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Why do they farm the(ir) land the way they do? Essays on the determinants of Austrian crop farmers' soil management

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by

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Declaration of authorship

I give my solemn word that I have compiled this work solely and without external help, have not utilized any sources outside those permitted and that the sources used have been given verbatim or quoted textually in the places indicated.

Vienna, May 2020 Heidrun Leonhardt

Abstract

Soil degradation and erosion are major problems of global scale. Agriculture is a key player in this respect, as farmers' soil management can foster or hinder its conservation. Therefore, agri-environmental policies attempt to steer farmers' soil management behavior towards conservation. Designing such policies requires a sound understanding of the determinants of farmers' behavior; an understanding that this thesis aims to enhance: Do Austrian crop farmers differ their soil management between land that is rented and land that is owned? Which contextual factors associated with renting contribute to or counteract such a difference? And which viewpoints on the determinants of their soil management exist among Austrian crop farmers?

To address each of these research questions, this thesis draws on adequate theories of farmers' behavior (conventional economic theory, institutional economics, and styles of farming). In a mixed-method design, it applies econometrics, content analysis, survey analysis methods, and Q methodology to analyze a range of different quantitative and qualitative data. The results of these analyses show that Austrian crop farmers barely differ their behavior between rented and owned land. This is mainly due to secure rental contracts, close landlord-tenant relationships, and widely applied agri-environmental schemes. Moreover, four different viewpoints on the determinants of soil management exist among Austrian farmers, here termed Nature Participants, Pleasure Seekers, Traditional Food Providers, and Profit Maximizers.

From these results, this thesis draws the following conclusions: First, context matters when analyzing or governing behavior, and investigating individual behavioral determinants in isolation provides limited insights. Second, farmers are a heterogeneous group, and policy needs to take this into account by providing a policy mix. Third, given the right circumstances, the renting of agricultural land does not hinder soil conservation.

Kurzfassung

Die vorliegende Dissertation untersucht die Bestimmungsgründe des Verhaltens österreichischer LandwirtInnen in Bezug auf Bodenschutz im Ackerland. Sie beantwortet dabei drei Forschungsfragen: Gehen LandwirtInnen mit gepachtetem Ackerboden anders um als mit dem Boden auf Eigentumsflächen? Welche Umstände der Pacht tragen zu solch einem unterschiedlichen Umgang bei oder wirken Unterschieden entgegen? Welche Sichtweisen auf die Bestimmungsfaktoren der Bodennutzung gibt es unter österreichischen AckerbäuerInnen?

Drei verschiedene Theorien zum Verhalten von LandwirtInnen (herkömmliche Ökonomik, Institutionenökonomik und die ‚styles of farming' Theorie) bilden die Basis für ein „mixed-method" Forschungsdesign, in dessen Rahmen diese Forschungsfragen beantwortet werden. Mittels ökonometrischer Methoden, qualitativer Inhaltsanalyse, Umfrageauswertungsmethoden sowie der Q Methode werden sowohl quantitative als auch qualitative Primär- und Sekundärdaten analysiert. Die Ergebnisse zeigen kaum Unterschiede im Bodenschutz zwischen Pacht- und Eigentumsflächen. Dies ist vor allem auf langfristige Pachten, gute Beziehungen zwischen PächterInnen und VerpächterInnen sowie umfassende Agrarumweltmaßnahmen zurückzuführen. Des Weiteren beschreibt die vorliegende Arbeit vier unterschiedliche Sichtweisen auf den Umgang mit dem Boden, die unter österreichischen LandwirtInnen verbreitet sind.

Aus diesen Ergebnissen lässt sich schlussfolgern, dass erstens bei einer Analyse einzelner Bestimmungsgründe menschlichen Verhaltens deren Kontext mitbetrachtet werden muss; die Untersuchung einzelner Faktoren limitiert die Erkenntnismöglichkeiten. Zweitens sind LandwirtInnen eine heterogene Gruppe, was insbesondere in der Politikgestaltung mitbedacht werden sollte. Drittens ist unter den in Österreich gegebenen Umständen nicht zu erwarten, dass steigende Pachtanteile eine negative Auswirkung auf den Bodenschutz haben.

List of appended papers

This dissertation is submitted as a cumulative dissertation that consists of a framework article and the three accepted research papers listed below. The full papers are included in the appendix to this thesis in their revised version.

Leonhardt, H., Penker, M., Salhofer, K., 2019. Do farmers care about rented land? A multi-method study on land tenure and soil conservation. Land use policy 82, 228–239. https://doi.org/10.1016/j.landusepol.2018.12.006

Leonhardt, H., Braito, M., Penker, M., forthcoming. Why do farmers care about rented land? Investigating the context of farmland tenure. Journal of Soil and Water Conservation. Accepted on 12.5.2020.

Braito, M., Leonhardt, H., Penker, M., Schauppenlehner-Kloyber, E., Thaler, G., Flint, C., forthcoming. The plurality of farmers' views on soil management calls for a policy mix. Land use policy. Accepted with minor revisions on 14.2.2020.

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1. Introduction

Healthy soils, the "living epidermis of [our] planet" (Amundson et al., 2015, pp. 1261071–1), are indispensable for human existence. Soils are essential for food, water, and energy security (McBratney et al., 2014), provide multiple ecosystem services (Adhikari and Hartemink, 2016; Dominati et al., 2010; McBratney et al., 2014) and have the potential to contribute to reaching several of the Sustainable Development Goals recently adopted by the United Nations (Keesstra et al., 2016). However, the world's soils are under threat by human activity. While soil transformation processes occur naturally as soil gets washed away in some places and redeposits in others, anthropogenic activities have dramatically increased the speed of these developments, rendering them unsustainable (Amundson et al., 2015). Globally, a large share of soils is now at least moderately degraded, and Europe is considered to have an especially long history of soil degradation (FAO and ITPS, 2015). One of the main threats to healthy soils and their functions is soil erosion (Ronchi et al., 2019), where soil is (re)moved by water or wind and thus lost in the short and medium run. Estimates of soil losses due to water erosion range from 1 t per ha and year (Cerdan et al., 2010) to 2.46 t per ha and year in EU countries (Panagos et al., 2015). For Austria, these numbers have been calculated to range from 1 t per ha and year (Cerdan et al., 2010) to 7.19 t per ha and year (Panagos et al., 2015). Especially on tilled cropland, soil loss has been found to be considerably higher than these numbers and amount up to 40 times the natural soil formation rate (Verheijen et al., 2009).

This latter finding already points to one of the main actors with respect to soil erosion and degradation: agriculture. According to Louwagie et al. (2011), six out of the seven soil degradation processes defined by the EU, among them erosion, are closely linked to farming. Amundson et al. (2015, pp. 1261071–4) even declare that "[a]gricultural soil erosion is one of the most destructive human perturbations to soil sustainability". This is particularly true for cropland, but depends on the specific agricultural practice applied: Montgomery (2007) shows that conventional plowing of cropland leads to great soil losses through erosion, but using conservation tillage has the potential to reduce soil loss to sustainable levels. Farming practices may thus cause erosion, but may also prevent it.

In addition, agriculture is not only a main factor in accelerating or slowing down soil erosion, but is also directly affected by the negative effects of soil loss and degradation. With the loss of (healthy) soils, yields decrease, which leads to a reduction in farmers' productivity (Panagos et al., 2018) and therefore income. If these (on-site) costs from yield losses are greater than (on-site) benefits from not switching to a more soil-conserving practice, farmers should have an interest to apply soil-conserving practices and thereby reduce soil loss. However, there are several reasons why this mechanism may not be sufficient in the long run and/or for society at large.

First, due to the long-term nature of soil loss and degradation, farmers may not be aware of the problem, as it may not have an impact on their current yields but – since effects are accumulating – on future yields (Graves et al., 2015; Kuhlman et al., 2010). Especially in deep and fertile soils, effects may thus simply not be visible, presenting an information problem (Fletcher, 1986); or they may be irrelevant to the farmer for their own farming life-span. Second, even if effects become visible, farmers can compensate the loss of soil and nutrients by increasing inputs such as fertilizers and thereby mask the problem for some period of time (Louwagie et al., 2011). In addition to masking an effect that will inevitably play out at a later point in time if soil gets washed away entirely, this can lead to undesirable external effects, such as fertilizer emissions to ground- or surface water (Brevik et al., 2015). Third, even if farmers are aware of soil loss and its effects, they may face or perceive a trade-off between immediate economic returns from the farming practices they currently apply and investments into soil conservation that will only bear fruit in a distant future (Fletcher, 1986; Prager et al., 2011). This problem is aggravated if farmers have a short time horizon for farming their land, due to, for example, the prospect to give up farming, insecure land tenure, or short-term renting (Ervin and Ervin, 1982; Higgins et al., 2018). Fourth, next to on-site costs, erosion can cause off-site costs that may not be considered by the farmer. These costs include third-party expenses for clearing up damages to roads, sewer systems, or neighboring land (Crosson, 1984; Graves et al., 2015; Kuhlman et al., 2010). Last – and relatedly –, there are other negative effects for society at large if soils are lost or degraded, as food security, water security, and other ecosystem services that serve humanity as a whole (e.g., climate regulation due to carbon sequestration) depend on healthy soils (McBratney et al., 2014; Rojas et al., 2016). Put differently, while land is usually considered a private good (implicitly granting the owner of that land the right to erode its soil (Fletcher, 1986)), land and the soil on it also have characteristics of a public good (Kutter et al., 2011; Louwagie et al., 2011).

Due to these public good characteristics of soils, including the existence of future and off-site costs, fostering soil conservation in agriculture justifies and requires policy intervention (Bartkowski et al., 2018; McBratney et al., 2014; Montanarella and Vargas, 2012). As a consequence, many countries have introduced agricultural policies to reduce soil loss and degradation (Baylis et al., 2008; Kutter et al., 2011; Prager et al., 2011; Ronchi et al., 2019). The EU has not issued binding legislation directly concerned with soil conservation (Ronchi et al., 2019), but the topic is addressed in other EU legislation (on water or nitrates, see Louwagie et al. (2011)) and features prominently in the EU's common agricultural policy (CAP). In the CAP's first pillar, part of the cross-compliance measures and 'greening' requirements relate to soil conservation; and several of the measures in the rural development program of the CAP (it's second pillar) target soil conservation, among other goals (Kutter et al., 2011). Many of these policies are designed and implemented on a member state basis and are complemented by additional soil conservation related legislation (Ronchi et al., 2019). In this manner, hundreds of mandatory, voluntary incentive-based, and awareness-increasing measures for agricultural soil conservation have been implemented across Europe (Kutter et al., 2011).

In Austria, which is the focus of this thesis, soil protection legislation beyond the above-mentioned EU regulations is a competence of the federal states (Ronchi et al., 2019). Most interesting for this thesis is agricultural soil conservation, which is primarily governed through the Austrian implementation of the CAP. Within the CAP, the greening requirements in Austria include soil-enhancing measures such as a minimum amount of crop diversity (e.g., through crop rotation), the protection of permanent grassland, and the creation of ecological 'priority areas' such as fallow or landscape elements (BMLFUW, 2020). In addition, the Austrian 'ÖPUL' (Österreichisches Programm für umweltgerechte Landwirtschaft) implemented under the second pillar of the CAP includes a host of incentive-based agri-environmental schemes (AES), many of them targeted at soil conservation. Austria follows a strategy of providing 'broad and shallow' AES and thus explicitly aims to incentivize as many farms as possible to participate in ÖPUL schemes (BMLFUW, 2015; Zimmermann and Britz, 2016). This strategy appears successful, as 83% of Austrian farms participate in, on average, three different ÖPUL schemes (BMLFUW, 2019). In addition to these nationwide programs, some local soil conservation efforts that address farming exist, initiated by local authorities or, e.g., NGOs.

If such soil conservation policies – whether incentive-based, voluntary, or even mandatory – are to be effective, they require a sound scientific basis and evaluation. Soil scientists and technical solutions to conservation problems are of obvious importance in this respect, and are necessary to develop and test soil-conserving practices (Bouma, 2005; McBratney et al., 2014). However, farmers also need to comply with or take up these practices to achieve conservation goals at large. Moreover, negative (side-) effects of soil-conserving practices for other aspects of farming need to be avoided or minimized. Therefore, an understanding of why farmers (do not) take up particular soil management practices or why they (do not) change their respective behavior is essential. Research based on social and behavioral sciences is needed to gain such an understanding (Lovejoy and Napier, 1986; Mills et al., 2017), and has already provided many insights that are useful for policy making (Dessart et al., 2019).

The focus of this thesis

Naturally, a wealth of such literature on farmers' behavior with respect to soil conservation already exists. The work presented in this thesis aims at contributing its part to this literature, enhancing our basic understanding of some of the determinants of farmers' behavior with respect to the soil that they farm. All three essays included here shed light on different – potentially influential – aspects of farmers' behavior. Two essays place a particular focus on agricultural land tenure and its influence on soil conservation, while the third considers farmers' subjective viewpoints on soil management.

The former research interest stems from an observation of increasing shares of rented agricultural land in several countries of the Global North, among them Austria (Ciaian et al., 2012; Holzer et al., 2013). There is a long-standing notion that land renting may be associated with less investment into soil conservation than land ownership (Bartkowski et al., 2018), due to the shorter planning horizon that

farmers face for rented land (Ervin, 1982). If this claim is true, then the rise in rental shares would be a cause for concern. Therefore, the first set of research questions that this thesis addresses concerns the renting of cropland and its effects on soil conservation. In particular, this thesis first aims to answer the following questions (RQ1):

Do Austrian crop farmers differ their soil management depending on whether land is rented or owned? Why or when do farmers (not) adopt different management between rented and owned land?

The results of this first research endeavor as well as previous findings for the US (Carolan et al., 2004; Ranjan et al., 2019) suggest that only particular aspects or circumstances of renting may present barriers to soil conservation, and not rental per se. This thesis therefore then aims to provide a more detailed and nuanced answer to the second part of RQ1; more precisely the following question (RQ2):

Which contextual factors associated with renting contribute to or counteract a difference in conservation efforts between rented and owned cropland?

The thesis then moves from investigating renting as one particular behavioral determinant to the discourse of 'all' potentially important influences on behavior. The aim here is to investigate where farmers place their own soil management in this space of potential influences. This is motivated by the notions that there is a vast array of factors that potentially influence farmers' behavior (Prokopy et al., 2019; Reimer et al., 2014); that farmers are heterogeneous in what guides their decisions and their behavior (Davies and Hodge, 2007; Schmitzberger et al., 2005); and that farmers themselves are the best to judge what they consider important behavioral determinants (Davies and Hodge, 2007). The associated research question (RQ3) is:

Which viewpoints on the determinants of their soil management exist among Austrian crop farmers?

Building on the answer to this latter research question, this thesis also derives policy recommendations for addressing the heterogeneous groups of farmers that hold different viewpoints on soil management.

All research presented here focuses on Austrian crop farmers and was conducted between 2016 and 2019.

2. Data and methods

In line with the different research questions outlined above, this thesis applies different methods to generate and analyze different data. Overall, this thesis therefore uses a mixed-method design. According to Goerres and Prinzen (2010), such a mixed-method design is superior to a mono-method approach for studying the behavior of individuals if two necessary conditions are met: The social phenomenon in question needs to exhibit some degree of inertia (such that the phenomenon or causal relationship does not change between the points in time where the different methods are applied), and the research project as a whole needs to be guided by a sufficiently broad research question or aim

(such that it is meaningful to break the overall research question down into smaller questions that can each be answered by single methods). Both conditions are met in this thesis. Moreover, Goerres and Prinzen (2010) suggest additional sufficient conditions for a meaningful application of mixed methods, several of which are met in this research project (e.g., unexpected results in a quantitative study that warrant further exploration; generating a quantitative measurement after a qualitative one). Therefore, it is to be expected that a mix of methods as applied here leads to a higher level of understanding of the behavior of farmers than a mono-methodological approach would.

The data used for applying these multiple methods include both secondary data as well as primary data that were collected for the purpose of the study. Each of the research questions that this thesis aims to answer is addressed through analysis of adequate secondary data sets where existent and provided, or by generating and analyzing new data via appropriate data-collection methods. These data include:

- Plot-level data from the integrated accounting and control system (IACS), which is collected for the purpose of administering agricultural subsidy payments related to the CAP (provided by the Austrian Ministry of Agriculture)
- Transcripts of qualitative semi-structured interviews with 26 farmers
- Data of a Q methodological study (Q sorts and post-sorting interviews) with 34 farmers
- A questionnaire survey with 344 farmers that are part of the Austrian farm accountancy data network (FADN), a network that is used to gather annual micro-economic data for EU reporting.

These data were analyzed roughly in a chronological order as listed here, such that later data collection methods could build on insights from earlier stages. In doing so, the thesis follows a sequential mixed-method design, with both explanatory (a qualitative method being used to explain previous quantitative results) and exploratory (a qualitative method being used to develop a quantitative method) components (Cameron, 2009). For example, the qualitative interviews were conducted at a time where first results from analyzing the plot-level data were already available, such that the interview questions helped understand the (non-)findings of these quantitative analyses. The interviews (of which the Q methodological study was a part of), in turn, provided important insights for designing the questionnaire survey, which was used to test and substantiate the qualitative findings. In addition, six stakeholder interviews, which had taken place in the very early stages of the overall project, had already provided insights into the issues at hand and helped both to analyze the IACS data as well as to prepare the interviews with farmers.

To analyze the above-listed data, this thesis combines the following methods:

- Econometric analysis of the IACS data set using linear probability models with cluster-specific fixed effects
- Qualitative content analysis of 26 of the semi-structured farmer interviews
- Q methodology

- Survey data analysis methods including conventional statistical tests

These methods are presented in more detail in each of the essays. Essay one applies a multi-method design in itself, whereas the other essays follow mono-method designs. Each individual essay considers different behaviors that are all related to farmers' soil conservation. Essay one analyzes crop choice as well as what farmers themselves considered when talking about soil conservation in the interviews. Essay two considers sixteen different soil conservation practices, many of which are also part of AES within ÖPUL. These practices range from a 'diversified crop rotation' to the use of no-till technology. Essay three does not directly investigate behavior, but behavioral determinants. Farmers were asked to consider their 'soil management' in a broad sense when asked about these determinants.

3. Theoretical considerations

This thesis is not embedded in one encompassing theoretical framework. Instead, the individual essays and research questions each draw, sometimes implicitly, on their own theoretical foundations. This section briefly sketches the three theories – conventional economic theory, classical institutional economics, and styles of farming – most present in the three essays, and evaluates which of the research questions could be meaningfully conceptualized by each theory. In doing so, it attempts to outline that such a theoretical pluralism (based on philosophical pragmatism) can, in conjunction with the methodological pluralism implemented in the mixed-method design, be helpful in understanding the phenomena and relationships under question in a holistic way (Onwuegbuzie and Johnson, 2006). In addition, such an approach enhances theoretical understanding, as it fosters evaluating and appreciating the strengths and weaknesses of each theoretical approach.

As a first example, conventional economic theory (i.e., rational choice models based on the assumption of utility maximization) can easily be used to model and understand why farmers may apply different soil conservation practices on rented and owned land (RQ1 and parts of RQ2). Soule et al. (2000) and Deaton et al. (2018) develop such models formally, based on McConnell's (1983) economic model of soil conservation. They introduce a parameter reflecting tenure security in a two-period model. This parameter describes the likelihood that a farmer benefits from future soil quality (or land value) and thus determines the present value of land, given a specific practice. These authors then show that whether or not a farmer applies a specific practice depends, *inter alia*, on this tenure security parameter, which describes, e.g., the type of tenure (e.g., fixed vs. cash rent), the length of a rental period, or the security of renting. Deaton et al. (2018) additionally use this model to conceptualize the effect of incentives or contractual requirements by landlords to apply conservation practices; as well as the impact of renters' reputation as 'good stewards', which brings about nonpecuniary benefits that can be interpreted as increased future net returns. In line with these extensions, it seems viable to include other contextual factors of renting into this model in a similar fashion to conceptualize other aspects of RQ1 and RQ2 (on renting and its context) of this thesis. RQ3

on farmers' viewpoints does, however, not directly address behavior and could thus not directly enter such a model. Nevertheless, it could conceivably be linked to behavior more explicitly, and could then enter such an economic model of soil conservation by conceptualizing the (present) value of land and farming in terms of the utility derived from it in a broader sense. That is, the net present value that farmers derive from the land they farm would be conceptualized not only in terms of monetized payoffs (net returns and land value), but also in terms of the utility derived, e.g., from complying with one's farming goals and views, including environmental goals or farming lifestyles. Farmers would then be conceptualized as deriving different levels of utility from different practices, depending on their viewpoints. Moreover, different viewpoints held by farmers would most likely also translate into different discount rates applied to future land values. However, while it may be interesting to develop such a model theoretically, other theories appear better suited to conceptualize farmers' viewpoints and their relationship with behavior.

Another theoretical framework that underlies essay one in particular and that fits large parts of this thesis is institutional economic thinking, particularly the lines of thought of 'old' or 'classical' institutional economics (Vatn, 2017). The main proposition of this line of thinking is that formal and informal institutions guide people's behavior by constraining and enabling certain behavioral options. This happens both consciously as well as unconsciously by shaping people's thoughts and conceived norms (Vatn, 2005). In this sense, land tenure – a prime example for a formal institution that defines property rights – shapes how farmers think of their land and which behavioral options they perceive as viable or 'normal' on that land. The specific characteristics of renting (such as contract terms or length) shape behavior in a similar manner. Moreover, other aspects of renting such as general farming norms and to some extent also the relationships with landowners (the 'social relationship' that is part of any property relationship, see von Benda-Beckmann et al. (2006)) can conceivably be conceptualized as informal institutions that influence (conservation) behavior. However, it is trickier to place RQ3 within the thinking of institutional economics. Styles of farming (see next paragraph) or the related farmer viewpoints may, with some reservations, indeed be understood as 'normative frameworks' (Davies and Hodge, 2007) that resemble informal institutions in that they create 'contexts of meaning' (Vatn, 2017, p. 31), and in doing so shape behavior. However, the fundamentally subjective nature of viewpoints renders it somewhat questionable whether they should be considered to be part of the "conventions, norms and formally sanctioned rules of a society", the definition of institutions given by Vatn (2005, p. 60). Instead, RQ3 may be better understood in its own theoretical framework.

These just-mentioned 'styles of farming' present such a theoretical framework that appears best suited to approach RQ3 of this thesis. This concept has mainly been put forward by van der Ploeg (1994), and is to some extent applied in essay three. While there appears to be no unified approach or even definition of such farming styles (Vanclay et al., 1998), studies referring to this theoretical idea all share a common notion that farmers are diverse and heterogeneous (Walder and Kantelhardt, 2018).

Notwithstanding this diversity, there is only a discrete set of farming styles (Vanclay et al., 1998), which can be understood as 'perceptual frameworks', 'mental frameworks', or 'identities' that farmers hold and that guide their decisions (Davies and Hodge, 2007). These styles (or typologies) represent different responses to outside influences (such as markets, technology, and policies, see van der Ploeg (1994)) and may lead to specific ways of organizing a farm enterprise (Vanclay et al., 1998) by the groups of farmers adhering to one such style. Since these perceptual frameworks guide farmers' decisions, they can serve as a useful basis for describing, understanding, and potentially altering behavior through policy that addresses each style (Fairweather and Klonsky, 2009; Walder and Kantelhardt, 2018). Schmitzberger et al. (2005) have, for example, found that ecological outcomes do indeed correlate with farming styles, and others have therefore proposed approaching farmers holding different styles with different policies (Davies and Hodge, 2007; Walder and Kantelhardt, 2018). RQ3 of this thesis is based on such an understanding of (grouped) diversity of farmers and their viewpoints. However, as opposed to previous work in this direction, it pertains only to soil management, not viewpoints on farming as a whole. It therefore assumes that distinct viewpoints on soil management in particular exist, which may be derived from farmers' more general viewpoints on farming, but may also differ from them. Indeed, as the results show, there is considerable overlap between the viewpoints on soil management discovered in essay three and previous studies with a broader approach, but differences do exist. In addition, the results show that all viewpoints on soil management place a similar non-importance on the tenure status of a piece of land. Thus, although a theory on farming styles may be introduced into questions on land tenure and soil conservation by assuming, e.g., that different farming styles are related to different 'tenure effects', the results do not support such an assumption. This theoretical approach therefore appears ill-suited for framing research RQ1 and RQ2 of this thesis.

In addition to the three frameworks presented here, there is a host of other theories that aim to explain behavior or behavioral change – for an introductory overview see, for example, Stern (2018). Many of these theories could conceivably be applied to understanding farmers' soil conservation behavior, and have been so in other work. Many of them, however, also include additional behavioral determinants than the ones investigated here, such that additional aspects as well as different methods would need to be covered in order to satisfy the respective theory. Therefore, even if other theoretical options are available, the frameworks that (implicitly) underly this thesis appear adequate to each research question; and theory, questions, and methods are aligned in a meaningful manner.

