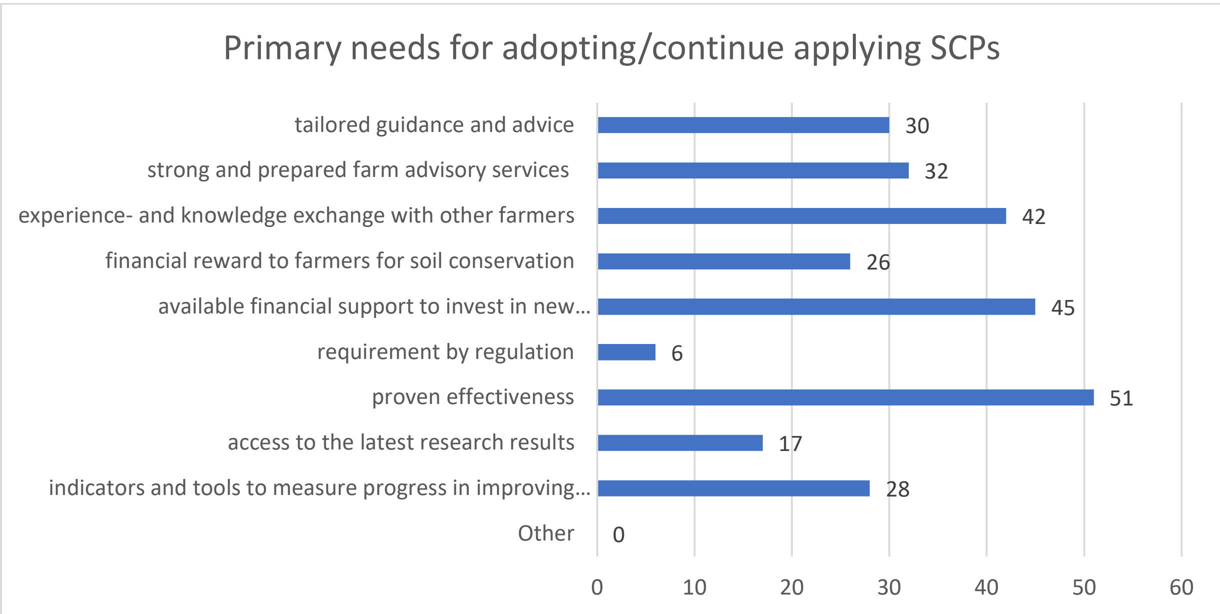
14. From whom/where do you usually get information on soil management and soil conservation? * (select max. 5)



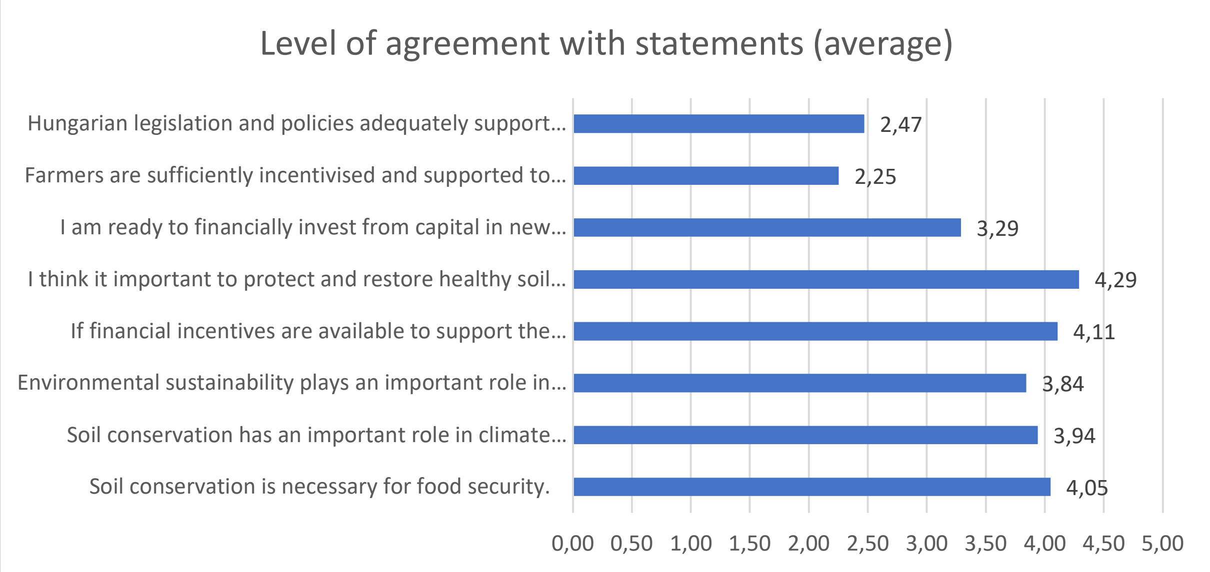
15. How much do you trust the below sources when you are looking for reliable information on soil management and soil conservation?
1 (not at all) - 5 (very much)



16. What do you primarily need in order to start or continue applying soil conservation practices? * (select max. 5)



17. To what degree do you agree with the below statements? *
1 (not at all) - 5 (very much)



Appendix 13. Information-based soil governance best practices

Table 0-18. Good examples of information-based policies for agricultural soil conservation from around the world

	Name and short description of policy	*Country*	*See source for more information*
1	Living Labs and Lighthouses to demonstrate the work of soil health pioneers	United Kingdom	(UK Soils, 2021b)
2	'uksoils': Online platform supporting the collaboration and shared learning of national stakeholders to improve soil health	United Kingdom	(UK Soils, 2021a)
3	Catchment-level community-based soil conservation with participatory methods	Kenya	(Pretty, 2002)
4	No-till research and extension groups on regional and national levels	Argentina	(Pretty, 2002)
5	Adaptive research: working with farmers at micro-catchment level to ensure technologies are fitted well to local circumstances	Brazil	(Pretty, 2002)
6	Farmer-controlled extension service with high levels of technical expertise	Denmark	(Prager et al., 2011)
7	Catchment Sensitive Farming initiative with free training, advice and support provided to farmers on sustainable land management on a catchment level	England	(Prager et al., 2011) (Natural England et al., 2021)
8	Ontario's Environmental Farm Plan Programme: voluntary participation by farmers to assess environmental risks, develop management plans, and raise environmental awareness on their farms	Canada	(FAO, 2001)
9	Co-production of knowledge in soil governance by multi-stakeholder Soil Focus Groups	Scotland	(Prager & McKee, 2015)
10	Participatory natural resource management by multi-stakeholder actor networks, building on workshops, capacity-building, international research collaborations and farm demonstrations	Ethiopia	(Institute of Development Studies, 2006)