4. Summary of publications

This section introduces the three essays that constitute this thesis. Each essay was written jointly with several co-authors. The authors of essay 1 are Heidi Leonhardt, Marianne Penker, and Klaus Salhofer. Essay 2 was written by Heidi Leonhardt, Michael Braito, and Marianne Penker. The authors of Essay

3 are Michael Braito, Heidi Leonhardt, Marianne Penker, Elisabeth Schauppenlehner-Kloyber, Georg Thaler, and Courtney Flint.

Essay 1: Do farmers care about rented land? A multi-method study on land tenure and soil conservation (Leonhardt et al., 2019)

Whether farmers treat land under different tenure settings differently, or, a narrower version of this question, whether farmers treat rented land differently than owned land, are classic economic questions that have sparked a wealth of theoretical and empirical research. Theoretical considerations suggest that secure and long-term tenure (in the form of private ownership or other ways of increasing the security of rights to use the land under question) will lead to greater soil conservation efforts, as farmers have some certainty that they themselves will reap the benefits of conservation investments (Lichtenberg, 2007; Soule et al., 2000). Empirical research from the Global South largely supports this conclusion (Higgins et al., 2018). However, it is less clear whether the same proposition is true for renting vis-à-vis ownership, as are empirical findings in this respect (Varble et al., 2016; Wauters and Mathijs, 2014, see also literature reviews in essay 1 and 2). In addition to findings being ambiguous, the wealth of empirical research addressing this question comes either from the Global South or from North America, while the European context appears under-investigated.

In light of increasing rental shares in many European countries as well as growing concerns over soil degradation, this is surprising and warrants closer study. Given that the European policy context differs fundamentally from other contexts, it appears essential to investigate whether the strong European institutions concerning land markets and conservation are enough to prevent adverse effects from the growing popularity of agricultural land renting. In the essay presented here, Leonhardt et al. (2019) therefore take to this issue and investigate whether and why Austrian farmers differ their soil management between rented and owned plots of cropland.

They do so by means of combining a large-scale quantitative investigation using secondary data from the IACS with a qualitative analysis of interviews with farmers. In the quantitative part of this multi-method study, the authors use a regression model with cluster specific fixed effects (Cameron and Trivedi, 2005). They examine whether farmers plant different crops (wide-row crops, corn, legumes) on their rented and owned land, using plot-level data on a vast majority of Austrian cropland. In the qualitative part of the study, the authors apply a qualitative content analysis (Mayring, 2015) to analyze 26 semi-structured interviews with Austrian crop farmers. In doing so, they investigate other soil conservation practices that farmers may differ between their rented and owned land, and examine the circumstances under which and the reasons why farmers do (not do) so.

The results of the regression model show that there is indeed a correlation between renting and the planting of wide-row crops (and corn in particular), but this relationship virtually disappears once farm(er)-level variables are accounted for by the fixed effects. Therefore, a farms' propensity to rent

appears to be related to its propensity to plant wide-row crops, but, by and large, farms do not exhibit a tenure effect (i.e., a statistically significant relationship between renting and crop choice). Leonhardt et al. (2019) additionally investigate whether different types of farms exhibit such a tenure effect. They find that larger farms and farms with livestock tend to plant more wide-row crops on rented plots than on owned plots, and the opposite is true for organic farms.

The results of the qualitative analysis show that farmers do, under certain circumstances, differ some of their management practices between rented and owned plots. In particular they apply less (long-term effective) fertilizer and less calcium carbonate on rented plots than on owned plots, and, to a lesser extent, farmers alter their crop choice or their care about soil compaction on rented land. However, these differences largely apply only if a rental contract is about to end, if the renting of a plot is generally perceived to be insecure, and because renting is related to a plot's distance to the farmhouse. In contrast, other aspects of renting counteract a negative tenure effect: a close social relationship between landlords and tenants (e.g., due to kinship or neighborship), perceived rental security, and a general attitude of the farmer that supports conservation or works against perceiving a distinction between 'mine' and 'not mine'.

Leonhardt et al. (2019) thus conclude that under the current circumstances in Austria and its formal (e.g., land market regulations, AES programs) and informal (e.g., close social relationships, strong norms of what behavior is perceived as good farming) institutional context, renting does not lead to large-scale problems for soil conservation. While they acknowledge that this may change in the future due to changing social relationships and property relations, they conclude that currently there is no grave cause for concern.

Essay 2: Why do farmers care about rented land? Investigating the context of farmland tenure (Leonhardt et al., forthcoming)

The second essay presented here, Leonhardt et al. (forthcoming), builds on the findings just described. Leonhardt et al. (2019) already highlighted some contextual factors of renting that appear to influence a tenure effect. In addition, previous research has similarly found mixed evidence concerning the existence of such an effect (Prokopy et al., 2019). This indicates that it is highly contextual whether or not renting has a negative impact on farmers' soil conservation. For example, Carolan et al. (2004) and Ranjan et al. (2019) have identified several barriers that may hinder soil conservation on rented land – but these barriers need not be in effect in every setting. Similarly, previous studies describe a relationship between soil conservation and other aspects of renting such as lease length (Deaton et al., 2018), lease type (Soule et al., 2000), and the presence of AES or other conservation policies (Sklenicka et al., 2015). The relationship between landlords and tenants has been the object of study with respect to rental prices (Bryan et al., 2015; Taylor and Featherstone, 2018) and has been found to

be important for conservation in several qualitative studies (Carolan, 2005; Petrzelka et al., 2012). However, these studies usually consider these aspects in isolation and focus on only one factor.

In response to this, Leonhardt et al. (forthcoming) consider an array of contextual factors of agricultural land renting and their relationship with soil conservation practices. In particular, they investigate the impact of tenants' social ties with landlords, plots' distances to the farmhouse, and the prevalence of plot-level management difficulties on the application of sixteen different conservation practices, of which several are part of AES. Moreover, they evaluate the potential of lease length and security, rental prices, and contractual obligations to mediate a tenure effect.

The study's results are based on a questionnaire survey with 343 farmers that were part of the FADN and farmed rented and owned cropland. Among other aspects, respondents were asked to select 'typical' rented and owned plots that they farm, and describe these plots and the practices applied on each. The data are analyzed using standard statistical methods and a content analysis of responses to open-ended questions; at the outset, a McNemar's test (McNemar, 1947) is used to analyze the existence of a tenure effect.

The results confirm Leonhardt et al.'s (2019) findings in that the hypothesized tenure effect is virtually non-existent, also in this survey data set (for all but one of the 16 practices investigated). Leonhardt et al. (forthcoming) then therefore draw primarily descriptive and qualitative conclusions from their investigation. The results show that the vast majority of survey respondents rented from landlords they knew personally (either family or otherwise), that their leases were largely long-term, their rented land was further away from the farmhouse than owned land but still at a manageable distance, and there were no significant differences between rented and owned land with respect to management difficulties (such as steepness). Formal conservation requirements in rental contracts were rare, while applying practices for which AES exist was common for both owned and rented land. Drawing on these insights as well as respondent's observations concerning other farmers, Leonhardt et al. (forthcoming) then develop a simple conceptual model of what influences a potential tenure effect. They identify five important contextual factors that have an impact on a tenure effect for cropland: rental duration and security, the landlord-tenant relationship (which, in turn, is influenced by kinship and personal contact, as well as the physical distance between landlords and tenants), the location of plots with respect to the farmhouse or the farm's land, formal requirements such as AES and contractual obligations, as well as rental prices.

Therefore, similar to Leonhardt et al. (2019), Leonhardt et al. (forthcoming) conclude that given the current circumstances of agricultural land renting, there appears to be no (substantial) negative effect of renting on soil conservation efforts in Austria. Attributing this finding to the contextual factors listed above provides insights for other contexts in which these factors may be different (e.g., short-term rental contracts) and a tenure effect thus exists. In such a case it may be sufficient to address the context of renting in order to prevent negative effects, for example by fostering rental security via

rental market regulations; or ensuring that AES are designed in a way that accounts for the needs of tenants.

Essay 3: The plurality of farmers' views on soil management calls for a policy mix (Braito et al., forthcoming)

The results from the first two essays show that focusing on land tenure has only limited explanatory power for enhancing our understanding of why crop farmers in Austria do or do not apply conservation practices on the land they farm. Considering the social, institutional and natural circumstances of renting provides some additional explanations, but this also points to the fact that these aspects may be important for understanding farmers' behavior in general, not only on rented land. Moreover, the studies also show that socio-psychological aspects of the farmer such as their attitude towards ownership or soil conservation are important behavioral determinants.

The third essay presented here (Braito et al. forthcoming) therefore takes a wider approach to understanding farmers' soil management. The study considers aspects related to the farmer, the farm, the socio-institutional context as well as the natural context of a farm to explore the subjective determinants of soil management. In doing so, Braito et al. (forthcoming) also take a more farmer-centered stance and focus on the subjective *viewpoints* on soil management that exist among Austrian crop farmers. This also accounts for the realization that farmers are a heterogeneous group, which, in a secondary aim of the study, is then used to derive policy recommendations for designing agricultural policies in a way that is attractive to all farmers.

To explore and delineate Austrian farmers' viewpoints on soil management, Braito et al. (forthcoming) apply Q methodology with 34 farmers. In Q methodology, interviewees are asked to sort cards with statements printed on them according to their level of (dis-)agreement in a quasi-normal shape. All statements present potential answers to one particular question (Watts and Stenner, 2012). In Braito et al. (forthcoming) the statements all reflected potential determinants of soil management, i.e., aspects relating to farm, farmer, socio-institutional context, and natural context. "What determines how you manage your soil?" was the question to which interviewees sorted the statements. The result of the sorting is an expression of the interviewees' viewpoints on the issue at hand, and these expressions – 'Q sorts' – are then compared and analyzed statistically. In essence, Q Methodology allows the researcher to detect groups of farmers that view an issue similarly and delineate these viewpoints using both quantitative and qualitative information from the Q sorts and interviews accompanying the sorting procedure (Watts and Stenner, 2012).

The final results of any Q Methodological study are a number of viewpoints that differ from each other, but are each shared by a number of people. Braito et al. (forthcoming) distinguish the following four viewpoints on soil management among their interviewees: *Nature Participants*, driven by their relationship with nature and with a focus on innovation in soil management; *Pleasure Seekers*, sharing

a focus on nature but considering personal freedom and joy as essential; *Traditional Food Providers*, prioritizing food production and valuing traditions in managing their soil, and *Profit Maximisers*, motivated by their farms' economic viability and profitability. In addition, several aspects were considered equally (un)important for soil management by all viewpoints: the biophysical environment of the farm (including weather conditions) was a very important behavioral determinant for all; social pressures such as gossip were ranked as unimportant; and, in line with the findings from the previous essays, the security of tenure of piece of land was considered irrelevant to soil management by all viewpoints.

Despite these communalities, one conclusion from this study is that farmers are heterogeneous with respect to what they see as influential for their soil management (corroborating findings that farmers are heterogeneous with respect to their overall farming goals or styles, as outlined in section 3). Based on this result and on the importance that each viewpoint places on selected aspects (e.g., policy interventions, knowledge sources), Braito et al. (forthcoming) then derive policy recommendations. Since each viewpoint is motivated by different aspects, different policy measures may be needed to address the farmers sharing each view. For example, farmers sharing viewpoints that focus on farmer's relationship with nature might react to appeals to precisely these human-nature relationships. Others may be more susceptible to AES, which appeal to financial considerations. Therefore, Braito et al. (forthcoming) suggest that a mix of the following policies may be, in sum, attractive to all farmers and thus foster soil conservation: AES, appealing to the human-nature relationship types 'partner' and 'steward' (Braito et al., 2017), offering training and experimentation services, fostering social networks, and raising the social reputation of farmers.

5. Conclusions: contributions to science and policy

This thesis addresses three research questions that all aim at providing insights into farmers' soil conservation and soil management behavior. It begins with a rather narrow question that investigates the hypothesis whether farmers treat land they rent different from land they own. It then broadens its focus to consider the wider context of renting in addition to tenure alone. Finally, this thesis expands its focus to investigate all potential influences on farmer behavior and to explore where farmers situate themselves in this space of potential influences. Considering these three approaches together, several conclusions arise that present unique contributions to the literature on farmer behavior.

Main insights and contributions to the literature

First, the research presented here shows in different ways that when aiming to understand behavior, *context matters*. This is true at a more general level, where, for example, Braito et al. (forthcoming) find that aspects of the social context matter for many farmers, and the bio-physical farm context is considered a particularly central behavioral determinant by all farmers. At a more specific level, both

Leonhardt et al. (2019) as well as Leonhardt et al. (forthcoming) show that, e.g., biophysical features of plots as well as the social relationships between landlord and tenant matter for understanding farmers' behavior on rented land, not just the mere formal property status. That context matters, is, of course, not surprising. The theory section of this thesis has already outlined that this is one of the conclusions that can be drawn from an institutional economics perspective. Moreover, numerous studies of farmers' behavior consider the natural and social contexts of behavior in one way or the other, and find them to be significant determinants of farming practice (Dessart et al., 2019; Mills et al., 2017; Prokopy et al., 2008). Mills et al. (2017, p. 285), for example, point out that "there is an intricate interaction of agronomic, cultural, social and psychological factors; and each of these factors plays interwoven roles in each national, regional and specific farm context." However, there is also ample research that does take such contextual factors into account, not least research on land tenure (Prokopy et al., 2019). Sociologists in particular lament that contextual factors related to structural issues are all too often ignored when analyzing farmers' behavior (Lovejoy and Napier, 1986; Prokopy et al., 2019). In a similar but even narrower vein, Burton (2004) criticizes that behavioral research in agricultural studies often focuses on single behavioral determinants such as attitudes, ignoring other socio-psychological influences. The results of this thesis reinforce such critical notions. In itself, this thesis does in parts take such a broader view, or else controls for contextual factors by choice of methods. However, there is still room for improvement in this respect, as, for example, wider market and economic structures, or the cultural and political context and their relationship with behavior remain under-investigated.

Second, another broad conclusion that can be drawn from this thesis (particularly – and most obviously – from Braito et al. (forthcoming), but also in a subtler way from Leonhardt et al. (2019)) is that *farmers differ*. They differ in their viewpoints on soil management as described in Braito et al. (forthcoming), but also in their behavior with respect to rented land, as the results in Leonhardt et al. (2019) show. Whether the differences in behavior can be traced back to differences in viewpoints or whether differences in both are due to differences in the farm's context is a question for further research. Whatever the relationship, the conclusion that "farmers … are not one homogeneous group" (Darnhofer et al., 2005, p. 49) is by no means new, as the brief theoretical outline on farming styles as well as decades of research in this field show (van der Ploeg, 1994). Nevertheless, it is an essential postulate to keep in mind when studying farmer behavior. In this respect it is also useful to note that farmers may differ in different ways depending on the aspect under question. While most research on farming styles focuses on the overall approach to farming, Braito et al. (forthcoming) apply the idea to a specific notion, namely soil management, and still find essential differences in viewpoints. Therefore, even studies focusing on specific aspects of behavior should account for such differences. In addition, and as will be further elaborated in the section on policy conclusions, keeping in mind that 'farmers differ' can be a helpful guide for policy making, as Braito et al. (forthcoming) argue.

Third, and turning to more narrow conclusions and contributions to the literature, this thesis adds to and confirms the literature on a potential 'tenure effect' that finds little to *no relationship between tenure status and soil conservation* efforts (Cole and Johnson, 2002; Lee, 1980; Prokopy et al., 2019, 2008). The finding that renting does, under the current circumstances in Austria, not necessarily lead to a substantial reduction in soil conservation on cropland is particularly well founded: The very large and comprehensive dataset analyzed in Leonhardt et al. (2019) is noteworthy, as is the mix of methods of the entire thesis that all lead to similar conclusions. Even Braito et al. (forthcoming) find that the time horizon for a farmed plot does not determine soil management, although the focus of the study is not tenure. Therefore, the conclusion that renting does not necessarily have an impact on soil management is clearly substantiated. In addition, the geographical focus of this thesis presents another contribution to this strand of literature. As mentioned before, most studies on tenure and soil conservation have to date focused on countries of the Global South or on North America, where the institutional background is fundamentally different from the European context. This thesis therefore provides insights into the (non-)existence of a tenure effect in a country with strong and stable institutions, a small-scaled farming sector, and a countryside with strong social ties.

Fourth, and relatedly, to date only an emerging and still small strand of literature draws attention to the exact *circumstances of renting* and the resulting barriers to conservation (Carolan, 2005; Carolan et al., 2004; Ranjan et al., 2019). A large part of this thesis adds to this research strand by focusing on the aspects of renting that support or counteract a potential negative effect on conservation efforts, concluding that these contextual factors are of great relevance. It draws together already existing but scattered aspects and investigates them in a comprehensive way. It also provides new insights especially with respect to the role of AES (Leonhardt et al., forthcoming) and farmers' general attitudes (Leonhardt et al. 2019). These aspects have to date not received much attention in the literature on the circumstances of renting.

Last, on a methodological level this thesis shows that combining different theoretical approaches and methods to investigate related research questions can increase the validity and credibility – or 'legitimation' (Onwuegbuzie and Johnson, 2006) – of insights into the matter at hand. The fruitful interplay between different quantitative and qualitative methods becomes most obvious in the questions relating to agricultural land renting and its impact on behavior: The quantitative investigation of secondary data first showed a very small difference between behaviors on rented and owned land; a qualitative analysis of interviews then provided insights into the context of renting, which illustrated and explained these quantitative findings by, inter alia, rental security and personal relationships (Leonhardt et al., 2019); and finally, building on these insights, a questionnaire study provided insights on the prevalence and extent of these contextual factors, and confirmed their importance (Leonhardt et al., forthcoming). Moreover, the questionnaire enabled the investigation of a whole array of conservation practices, which is (usually) not possible with secondary data. Combining Q methodology with other methods is similarly planned for the study by Braito et al. (forthcoming),

where the viewpoints identified via the analysis of Q sorts will be re-identified among survey respondents. This will allow linking the viewpoints to actual behavior. Taken as a whole, all the approaches mentioned here together allow for an in-depth picture of soil conservation in Austrian crop farming and its unique particularities and thus make a strong case for mixed-method approaches.

Policy relevance of findings

As argued in the introduction section of this thesis, understanding farmer behavior is fundamental for agricultural policy making. This section therefore presents some insights for policy makers that can be derived from this thesis' results and conclusions.

First, the conclusion that context matters is not only relevant to research, but also to policy makers. The behavior that farmers exhibit does not only depend on one single aspect such as the tenure status of their land or the design of a specific policy, but on many other contextual factors. This increases the degree of uncertainty of any policy change, but can also be an opportunity to explore other intervention points than farmers' concrete behavior. For example, to ensure that farmers have an incentive to conserve soil on the land they farm, policy makers need not necessarily try to influence behavior directly. Instead they can create circumstances that induce long-term thinking by farmers, that support pro-soil conservation norms among the farming community (as opposed to, for example, food production-oriented norms), or that create a culture of learning and innovation. This notion becomes particularly obvious in Leonhardt et al. (forthcoming) and the context of renting: If renting leads to a lack of soil conservation under specific circumstances, then it is not necessarily the land rental (or sales) market itself that needs to be regulated. Instead, policy could foster long-term landlord-tenant relationships, encourage the specification of conservation measures in rental contracts, or design other conservation policies in a way that is compatible with the risks and particularities of tenant farmers.

Second, and as already outlined in essay three, the realization that farmers hold different views and are influenced or dependent on different factors has relevant consequences for designing agricultural policy. As Davies and Hodge (2007, p. 324) put it: "Understanding more clearly the normative frameworks of farmers can … help to anticipate in what ways policy may be received positively and in what ways it runs contrary to farmers' core objectives and beliefs." That is, since farmers hold different views, they will not all be attracted by the same types of policies, to the extent that a specific policy may even crowd out farmers if it is completely at odds with their views (Greiner and Gregg, 2011). Therefore, policy makers should take care to design policies that target different types of farmers in different ways. Previous research has stressed the same point (Davies and Hodge, 2007; Mills et al., 2017; Walder and Kantelhardt, 2018), but also highlighted that this targeting of farmer types can be tricky, as farmer types are not directly observable by policy makers (Dessart et al., 2019). Dessart et al. (2019) suggest that providing a policy mix and segmenting farmers according to some observable characteristics may be solutions to this problem.

Third, and more narrowly, this thesis presents holistic insights into the (soil conservation) behavior of Austrian crop farmers and is therefore first and foremost of interest to Austrian policymakers who intend to implement any change in policy design. They can directly benefit from this thesis' findings on important contextual factors of renting or on the prevalent viewpoints on soil management among crop farmers. In addition, however, even if these results are at first sight confined to the Austrian context, conclusions can be drawn for other contexts precisely by taking the Austrian particularities into account. An example is the lack of a tenure effect in Austria due to the circumstances of renting – this insight can be used to consider these circumstances (e.g., the length of rental contracts or landlord-tenant relationships) in other contexts and possibly alter them in a way that counteracts a negative tenure effect. Moreover, the results presented here reflect farmers in a European country with a rather small-scaled agricultural sector and a focus on sustainability in its AES structure. Other regions in Europe exhibit quite similar circumstances.

In sum, as argued in the introductory section of this text, any insights into the determinants of farmers' behavior can help to design policies that foster soil conservation. This thesis, therefore, contributes some small but important pieces of evidence that can help to achieve the goal of sustainable soil use in agriculture.

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7. Appendix: The three essays

Essay 1: Do farmers care about rented land? A multi-method study on land tenure and soil conservation (Leonhardt et al., 2019)

Essay 2: Why do farmers care about rented land? Investigating the context of farmland tenure (Leonhardt et al., forthcoming)

Essay 3: The plurality of farmers' views on soil management calls for a policy mix (Braito et al., forthcoming)

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Do farmers care about rented land? A multi-method study on land tenure and soil conservation

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ABSTRACT

Does ownership status of agricultural land determine farmers' soil use behaviour? Why (not)? We investigate this old question using multiple methods and data. We apply econometric analysis to plot-level data to determine whether planting decisions differ between rented and owned plots. In addition, we analyse interviews with Austrian farmers with the aim of explaining (a lack of) differences. We find a very small influence of tenancy on crop choice in the quantitative part of the study, and qualify these findings in the qualitative part. If at all, interviewed farmers treat rented and owned land differently primarily with respect to fertilization or liming, particularly if the rental is insecure or short-term. We find that renting is often perceived as long-term and secure in Austria, resulting in equal soil conservation behaviour on rented and owned plots. Personal relationships between renter and landowner as well as farmers' attitudes additionally support soil conservation.

1. Introduction

The question of how different land property rights affect farmers' resource allocation decisions is a classic economic question. Scholars including Adam Smith, John Stuart Mill and Alfred Marshall have already debated the influence of land tenure arrangements on farmers' investment in land (Johnson, 1950). While the debate has its origins in the efficiency effects of sharecropping arrangements compared to full ownership ('Marshallian inefficiency', see e.g., Quibria and Rashid, 1984 for a discussion), it has since expanded to cash rental arrangements and soil conservation. The general reasoning conceives of a trade-off between short-run economic payoffs and long-term investments, e.g., into soil fertility and soil erosion control. While farmland owners tend to have strong incentives to invest in soil conservation to protect the value of their land, renters, due to their shorter planning horizon, are assumed to focus on short-term profits and, in doing so, deplete the soil (Lee, 1980).

Previous research on the relationship between tenure and investments in land quality is most abundant for countries of the Global South. Interest has largely focused on these countries as rental and ownership are both not necessarily secure in less developed countries and the institutional background is generally weaker than elsewhere. Moreover, land markets have been established only recently in some countries, e.g., China (Gao et al., 2012). While many studies show that security of rental (and ownership) tends to have positive effects on investments in most cases, there is also contradictory evidence. For example, Gebremedhin and Swinton (2003); Abdulai et al. (2011), and Lovo (2016) empirically show that more secure forms of tenure have a positive effect on soil conservation investments in different African countries, as do Muraoka et al. (2018), who additionally show that this is primarily true for productivity and long-term investments, but not for investments that pay off in the same year. Brasselle et al. (2002) find no effect of tenure security on investments. Comparing rental and ownership, Jacoby and Mansuri (2008) investigate the application of manure on plots with different property status in Pakistan, and find that both sharecropping and cash rental decrease this investment into soil fertility, but long-term contracts minimise this effect. Conversely, Shaban (1987) finds an effect on input and output intensities only for sharecropping and not for cash rental as compared to ownership in India. More general, a review of studies from middle- and low-income countries (Higgins et al., 2018) and a review of African studies only (Fenske, 2011) conclude that the effect of tenure security on investments in land quality is positive to ambiguous, but results depend on the indicators and methods used. Importantly, some authors show that causality may also be reversed in this context, such that investments into land increase farmers' tenure security (e.g., Brasselle et al., 2002; Deininger and Jin, 2006; Moreda, 2018).

This literature provides some insights that may also be relevant for

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other contexts. First, a negative effect of rental on investments appears to be more robust for sharecropping arrangements than for cash rental, although evidence is not fully conclusive and impacts may depend on supervision by landowners (Deininger et al., 2013; Jacoby and Mansuri, 2009; Shaban, 1987). Second, effects appear to be more pronounced where rental is insecure and/or short-term (e.g., Jacoby and Mansuri, 2008). Third, the studied variables vary widely, and different types of investments may by influenced differently by property status. Last, empirical methods to estimate the effect of property status have been continuously developed in these studies, with econometric methods using household fixed effects (that essentially compare plots of farms that are owner cum tenants) now being widely applied as a robust approach.

With this background in mind, one might expect that in countries of the Global North, the effects of property status on investments into land and conservation behavior in particular may be less pronounced, as security of tenure (and ownership) is usually guaranteed. Moreover, focusing on cash rental, which is the focus of our paper, may also reduce potential effects. However, the existing empirical studies, primarily from North America, produce inconclusive results. The earliest studies on the impact of land tenancy on soil conservation date back to the 1930s, when soil erosion became an important issue in the wake of the 'Dust Bowl' in the US. Schickele and Himmel (1938) were among the first to provide empirical evidence that land rental may indeed discourage soil conservation, but they also emphasize the importance of the relationship between landlord and renter (e.g., family relations) for land use decisions. Further findings for North America from the 1980s range from higher soil erosion rates and fewer conservation practices on rented fields than on owned fields (Ervin, 1982), to no difference in soil erosion between rented and owned land (Lee, 1980), to renters being actually more likely than owners to adopt minimum tillage, a soil conservation system (Lee and Stewart, 1983). Twenty years later, Soule et al. (2000) find renters to be less likely to adopt soil conservation practices than owners, Cole and Johnson (2002) find no effect of tenure on soil erosion (accounting the finding to community norms and farmers' concerns about their reputation), and Fraser (2004) finds that owners plant more soil-conserving crops (such as perennials, grain and forage legumes) than renters. Most recently, Varble et al. (2016) find that while renters are less likely to rotate crops, they are more likely to use conservation tillage.

In contrast to North America, very little empirical evidence exists for Europe. To the best of our knowledge, only three European studies explicitly address the topic: Myyrä et al. (2005) find that in Finland, plots farmed by their owner have higher levels of soil pH and soil phosphorus than rented plots, suggesting that farmers invest more into owned land. Sklenicka et al. (2015) investigate the link between tenancy and crop choice in the Czech Republic and conclude that renters are more likely to plant wide-row crops (prone to soil erosion) than owners, but differences are mitigated by the more common participation of renters in agri-environmental schemes (AES) to some extent. Walmsley and Sklenička (2017) show that soil quality is higher for owned plots than for rented plots under conventional farming, but find no differences for organic farms. All three studies rely on relatively small samples. Additional research based on large samples therefore appears desirable. Moreover, there are at least two further reasons to contribute empirical evidence for Europe.

First, the historical and institutional background of farming as well as agricultural land markets differ substantially from those in other parts of the world, such that results found elsewhere cannot easily be transferred. In (Western) Europe, institutions are strong and land markets, including the rental market, are often strongly regulated (Swinnen et al., 2016). This increases the security of rental (and ownership), at least for the agreed rental period. However, differences between rental and ownership with respect to the farmers' time horizons and thus pay-back time for investments remain, depending on the length of rental. We thus expect the situation to be different from countries with weak institutions, but as the examples from the Czech Republic and Finland show, it appears still plausible to find an effect of rental on soil conservation practices.

Second, recent developments in agricultural land markets demand increased attention. In particular, agricultural land sales markets are extremely tight in most EU countries, with the share of land changing owner at less than 1% per year in several of the old EU member states (Ciaian et al., 2012a). At the same time, the average farm size in EU-27 (EU-15) countries has increased by almost 40 (30)% in total and 3.1 (2.4)% per year from 11.9 (23.4) hectares (ha) in 2005 to 16.2 (27.8) ha in 2016 (Eurostat, 2018). As a result, the rental market is gaining importance. For example, rental shares already exceed 50% of the total utilized agricultural area (UAA) in France, Belgium, Germany, Slovakia, the Czech Republic, and Hungary, and they are increasing in most EU countries (Ciaian et al., 2012b). At the same time, soil degradation and erosion have increasingly become a concern. Globally, a third of all land is at least moderately degraded, with Europe having an especially long history of human-induced threats to soil fertility (FAO and ITPS, 2015). The costs of soil degradation for agricultural production are considerable, with estimates ranging from 212 to 620 million British pounds just for the UK (Graves et al., 2015). Agriculture is a key factor in this respect. Farmers experience the immediate impacts of soil degradation first-hand but also cause soil depletion and exhaustion through their land use. Therefore, governments and other actors increasingly aim to incentivise farmers to conserve soil (Louwagie et al., 2009; Panagos et al., 2016).

In light of these considerations, it is of interest to investigate whether efforts to support soil conservation may be counteracted by the recent developments in European land markets. To do so, we need to understand whether the formal property context – in our case, ownership and rental – of a piece of land is one of the mechanisms that determine farmers' soil conservation and the context in which this mechanism may be (in)active. We distinguish between land ownership and rental by referring to the analytical notion of property rights. Property defines a social relationship between actors with regard to a valuable property object, in our case land (Bromley, 1991; von Benda-Beckmann et al., 2006). Ownership expresses the fullest bundle of property rights. Owners can transfer partial rights to renters, who can make use of the land for an agreed period of time but usually do not hold further rights such as the right to transfer or to change the land. The metaphor of the bundle of property rights, which has found cross-disciplinary recognition (Bromley, 1991; von Benda-Beckmann et al., 2006), highlights that the involved parties are tied together in social as well as legal relationships. It is important to distinguish the formal rights ('categorical property relationships') from actual social relationships ('concretised social relationships'), as the de-jure property rights status may be quite different from actual property practices (von Benda-Beckmann et al., 2006). This makes it necessary for us to consider not only the legal relationship but also the wider social context between renter and landowner when analysing the potential effect of property rights. In addition, not only the mere type of property rights to a piece of land but also the nuanced formal and informal arrangements thereof matter for farmers' behaviour. Both are usually not covered in the existing literature. We address all these aspects in this study.

The aims of this study are (1) to test the hypothesis that farmers practise less soil conservation on rented land than on owned land and (2) to investigate the circumstances of rental that may cause or counteract this purported relationship. To address both aims, we first use regression analysis of an extensive secondary dataset at the plot level from the Austrian Integrated Accounting and Control System (IACS). We test whether there is an observed difference in crop choice between rented and owned land at the empirical level. To gain a deeper insight into the relationship between rental and soil conservation we then qualitatively analyse transcripts of semi-structured interviews with Austrian crop farmers. This gives us a deeper insight into when and why farmers make (no) differences in soil conservation between rented and

owned plots. The present study will thus add to the existing literature by expanding its geographical focus to the European situation, by providing well-founded evidence due to the exceptionally large and detailed dataset we use in the quantitative part, and by offering additional context through its combined use of quantitative and qualitative methods.

Soil conservation covers many aspects of farming, including crop residue management, soil amendments such as fertilisation and application of manure, contour farming and strip cropping, and the choice of cropping system (Beste, 2005; Blanco-Canqui and Lal, 2010). We consider both prevention of degradation (e.g., erosion), as well as active enhancement of soil as conservation. In the quantitative part of the study we use crop choice as an indicator for a practice that is within a farmer's control and that is available in our dataset. In the qualitative part we take a broader approach and do not predefine soil conservation, but use farmers' own understanding of the concept.

The remainder of this paper is organized as follows: We first introduce our study area, Austria. We then describe the quantitative and qualitative data, indicators, and methods used in chapter three. The fourth chapter presents the results from both study parts. Finally, the discussion brings both results together and puts them into the wider context.

2. Study area: Austria

Austria is a good example of a country that follows the general European trend of rental and structural change. Both the sales market and the rental market for agricultural land in Austria are regulated relatively tightly (Swinnen et al., 2016) at the level of the nine 'Bundesländer' (provinces). The respective 'Grundverkehrsgesetze' (property transaction laws) of each province regulate agricultural land sale transactions. While differences between provinces exist, these laws generally favour the transfer of land to neighbouring and active farmers over non-agricultural investors. Reference durations for different farming types provide a guideline for rental contract lengths, and, despite not being as strong as legal minimum durations, ensure some protection of renters (Holzer et al., 2013). Rental prices are, similarly, not explicitly regulated, but the law includes the concept of an 'adequate rent'.

While the number of farms is steadily decreasing, the utilized agricultural area (UAA) per farm increased from 12.6 ha in 1990 to 19.7 ha in 2016 (BMLFUW, 2017). This increase in farm area has largely happened via the rental of land that has been given up by other farmers (Holzer et al., 2013). According to IACS data, the share of rented land increased from 22.6% of UAA in 2001 to 39.2% in 2012, and the share of farms renting at least some part of their land has increased from 41.9% to 69.6% of farms (BMLFUW, 2013, 2002). Due to differing inheritance laws and traditions, there are substantial regional differences in rental shares between provinces, ranging from 24.6% in Salzburg (in the mid-west of Austria) to 63.6% in Burgenland (in the east). Moreover, cropland (43.8%) was rented more often than grassland (32.7%) in 2013 (BMLFUW, 2013). As a consequence, farmers' expenditures for rent as a share of total expenditures have increased continuously over the last few years (BMLFUW, 2016). In Austria, rental of farmland is predominantly cash rent, while sharecropping is virtually inexistent.

3. Data and methods

3.1. Quantitative data and indicators

Aside from having an immediate effect on the economic outcome of farming, individual crops also differ in their capacity to enhance or exhaust soils in the long run, and to foster erosion due to differing row spacing and canopy cover (see also Universal Soil Loss Equation, Wischmeier and Smith, 1978). We therefore use farmers' choice of crops as a proxy for their soil conservation efforts. We classify crops into three groups: wide-row crops, corn, and legumes. Wide-row crops tend to increase soil loss through run-off, particularly on sloping plots, as a large part of the soil remains uncovered for a prolonged period. Farmers can mitigate this effect by taking specific measures such as using mulch-till/no-till technology. Nevertheless, following Sklenicka et al. (2015), we propose that on average and compared to other crops, wide-row crops are more prone to erosion than other crops and thus we use them as an indicator for soil non-conservation.[1] Wide-row crops are comprised of corn, beets, potatoes, and sunflowers. Austrian farmers frequently grow potatoes and beets under contract, limiting their crop choice decisions to some extent. We therefore use corn alone as a second indicator for an intensive and erosion-prone crop choice. Conversely, legumes are considered soil enhancing, as they increase the available nitrogen in the soil. We use them as an indicator for a soil-conserving crop choice. Legumes include: clover, grass-clover ley, alfalfa, lupin, peas, peavine, beans (soy beans, field beans), lentils, chickpeas, and vetch.

The Austrian IACS dataset contains plot-level information on the main crops planted on each plot for all farms receiving direct payments under the Common Agricultural Policy of the EU, i.e., 86% of Austrian farms (Hofer and Gmeiner, 2012). Due to the minimum eligibility criteria for most AES, the dataset does not cover most farms that farm less than 2 ha UAA. Nevertheless, for cropland the coverage amounts to 99.3% when comparing the IACS dataset with the farm structure survey (FSS) (Hofer and Gmeiner, 2012), such that any potential bias from this lack of data should be negligible. The farms in our final dataset farm between 0.1 ha and 2800 ha with crops (mean: 22 ha, median: 12 ha) on up to 1089 plots (mean: 15 plots, median: 10 plots).

The dataset has three levels: plots, fields, and legal property items. Plots are the actual management units, planted with a single crop in one year (descriptive statistics for plots see below). Fields are a larger entity and may contain several plots, and thus several different crops. The average field in our dataset contains 1.18 plots, and field sizes range from 0.1 ha to 165 ha (median: 0.97 ha, mean: 1.7 ha). The property status of a piece of farmland is not assigned to the single farmed plot, but to underlying legal property items. These legal property items are not always congruent with plots or fields. Due to this mismatch and the structure of the data, property status can be extrapolated for only two thirds of plots and is unclear for the rest; we assign the property status 'unknown' to the latter. In addition, farmers occasionally swap plots, or farm plots without formally renting them (e.g., plots belonging to neighbours, family, etc.). We assign these plots (property status 'right to use' in the original dataset) to the same category, 'unknown'. All other plots are either 'rented' or 'owned'.

In addition, the dataset includes the following information at the plot level (either directly at that level, or extrapolated from the field level): plot size, slope angle, a crop yield indicator reflecting soil quality, altitude, information on plot-level AES participation (some of which can be used as indicators for ecologically sensitive areas), and geo-spatial location (coordinates). All plots are linked to the farm that farms them. Using geo-spatial information on the location of the farmhouse, we calculate a linear distance between a plot and the farmhouse to reflect accessibility of a plot.[2] The dataset additionally contains some information at the farm level: organic/conventional

[1] We also test only those farms not using mulch-till/no-till technology, see below.

[2] This introduces some error due to data and measurement errors, justifying a removal of outliers. We remove all plots from the sample that are outside 2 times the interquartile range of the lower and upper quartiles of the distance in logs, corresponding to plots closer than 17.4 meters to, or more than 63 kilometres away from the farmhouse. This excludes 688 plots farmed by 289 different farms.

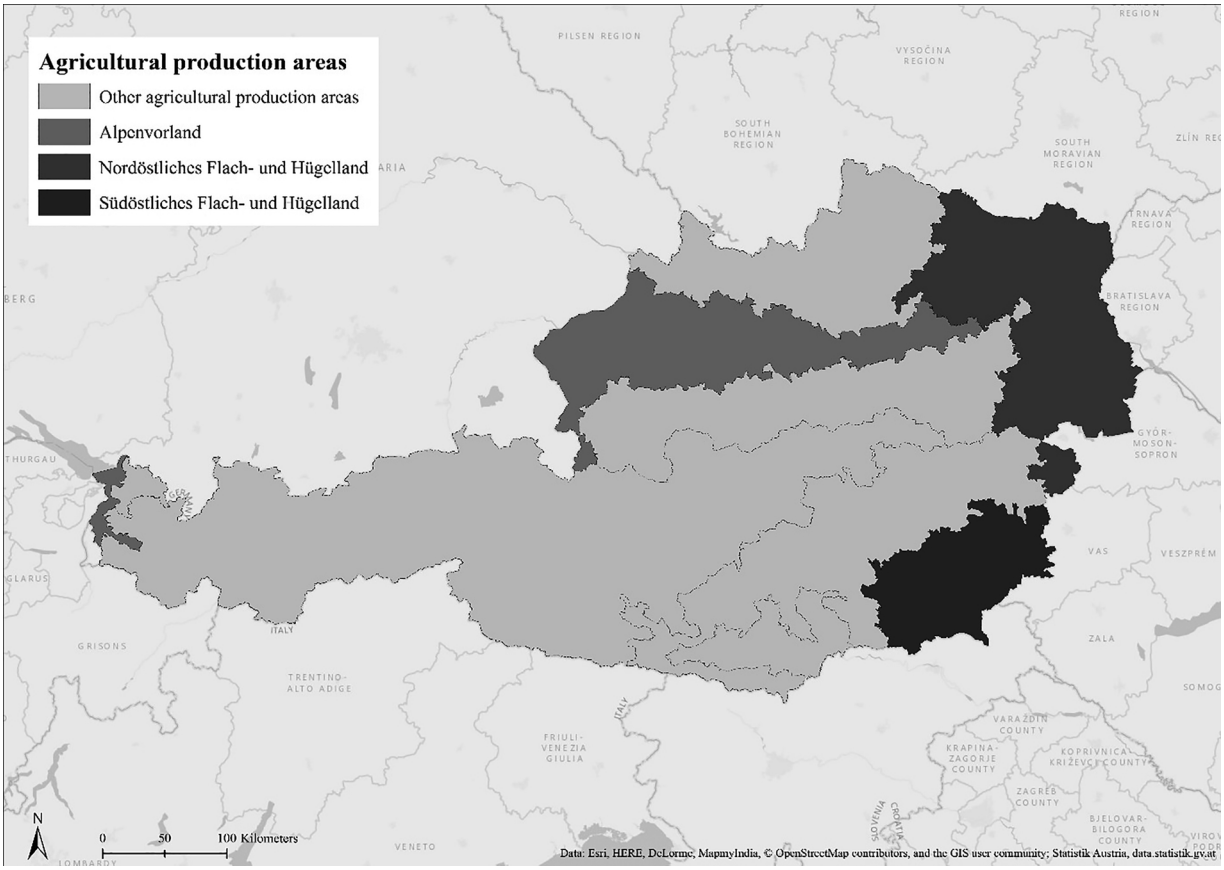

Fig. 1. Main Agricultural Production Areas of Austria.

farming, participation in soil-enhancing AES, farm standard output, and farm type.[3] We use this information to split the sample and investigate the farm type-specific effects of rental.

Based on climate, altitude, soil and topology, Austria is divided into eight main agricultural production areas (Statistik Austria, 2018). We select three production areas with a strong presence of crop production for this study (see Fig. 1): Alpenvorland (alpine foothills), Nordöstliches Flach- und Hügelland (north-eastern lowland and hills), and Südöstliches Flach- und Hügelland (south-eastern lowland and hills). We use all available data from these regions. Assuming that the cropland coverage of the IACS is approximately 99% for all regions alike, our dataset covers the vast majority of cropland in our study area.

We use data for the year 2012, the most recent year where all necessary information is available. The final sample includes 43,102 farms farming 670,760 plots with field crops. Out of these, 18.894 farms with 326.219 plots farm at least one (known) rented and one owned plot. Table 1 provides summary statistics of all plots by property status. We see that compared to owned plots, rented plots are slightly more frequently planted with wide-row crops, and slightly less frequently planted with legumes. Rented plots are smaller, flatter, of better soil quality, and at a lower altitude than owned plots, but all of these differences are small. Rented plots are also somewhat more frequently located in ecologically sensitive areas (areas designated as ecologically valuable with specific management requirements, compensated via AES) than owned plots. A large difference between rented and owned plots exists in their distance to the farmhouse. Rented plots are on average 1.3 km further away from the farmhouse than owned plots. Plots with an 'unknown' status show similarly minor differences to those with a known property status. We therefore retain these plots in our quantitative analysis to control for potential structural differences. To test the statistical significance of the differences in means between plots of different property status, we regress all variables on property status in turn. This allows us to account for the clustered structure of the data beyond a simple ANOVA by introducing cluster-robust standard errors at the farm level. With two

Table 1
Summary statistics of plot-level IACS data by property status.

	Owned	Rented	Unknown	Total
Number of plots	213,465	249,620	207,675	670,760
% of plots with wide-row crops	28.92	29.64	30.73	29.75
% of plots with corn	23.07	23.51	24.99	23.83
% of plots with legumes	9.17	8.68	8.17	8.68
Mean plot size (ha) (min-max)	1.49 (0.01-117.76)	1.26 (0.01-77.84)	1.6 (0.01-73.33)	1.44 (0.01-117.76)
Mean slope (%) (min-max)	6.48 (0.01-50.64)	5.58 (0.01-93.18)	5.99 (0-85.54)	5.99 (0-93.18)
Mean soil quality index (1-100) (min-max)	49.54 (0.1-100)	50.02 (0.2-99.7)	49.28 (0.1-99.9)	49.64 (0.1-100)
Mean altitude (m) (min-max)	312 (113-927)	272 (113-891)	288 (113-849)	290 (113-927)
% protected by AES	2.81	3.15	2.99	2.99
Mean distance to farmhouse (m) (min-max)	1505 (17-62,714)	2843 (18-63,353)	1999 (18-62,911)	2156 (17-63,353)
Number of farms				43,102

[3] Standard output is a standardised measure of farm revenues from different activities. It is used to classify farms by economic size and farming type (European Commission, 2014).

exceptions,[4] differences are statistically significant at the 1% level.

3.2. Quantitative model and estimation strategy

Some problems may arise when analysing the treatment effect of property status for crop choice. First, endogeneity problems due to a correlation of farm characteristics with property status as well as crop choice can bias the results. Our data set includes little information at the level of the farm, such as socio-economic factors including farmer's education, gender and age, and farm structural factors such as share of family labour, mechanisation, etc. Similarly, information at the district or regional level such as the presence of biogas facilities, climatic conditions, or regional traditions are missing. To control for such farm characteristics, we introduce cluster-specific fixed effects at the level of the farm. This allows us to estimate the treatment effect of property status in an unbiased way, as characteristics at the farm level (or higher, e.g., the regional level) that influence crop choice are now contained in and controlled for by the fixed effects. It is important to note that as a consequence only farms with both rented and owned plots will effectively contribute to the results concerning property status, reducing the number of farms and plots contributing to these results to 18.894 and 326.219, respectively[5]. Second, land quality differences between rented and owned plots may cause different crop choices and at the same time be related to differences in property status. We introduce all control variables available in the IACS dataset covering soil quality, slope, plot size, etc. at the plot level to account for such a potential bias. However, we cannot account for land quality differences that are e.g., caused by previous farming and management. This factor may correlate with property status, especially for newly rented plots (as previous farmers may have overused or otherwise degraded the land before losing the plot or quitting farming). This may bias our results. For example, such a (newly) rented plot then requires special care and the farmer will be more likely to plant e.g., legumes rather than corn during the first years, i.e., acting opposite to what we would initially expect. We however believe that this potential bias is small, as we have the impression that land transfers (via sale or rental) are relatively rare (see discussion section). Third, statistical problems may arise from sampling issues, such as farms being clustered. Given that our dataset covers > 99% of cropland and we include the entire dataset in our analysis we can avoid this problem.

To estimate the relationship between rental and crop choice, we thus use the following model:

$$ind_{ij} = \alpha_i + \boldsymbol{\beta'} \boldsymbol{D}_{ij} + \boldsymbol{\gamma'} \boldsymbol{X}_{ij} + \varepsilon_{ij} \quad (1)$$

where ind_{ij} is the respective indicator (e.g., presence of a wide-row crop) on plot j belonging to farm i and $\boldsymbol{D}_{ij}$ is a set of dummies indicating whether the plot is owned (default), rented, or the property status is unknown. α_i are cluster-specific fixed effects, $\boldsymbol{\beta'}$ and $\boldsymbol{\gamma'}$ are vectors of parameters to be estimated, $\boldsymbol{X}_{ij}$ is a vector of control variables, and ε_{ij} is an error term (Cameron and Trivedi, 2005).

We begin with a very simple model with no control variables $\boldsymbol{X}_{ij}$ and no cluster specific fixed effects b_i (model (1)). In the second step (model (2)), we extend the model by the following control variables $\boldsymbol{X}_{ij}$: size of the plot (hectares in logs), its slope angle (%), a soil-quality indicator (crop yield indicator, scale from 0 to 100), altitude (meters above sea), whether the plot is located in an ecologically sensitive area (dummy variables), and the linear distance between farmhouse and plot (metres in logs). For both models (1) and (2) we calculate cluster-robust standard errors (Cameron and Trivedi, 2005), as the observations are likely to be clustered by farm.

To account for farm-level heterogeneity, we introduce the cluster-specific fixed effects α_i, first without (3), then with control variables $\boldsymbol{X}_{ij}$ (4). These fixed effects (corresponding to farm-specific intercepts) are not explicitly calculated. Instead, they are eliminated using the within transformation (Cameron and Trivedi, 2005; Wooldridge, 2010).

The dependent variables ind_{ij} are all binary and describe the presence ($ind_{ij} = 1$) or absence ($ind_{ij} = 0$) of a specific crop on a plot. For such binary dependent variables, probit or logit models are usually preferred. However, in a fixed effects setting, these models suffer from the so-called 'incidental parameters problem' (Greene, 2004; Lancaster, 2000). Random effects probit or logit models are not affected by this problem, but assume the unobserved farm effects to be random and uncorrelated with the other explanatory variables. We therefore estimate a linear probability model (LPM). The estimated parameters of the model can then be interpreted as changes in the probability of the presence of a specific crop, i.e., wide-row crop, corn or legumes.

As the farm fixed effects eliminate all plot-invariant farm level characteristics, we cannot estimate whether different types of farms exhibit different effects of rental. To investigate this, we can, however, split the full sample according to various farm characteristics. We consider the following characteristics: (i) farms with a small, medium, or large standard output (cut-off points at 30,000 and 100,000 € standard output), (ii) different types of farms (predominantly animal husbandry, field crops, fodder crops, mixed farming), (iii) organic/conventional farms, (iv) farms participating in any of the following soil conserving AES (or not): direct seeding or and seeding on mulch (mulch-till/no-till), environmentally sound management of arable and grassland surfaces ('UBAG'), and greening of arable land.

3.3. Qualitative data and method of analysis

For the qualitative part of our study, we analyse the transcripts of 26 semi-structured interviews conducted with Austrian farmers in December 2017 and January 2018. All interviewees farm some amount of cropland, farm rented and owned plots and are situated in one of the three chosen agricultural production areas depicted in Fig. 1. Considering only farmers with both rented and owned land limits our results, as full owners or full tenants (very rare) may have a different attitude and report different practices than mixed tenure farmers. However, it also ensures compatibility with the quantitative analysis, where only farms with both types of plots contribute to the results.

Beyond these main criteria, participants were selected to cover a wide range of different farm types and farmers. We recruited interviewees via several channels, depending on the province: farm advisors of the Austrian Chamber of Agriculture provided direct farm contacts (Styria) or lists with contact information (Burgenland), an open call for participants in a newsletter of the Chamber of Agriculture of the province of Lower Austria, a call for participants among students of Agricultural Sciences at the University of Natural Resources and Life Sciences Vienna (yielding contacts in Burgenland, Lower Austria and Upper Austria, mostly students' parents or relatives), and contacts via environmental NGOs and extension services (mainly Upper Austria). In two cases, interviewees established contact with further farmers from their neighbourhood. In total, we approached 32 interviewees (none declined the interview, however 6 interviews could not be used due to no rented land, not in the required agricultural production area). We interviewed the main decision maker of each farm, which in four cases were two people (husband and wife or father and son). Aside from the interviewed couples, only one of the 26 analysed interviews was with a female farmer. Six farms were run as part-time farms (self-described) at the time of the interview, eleven had some kind of livestock, and six were organic farms. The interviewees were farming between 11 and 800 ha of cropland and were renting between approximately 10% and

[4] The percentage of corn does not differ significantly between rented and owned plots. The percentage of plots under AES does not differ significantly between rented and unknown plots, and differs significantly only at the 10% level between owned and unknown plots.

[5] We nevertheless retain also full-owners and full-renters in our analysis in order to get correct estimates of the influence of our control variables on crop choice.

Table 2
Regression results for wide-row crops.

Dependent variable: wide-row crops				
	(1)	(2)	(3)	(4)
Farm fixed effects	No	No	Yes	Yes
Unknown ownership	0.018*** (0.002)	0.021*** (0.002)	0.001 (0.002)	−0.004** (0.002)
Rented	0.007*** (0.003)	0.023*** (0.003)	−0.007*** (0.002)	0.002 (0.002)
log(size)		0.039*** (0.001)		0.052*** (0.001)
Slope angle		−0.001*** (0.0002)		−0.005*** (0.0002)
Soil quality indicator		0.002*** (0.0001)		0.002*** (0.0001)
Altitude		0.0002*** (0.00001)		−0.0004*** (0.00004)
Ecologically sensitive area		−0.218*** (0.005)		−0.125*** (0.005)
log(distance)		−0.009*** (0.001)		−0.002* (0.001)
Constant	0.289*** (0.002)	0.246*** (0.012)		
Observations	670,760	670,760	670,760	670,760
Households	–	–	43,102	43,102
R^2 (full model)	0.0003	0.025	0.264	0.289

Note.
* p < 0.1.
** p < 0.05.
*** p < 0.01. Robust standard errors in parentheses.

over 90% of their cropland. The interviewees held different rental contracts, many permanent with a 6- or 12-month notice period, others had contracts limited to three, five or ten years.

Table A1 in the appendix provides more detailed information about the interviewees.

Each interview lasted between 45 and 90 min. The interview guideline covered several topics: general information about the farm, rental conditions (including differences between rented and owned plots), soil conservation measures, and farmers' connection with soil. We did not define a priori what 'soil conservation' comprises, but let the interviewees decide what to include. For the present paper, we analyse only those parts of the interview transcripts that concern land rental and ownership. Transcripts were coded using qualitative content analysis with inductive category formation (Mayring, 2015). The category definitions for coding are defined as follows: (1) differences in land use between rented and owned plots explicitly mentioned by the farmers (referring to themselves or others); (2) circumstances of rental that farmers state as reasons for (not) treating rented plots differently than owned plots.

Coding and initial analysis were done using the software atlas.ti (Muhr, 2014). We coded relevant text parts and grouped emerging codes into code families named 'differences', 'yes' and 'no' for category (1), such that co-occurrences could be explored. For category (2), we analysed co-occurrences of the same families with the code families 'rationale for differences' and 'rationale for no differences'. Codes were then synthesised to produce a small number of central topics raised by the interviewees. To a limited extent, we accounted for the context of the farmers (e.g., organic/conventional farming) for analysis, but no effort was made to do, e.g., systematic axial coding.

4. Results

4.1. Quantitative results

Table 2 depicts the results of the linear probability model (LPM) for wide-row crops. We find that there is a statistically significant correlation between the planting of wide-row crops and land rental in a simple LPM without and with control variables (models (1) and (2)): The probability that a wide-row crop is planted on a rented plot is 2.3 percentage points higher than on an owned plot when controlling for plot-specific variables. However, this effect becomes insignificant once farm fixed effects are introduced (models (3) and (4)). On average, an individual farmer is thus equally likely to plant wide-row crops on an owned plot and a rented plot when farm and plot characteristics are accounted for.

For corn alone (see Table 3), the results are similar to wide-row crops. In an LPM with no farm-fixed effects, the probability that corn is planted on a rented plot is 3.2 percentage points higher than on an owned plot. Once farm-fixed effects are introduced, a statistically significant difference between rental and ownership remains, but its effect (0.7 percentage points difference in probability) is relatively small.

Similarly, the planting of legumes appears to be almost unrelated to the property status of a plot (see Table 4). Already the simple LPM shows only a very small effect of rental for the probability of legumes being planted on a plot, which is, contrary to expectations, positive (+0.5 percentage points difference in probability). This remains the same once farm fixed effects are introduced: It is on average 0.4 percentage points more likely for legumes to be planted on a rented plot compared to an owned plot for the same farmer.

In terms of model specification, the R^2s of models (1) and (2) show that not considering farm-level characteristics altogether provides a very poor fit of the data. Similarly, comparing models (1) and (3) as well as (2) and (4) with F-tests reveals the farm fixed effects to be significant at least at the 1% level, with F (43,101, 627,650) = 5.4195 for wide-row crops with no control variables and F (43,101, 627,660) = 5.2069 with control variables included.[6]

The coefficients of the control variables largely show expected signs: The larger a plot, the more likely a farmer will plant wide-row crops or corn. Legumes are also found more frequently on larger plots, but the effect here is much smaller. Better soil quality is positively correlated with the planting of wide-row crops and corn, but negatively (albeit with a very small effect) correlated with legumes. Steeper plots and plots at a higher altitude are less likely to be farmed with wide-row crops and corn, but more likely to be farmed with legumes. There is only a small negative and barely significant effect of the distance between a plot and the farmhouse on the planting of wide-row crops and an insignificant effect for corn. For legumes, the effect is slightly positive and statistically significant. The results for the indicator variable for 'ecologically sensitive area' are also as expected: being located in such a designated area greatly reduces the probability of wide-row crops (including corn) being planted on a plot but also reduces the probability of legumes. This confirms that farmers comply with the individually designed management plans for these plots, which may require leaving the land fallow or using it for fodder crops only.

Looking at different subgroups of farms for differences in the

[6] Results for corn and legumes are very similar and available upon request.

Table 3
Regression results for corn.

Dependent variable: corn				
	(1)	(2)	(3)	(4)
Farm fixed effects	No	No	Yes	Yes
Unknown ownership	0.019*** (0.002)	0.030*** (0.002)	0.004** (0.002)	−0.001 (0.001)
Rented	0.004 (0.003)	0.032*** (0.003)	0.002 (0.002)	0.007*** (0.002)
log(size)		0.028*** (0.001)		0.041*** (0.001)
Slope angle		−0.001*** (0.0002)		−0.003*** (0.0002)
Soil quality indicator		0.0001 (0.0001)		0.001*** (0.0001)
Altitude		0.0004*** (0.00001)		−0.0004*** (0.00003)
Ecologically sensitive area		−0.168*** (0.005)		−0.077*** (0.004)
log(distance)		−0.010*** (0.001)		0.001 (0.001)
Constant	0.231*** (0.002)	0.173*** (0.012)		
Observations	670,760	670,760	670,760	670,760
Households	–	–	43,102	43,102
R^2 (full model)	0.0004	0.024	0.331	0.347

Note: *p < 0.1.
** p < 0.05.
*** p < 0.01. Robust standard errors in parentheses.

Table 4
Regression results for legumes.

Dependent variable: legumes				
	(1)	(2)	(3)	(4)
Farm fixed effects	No	No	Yes	Yes
Unknown ownership	−0.010*** (0.001)	−0.006*** (0.001)	−0.0003 (0.001)	−0.001 (0.001)
Rented	−0.005*** (0.002)	0.004*** (0.002)	0.002* (0.001)	0.004*** (0.001)
log(size)		0.005*** (0.0004)		0.006*** (0.0004)
Slope angle		−0.0003** (0.0001)		0.001*** (0.0001)
Soil quality indicator		−0.001*** (0.0001)		−0.0001** (0.00005)
Altitude		0.0001*** (0.00001)		0.0001*** (0.00002)
Ecologically sensitive area		−0.050*** (0.003)		−0.043*** (0.004)
log(distance)		−0.003*** (0.001)		−0.002*** (0.001)
Constant	0.092*** (0.001)	0.113*** (0.008)		
Observations	670,760	670,760	670,760	670,760
Households	–	–	43,102	43,102
R^2 (full model)	0.0002	0.006	0.233	0.234

Note.
* p < 0.1.
** p < 0.05.
*** p < 0.01. Robust standard errors in parentheses.

planting of crops, we do not find statistically and economically significant (defined here as a difference greater than one percentage point between rented and owned plots) effects of rental for most subsamples. Table 5 shows coefficients and standard errors for the variable 'rented' for the model specification (4), i.e., including fixed effects and control variables. We find most significant effects at the level of farm types: livestock farmers are more likely to plant wide-row crops on rented plots than on owned plots (+1.6 percentage points difference, opposite sign than other farm types), and the relationship holds for corn (+1.7 difference). Mixed farms show a similar effect for corn (+1 difference), while fodder-crop farms are more likely to plant legumes on rented plots than on owned plots (+1.1 difference). Large farms show a tendency to plant more wide-row crops and in particular corn on rented plots (+0.9 difference for wide-row crops, +1.2 difference for corn). Conversely, organic farmers are less likely to plant wide-row crops on rented plots as opposed to owned plots (-1.3 difference, opposite sign than conventional farms), and farms that do not participate in the greening AES appear to be more likely to plant corn on rented plots than on owned plots (+1.2). All other subsamples do not exhibit a significant effect of rental, comparable to the full sample.

4.2. Qualitative results

The results from the qualitative part of the study concerning whether or not property status has an impact on soil conservation are mixed. While some interviewees state that they do differentiate between rented and owned plots, or would do so under certain circumstances, others maintain that they treat all their plots equally, irrespective of property status. Some assert that it is 'common', e.g., among their neighbours, to take less care about soil on rented plots compared to owned plots, or provide anecdotal evidence of such behaviour. Others, however, claim that they have not experienced this.

When interviewed farmers do mention differences in soil conservation (for themselves or others) between rented and owned plots, it is (in declining order of importance) with respect to the following: fertilization, liming, crop choice, soil compaction, and soil exploitation

Table 5
Effects of rental on crop choice (model specification (4)) for different subsamples.

		Coefficient (SE) wide-row	Coefficient (SE) corn	Coefficient (SE) legumes	No. of farms	No. of plots
Farm standard output (€)	Small	−0.006 (0.004)	0.001 (0.004)	0.008** (0.003)	19,532	153,652
	Medium	−0.001 (0.003)	0.004* (0.002)	0.003* (0.002)	13,897	268,091
	Large	0.009*** (0.003)	0.012*** (0.003)	0.001 (0.002)	9,325	246,106
Farm type	Animal husbandry	0.016*** (0.005)	0.017*** (0.005)	−0.0004 (0.002)	5,709	98,679
	Field crops	−0.0002 (0.003)	0.003 (0.002)	0.003* (0.002)	16,307	303,790
	Fodder crops	−0.004 (0.005)	0.001 (0.005)	0.011*** (0.004)	9,484	95,960
	Mixed farming	−0.002 (0.004)	0.010*** (0.004)	0.006** (0.003)	6,083	117,386
Participation in no-till/mulch-till AES	Yes	0.00002 (0.002)	0.005*** (0.002)	0.003** (0.001)	12,711	329,352
	No	0.005* (0.003)	0.009*** (0.003)	0.004** (0.002)	30,391	341,408
Organic farms (AES participation)	Organic	−0.012*** (0.004)	−0.009** (0.004)	0.005 (0.007)	3,556	70,201
	Conventional	0.004* (0.002)	0.009*** (0.002)	0.003*** (0.001)	39,546	600,559
Participation in UBAG AES	Yes	0.0004 (0.002)	0.005*** (0.002)	0.005*** (0.001)	18,977	405,006
	No	0.005 (0.003)	0.009*** (0.003)	0.001 (0.002)	24,125	265,754
Participation in greening AES	Yes	0.001 (0.002)	0.006*** (0.002)	0.004*** (0.001)	26,217	541,932
	No	0.009* (0.005)	0.012** (0.005)	0.003 (0.003)	16,885	128,828

Note.
* $p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$. Standard errors (SE) are cluster-robust.

or soil quality improvement in a general sense. However, for all of these practices we also find opposing statements. Examples that interviewees mention explicitly where they make no difference include: fertilization, liming, crop rotation, soil improvement through cover crops, erosion prevention measures (cover crops, reducing slope length), soil testing, and general soil exploitation or improvement.

When talking about differences in soil conservation practices, interviewees provide three arguments that justify why they do (or would) apply different soil conservation measures. First, the imminent end of rental is a (hypothetical) reason for not implementing measures with a long-term effect, such as specific types of fertilization (phosphorus-potassium (PK) fertilizer, heavy organic fertilizer) or liming: *"There would only be a difference if I knew that the rental contract is ending and … I cannot expect that I may or can continue renting that [plot], in that case I maybe would … cut down on fertilisation, at least with phosphorus and potash … so that I sort of … that I don't increase nutrients, but rather live on the substance that's there."* (P16 052). Crop choice or crop residue removal from a plot may also be adapted in the last year of a contract, to make good use of a plot: *"He lost 20 ha and then he did everywhere … he had never, I believe, baled the straw, but when he heard this he suddenly baled everything. That he squeezes the last out of it."* (P17 213)

Second, insecure rental is a reason for interviewees not to undertake investments in soil conservation. This is especially important when the costs of investment are high (e.g., soil quality of a rented plot is initially very low): *"What I am not so careful about on the rented plots that's the liming, right. … Because that is simply too much money for me at once that I am investing. And because, well, in my opinion, the landowner should also contribute a little bit."* (P4 110)

Third, the distance between a plot and the farmhouse may determine management decisions, and this distance is itself related to the property status. In particular, two interviewees mention that their rented plots are further away from the farmhouse than their owned plots, and thus the application of manure or crop rotations differ. Transporting manure across large distances is costly and time-consuming, as is travelling to distant plots for any farming operation, such that low-maintenance crops or fallow may be chosen for this land.

The reasons that interviewees provide for *not* having any differences in soil conservation practices can again be grouped into three categories: the social (property) relationship, rental security, and the general attitude of the farmer. In many cases, the relationship between landowner and renter appears to be close and personal (family, neighbours). To some extent, this ensures long-term rental by default (e.g., when a farmer rents land from their spouse) but also leads to a sense of responsibility towards the landowner. On the other hand, a landowner can also exert social control over a renter. Knowing the leaseholder personally and observing their conduct, landowners may impose informal requirements for (continued) rental, such as adhering to crop rotation or avoiding soil compaction: *"Actually, I have one landowner… It was like this: I got this plot three years ago, because he [the landowner] was not satisfied with the previous renter anymore, because for 15 years he had grown only corn. And he did tell me that it doesn't work like this. That if I want the plot, I have to work differently."* (P4 60) Ignoring these requirements may lead to the loss of rented plots in the long run, even if such conditions are not formally included in rental contracts (such contractual management requirements have been reported as being very rare). However, personal connections and resulting mutual trust appears to be under threat as landowners cease to live in the countryside and lose their connection to farming. One farmer illustrates this development and its consequences nicely: *"This one plot … that we lost, that was an indirect generational change. The old owner unfortunately died and his nieces inherited it. … And they live in [town near Austria's capital] and God knows where. And they wanted to see money. … When there is a generational change, then the connection to land and property itself isn't there anymore. … Then it all comes down to money. And this will, I believe, increase."* (P19 414–423).

Beyond the individual social ties between landowner and renter, social norms and expectations about what it means to be a good farmer (including conserving soil) by neighbours and villagers also play a role. Farmers expect others to gossip about them if they farm their (rented) soils badly, and talk disparagingly about other farmers who treat rented land inadequately and who thus "*don't think much*" (P15 364).

In addition, many interviewed farmers consider their rental secure, despite holding contracts that are terminable at short notice (6 months/one growing season), and this security induces them to conserve soil for

their own future farming. The perceived security of rental may be due to the personal ties just mentioned, but it may also be due to fragmented and interlaced plot structures that make access to individual plots difficult for other farmers, or because it is simply not common to terminate contracts. We find that some interviewees actively try to enhance their rental security by strengthening their relationship with the landowners or by 'signalling' to them that they are taking good care of their plots. For example, one interviewee pays his rent in person and brings Christmas presents to his landowners to "*keep the people with me*" (p17 430). Others make sure that their plots look neat and tidy to signal diligence to landowners.

Lastly, some farmers appear to not differentiate between rented and owned plots in terms of soil conservation as a matter of principle; this is either because of their generally positive attitude towards soil (protection) or their attitude towards property: *Farmer: "I don't have this feeling towards the farm or the plot, when I'm out there, to say 'There, this is mine now'. … I never had that. … I am farming it, and I am looking after it so that it is being preserved. But to say 'Ah, now I am on my field', I don't have that." Son: "Yes, and this is why the difference rented plot – owned plot, this is never there, somehow." (P19 645–650).*

5. Discussion and conclusion

In this paper, we investigate whether the property status of a piece of land is one of the mechanisms that determine farmers' soil conservation behaviour and under which circumstances this mechanism is in effect. More precisely, we first test the hypothesis that farmers treat rented land differently than owned land by statistically analysing this relationship using crop choice as an indicator. Subsequently we illustrate and broaden the results by means of a qualitative analysis of interviews with farmers.

Our econometric analysis is based on practically all plots of the main crop production areas in Austria. Results show an initial *correlation* between rental and the planting of erosion-prone wide-row crops. However, this relationship virtually disappears once farm heterogeneity is accounted for by introducing farm fixed effects, such that we do not find a sizeable *treatment effect* for rental. This means that there must be some characteristics at the level of the farm (or the region), which correlate with rental and simultaneously with the planting of wide-row crops. However, given the limited information in our data set, we cannot identify these characteristics. Instead, an analysis of different subsamples reveals that for some farm types, a (small) treatment effect of property status for crop choice does exist. This is most notably for livestock farms, which tend to plant more wide-row crops and corn on their rented plots than on their owned plots, contrary to other types of farms. A similar tendency exists for larger farms, and the opposite is true for organic farms. All other types of farms show no significant effect of rental on crop choice. Organic farms operate on a different rental market than conventional farms, due to the required transition period when converting conventional land to organic land. It may thus be that organic farmers are more dependent on particular rented plots and want to increase their rental security by planting less wide-row crops on these plots in particular. On the other hand, hog farmers who operate in a very competitive environment, or large farmers in general may be more economically-minded than others and thus exhibit a 'rental effect'. Other than that it is unclear why some types of farms or farmers should make a difference in crop choice between rented and owned plots and others do not.

However, the general findings of the quantitative analysis confirm some previous research. While evidence is generally mixed, especially studies that control for household fixed effects have shown to rarely produce significant results for rental in the context of countries of the Global South (Fenske, 2011). It is plausible that we find an even smaller effect in an institutional setting like Austria's. Nevertheless, even where we do not control for farm heterogeneity, the correlation between rental and crop choice is much smaller than, for example, the correlation found by Sklenicka et al. (2015) in a similar study based on a smaller sample for the neighbouring Czech Republic. While in this particular case historical and institutional differences may be of overriding importance, our qualitative analysis provides rich results that may explain and illustrate this (lack of a) finding.

First, given our quantitative data, we could only investigate farmers' crop choice. However, the interviews show that differences in soil conservation may, if at all, rather occur in terms of fertilization or liming. Analysing the application of fertilizer or other long-term investments may thus lead to different results (Myyrä et al., 2007, 2005). However, our dataset does not include such information, and large plot-level datasets including these variables are generally difficult to find. Future research, e.g., based on data from the Farm Accountancy Data Network, which provides detailed farm-level (but not plot-level) information, is needed to investigate this question.

Second, most theories of why farmers treat rented land differently than owned land rest on the assumption that rental is less secure than ownership and that limited rental periods shorten a farmer's planning horizon. Our interviewees, however, are often confident that their rental is secure and they will farm their rented land for a long time in the future, at least as long as they adhere to good agricultural conduct. This may either be because rental contracts are generally (and officially) long-term, or because even though contracts are short-term or terminable at short notice, farmers may perceive their rental to be secure and long-term. This links with what we pointed out in the beginning of this paper, that the nature of property in practice may be different from legal property rights (von Benda-Beckmann et al., 2006), and that there may be a difference between perceived tenure security and legal tenure security (van Gelder, 2010). Both situations will incentivise farmers to treat their rented plots like their own plots. Our findings concerning farmers' behaviour at the end of rental confirm that long-term and secure rental may indeed be an important mechanism mitigating a potential negative effect of rental for soil conservation. If farmers know that they are going to lose a plot in the near future, some farmers will indeed change their soil conservation practices, such as avoiding investments and/or adjusting their crop choice in order to receive an adequate return in the last year of rental. Due to a lack of data on the details of rental contracts we cannot substantiate this relationship in our quantitative analysis, as such contracts are usually not registered with authorities in Austria. Moreover, to our knowledge, there is also no data on the average turnover of rented land in Austria. We can therefore not substantiate the impression that terminating or not renewing a rental contract is rather the exception than the rule, explaining why any possible 'last year' effect of rental does not appear in our quantitative analysis. Thus, investigating the official length of rental contracts may still not lead to satisfactory results, as contracts may be limited on paper, but prolonged on a regular basis in practice.

Third, we find further factors that may counteract a potential negative effect of rental for soil conservation: social ties and farmers' attitudes. Our interviews show that many landowners and renters have close personal contact, with landowners exerting social control. In particular, landowners that have farming knowledge and live in the area observe farming and soil conservation practices of renters. They may either pick their renters carefully, and/or punish misconduct with a termination of rental. Farmers know this and adjust their behaviour accordingly, preventing differences in soil conservation between owned

and rented plots. This is in line with findings from Sweden (Grubbström and Eriksson, 2018), where landowners have been found to carefully choose who they sell or rent their land to, placing importance on good farming rather than purely economic considerations. In addition, we find that farmers generally want to live up to the expectations of their social surroundings about what it means to be a 'good' farmer, which includes farming all fields equally well. Again, it would be interesting to substantiate this in a quantitative analysis, but we have no data on contracting parties (e.g., family membership, place of residence) available.

In terms of farmers' attitudes, we find that, for some farmers, treating all their land equally is a matter of principle. Their motivation is either a holistic interest in conserving soil (e.g., for the future of humankind), or a matter of experiencing the same feelings of (non-) ownership towards all plots, independent of property status. This finding may connect with the literature on farming styles (Schmitzberger et al., 2005; van der Ploeg, 1994) – for example, the convictions or self-identity of some types of farmers could make them 'immune' to a potential negative rental effect. It would certainly be interesting to investigate this with respect to established farming styles or farmer identities. However, as our analysis includes only farmers with both rented and owned plots, it is important to note that we might miss out on particular farming styles and conservation practices among, for example, full owners.

Last, we find that the distance between a plot and the farmhouse may influence farmers' soil conservation efforts, confirming previous research (Grammatikopoulou et al., 2013). While not a direct effect of rental, this seems important given that rented plots are on average almost twice as far away as owned plots (see Table 1), and farms are becoming larger. Again, this appears to be most relevant with regard to fertilization, and thus it is not visible in our econometric model. Future research on this aspect should, however, take this finding into account.

Seen from a more general perspective, our findings also show that it is not simply the binary distinction 'rented' and 'owned' that matters, but rather several continuous dimensions such as tenure security, contract length, or strength of social relationship between landowner and renter. This puts into question the crude distinction between rental and ownership made in many studies, including the present one. It may be a convenient approach driven by data availability, but any such approach will limit the insights into causal mechanisms that are to be gained. Our aim here was to contribute to already existing literature on the topic, which often uses the same classification. Our results have both shown the limits of this approach but at the same time have enabled us to name some of the circumstances and thus dimensions of the property relationship that should be considered in the future.

In summary, our results show that formal and informal institutions matter for behaviour (cf. Vatn, 2015), i.e., they are mechanisms that do determine soil conservation, but they may have not only continuous, but also counteracting effects. Regarding formal institutions, it is not only the mere legal property status of a piece of land that is important but also its specificities such as the length and security of rental. We find that insecure rental and the near end of a rental contract may have particularly negative consequences for soil conservation. Informal institutions that appear important include personal relationships and social norms. This resonates with the definition of property given in the introduction to this text. Social relationships are an integral part of property relations. We find that in Austria, the shape of these social relationships supports rental security and soil conservation, and they thus counteract a potentially negative effect of rental. What is important in this context is that farmers and landowners can – and do – also actively influence the social circumstances of rental. For example, we find some 'signalling' behaviour of farmers towards their landowners with the aim of increasing rental security.[7] Others actively nurture their personal relationship with landowners. Conversely, landowners who have an interest in soil conservation use informal requirements to incentivise their renters to comply with their wishes.

We find some indications that problems may arise when the relationship between landowner and renter is less personal. This might become a more pressing issue in the future. The next generation of landowners may have less connection to the land they inherited and less farming knowledge than their parents (cf. our interviews). Informal requirements by landowners towards farmers will then decrease, and farmers will have fewer opportunities to prove that they 'deserve' a long-term rental due to their soil conservation behaviour. Social norms may still incentivise farmers to adhere to what is seen as good farming practices, but this may be not enough to outweigh the loss in direct contact with landowners. Formal provisions in rental contracts concerning soil quality could be an option that appears to be already in use in rare cases. Legal regulations (such as minimum rental periods) or specifically-designed AES may be another option to avoid potential negative effects of increasing rental shares. However, further research on the developments of landowner-renter relationships is required to substantiate this impression and help design adequate incentive schemes.

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Appendix A

[7] This resonates with studies that show that tenure security is also a function of investments, not only the other way around. Farmers have been found to increase their tenure security by investing in the land (Brasselle et al., 2002; Moreda, 2018).

Table A1
Interviewee details.

No.	Prod. area	Interviewee(s)	part-time (self-stated)	Livestock, other	organic	Cropland (ha)	% rented (approx.)	usual rental contract length	farm manager since
P01	Alpenvorland	farmer couple		Hogs, bulls		21	38%	permanent, 6 months notice	2002
P02	Nordöstl. Flach- und Hügelland	male farmer (sen.)		Hogs, horses	x	75	47%	permanent, 12 months notice	2002
P03	Nordöstl. Flach- und Hügelland	farmer couple	x	–		19	18%	permanent, 12 months notice	1990
P04	Alpenvorland	male farmer (jun.)	x	Vegetables		11	87%	permanent, 6 months notice	2018
P05	Südöstl. Flach- und Hügelland	male farmer		–		320	63%	10 years, 12 months notice (if sold)	1975
P06	Südöstl. Flach- und Hügelland	male farmer		Hogs		34	59%	5 years and permanent	1999
P07	Nordöstl. Flach- und Hügelland	male farmer		–	x	190	63%	5 years	2013
P08	Südöstl. Flach- und Hügelland	male farmer (sen.)		Hogs		25	48%	5 years and permanent	1997
P09	Südöstl. Flach- und Hügelland	male farmer	Until recently	–	x	18	0% (28%)[a]	permanent	1995
P10	Südöstl. Flach- und Hügelland	male farmer (jun.)	x	–	x	56	46%	5 years	2018
P11	Nordöstl. Flach- und Hügelland	male farmer		–		270 (more abroad)	80%	permanent	1987
P12	Nordöstl. Flach- und Hügelland	male farmer		–	x	60	50%	permanent, 12 months notice	1985
P13	Südöstl. Flach- und Hügelland	male farmer		Dairy cows		39	46%	5 years	2014
P14	Südöstl. Flach- und Hügelland	male farmer		Hogs		80	50%	permanent	2006
P15	Nordöstl. Flach- und Hügelland	male farmer		–		800 (partly abroad)	50%	5 years and permanent, 6 months notice	2006
P16	Nordöstl. Flach- und Hügelland	male farmer		–		110	77%	permanent	2015
P17	Südöstl. Flach- und Hügelland	male farmer		–		190	92%	Permanent and some limited, 6 months notice	1995
P18	Nordöstl. Flach- und Hügelland	female farmer	x	–		40	63%		2014
P19	Alpenvorland	male farmer (sen. + jun.), partly wife		–		175	66%	permanent, 12 months notice	1993
P20	Alpenvorland	male farmer		Hogs		55	31%	3 years	2016
P21	Nordöstl. Flach- und Hügelland	male farmer		Hogs		95	63%	permanent, 12 months notice	1991
P22	Nordöstl. Flach- und Hügelland	male farmer (sen.)	x	–	x	38	32%	5 years	2010
P23	Südöstl. Flach- und Hügelland	male farmer	x	–		20	50%	5 years (AES period)	2015
P24	Südöstl. Flach- und Hügelland	male farmer		Hogs, Vegetables		77	10%	permanent	2014
P25	Alpenvorland	male farmer, partly wife		Dairy cows		31	81%	permanent, 6 months notice	1999
P26	Südöstl. Flach- und Hügelland	male farmer, partly wife		Hogs		43	77%	permanent, 6 months notice	1998

[a]Farmer had very recently lost his rented plots (7 ha).

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Why do farmers care about rented land? Investigating the context of farmland tenure

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Abstract: Rental shares of agricultural land have increased in many countries, as have soil degradation and erosion. Theory suggests that these trends may be correlated, yet empirical findings are mixed. This ambiguity indicates that a 'tenure effect' on conservation may be highly contextual. Our research investigates farmers' soil conservation behavior on rented land and aims to disentangle the contextual factors involved. These factors include rental duration and security, the nature of the landlord-tenant relationship, plot-specific features of the land, formal requirements such as agri-environmental schemes (AES) or contractual obligations, as well as rental prices. We survey Austrian crop farmers and find, *prima facie*, no differences between rented and owned cropland in the application of 16 different soil conservation practices. We also find that, in our sample, renting appears to be secure and long-term; there are few cases where landlord-tenant relationships are distant; where rented plots are far from the farm house; and most farmers in Austria participate in AES that are applied independent of tenure status. We therefore propose that a purported tenure effect is indeed contingent on the contextual factors listed above, which may support or counteract soil conservation on rented land. Thus, policy makers and extension services can foster soil conservation on rented land by addressing these contextual factors. Points of intervention include designing AES contracts in a way that reduces risks for tenant farmers, supporting secure and long-term renting, encouraging close landlord-tenant relationships, and promoting the inclusion of conservation requirements in rental contracts.

Key words: farmer behavior—landlord-tenant relationship—land ownership—leased land—soil conservation

Farming rented land is an integral part of agriculture and thus a key issue for soil conservation. Although there is substantial variation between countries, rental shares of agricultural land are high in many regions of the world, including the Global North. In several EU member states rental shares have increased in recent decades and exceed 50% in countries such as Germany or France (Ciaian et al. 2012b; European Commission 2020). This is often due to a combination of farm expansion (e.g., the average farm size in the EU-27 countries has increased by 40% from 2005 to 2016 (Eurostat 2018)) and competitive land sales markets (Ciaian et al. 2012c, 2012a). In the United States, rental shares have not changed substantially in recent years, but leasing is nevertheless of great importance: In some states up to 46% of acreage is rented, and overall 54% of cropland is farmed by tenants (Bigelow et al. 2016; Jackson-Smith and Petrzelka 2014).

There is a general preconception that only farmers who own their land have an adequate incentive to conserve soil and invest in practices that will pay off in the long run. In contrast, farmland renting and several aspects thereof have been seen as barriers to conservation (Soule et al. 2000; Carolan et al. 2004; Ranjan et al. 2019b). Since soil conservation is a global challenge (FAO and ITPS 2015; Montanarella and Vargas 2012), tenure has received scholarly attention as one potential influential factor for farmers' behavior in this respect.

Most research on the relationships between tenure status and farmers' conservation behavior falls into two categories: In one strand of literature, tenure is included as one explanatory variable among others when investigating the adoption of conservation activities. A wide variety of such activities has been examined in this way. Often, the type of measure investigated depends on the region of investigation due to different institutional backgrounds: European studies tend to focus on participation in agri-environmental schemes (AES), where participants receive compensation payments for adhering to specific practices. Studies from other regions, e.g., the United States, often take a broader approach and investigate the uptake of agricultural best management practices (BMP) such as conservation tillage. Although individual studies sometimes find a (statistically significant) relationship between tenure and conservation behavior, several reviews of the evidence do not confirm a consistent effect in any direction. For an overview of such reviews see Lastra-Bravo et al. (2015) on AES adoption in EU countries; Prokopy et al. (2008) and Baumgart-Getz et al. (2012) on BMP adoption; Carlisle (2016) and Prokopy et al. (2019) on soil health or conservation practices all in the United States; and Knowler and Bradshaw (2007) as well as Wauters and Mathijs (2014) on soil conservation practices with a more global approach. Only one review of qualitative studies in the United States that investigates the uptake of conservation practices and programs finds that renting of agricultural land is consistently considered a barrier to their adoption (Ranjan et al. 2019a).

The second strand of literature is dedicated exclusively to the investigation of a 'tenure effect', aiming to explain either farm management behavior and outcomes (such as investments or efficiency) or soil

conservation efforts based on tenure status. Results here are similarly ambiguous. For the Global South, where tenure and in particular the renting of land is often insecure due to weak institutions, results tend to confirm the assumption that increased tenure security fosters long-term productive and environmentally-beneficial investments (Lawry et al. 2014; Higgins et al. 2018), but there is also contradictory evidence (Place 2009; Fenske 2011). Research from North America dates as far back as the 1930s (Schickele and Himmel 1938), with interest increasing again in the 1980s (Lee 1980; Ervin 1982; Dillman and Carlson 1982; Lee and Stewart 1983; Derr 1987) and since the early 2000s. Already early studies find mixed evidence of a potential tenure effect, with, for example, Lee (1980) finding no effect but Ervin (1982) finding a negative effect of renting on soil loss, and van Vuuren and Ysselstein (1986) finding a negative effect of renting for several conservation measures. Lee and Stewart (1983) find renters to be *more* likely to practice minimum tillage than owners. Later, Cole and Johnson (2002) find no tenure effect for soil loss, whereas Soule et al. (2000) do find an effect for conservation practices such as minimum tillage, as does Fraser (2004) for the planting of soil conserving crops. More recently, Varble et al. (2016) find that tenants are more likely to use conservation tillage than owners, but less likely to rotate crops and Deaton et al. (2018) find a tenure effect for cover crops, but this effect is contingent on lease length and the farming background of the landlord. For Europe, only a handful of studies exist. Myyrä et al. (2005) and Walmsley and Sklenicka (2017) investigate soil quality parameters for Finland and the Czech Republic, respectively, and find a negative tenure effect. Sklenicka et al. (2015) find a negative effect of renting on crop choice in the Czech Republic, while Leonhardt et al. (2019) find only very small effects for crop choice in neighboring Austria.

Thus, the literature to date appears inconclusive regarding the conventionally assumed negative effect of cropland renting on soil conservation. One lesson that can be drawn from this is that a potential tenure effect is probably highly contextual, depending on the farming practice under question, the region investigated, as well as details of renting, among other factors. Details of rental arrangements are taken up in few studies, including differentiating between share renters and cash renters (Ervin 1982; Soule et al. 2000), considering information on lease length (Fraser 2004; Deaton et al. 2018), or focusing on absentee landlords (Petrzelka et al. 2013; Petrzelka and Armstrong 2015) and how they and their relationship with tenants differs from residential landlords (Dillman and Carlson 1982; Ulrich-Schad et al. 2016). In addition, other aspects such as the personal relationship between landlords and tenants have been investigated in the context of rental prices (Bryan et al. 2015; Taylor and Featherstone 2018), but have also been suggested as a potentially important aspect for conservation by Carolan (2005) and Leonhardt et al. (2019). A more comprehensive investigation of these contextual factors within one study is, however, missing from the literature. Moreover, most studies focus on a single or a small number of conservation measures, disregarding that farmers may apply several measures at once.

Our study considers a wide array of different practices as well as several contextual factors of renting. In particular, this study aims to answer the following research question: W*hich contextual factors potentially support or counteract an effect of tenure on soil conservation?* As no secondary data that cover such information are publicly available, we collected data via a questionnaire survey with Austrian part-tenant farmers, i.e., farmers who farm both rented and owned land. We first examine this data set with respect to the existence of a tenure effect for a variety of soil conservation practices. We then investigate several circumstances of leasing and their potential for supporting or counteracting an effect of tenure on conservation practices. These include the length and security of rental, characteristics of the landlord-tenant relationship, and plot-level features of the land. We thus provide an unprecedented level of detail, which, we hope, will clarify previous investigations of the topic and help refine theoretical considerations of tenure and soil conservation.

The underlying theoretical model can be described as follows: Tenure is one determinant of the soil conservation practices that farmers apply on their arable land. We focus on renting (where landowners transfer part of their rights to a tenant for a limited period of time) as opposed to full ownership. In line with the literature mentioned above, we hypothesize that farmers are less concerned about soil conservation on rented plots than on plots they own and thus apply fewer soil-conserving practices. Due to the shorter planning period associated with a lease, renters are less likely than owners to reap the benefits of conservation investments, particularly those with a long pay-back period. However, we further assume—and know from previous research—that the following factors may influence the existence or intensity of this tenure effect: the length and security of renting (Deaton et al. 2018), plot characteristics such as its distance to the farmhouse or farming difficulties (e.g., sloping land, soil quality) (Deaton et al. 2018; Leonhardt et al. 2019), the rental price (Ranjan et al. 2019b), and the relationship tenants have with their landlords (including kinship or other personal ties as well as whether the landlord is residential or absentee) (Ulrich-Schad et al. 2016; Bryan et al. 2015; Taylor and Featherstone 2018; Leonhardt et al. 2019). In addition, we posit that conservation requirements specified in the rental contract may also influence a tenure effect (Derr 1987), as may farm-level aspects such as participation in AES that need to be applied to an entire farm operation (Sklenicka et al. 2015).

Materials and Methods

We conduct our study in Austria, a country that follows the general trend of structural change in agriculture with increasing farm sizes and increasing rental shares. A particularly interesting feature of Austrian agriculture is a strong focus on sustainable farming techniques, including comparably high shares of organic farming and strong support for and uptake of voluntary AES (BMLFUW, 2019). This section introduces the particularities and developments of the Austrian agricultural sector as well as our questionnaire design, data and methods of analysis.

Study Area: Austria. In the past decades, the number of farms in Austria has decreased steadily, while the utilized agricultural area (UAA) per farm has increased from 12.6 ha in 1990 to 19.7 ha in 2016 (BMLFUW 2017). Compared to many other European countries with a similar historical and economic development, Austrian agriculture, however, remains relatively small-scaled. This is mostly due to the alpine nature of Austria's geography, which also makes crop production predominant only in the country's relatively flat north-east and south-east. Austria's accession to the EU in 1995 has not altered the ongoing trend towards larger farms, but has changed the institutional setting of subsidies and AES. Austrian agricultural policy is now guided by the Common Agricultural Policy (CAP) of the EU with its two pillars of production support (first pillar) and rural development (second pillar). Payments from the first pillar are based on a farms' land area and tied to compliance with so-called 'greening' requirements (keeping permanent grassland intact, growing more than a single crop, and taking 5% of cropland out of production for flower strips, fallow, etc.). Being part of the second pillar, AES are of major importance for Austrian farming: both payment levels as well as participation rates are among the highest in the EU (Zimmermann and Britz 2016). Farms can select from over 20 different schemes with various environmental and societal objectives and differing intensities (BMLFUW 2015). Per-hectare payment levels are designed to compensate farmers for additional costs or losses caused by the practice. In 2018, 83% of all farms that received any subsidies (which 86% of farms, farming over 99% of Austrian cropland do, see Hofer and Gmeiner (2012)) received AES payments for, on average, three different schemes per farm (BMLFUW 2019). Farmers usually sign up for these schemes for a period of five or six years within a given CAP period.

Renting of agricultural land is of increasing importance for Austrian farmers, and for crop farmers in particular. Between 1960 and 2010, the amount of rented land has almost tripled (Holzer et al. 2013) and amounted to 39.2% of UAA in 2012, the last year where this information is available. The share of part-tenants has increased from 41.9% in 2001 to 69.6% in 2012 (BMLFUW 2002, 2013). Full tenants who do not own any of their land are rare; in 2010 6% of farmers rented all their land according to the farm structure survey (Statistik Austria 2010). The share of rented land varies by region, ranging from 24.6% in the mountainous mid-west to 63.6% in the east and is higher for cropland (43.8%) than for grassland (32.7%) (BMLFUW, 2013; all data are for 2012). Fixed cash rental arrangements are predominant, with sharecropping being virtually inexistent. As data on rental prices, contract durations, or other contract specifics are not centrally collected or published, we do not have any a priori information on these factors. The law on agricultural land renting includes non-binding 'reference durations' of five to fifteen years for the renting of different types of agricultural land as well as the concept of an 'adequate rent', both of which serve primarily as reference points for conflict resolution (Holzer et al. 2013).

Data Collection. As part of a larger project on renting and ownership of cropland in Austria, we designed an online questionnaire for Austrian farmers participating in the farm accountancy and data

network (FADN). This network is used to gather annual micro-economic data for official reports at the EU level. The FADN is designed to be representative of 'commercial' farms, thus only farms with a standard output (a measure of a farm's production potential) between 15,000 € and 750,000 € are eligible. These eligible farms are representative of around 50% of all farms, but over 90% of all farms' economic activity and 93.5% of cropland (BMLFUW 2018). Out of the 76,056 eligible farms, 1,897 were part of the FADN in 2017 (AWI and BMLFUW 2018). Farms are selected into the network based on strata that reflect different farm types, economic size classes, regions, and mountain farm classification categories (reflecting different levels of natural handicaps). Participation is voluntary, but initiated by extension services.

Data collection for the FADN is administered by an Austrian tax and accountancy consultancy firm on behalf of the federal ministry. This firm assisted us in pretesting the questionnaire, identifying and contacting farmers, disseminating the questionnaire, and ensuring an adequate response rate. We invited those 1,147 FADN-farmers who farmed at least 5 ha of cropland and rented part of this land to participate in the study in winter and spring 2017/2018. Farmers were contacted first via e-mail, with two reminders sent out. In addition, regional FADN advisors contacted and encouraged farmers who had not responded yet via phone and during their annual farm visits, which take place during winter/spring. Where necessary, these advisors also assisted with completing the questionnaire during farm visits. Using such different modes of contacting and surveying respondents contributes to adequate response rates and representativeness (Stern et al. 2014). Since contact details (e-mail addresses, phone numbers, addresses) remained with the consultancy firm for data protection reasons, we did not conduct any additional non-response bias checks. 344 fully completed questionnaires were returned, one of which had to be excluded since the respondent did not rent any cropland at the time of the survey. This response rate of over 31% ensures reasonable statistical power (Faul et al. 2007). For those analyses that compare rented and owned plots directly, we excluded another five respondents as they did not own any of their cropland.

Table 1 compares respondents and non-respondents based on economic indicators from the official FADN data set. While respondents were required to enter their 5-digit FADN ID for completing the survey, only 300 provided a correct ID that could be matched to the FADN data set for this comparison. Survey respondents farmed larger farms and had a higher share of arable land and rented land than non-respondents. This is possibly due to our focus, which may have made specialized crop farmers (which tend to have a larger UAA than farms with livestock) with higher shares of rented land more likely to reply or be approached by FADN advisors. Respondents were also less capital and labor intensive than non-respondents; however, this is related to their larger UAA (capital and labor endowments were not significantly different between both groups). Thus, given the sampling criteria and topical focus, our survey participants appear not to differ significantly from all FADN farms in terms of economic indicators.

Table 1
Comparison of survey respondents' and non-respondents' characteristics, arithmetic means.

	Non-respondents	Respondents†	Significant difference in median‡
n	847	300	—
UAA (ha)	46.40	52.56	**
Share arable land (of UAA)	74.30%	81.05%	**
Rental share (of UAA)	39.48%	46.28%	***
Livestock/ha (LU)	1.28	1.23	—
Capital/ha (1,000€)	11,532.35	9,917.45	***
Labor/ha (AWU)	0.05	0.04	**
Income/ha (€)	1,126.39	1,048.68	—
Productivity (Inputs/Outputs)	1.16	1.13	—
AES payments/ha	159.68	168.81	—
Fertilizer/ha (100kg)	0.92	0.94	—
Payments for LFA/ha	51.53	39.33	—

Notes: ***p < 0.001, **p < 0.01, *p < 0.05
LU = livestock unit, AWU = annual work unit, LFA = less favored area
†: Only those who provided a correct FADN ID.
‡: Test for significance in differences: Wilcoxon rank-sum test for non-normally distributed data.

Questionnaire Design. Our questionnaire consisted of three main parts and took participants about 20-30 minutes to complete. All relevant parts of the questionnaire can be found online: https://homepage.boku.ac.at/leonhardth/JSWC_questionnaire/. Part one contained general questions on the leasing of cropland, including the amount of land rented, its distance to the farmhouse, from whom it was rented, and rental conditions (type of contract, length of rental, specific requirements, rental price).

In part two, respondents were asked to consider a typical rented and a typical owned plot of cropland that they farmed and provide further details. We asked them to select plots that were, in their opinion, representative of the majority of plots they rented or owned. Focusing on specific plots was necessary to investigate plot-specific features and because Austrian farmers usually rent a number of plots from several landlords. For these 'typical' plots, respondents were first asked to state for each of the practices listed in table 2 whether they applied it on each of the plots with compensation, without compensation, or not at all. Table 2 also shows whether any nationwide AES support these practices, but does not list regional or local schemes or legal restrictions. Second, respondents were asked to provide some characteristics of their typical rented and owned plots, including farming difficulties (steep slopes, poor soil quality, protected area), their distance to the farmhouse, and farmers' relationship with the owners (of rented plots) or previous owners (of owned plots).

Table 2
List of soil conservation practices considered in the survey and existence of respective AES.

Practice	**Nationwide AES**
Applying compost	None
Conservation tillage (including no-till, strip-till, mulch till)	Specific AES (all erosion-prone crops of the farm)
Creation of wind protection elements (e.g., hedgerows)	None
Cultivation of cover crops – "Intercropping"	Specific AES (on 10% of cropland)
Cultivation of cover crops – "Evergreen"	Specific AES (on 85% of cropland)
Cultivation of winter-hardy cover crops	Option in both cover crop AES
Diversified crop rotation	Minimum crop rotation part of CAP-greening and AES
Not applying fertilizer	Reduction or seasonal prohibition of synthetic fertilizer part of several AES
Not applying fungicides and growth regulators	Specific AES (all plots with cereals)
Not applying pesticides	Reduction or seasonal prohibition part of several AES
Not applying sewer sludge	Part of AES in designated groundwater protection regions during specific time periods
Organic farming	Specific AES (entire farm operation)
Precision farming	No AES, but investment subsidies may apply
Preservation of valuable landscape elements	Part of AES (if present)
Regular soil sampling	Part of AES in designated groundwater protection regions
Use of machinery that prevents soil compaction	None

In the third part of the questionnaire we asked respondents about their observations of other farmers' conduct on rented and owned land; a topic that had come up in previous interviews. We asked respondents to indicate whether and why they thought others did or did not treat rented land differently than owned land in several closed questions, with the option to provide more information in a text field.

The final part of the questionnaire gathered some demographic information and included an open-ended question to give respondents the possibility to raise any additional aspects of renting and soil conservation that they thought were important or missing. Providing interesting additional information, 83 (24%) respondents made use of this opportunity.

Data Analysis. To analyze the existence of a tenure effect, we compare respondents' stated soil conservation practices on their typical rented and owned plots. To assess the statistical significance of differences we use a McNemar's test statistic (McNemar 1947), which determines whether the proportion of farmers applying the practice only on their rented plot equals the proportion of farmers applying the practice only on their owned plot. In addition, we create a simple aggregate index of management differences by summing up the number of practices applied on the typical rented plot and subtracting the number of practices applied on the typical owned plot. We use descriptive statistics (counts, percentages, means) to analyze respondents' observations concerning other farmers, as well as a content analysis of the corresponding open-ended questions (details below).

To analyze contextual factors of renting, we consider the rental conditions of the typical plots, the information gathered on the circumstances of renting in general, and the answers to the corresponding open-ended questions. We compare plot-related variables (distance to the farmhouse, farming difficulties) for farmers' typical rented and owned plots, using Wilcoxon signed-rank tests (for the continuous and non-normally distributed variables) and McNemar's test statistics (for the yes/no variables on the presence of specific farming difficulties). We use an ANOVA and Tukey's honest significance test (Tukey 1949) to examine how the aggregate index of management differences differs by landlord-tenant relationships. To describe general rental conditions that may influence a potential difference between renting and ownership as well as respondents' observations relating to other farmers, we use descriptive statistics (counts, percentages, means) of quantitative responses and a content analysis of qualitative responses.

All responses to the open-ended questions are analyzed using content analysis with inductive coding (Mayring 2015). We code all relevant answers and group them into two categories, corresponding to our main research interests: 'differences between rented and owned plots' and 'contextual factors that explain (the lack of) differences'. Codes are specific practices or contextual factors and are simply listed in the results.

All quantitative data handling and analysis was conducted with R (R Core Team 2018) using base functions and the data.table package (Dowle and Srinivasan 2019), figures and graphs were produced using the package ggplot2 (Wickham 2016). The software package atlas.ti was used for qualitative data analysis.

***Descriptive Information*.** Table 3 lists demographic characteristics of survey respondents as well as basic information on their rental contracts. Respondents were slightly older than the national average according to agricultural beneficiaries data (especially farmers between 50 and 59 were overrepresented in our survey [42%] compared to all beneficiaries [35%]); and fewer women participated (13%) than would be expected (officially, 26% of all farms are operated by women, which may, however, be biased upwards due to retirement insurance reasons; BMLFUW 2018). Concerning other characteristics, our sample is either by design not representative of the general farming population (only farms with rented and arable land), or no data for comparison are available (information on education and rental contracts). The data participants entered in the survey do not fully match up with data from the FADN for the amount of arable land farmed, which may be due to the way this number is calculated in the FADN (as a sum of several subcategories). Among survey participants, most rental contracts were written contracts and most land was rented in exchange for monetary rent.

The majority of respondents were from those federal states of Austria where arable land is prevalent: Lower Austria (151), Styria (59), Upper Austria (47), and Burgenland (30). The remaining 13 identifiable survey respondents were from the states in Austria's mountainous west and south (only those with a correct FADN ID).

Table 3
Respondents' personal and farm characteristics as stated in the questionnaire.

Variable	Value
Mean age (min – max)	49 (19 to 69)
Mean years farming experience (min – max)	21 (<1 to 57)
Gender: male (%)	87
Level of education (n (%))	
Compulsory school	11 (3)
Apprenticeship	25 (7)
Specialized agricultural education	79 (23)
Master craftsman (agricultural or other)	146 (43)
Matura (degree permitting university entrance)	60 (17)
University/technical college	19 (5)
Rented arable land in ha, mean (median)	25.3 (14.1)
Owned arable land in ha, mean (median)	24.3 (20)
Rental share of arable land in %, mean (median)	44 (43.48)
Rental contracts (% rented land):	
written without help	46
written with help (extension services, notary, etc.)	35.5
verbal	18.5
Rent type (% rented land):	
monetary rent	92.5
non-monetary benefits	2.2
no compensation	5.2
Rent paid in €/ha, mean (median)	354 (300)

Results

The Existence of a Tenure Effect. Table 4 reports the responses for each soil conservation practice for both 'typical' plots. The first column shows the number (and share) of respondents who applied the respective practice on both their plots and received subsidies for doing so. The second column similarly shows the number of farmers who applied the practice on both plots, but without subsidies. The third and fourth column report numbers of respondents who applied the practice on neither of their typical plots and on only one of the plots, respectively. The following columns provide more details for the latter case, showing whether farmers applied the practice on only their rented (column five) or owned (column six) plot, and whether there is a statistically significance between those two numbers (last column). We do not show all potential answers in table 4: As there were very few cases where a practice was applied with subsidies on one of the plots and without subsidies on the other, we do not show these numbers (percentages per row do not sum to 100 for this reason). In addition, we do not show whether those who made a difference between rented and owned land applied each practice with or without subsidies, as respondents made very few differences between

rented and owned plots in general (see next paragraph). A test for marginal homogeneity over all answer categories confirms that there are no statistically significant differences between the two plots that are based on the distinction between subsidized and unsubsidized. We therefore collapse the "yes, subsidized" and "yes, unsubsidized" categories into one "yes" category for all further analyses.

We see that the most frequent soil conservation practices applied on both rented and owned plots were crop rotation (94.4%) and intercropping (cover crops on 10% of a farm's cropland) (81.1%). In contrast, 92% of respondents indicated not creating wind protection elements on either rented or owned plots, and just over 85% indicated not using precision farming, and not applying compost. Concerning subsidized and unsubsidized practices, we cannot assess whether AES had an impact on the uptake of measures since not all AES are applicable to all farms. However, we see that, for example, the three practices with the highest share of respondents in the "on neither" column are all practices for which no AES exist. Conversely, the practices with the smallest share of respondents in this column are a diversified crop rotation and intercropping, two practices that are part of the two most widespread AES for crop farmers. Turning to columns 5 to 7, the results show that respondents very rarely indicated applying different soil conservation practices on their typical rented and owned plots. Looking at the number of respondents who applied different practices on rented and owned plots, we see that preserving valuable landscape elements (14.8%), taking regular soil samples (8.3%), and not applying sewer sludge (8%) were the most commonly mentioned. However, there appears to be no clear direction of differences for the former two practices – similar numbers of respondents indicated applying them on their rented or owned plot only. Not applying sewer sludge on plots is the only practice where we see a statistically significant difference at the five-percent level: 20 farmers refrained from using sewer sludge only on their typical rented plot, while seven did so only on their typical owned plot.

Table 4
Comparing farmers' conservation practices on their typical rented and owned plots.

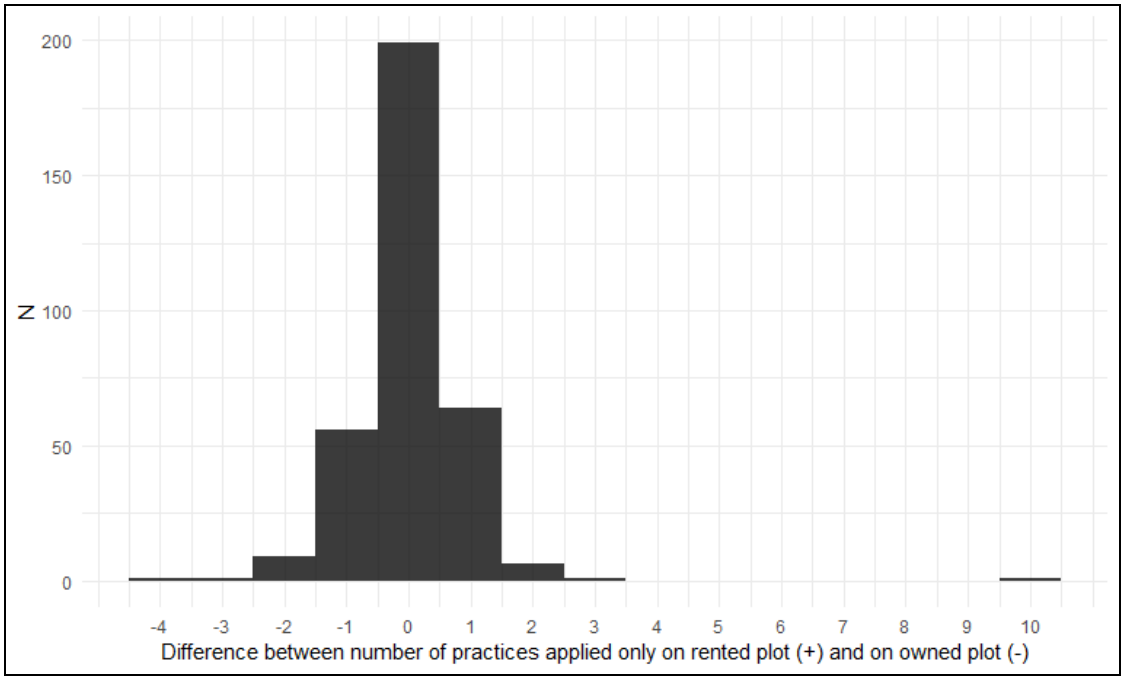
Which soil conservation practices do you apply on your typical rented/ owned plot?	**stated soil conservation practices**						**test statistics**
	on **BOTH** subsidized	on **BOTH** unsubsidized	on **NEITHER**	on **EITHER**	on **rented only**	on **owned only**	matched pairs
	n (%)				n		χ^2 (p-value)
compost	4 (1.2)	26 (7.7)	289 (85.5)	**18 (5.3)**	8	10	0.05 (0.81)
conservation tillage	136 (40.2)	23 (6.8)	163 (48.2)	**12 (3.6)**	8	4	0.75 (0.39)
crop rotation	164 (48.5)	137 (40.5)	11 (3.2)	**8 (2.4)**	3	5	0.12 (0.72)
"evergreen" cover crops	72 (21.3)	22 (6.5)	234 (69.2)	**8 (2.4)**	3	5	0.12 (0.72)
intercropping	246 (72.8)	20 (5.9)	48 (14.2)	**16 (4.7)**	7	9	0.06 (0.8)
landscape elements	110 (32.5)	22 (6.5)	148 (43.8)	**50 (14.8)**	23	27	0.18 (0.67)
no fertilizer	47 (13.9)	6 (1.8)	277 (81.9)	**7 (2.1)**	6	1	2.28 (0.13)
no fungicide	83 (24.6)	27 (8.0)	212 (62.7)	**11 (3.3)**	5	6	0 (1)
no pesticide	50 (14.8)	9 (2.7)	264 (78.1)	**10 (3.0)**	5	5	0 (1)
no sewer sludge	47 (13.9)	107 (31.7)	148 (43.8)	**27 (8.0)**	20	7	5.33 (0.02)*

organic farming	76 (22.5)	1 (0.3)	256 (75.7)	**5 (1.5)**	2	3	0 (1)
precision farming	8 (2.4)	34 (10.1)	290 (85.8)	**4 (1.2)**	2	2	0 (1)
soil protecting machinery	19 (5.6)	82 (24.3)	213 (63.0)	**13 (3.9)**	5	8	0.31 (0.58)
soil samples	37 (10.9)	129 (38.2)	134 (39.6)	**28 (8.3)**	14	14	0 (1)
wind protection elements	4 (1.2)	7 (2.1)	311 (92.0)	**14 (4.1)**	5	9	0.64 (0.42)
winter-hardy cover crops	56 (16.6)	22 (6.5)	239 (70.7)	**15 (4.4)**	11	4	2.4 (0.12)

Notes: * p < 0.05. Percentages in one line do not sum to 100 as not all possible combinations are depicted.

For further analyses, we create an aggregate index of management differences (the number of practices applied on the typical rented plot minus the number of practices applied on the typical owned plot). Figure 1 shows the distribution of this index, confirming again that there is no clear direction of differences: A majority of farmers applied the same number of practices on both their plots (index = 0), and similar numbers differed by one (or more) practices in either direction (i.e., a similar number of respondents applied one more practice on their rented plot than on their owned plot as the other way around). The outlier at +10 stems from a farmer who stated that he applied 10 of the listed practices only on his rented plot.

Figure 1
Distribution of the aggregate index of management differences between rented and owned plots.



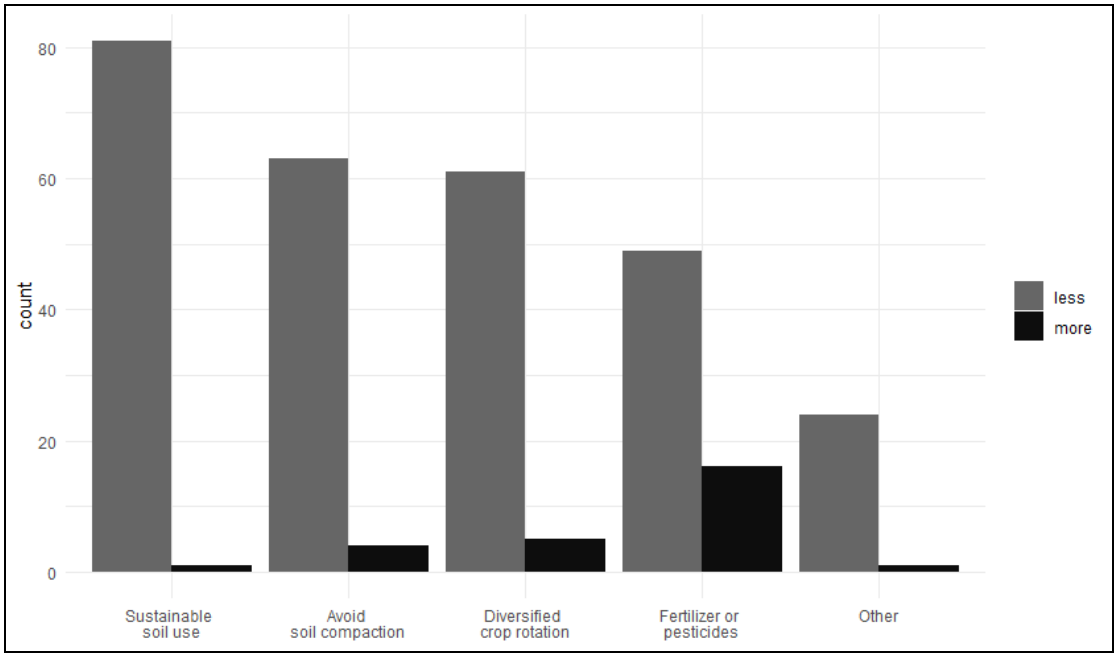
Note: Zero means the same number of practices is applied on both typical plots.

Looking at farmers' observations about *other* farmers, 104 out of the 343 respondents (30.3%) stated that others did apply different practices on rented and owned plots, whereas 239 (69.7%) stated that they did not observe any differences. Those who observed a difference were presented with a number of practices and could select whether they thought others applied each practice more, less, or equally

on their rented plots compared to owned plots. Respondents mostly observed less careful soil tillage (83), less prevention of soil compaction (65), and a less diversified crop rotation (63) on rented fields (figure 2). Those 25 farmers who observed "other" differences were asked to provide more detail in a text field. They mentioned that others, on their rented land, cultivated soil that was too wet, neglected liming, used less cover crops/catch crops, and focused on *"short-term profit"* and "*intensively getting everything out of it.*" The topic also recurred in the open-ended general question at the end of the questionnaire. Here, farmers mentioned differences in liming and the application of phosphorus-potassium fertilizer to the detriment of rented lands, as well as more humus formation on rented plots compared to owned plots.

Considering these results, we see a surprising discrepancy between respondents' self-reported practices (no differences between rented and owned land) and their perceptions about others (almost one third of respondents observed differences). As a previous study of agricultural land tenure in Austria has also found a very limited tenure effect based on secondary data that are subject to external cross-checking (Leonhardt et al. 2019), we tend to give greater credence to farmers' self-reported behavior than to their observations about others. However, this finding also shows some important limitations of our approach, which we discuss further below. Before doing so, however, we turn to our main research aim: the potential explanations about why or under which circumstances rented land might be treated differently from owned land.

Figure 2
Observations about other farmers' practices on rented land.



Note: Only includes responses of participants who observed different soil conservation behavior by others on rented and owned land.

Contextual Factors: The Circumstances of Renting. For our quantitative analysis of contextual factors that may influence a tenure effect, we compare the typical rented and owned plots with respect to their characteristics and relate these characteristics to the indicator of soil management practices introduced above (see figure 1). First, the typical owned plots were on average closer to the farmhouse (mean distance 1.9 km) than rented plots (3.3 km). This difference of 1.4 km is statistically significant ($p < 2.2e^{-16}$). However, there is no statistically significant relationship between the distance of a rented plot to the farmhouse and the aggregate index of management differences ($p = 0.415$).

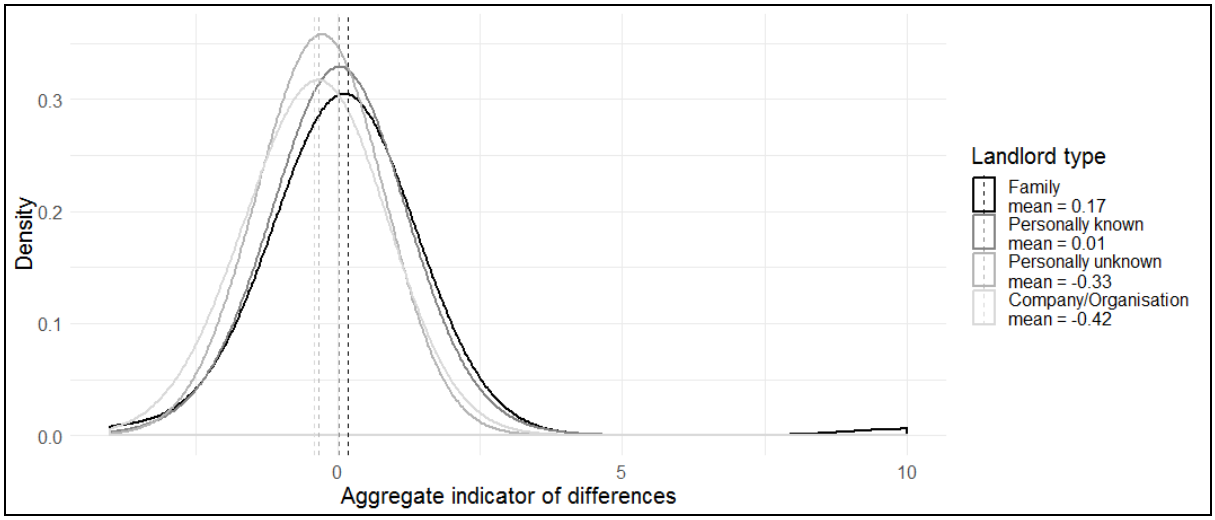
Second, we used three items to assess difficulties farmers are often confronted with on their land and which might force them to apply specific soil conservation practices: steep slopes, protected area, and poor soil quality. Table 5 depicts the prevalence of these difficulties on respondents' typical plots. While some respondents had to deal with difficulties on some of their plots, we do not find any statistically significant differences in the proportion of difficulties between rented and owned land.

Table 5
Prevalence of plot related difficulties on rented and owned plots.

	stated difficulties				**test statistics**
Are you confronted with specific difficulties?	on **BOTH**	on **NEITHER**	on **rented only**	on **owned only**	
	n				χ^2 (p-value)
none	218	86	17	17	0 (1)
slope	68	237	13	20	1.09 (0.30)
protected area	18	310	3	7	0.9 (0.34)
poor soil quality	49	253	17	19	0.03 (0.87)

Third, we asked about respondents' social ties with the owners (of rented plots) or previous owners (of owned plots) of their plots. We see that only 4.4% of our respondents indicated renting their typical rented plot from landlords they did *not* know personally or from a company or organization. All other farmers rented from family/relatives (20.4%) or landlords they otherwise knew personally (75.1%). All respondents acquired their typical owned plot either from a previous owner they knew personally, such as family/relatives (95.3%) or others (4.7%). Thus, whether rented or owned, farmers had close social relations with their landlords or previous owners. To test whether this relationship has an impact on conservation measures, we investigate whether the indicator of management differences between the two typical plots (see figure 1) varies by landlord-tenant relationship type. The grouped density plot in figure 3 shows that the arithmetic means of the aggregate index do vary by relationship type as expected: The closer the landlord-tenant relationship, the more practices were applied on the rented plot compared to the owned plot and vice versa. However, these differences are not statistically significant between any two of the four groups according to an ANOVA ($p = 0.199$) and ensuing Tukey's honest significance test.

Figure 3
Density plot of the aggregate indicator of management differences (cf. figure 1) by landlord-tenant relationship type.



Due to the lack of substantial and directional differences between rented and owned plots regarding characteristics of as well as practices applied on these plots, further comparative and multivariate analyses of the plot-related data did not reveal any statistically significant relationships. We thus do not display any results of such further analyses and models here. However, the more general descriptive and qualitative information from the other parts of the questionnaire that we present in the following provides additional insights.

First, we consider the general information on rented cropland that respondents provided in the first part of the questionnaire. This confirms that most of the respondents' rented cropland was typically close to their farmhouse, with 84% of all rented land being within 5 km, and an additional 12% within 10 km of the farmhouse location. Only 4% and 0.5% of rented cropland were between 10 and 20 km, or more than 20 km away, respectively. Moreover, and confirming the results for the typical rented plots, 48% of respondents indicated that they rented some land from family, with the average respondent renting 22.4% of their rented land from family. The majority of rented land, 71.2%, was rented from people that farmers knew personally (90% of respondents rented some land from this category of owners), and only 1.6% and 4.6% of rented land were owned by landlords not personally known and by organizations or companies, respectively.

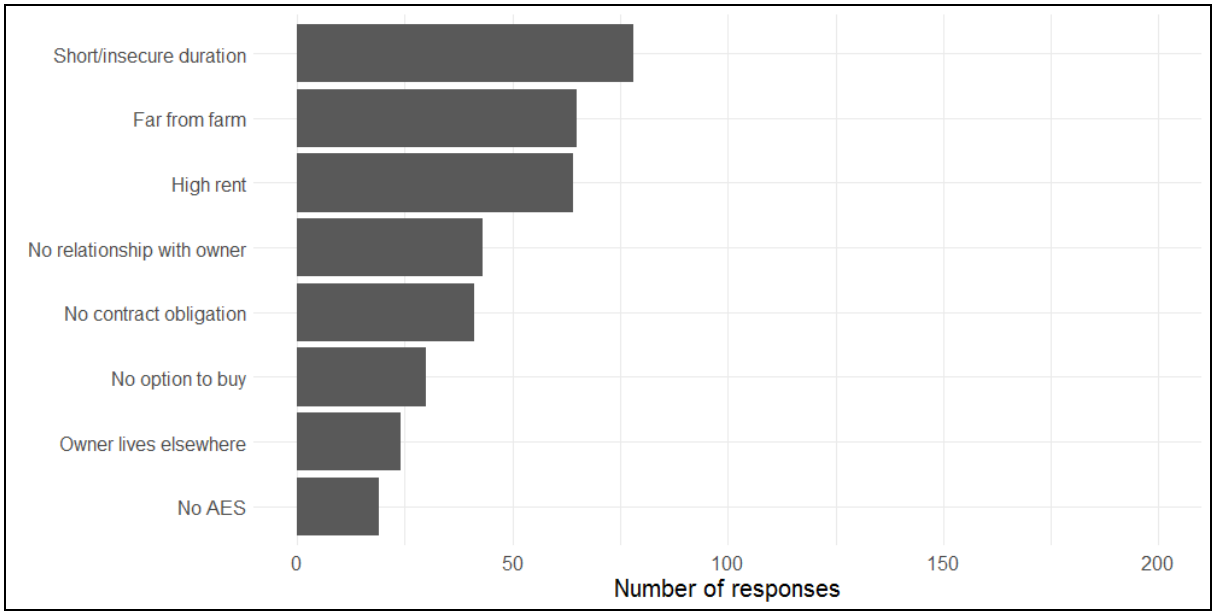
In addition, cropland renting appeared to be very secure and long-term for most farmers. A total of 72.2% of rented land was under contracts with unlimited duration (with 85% of respondents indicating that they rented at least some cropland under such contracts). Further 15% of rented cropland was under 5-year contracts, 7.9% under limited contracts longer than 5 years, and only 3.7% under shorter contracts. Of those respondents who had some land under limited-duration rental contracts, 91% indicated that they expected to "likely" (40%) or "very likely" (51%) have their

contracts renewed after the end of the rental period (further 8% were neutral and only one respondent considered it very unlikely that his/her contract would be extended).

Considering that landlords may require tenants to use or refrain from particular practices, we asked respondents whether this was the case for any of their rented land. Most (92%) indicated no such requirements by landlords; 6% (22 participants) reported a prohibition of applying sewer sludge, five were required to avoid soil compaction, while taking soil samples and enhancing the humus-content of soil were each mandatory for three respondents. Two farmers indicated in a text field of the survey that their landowners required them to plant legumes or not plant silage maize, others reported particular requirements tied to specific landscape elements, water protection, or compensation areas. Looking at those 22 participants who were prohibited to use sewer sludge on some of their rented land, we find that none of these 22 respondents stated that they refrain from sewer sludge use on their rented plot only. On the contrary, 2 out of the 27 respondents who differed between their rented and owned plot with respect to sewer sludge stated that they refrain from the use of sewer sludge on their typical *owned* plot only, thus applying sewer sludge on their typical rented plot. Therefore, contractual requirements do not provide an explanation for the one practice where we find a significant effect of tenure on its application.

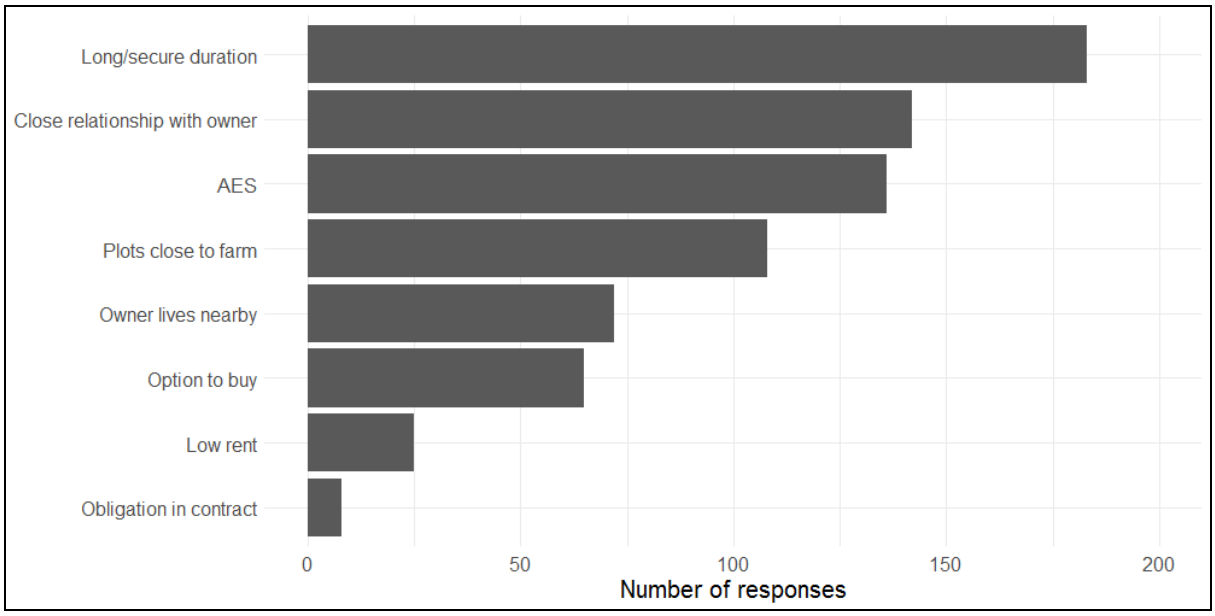
Second, we turn again to the observations that respondents made about other farmers' soil management. Figures 4 and 5 present the frequencies of answers to the closed questions on reasons why others did or did not make a difference between rented and owned land. We see that those who did think that others treat rented land differently than owned land largely believed that this was due to short or insecure rental, followed by a large distance between the farmhouse and rented plots, high rental prices, no close relationship with landowners, and no contractual obligations to take care of rented land. In the text field, some respondents added that other farmers wanted to keep costs down or that treating rented land worse than owned land was due to ignorance by tenants as well as landowners. Those respondents who thought that others treated rented and owned land equally mainly believed that this was due to long and secure rental, close social relationships with landowners, participation in AES, and distances between plots and the farmhouse being similar. Additional arguments provided in the text field were that only good soil use ensured good yields and income, that it was easiest to use the same machinery, crop rotation, and work program on the entire farm, independent of tenure, that plots were often contiguous or even swapped between farmers, such that ownership status was blurred, and that it was a general principle for other farmers to treat all soils well.

Figure 4
Explanations for a tenure effect in other farmers' behavior.



Note: Only includes responses of participants who observed different soil conservation behavior by others on rented and owned land.

Figure 5
Explanations for the lack of a tenure effect in other farmers' behavior.



Note: Only includes responses of participants who observed the same soil conservation behavior by others on rented and owned land.

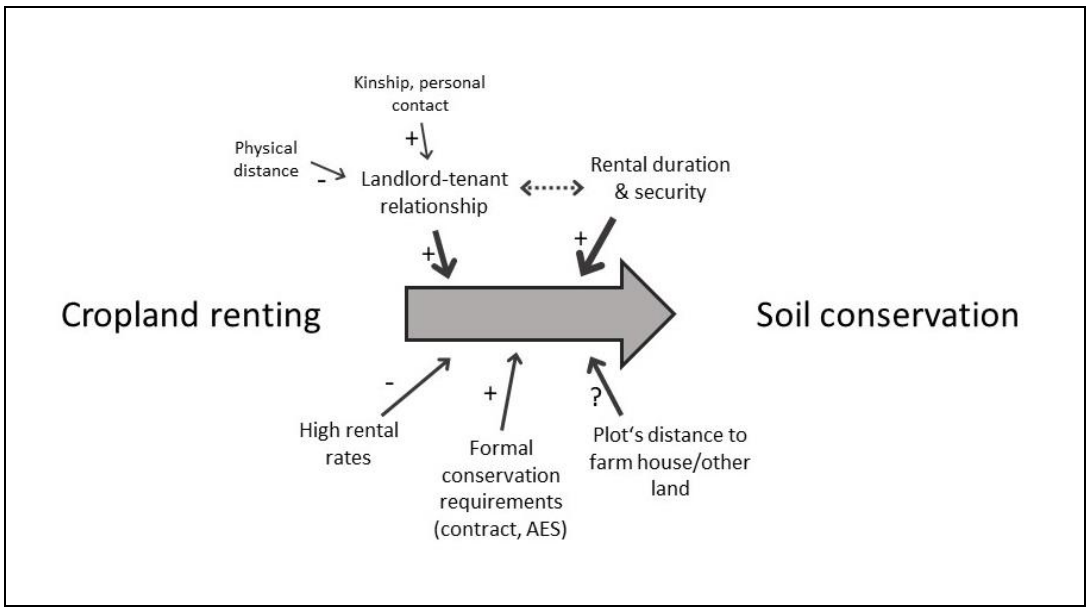
Third, the arguments provided in the open-ended question at the end of the questionnaire on why rented and owned plots were treated differently included the distance between farmhouse and the

plots, and that *"on owned soils the owner = operator takes on more responsibility. When the owner is someone else, for sure some responsibility for the soil is lost."* Others provided rationales for why they themselves or others made no difference based on tenure, including again the argument that treating the soil well is important for yields and earnings, that long-term contracts lead to similar treatment, that plots were contiguous and sometimes swapped between farmers, and that the general principles and attitudes of a farmer were more important than property status as illustrated by this quote: *"I treat every soil (whether rented or owned) the same! This is where our food grows, and we should take proper care of this soil!"*

While not directly explaining the *differences* between rented and owned plots, another line of reasoning was recurrent in the answers to the final open-ended question: If landlords' main focus is to receive the highest rent possible, they may rent their land to farmers who are less careful in their soil use than others, either because these tenants are then subject to strong economic pressures or because they generally do not have a conservation mind-set. Two quotes illustrate this to the point: *"The landlord decides whether rented plots are treated decently. If you always want to achieve the highest rent … you have to live with the fact that the tenant will by necessity need to 'exploit' the soil, as otherwise he will have to put money into it [i.e., make a loss]."* and *"High rents evoke an exploitation of the soil – but mostly by farms that do the same on their own plots."*

Our Findings in Context. Figure 6 summarizes the main factors that we identified as influential for the (non-)existence of a tenure effect. The '+' and '-' signs indicate the hypothesized direction of the influence and line thickness indicates how important we believe each factor to be in comparison to the others. The '?' indicates that the direction of this factor's influence is unclear.

Figure 6
Hypothesized influences on tenure effect, including suspected importance (line thickness) and direction (+/-/unclear).



First, rental security and long-term rental periods appear to be major factors that counteract a negative effect of renting for soil conservation. This confirms previous studies (Deaton et al. 2018; Ranjan et al. 2019b), makes intuitive sense, and is a major reason why many countries have legal minimum rental periods for agricultural land (Ciaian et al. 2012d), providing tenant farmers with a longer planning horizon. Despite a lack of such (binding) regulations in Austria, we find that leasing appears to be secure and long-term for our respondents, perhaps due to close landlord-tenant relationships (see next paragraph). In addition to secure renting, tenants may sometimes have the option to buy their rented land in the future, extending the time horizon for this land even further. With such prospects for rented land, investments into its soil quality make economic sense for farmers just like for their owned land. The respondents of our questionnaire frequently raised this argument themselves in their comments: only good treatment of the land ensures good yields and earnings in the long run.

Second, a mechanism that has both an influence on rental security as well as on how farmers treat their land is the relationship between landlords and tenants. In our sample, tenants mostly knew their landlords personally. Additionally, a substantial number of respondents even rented land based on verbal agreements, requiring a certain level of trust that most likely requires knowing each other personally. In general, a close personal relationship increases mutual trust and commitment and thus may implicitly enhance rental security as well. Other studies have found an impact of the relationship between the contractual partners on aspects such as land sales prices, land rental prices, and rental contract type (Perry and Robinson 2001; Bryan et al. 2015; Taylor and Featherstone 2018), confirming that this relationship is an important contextual factor.

In addition to this general mechanism, recent literature suggests that it may make a difference for tenants' conservation behavior whether their landlords live close by or far away: Absentee landlords have been found to differ from residential landlords, with consequences for conservation measures (Petrzelka and Armstrong 2015; Ulrich-Schad et al. 2016). The physical distance between landlord and tenant may not only have an impact on the personal relationship between both parties but also on how closely landowners can monitor farmers' conduct. The further away a landlord lives from the land they rent out, the more distant the personal relationship between them and the tenant may be, and the less likely it is that the landlord can observe what the tenant does. This may, in turn, have an impact on tenants' behavior and care – a principal-agent problem, where the principal (the landlord) cannot fully control the behavior of the agent (the tenant) due to asymmetric information, and both have differing interests or goals (Eisenhardt 1989). As research on principal-agent problems in agricultural land renting has shown, this problem may be mediated and thus addressed by contractual terms, including lease length and type (Lichtenberg 2007; Oskam and Feng 2008). In addition to these fundamental contract terms, it would be possible to include specific conservation requirements in rental contracts. While we do not find such contractual obligations to be widespread among our respondents, others have already suggested this as a policy measure (Ranjan et al. 2019b).

On the other side of this coin, the prevalence of close relationships as opposed to a principal-agent problem may also explain our finding that farmers were more likely to refrain from the use of sewer sludge on their rented plots as opposed to their owned plots. Since we cannot explain this finding by contractual requirements, a plausible explanation could be a 'signaling' effect as also described by Leonhardt et al. (2019): Applying sewer sludge is potentially seen as detrimental to soil and environment in the long run (especially since a general prohibition for all of Austria has recently been discussed), because sewer sludge has the potential to contain heavy metals, microplastic and other problematic materials, despite being a readily available fertilizer (Oliva et al. 2009). As landlords mostly know their tenants and may even observe their conduct, tenants may fear that their landlords object to the use of sewer sludge even if not formally required in the contract and adjust their behavior accordingly. This may similarly apply to other conservation measures, counteracting a negative tenure effect.

A third reason that may explain the (non-)existence of a tenure effect is a plot's location with respect to the farmhouse or other land of a farm. Rented plots are often further away from the center of a farm than owned plots, making travel more time-consuming and costly. This may influence the practices that farmers apply on these plots (Grammatikopoulou et al. 2013), especially if measures require multiple trips to a single plot. It is important to note, however, that this difference does not necessarily mean that less soil conservation happens on the more remote plots – it may also have an opposite effect, depending on the type of practice chosen and how time-consuming it is. We indeed find that our respondents' rented plots were further away from the farmhouse than owned plots, but do not find differences in the type or the number of practices applied. One reason for this may be that a mean distance of 3.3 km in our sample is still manageable and may thus not influence soil management. In this regard, a 'typical' plot may also be different from a potential 'extreme' or 'outlier' plot; i.e., while some rented plots might indeed be at a distance to the farm that does have an effect on how that plot is treated, this may not be the typical plot a farmer thinks of when answering the questionnaire. Another aspect of a plot's location is that if rented plots are contiguous to other (owned) plots, or a single management unit consists of several plots with differing tenure status, this likely leads to uniform treatment of this land due to procedural reasons – for better (Leonhardt et al. 2019) or worse (Sklenicka et al. 2014).

Fourth, AES may be an important reason for why there is no effect of renting on soil conservation. Many of the practices we investigate are part of such subsidized schemes, and in Austria participation in these schemes is generally high. Several AES require farmers to apply the subsidized measures on all relevant plots of the farm (e.g., on all erosion-prone crops), irrespective of ownership status. Subsidies for organic farming are the strictest in this case: The entire farm operation needs to be farmed organically in order to receive the respective subsidies. Such requirements will, by default, decrease differences between rented and owned plots for AES participants. However, even for

measures that are not part of any AES (e.g., using soil-protecting machinery, precision farming, application of compost, or creating wind protection elements), we do not see substantial differences between rented and owned plots, confirming the lack of an overall adverse effect of renting under the current circumstances in Austria. The same is true for measures that do not need to be applied on the entire farm, such as cover crops. Nevertheless, AES may be an important mechanism counteracting a negative tenure effect on soil management by encouraging conservation measures in general, especially if their application is required on all plots of a farm. Sklenicka et al. (2015) similarly find that greening requirements from the CAP as implemented in the Czech Republic equalize an otherwise existing tenure effect. In addition, in Austria, agricultural policy and AES even have an impact on the rental market, as rental contracts are sometimes tied to the CAP period so that farmers have some security in their subsidy income. Moreover, AES commitments are tied to the land to some degree, i.e., in case a tenant farmer loses part of his land to another farmer, the new farmer can continue the AES commitments with little administrative effort. Even if this is not the case, the farmer who initially entered into the AES contract does not lose any payments for the period where the practice was actually applied. This reduces the risk that tenants face when entering into an AES contract, likely encouraging participation of rented land in such schemes.

One last influential aspect are rental prices. Previous research confirms that high rental rates may be a barrier to conservation efforts (Ranjan et al. 2019b). Depending on whether this effect is direct (a farmer needing to make an immediate profit from a particular rented plot to compensate for high rental payments) or indirect (landlords who are asking for high rents attract tenants who farm intensively and are focused on short-term returns), overall effects will appear in a direct comparison of practices on rented and owned land or only on a general level. Related to this argument, several respondents expressed concerns about the future developments of (rising) land rental prices and their potential effect.

Together with other aspects such as farmers' *"fundamental attitude to treat every soil well"*, as well as procedural reasons (such as uniform machinery use or crop rotation plans), the factors depicted in figure 6 and described here all appear to work against a potential adverse effect of cropland renting in the Austrian context. It is therefore perhaps not surprising that we find no tenure effect, as there are few cases where landlord-tenant relationships are distant; where rented plots are far from the farm house; and there are generally few commercial farms that do not participate in AES. Our study thus adds to the literature that finds little or no association between the ownership status of land and soil conservation efforts (Prokopy et al. 2019) but provides valuable additional insights on underlying contextual explanations.

***Limitations and Generalizability*.** The above-mentioned discrepancy between respondents' self-reported behavior and their observations about others indicates limitations but also potential for

improvement of the study design of future investigations. We see at least four explanations with respect to this discrepancy, which can be used as guidance for improvements in future research.

First, our questionnaire design might be to blame for the different results, as we did not use the same list of soil conservation practices in part two (practices on typical rented and owned plots) and part three (observations about others) of our questionnaire, due to the different possibilities and objectives of these two sections. While part two of the questionnaire was designed to compare the application of very specific measures (e.g., "using winter-hardy cover crops"), part three needed to be more general (e.g., "careful soil tillage"), as it is hardly possible to observe others' behavior in such detail. More general aspects of respondents' soil management might therefore not be reflected in their specific answers, such as the timing of measures, care and thoroughness of applying them, or attentiveness to specificities of plots. On the other hand, other farmers' specific practices might not be easily observed by neighbors, leading to an incomplete picture of actual soil conservation. In additional, as briefly mentioned above, statements about farmers' own behavior were related to their typical plots, which may not be fully representative of all plots and the practices applied there. There may be 'non-typical' rented as well as owned land, for which we cannot draw any conclusions here. While a focus on specific plots was necessary in our case, other options such as asking farmers about their most recently rented plot or plots pre-selected by the interviewer are conceivable.

Second, our respondents may have misreported their own behavior. This could be due to, for example, a social desirability bias (Grimm 2010) or a biased perception of their behavior. However, since the survey was in most cases conducted without an interviewer present (Dillman et al. 2009) and we asked for very specific and potentially testable behavior, we hope to have reduced this bias. External cross-checking (e.g., via agricultural beneficiaries data) could provide insights into the extent of misreporting for AES, but to date this is not feasible with our data. As Leonhardt et al. (2019) show, these beneficiaries data can also provide valuable insights by themselves, but are usually limited to unspecific indicators of behavior such as crop choice.

Third, our respondents might have had a wrong perception of others' behavior. This could be caused by projecting preconceived opinions onto others' behavior, similar to effects such as confirmation bias or cherry-picking for evidence (Nickerson 1998; Kahneman 2011). This explanation appears likely to us, as there is a preconceived opinion among the general public that farmland renting leads to short-sighted behavior, while empirical results are mixed. This could be reflected in our questionnaire, with respondents having a preconceived opinion but reality being different. Unfortunately, we cannot check for such a bias unless we could link our data to geo-spatial agricultural beneficiaries data (which is available in theory).

Fourth, while the FADN is designed to be economically representative, we cannot fully exclude the possibility that our sample of respondents is not representative of the population of all farmers, with

respondents being less inclined than others to differ their practices based on property status. Both, participation in the FADN as well as in our survey were essentially voluntary, although in both cases encouraged by extension services / FADN advisers. While the FADN is not a network in the sense of the word (participants do not know each other), these are nevertheless farmers who are aware about the economics of their farm in great detail based on the numbers they report, which may potentially alter their (business) behavior compared to the general population of farmers. In addition, while our study participants did not differ substantially in unexpected ways from eligible non-participants with respect to economic indicators (see table 1), we do not know whether they differed in socio-psychological characteristics such as attitude towards conservation. Since participants were contacted in different ways (e-mail, telephone, in-person), we hope that such bias is small, but as we did not have the opportunity to conduct non-response bias checks we cannot know with certainty.

In addition to these points of concern that may all apply to some extent, it is important to note that our results are based on the particular ecological, social and institutional context of agriculture in Austria. For example, compared to many other countries of the Global North, farming in Austria is relatively small-scaled and family-farm oriented, and many farms are run part-time (BMLFUW 2019). This is both a result of and a reason why agricultural policy has already for many years focused on the multifunctionality of agriculture (i.e., agriculture as a provider of ecological, social and economic goods and services, see van Huylenbroeck et al. (2007)) in, e.g., its subsidy schemes (BMLFUW 2015). Social networks in the countryside are often tightly knit, people know each other well, including their neighbors and landlords. These circumstances have an influence on the context of renting that we have investigated.

Aside from these wider circumstances, the immediate contextual factors are of obvious importance. We may therefore see negative effects of renting on conservation efforts where any or several of the factors depicted in figure 6 are different than in the Austrian case. This is in line with, for example, findings from the Global South, where tenure is often insecure and studies tend to find a negative effect on conservation investments (Higgins et al. 2018). The Czech Republic is another example; here landlord-tenant relationships are often distant and farms as well as fields are very large (despite fragmented ownership), due to the country's history (Sklenicka et al. 2014). Sklenicka et al. (2015) and Walmsley and Sklenicka (2017) have, correspondingly, found a negative effect of renting on soil conservation. However, it is not clear which or how many of the contextual factors are necessary conditions for successful mitigation of a negative tenure effect. Comparing several regions with different institutional and cultural backgrounds would be an interesting option for future research to draw better conclusions. Moreover, focusing on individual selected contextual factors or barriers should be considered in future studies. For any such research, we recommend to carefully consider the practice under question, as this may be another factor that has an influence on the existence of a tenure effect (Varble et al. 2016), although we do not find differences by practice in our study.

Summary and Conclusions

This study investigates the contextual factors of renting that influence whether or not farmers apply different soil conservation practices on rented and owned cropland. We find that rental duration and security, the landlord-tenant relationship, the location of plots, formal requirements such as contractual agreements and AES, as well as rental prices all have an influence on the relationship between cropland renting and soil conservation practices. Given the current circumstances of agricultural land renting in Austria with respect to these factors, we do not find significant differences in the practices that the surveyed farmers applied on their rented plots compared to plots they owned for 16 different conservation measures. Due to this lack of differences, we cannot confirm quantitatively whether this is truly due the contextual factors described, but our descriptive and qualitative evidence (e.g., from the answers to open-ended survey questions) supports this argument. Further research focusing on the individual factors as well as in contexts where farmers do differ their practices based on tenure status of a plot would be required to draw better conclusions about, for example, the intensity of relationships or necessary versus contingent contextual factors.

Understanding that a tenure effect is contingent on the factors listed above can be used by policymakers to provide an institutional framework that supports soil conservation on rented land in cases where renting does have detrimental effects on farmers' behavior. One option are land market regulations, as they can directly influence rental security and rental rates and are thus powerful instruments, but possibly to the detriment of market efficiency and dynamism. Austria's rental market is not strongly regulated compared to some other European countries (Ciaian et al. 2012d) and in the current situation there appears to be no need for further market intervention from a soil conservation point of view. However, for other contexts, this may well be an option to increase tenant farmers' security, both in terms of planning horizon as well as financially. Such regulations may especially be important in regions where a substantial number of farmers are full tenants, as their dependence on renting exacerbates insecurities. AES are another evident intervention point, but they require careful design for cases where rental is not secure for the full commitment period. Encouraging rental contract durations that are in line with scheme commitment periods would serve the same purpose. Altering lease terms may in general be a promising option (Ranjan et al. 2019b). As extension services in Austria often provide templates for rental contracts that many farmers make use of, adjusting these templates accordingly provides some leverage in this respect. For example, conservation measures such as soil testing or cover crops could be included as explicit requirements by interested landlords or tenants.

Other contextual factors are more difficult to address by policy makers or extension services, most notably the relationship between landlords and tenants. Ranjan et al. (2019b) list some measures, including improving the communication between landlords and tenants, and informing landowners

about soil conservation. This seems especially important for absentee landlords (Petrzelka et al. 2013). Establishing platforms to support local rental markets and thereby support geographical proximity between tenants and landlords may be another option, as are pre-emptive land purchasing rights for local farmers, as they exist in some countries (Ciaian et al. 2012e). When such contextual factors are accounted for, rental markets can be an efficient way of allocating agricultural land without adverse long-term effects on soil conservation.

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The Plurality of Farmers' Views on Soil Management calls for a Policy Mix

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Abstract

While soil degradation is continuing to threaten the global agricultural production system, a common understanding of how to encourage sustainable soil management is missing. With this study, we aim to provide new insights on targeted policies that address the heterogeneity of farmers. We scrutinized the plurality of views on soil management among arable farmers in the Austrian (and European) policy context. To do so, we applied Q methodology, a method that identifies different perspectives on a topic present in a population and analyzes this subjectivity statistically. We interviewed 34 arable land farmers who varied in their farming backgrounds. The results yielded four different viewpoints on soil management held by the interviewed farmers: two rather ecocentric perspectives (*Nature Participants*, *Pleasure Seekers*) and two rather anthropocentric perspectives (*Traditional Food Providers*, *Profit Maximizers*). Our study shows that farmers' soil management is influenced by more than economic considerations and suggests that a mix of policy approaches is needed to reach all farmers and avoid adverse effects of excluding farmers. We provide several suggestions for policymakers on how to complement agri-environmental policies: appealing to human-nature relationships, offering training and experimentation services, fostering social networks, and raising the social reputation of farmers.

Keywords: farmers' viewpoints, soil management, Q Methodology, farmer behavior, soil conservation policy

1 Introduction

Soil erosion and the loss of soil biodiversity and fertility threaten the global agricultural production systems (Lal, 2015). Apart from natural processes that continually shape the state of soils, agricultural activities trigger soil degradation (Panagos et al., 2014). As soil management can not only degrade, but also restore soils (Lal, 2015), it is addressed in the 2030 Agenda for Sustainable Development by the United Nations (Tóth et al., 2018). However, a common strategy to encourage sustainable soil management is missing so far (Panagos et al., 2016), and the effectiveness of soil conservation policies is questionable (Kutter et al., 2011). A comparative analysis by Kutter et al. (2011) of hundreds of mandatory, voluntary incentive-based and awareness-increasing soil conservation policies across 24 EU countries revealed that most policies did not sustainably achieve their targeted environmental goals, but also that different policy mechanisms addressed similar soil conservation issues.

A small but growing body of literature (Frey and Jegen, 2001; Kieninger et al., 2018; Rode et al., 2015; Vatn, 2010) indicates that monetary incentives (the most common soil conservation policy) may not be enough to promote sustainable soil management practices substantially. Monetary incentives such as agri-environmental schemes (AES) do have the intended and primary effect of motivating behavioral change by offering financial rewards. However, they also have an often underestimated secondary effect of undermining intrinsic motivations for conservation or excluding individuals who, due to their mindset, do not feel addressed by the policy's framing (Baum and Gross, 2017; Dessart et al., 2019; Pannell et al., 2006). Therefore, long-term changes in soil management might be better promoted by adding other or supplementary measures, such as facilitating group learning (Prager and Creaney, 2017). This calls for behavioral insights into policymaking. Policymakers need to understand how farmers themselves perceive (their) soil management and how their mental models link with their management practices (Bartkowski and Bartke, 2018; Davies and Hodge, 2007). Dessart et al. (2019) identified several knowledge gaps regarding the interactions between soil management policies and how they can be orchestrated to meet the plurality of farmers' cognitive and normative mental models. According to them, these knowledge gaps might explain why secondary policy effects, such as crowding-out or rebound effects, are not yet fully understood, particularly in the context of farming practices.

Baum and Gross (2017) address these secondary effects and show that policies for behavior change are effective only if they understand and consider both (1) individual behavioral determinants and (2) the context that frames those determinants, and ultimately the expression of a particular behavior. The authors suggest a governance approach that considers the complexity of farmers' daily soil management decisions and rightly appreciates the context of those whom the policy addresses (Knowler and Bradshaw, 2007; Prager and Posthumus, 2011).

Regarding individual behavioral determinants, many studies have collected and examined variables that might explain diverging soil management practices (for an overview, see Dessart et al., 2019). For example, a review of 23 publications on farmers' adoption of conservation measures identified more than 150 explanatory variables (Prager and Posthumus, 2011). However, studies often underscore that farming has many facets and is not just about running a business and optimizing income (McElwee, 2004). Farming decisions are, like any other human behavior, guided by a multiplicity of thoughts, which emerge from their beliefs, attitudes, norms, and values (Hamdy and Aly, 2014; Karali et al., 2014; Knowler and Bradshaw, 2007; Mattison and Norris, 2005; Prager and Posthumus, 2011; Rajendran et al., 2016), as well as individual and collective understandings of the human-nature relationship (HNR) (Muhar et al., 2018). Thus, farmers are anything but a homogenous group (Darnhofer et al., 2005), and better understanding their soil management is a difficult endeavor.

Regarding the context that frames behavioral determinants and ultimately the expression of farmers' behavior, we need to acknowledge that farmers are embedded in their unique contexts, such as families, the society they live and work in, changing policies and legislations, developments of global markets or changing customer demands. However, the context not only shapes the local reality of farmers, it also influences their social-cultural concepts of nature (e.g., HNR). In this regard, Muhar et al. (2018) present a conceptual model that integrates socio-cultural concepts of nature into existing concepts of governance of social-ecological systems. Empirically, only a few studies investigate the adoption of soil conservation across contexts (Knowler and Bradshaw, 2007). As one of those few, Prager and Posthumus (2011) relate environmental, economic, institutional, and local variables to the adoption of soil conservation. More recently, Bartkowski and Bartke (2018) reviewed 87 European studies to identify leverage points for soil conservation policies and distinguish between farm and farmer characteristics, the social-institutional environment, economic constraints, and decision characteristics (e.g., how well a practice fits with existing farm management).

With our study, we aim to provide new ideas for targeted policies for sustainable soil management. As discussed above, such policies should be geared to the heterogeneity of farmers but should also take the farmers' context into account. We thus first scrutinize farmers' views on soil management, to understand the plurality of these viewpoints. More specifically, we are interested to see which different views on soil management we can distinguish among Austrian crop farmers. Based on these insights, we then develop suggestions of how policies can take this plurality into account. Thus, with this study we aim to support policies that strive to address and crowd-in farmers holding different views.

Empirically, *Farming Styles* identification and using *Q Methodology* to assess farmer perspectives are promising research approaches to deduce and distinguish farmers' viewpoints. Both methods allow being integrative in the sense of discerning the individual embedded in a broader context. *Farming Styles* differentiate groups of farmers that share a particular mindset (Ploeg, 1994; Schmitzberger et al., 2005). This approach has, among other things, helped to better understand variability in farmers' conservation practices (Schmitzberger et al., 2005). While farming style research is criticized for overly relying on

the researchers' assessment, *Q Methodology* allows focusing on what people (in our case farmers) themselves select to be their approach to farm management (Fairweather and Klonsky, 2009). Therefore, *Q Methodology* has proven helpful in differentiating farmers' environmental perspectives (Davies and Hodge, 2007) and viewpoints on environmental behavior (Walder and Kantelhardt, 2018). As we aim to unravel farmers' soil management perspectives, we consider *Q Methodology* as well-suited to our research aim. The method combines qualitative and quantitative elements, which allows us to be comprehensive while still being able to reduce complexity. After identifying farmers' views on soil management, we discuss how soil conservation policies align with the identified viewpoints, and which types of policy may be promising options in the future.

In the remainder of the paper, we first explain *Q Methodology*. We summarize the existing research on soil conservation and variables influencing farmers' soil management, as such a thorough literature review constitutes the variable set of our Q study. We then describe our sample and process of data collection. Afterward, we describe the results regarding the viewpoints we have found to exist among farmers. The discussion chapter then links our findings to policy. We close with a brief conclusion.

2 Material and Methods

Q Methodology is a method that identifies different perspectives on a topic present in a population, and that quantifies this subjectivity through statistical calculations (Watts and Stenner 2012). In *Q Methodology*, respondents rank statements (the *Q set*) relating to a main question by placing them in a quasi-normal distribution (the *Q sort*) according to their level of (dis)agreement. Statistical analysis of the resulting *Q sorts* works like a 'flipped around' factor analysis: the statements themselves become the sample of the study, while the participants are the variables of interest (Watts and Stenner, 2005). The factors (i.e., patterns of similarity) are extracted from a correlation matrix between participants' *Q sorts*, rotated, and characterized by the *Q sorts* that define ('load on') each factor. This *Q pattern analysis* results in a set of statement rankings that each depict a distinct viewpoint or group perspective. The final results are descriptive narratives of these rankings that additionally draw on post-sorting interviews with respondents. While in *Q Methodology* the *Q set* needs to be representative of the field of enquiry, participants do not need to be representative of the underlying population in the usual sense, but rather cover all potentially existing viewpoints, i.e., ensure diversity of opinions (Watts and Stenner 2012). The next sections describe the *Q set*, the *Q sorting* procedure and participant selection, and the *Q pattern analysis* specification we used for our study in detail.

2.1 Q set

The *Q set* reflects the broader discourse on a given topic in society and literature, providing a holistic or complete picture of the issue at hand (Watts and Stenner, 2005; Webler and Tuler, 2001), in our case

farmers' soil management. Developed by the researcher, the *Q set* comprises a carefully selected subsample of the discourse in the form of heterogeneous statements (theory-based and empirically assessed), each making a different assertion about the subject of research (Watts and Stenner, 2005). In its final form, the *Q set* is a set of cards with these statements printed on them that study participants sort according to their (dis)agreement.

To compile our Q set, we first conducted a literature review on farmers' soil management and its determinants. Applying a semi-structured interview guideline, we then interviewed six expert stakeholders from public authorities (ministry of agriculture, agricultural county administration), extension services (chamber of agriculture), and an environmental NGO concerned with soil conservation. As a result of this first phase, we derived more than 100 statements that reflect the broader discourse of soil management internationally, and in Austria in particular.

In order to manage the large scale and complexity of the subject, we categorized the statements systematically (Brown, 1993; Watts and Stenner, 2005). We reviewed existing categorizations and frameworks that proved to be helpful in previous studies. We found multiple variations in how to categorize influential variables of farmers' decision-making. Among them, Bartkowski and Bartke (2018) grouped variables influential for farming in six groups in a review of 87 European studies: characteristics of the farm, characteristics of the farmer, behavioral characteristics of the farmer (e.g., attitudes), social-institutional environment, economic constraints, and decision characteristics (e.g., goodness of fit). In their individual-centered framework, Baum and Gross (2017, p. 55) distinguished between internal behavioral determinants and split contextual variables into three distinct levels: individual-level context, socio-institutional context, and techno-economic context. Dessart et al. (2019) organized behavioral determinants based on their 'distance' from the decision-making and distinguish between dispositional variables (e.g., personality, farming objectives, moral concerns), social variables (e.g., norms), and cognitive variables (e.g., knowledge).

Drawing from all these studies, we categorized our statements into the following four categories: farmer, farm, socio-institutional context, and natural context. Sorting across these categories ensured that our final Q set was comprehensive enough to portrait the real world as relates to farmers (Brown, 1993).

The first category, ***farmer***, includes statements related to the farmers' personal disposition and experience. This category acknowledges that farmers' behavior is ultimately the result of a complex and often subconscious decision-making process influenced by mental models and intrinsic motivations (Greiner and Gregg, 2011; Prager and Posthumus, 2011; Ryan et al., 2003). The second category, ***farm***, acknowledges that each farmer is influenced by characteristics of his/her farm, household characteristics (including economic considerations, potential farm successions, etc.), and nearby reference groups. The third category, ***socio-institutional context***, consists of influences that are exogenous to the farm and the farmer, and thus, not directly influenceable by the farmers themselves. These influences are designed and managed through public authorities or institutions, or they evolve from market dynamics and the

socio-economic environment at large. The fourth category, ***natural context***, acknowledges that each farmer is embedded in a unique natural, non-human setting that forces them to tailor their farming practices accordingly. However, the natural context not only frames the thematic focus of a decision process, it also affects farmers' situational HNR (Muhar et al. 2018). Thus, farmers may build a particular relationship with nature, which translates into behavioral patterns (Braito et al., 2017; Stupak et al., 2019) and which has been found to be a valuable concept for understanding farmers' behavior by Yoshida et al. (2018). We thus included several such types of human-nature relationships (HNR) in the Q set.

In the next step, we merged related statements and discarded duplicates, resulting in a robust set of 34 statements. We standardized the style and wording of the statements to reduce misinterpretation and ease the sorting for the respondents (Watts and Stenner, 2012). Table 1 shows all 34 statements, including the categorization, the labels that we use henceforth to facilitate the text, and the sources from where we distilled the statements. Finally, we pre-tested the *Q set* with people familiar with farming in Austria. As a result of the pre-test, we reformulated statements that our test candidates found confusing, incohesive, imprecise, or merely ambiguous. Moreover, we became aware of the importance of the guiding question's simplicity to support the cognitively challenging exercise of sorting 34 statements accordingly. Thus, the pre-test resulted in a rephrasing of the guiding question as well as slight rewordings of some statements.

Table 1: The *Q set* – list of statements related to farmers' soil management allocated along the categories

categories	#	Q statements	labels	Source/Literature
Farmer	1	Dealing with my soil ought to give me pleasure	***pleasure***	Stakeholder interviews
	2	When dealing with my soil my freedom as a farmer is my main concern	***freedom***	(Karali et al., 2014)
	3	I would deal with my soil differently if I had more time	***time availability***	(Dwyer et al., 2007)
	4	I attend training and extension services to learn more about soil use	***training***	(Arbuckle, 2012; Carlisle, 2016)
	5	Traditional, passed-down knowledge determines how I deal with my soil	***traditional knowledge***	(Karali et al., 2014)
	6	When dealing with my soil I rely on my own education and experience	***education***	(Arbuckle, 2012; Carlisle, 2016)
	7	When dealing with my soil I pay attention to my health	***health***	(Cranfield et al., 2010; Karali et al., 2014; Knowler and Bradshaw, 2007)
	8	I try new things when dealing with my soil	***openness to change***	(Knowler and Bradshaw, 2007; Prager and Posthumus, 2011; Reimer et al., 2014)
Farm	9	The economic viability of my farm is top priority for me when dealing with my soil	***profitability****	(Barbayiannis et al., 2009; Boardman et al., 2003; Carlisle, 2016; Defrancesco et al., 2007; Dwyer et al., 2007; Lahmar, 2010; Robinson, 1999)
	10	The distance between a plot and my farm influences how I deal with my soil	***distance***	(Barbayiannis et al., 2009; Lahmar, 2010)
	11	The number of years that I will still farm a plot determines how I deal with my soil	***tenure security***	(Carlisle, 2016; Daloğlu et al., 2014; Karali et al., 2014; Leonhardt et al., 2019; Sklenicka et al., 2015)
	12	When dealing with my soil I avoid expensive investments	***avoid expensive investments***	(Carlisle, 2016)
	13	When dealing with my soil I want to avoid risks	***risk***	(Karali et al., 2014; Sattler and Nagel, 2010)
	14	When dealing with my soil I have a responsibility for employees and helping people	***responsibility for workers***	Stakeholder interviews
	15	When dealing with my soil I pay attention to the tidiness and neatness of my plots	***tidy plots***	(Ryan et al., 2003; Schneider et al., 2010; URBAN, 2005)

Socio-institutional context	16	When dealing with my soil I think about future generations	***future generations***	(Ryan et al., 2003)
	17	I coordinate with my neighbors when dealing with my soil	***coordinate with neighbors***	Stakeholder interviews
	18	How I deal with my soil ought not to have any negative impact on my neighborhood	***care for neighbors***	(Ryan et al., 2003)
	19	When dealing with my soil I go by the requirements and expectations of my customers	***customers' expectations***	(Karali et al., 2014)
	20	I implement expectations of society in how I deal with my soil	***society's expectations***	(Karali et al., 2014; Mills et al., 2017; Uthes and Matzdorf, 2013)
	21	My duty to provide food for society shapes how I deal with my soil	***food provision***	(Burton, 2004; Burton and Wilson, 2006)
	22	When dealing with my soil I avoid doing things that would make me the subject of gossip	***gossip***	(Karali et al., 2014)
	23	How I deal with my soil depends on agri-environmental schemes	***depend on AES***	(Batáry et al., 2015; Boardman et al., 2003; Hodge, 2001; Uthes and Matzdorf, 2013; Zechmeister et al., 2003)
	24	Voluntary programs and schemes are a useful guidance for how I deal with my soil, no matter whether I formally participate	***guided by AES***	(Pavlis et al., 2016; Wilson and Hart, 2001)
	25	Experiences of colleagues give me guidance for dealing with my soil	***others' knowledge***	(Coughenour, 2003; Falconer, 2000; Karali et al., 2014)
	26	How I deal with my soil is determined by laws and governmental regulations and sanctions	***laws & sanctions***	(Gorton et al., 2008; Karali et al., 2014; Posthumus and Morris, 2010; Prager and Posthumus, 2011)
Natural context	27	When dealing with my soil I take account of the natural conditions of the plot, such as soil quality, slope, etc.	***natural conditions***	(Bielders et al., 2003; Prager and Posthumus, 2011; Wilson and Hart, 2001)
	28	By dealing with my soil I avoid damages by natural influences (e.g., climate change, pests)	***natural influences***	(Mitter et al., 2018; OECD, 2014)
	29	The weather determines how I deal with my soil	***weather***	(Karali et al., 2014)
	30	When dealing with my soil I steer nature for my own use	***master***	(Braito et al., 2017)
	31	When dealing with my soil I work together with nature	***partner***	(Braito et al., 2017)
	32	When dealing with my soil I feel as a part of nature and its cycles	***participant***	(Braito et al., 2017)
	33	When dealing with my soil I have a responsibility for nature	***steward***	(Braito et al., 2017)
	34	When dealing with my soil I do not think about nature	***apathy***	(Braito et al., 2017)

In Table 1, we translated the original German statements into English. Two expressions turned out to be ambiguous in English and need further explanation. The German word "Wirtschaftlichkeit" translates roughly to profitability, economic efficiency, economic viability. For practical reasons, we use *profitability* when referring to farmers' economic considerations in the remainder of the text. Likewise, the German word "Freude" translates roughly to joy, pleasure, delight, or happiness. We use the word *pleasure* when referring to farmers' positive feelings when managing their soils.

2.2 Q sort

The expression of the *Q sorts* reveals the participants' subjective viewpoints towards the research focus (Brown, 1993). Respondents rank each statement of the *Q set* in the specific shape of the *Q sort*, placing every statement in relation to all other statements, i.e., the broader *Q set* (Webler and Tuler, 2001).

Q Methodology does not require a large number of participants to conduct this sorting (Watts and Stenner, 2005), but heterogeneous viewpoints need to be represented (Brown, 1980). For our research, we selected 34 arable land farmers in Austria, who varied in their farming backgrounds and thus potentially held different perspectives on soil conservation. Farmers were contacted by different means, including contact established via extension agents and other stakeholders, an open call in a newsletter, and a call among students of agricultural economics. The participants (primary decision-makers of the farm) were

interviewed by one of the co-authors during winter 2017/18, in most cases on their farms. In addition to approaching the participants on their farms, we tried to avoid a potentially intimidating appearance and language, and avoided our academic titles, in order to reduce social desirability bias. The sorting procedures, including post-sorting interviews, lasted between 45 minutes and 2 hours.

Respondents were first asked to read all statements and create three piles (generally agree – indifferent/ do not know – generally disagree) concerning the central question "What influences your soil management?". This helped them to get a first impression of the range of available opinions (statements) and to ease the subsequent sorting procedure (Brown, 1993). Next, respondents rank-ordered the statements into a predefined sorting grid (Figure 1), representing a quasi-normal distribution and thus symmetrical about the middle (Brown, 1993; Watts and Stenner, 2005). The sorting along the scale from -4 (*fully disagree*) to +4 (*fully agree*) dictates the number of statements the respondent can assign to each rank. During the sorting procedure, respondents were encouraged to ask questions or discuss thoughts (Watts and Stenner, 2012). Once respondents were finished and satisfied with their ranking, we conducted brief post-sorting interviews as recommended by Watts and Stenner (2005). This provided us with further insights regarding a) the respondents' interpretation of the statements, b) the respondents' motivations for ranking statements at the extremes (-4, +4), c) the comprehensiveness of the *Q set*, and d) general comments from the respondents. These sorting procedure and the post-sorting interviews were audio-recoded and transcribed for later analysis.

	Most disagree								**Most agree**
Ranking value	-4	-3	-2	-1	0	+1	+2	+3	+4
Number of statements	(2)	(3)	(4)	(5)	(6)	(5)	(4)	(3)	(2)

Figure 1: Forced choice distribution

2.3 Q pattern analysis

The *Q pattern analysis* reveals viewpoints that are shared by groups of participants. By-person factor analysis and correlations between participants identify groups of participants who sorted the statements in similar ways and thus hold characteristic viewpoints (Stephenson, 1936; Watts and Stenner, 2005).

To prepare this analysis, the final *Q sorts* were photographed and then digitalized using the free software package PQMethod[1]. We excluded one participant from our analysis as he did not properly understand the sorting instructions (despite efforts to resolve the misunderstanding) and we could thus not trust his ranking. In a first step, we correlated all *Q sorts* to reflect the relationship of each *Q sort* to every other *Q sort* (Watts and Stenner, 2005) and to identify the degree of similarity between any two *Q sorts* (ranging from -1 to +1) (Brown, 1993). Next, we factor-analyzed the correlation matrix applying a Principal

[1] http://schmolck.org/qmethod/

Component Analysis (PCA) with a Varimax Rotation, in order to detect patterns among the *Q sorts* and to extract different viewpoints (Schmolck, 2002; Walder and Kantelhardt, 2018). In contrast to regular PCA, *Q Methodology* correlates respondents instead of variables in order to detect relationships between them. This results in a small number of combinations of sorted statements, so-called factors. A factor is "the weighted average *Q sort* of a group of respondents that responded similarly" (Zabala and Pascual, 2016). The loadings of the initial *Q sorts* on these factors describe to which extent a participant corresponds – positively or negatively – with each viewpoint (Schmolck, 2002).

We only extracted factors if (a) their Eigenvalue was larger than one, (b) they were defined by at least two Q sorts, and (c) if they reasonably reflected the real world (Watts and Stenner, 2005). While (a) and (b) helped us to identify the minimum number of factors, we used (c) to narrow the number of factors down to a quantity that still allowed us meaningful interpretations; a process that we did in a small workshop setting with all co-authors of this article. As a result, we extracted four factors representing different viewpoints on soil management. In order to obtain the best result, we first 'flagged' associated factors and *Q sorts.* Second, we raised the suggested significance threshold value for a *Q sort* from ± .50 (Brown, 1993) to ± .55 to assure a higher resemblance of the loading *Q sorts* to the respective factor array. And third, we excluded *Q sorts* from defining a factor if their factor loadings for a second factor was higher than the calculated significance level of the study[2] (at $p < .01$). We only excluded the *Q sorts* from defining the factors, not the post-sorting interviews of the farmers. The software-defined Varimax rotation accounted for a total explained variance of 67%, with 18 uniquely and significantly loading *Q sorts*. To increase the amount of loading *Q sorts*, we rotated the results modestly by hand and were able to increase the loading *Q sorts* to 23 by keeping the total explained variance constant at 67%.

The final result of a Q Methodological study is a set of narrative descriptions of the viewpoints that exist among the participants. These descriptions are based on a qualitative interpretation of the quantitative results (e.g., the factors) and of the transcribed post-sorting interviews.

3 Results

Table 2 shows the factor loadings of all Q sorts (farmers) for the four extracted factors. The correlation scores indicate that factors were less distinct than expected. We considered alternative solutions with fewer factors, but settled for the four-factor solution, as it provides valuable insights into the nuances that separate viewpoints, which might at first glance appear similar. Moreover, we attribute the high correlations to our narrow subject of investigation as well as the by-hand rotation. However, we also make use of the commonalities and analyze the statements that all factors view similarly.

[2] For $p < .01$: 2.58* (1/√number of items in the Q set) = .44 for our study.

Table 2: *Q sorts* (farmers) factor loadings (bold scores indicate that the Q sort defines the factor)

Q sort	**Factor 1**	**Factor 2**	**Factor 3**	**Factor 4**
1	0.41	0.38	**0.55**	0.08
2	0.37	0.34	**0.68**	-0.09
3	0.20	0.13	**0.68**	-0.01
4	0.42	-0.02	0.23	**0.59**
5	**0.64**	0.35	0.24	0.38
6	0.29	0.31	**0.59**	0.35
7	**0.73**	-0.23	0.26	0.20
8	**0.72**	0.21	0.43	-0.05
9	**0.71**	0.33	0.27	0.21
10	0.39	0.11	0.54	0.55
11	0.44	**0.63**	0.25	0.22
12	0.51	0.03	0.61	0.21
13	0.24	-0.01	0.38	**0.75**
14	0.11	0.09	**0.76**	0.24
15	0.63	0.46	0.41	0.27
16	**0.72**	0.15	0.22	0.18
17	0.26	0.54	0.21	0.54
18	0.01	**0.87**	0.17	0.06
19	0.42	0.31	0.40	0.54
20	**0.58**	0.29	0.22	0.43
21	**0.75**	0.17	0.24	0.22
22	0.55	0.07	0.48	0.00
23	0.25	0.57	0.26	0.54
24	0.58	0.47	0.22	0.30
25	**0.61**	0.14	0.17	0.18
26	0.50	0.31	0.25	0.48
27	0.31	0.45	0.47	0.35
28	**0.71**	0.07	0.13	0.29
29	**0.66**	0.44	0.11	0.29
30	**0.62**	0.42	0.15	0.32
31	0.34	0.39	0.06	**0.73**
32	**0.67**	0.14	0.32	0.34
33	0.06	-0.01	**0.66**	0.27
Number of defining *Q sorts*	12	2	6	3
Explained variance in %	26	12	16	13
Eigenvalue	8.91	3.96	5.28	4.29
Correlation between factor scores				
Factor 1		0.42	0.64	0.68
Factor 2			0.46	0.35
Factor 3				0.54

Table 3 describes the characteristics of the whole sample and each factor. Respondents were, on average, 46.6 years old and had an average of 16 years of farming experience. The average farm in our sample covered 101 ha. Thirty respondents (91 %) were male farmers; three were women. The majority of the respondents completed vocational education (55 %). Twenty-seven respondents (82 %) were full-time farmers, fourteen grew field crops (42 %) exclusively, while the other nineteen (58 %) ran mixed farming systems, and nine (27 %) were organic farmers.

As Table 3 shows, we were quite successful in selecting demographically diverse respondents who supposedly hold diverse viewpoints. Although different databases do not allow a direct comparison to the overall population of Austrian (arable) farmers, we provide, for the curious reader, the following information that can be found in BMLFUW (2019). According to the farm accountancy data network (which excludes very large and small farms), the median Austrian farmer is between 45 and 49 years old and

the average crop farmer in this network manages approximately 50 hectares of cropland. According to agricultural beneficiaries data, women operate about 25 % of crop farms (which may be biased upwards due to retirement insurance reasons). Around 50% of the Austrian farms are run full-time (although this share is likely to be higher for crop farms) and 21 % are organic farms. No comparable data are available for farmers' educational level, years of farming experience, and share of direct marketing.

Table 3: Respondents' characteristics

	full sample	**F1**	**F2**	**F3**	**F4**
Number of farmers	33	12	2	6	3
Age [mean] (min-max)	46.6 (24-69)	46.4	30.5	47.5	53
Experience as a farmer [mean years] (min-max)	16.3 (0-43)	17	3.5	18.5	23
Farm size arable land [mean ha] (min-max)	100.8 (6-800)	88	122.5	96.3	15
Gender (male)	30 (91%)	11	2	6	2
Level of education					
Vocational	15 (45%)	5	2	3	2
Secondary	11 (33%)	4		3	
University	3 (9%)				1
Other/unknown	4 (12%)	3			
Full-time farmers	27 (82%)	10	2	5	3
Type of farming					
Field crops only	14 (42%)	5	1	2	1
Mixed farms	19 (58%)	7	1	4	2
Of which:					
Cow (dairy)	6 (18%)	4	-	1	-
Cow (fattening)	2 (6%)	-	-	-	1
Pig	10 (30%)	3	1	3	1
Poultry	1 (3%)	-	-	-	-
Organic farming	9 (27%)	3	1	-	2
Direct Marketing	11 (33%)	4	-	2	3

Table 4 describes each factor as a hypothetical Q sort and lists each statement with its respective rank it would have on the Q distribution. Particularly interesting are statements ranked at the two extremes (±4 and ±3), but also those that are ranked higher or lower than by any other factor. Additionally, Table 4 shows distinguishing statements that are differentiating the respective factor from the other factors statistically, and consensus statements, which are statements that are similar across all factors.

Table 4: List of statements and factor scores

		Statements[b]	**Factor scores**[a]			
			F_1	**F_2**	**F_3**	**F_4**
Farmer	1	pleasure	2	2	1	4
	2	freedom	-2	3	-1	2
	3	time availability	-3	-4	-4	**1**
	4	training	2	3	2	**-1**
	5	traditional knowledge	-1	**3**	-1	0
	6	education	1	0	3	2
	7	*health*	*0*	*0*	*0*	*1*
	8	openness to change	1	0	0	0
Farm	9	profitability	-1	1	**4**	0
	10	distance	-1	-1	-3	-2
	11	*tenure security*	*-2*	*-3*	*-2*	*-2*
	12	avoid expensive investments	-3	-4	-1	0

	13	risk	-1	0	1	-1
	14	responsibility for workers	0	**2**	-3	-1
	15	tidy plots	**-1**	4	2	1
Socio-institutional context	16	future generations	3	1	2	2
	17	coordinate with neighbors	-3	-2	-4	-4
	18	care for neighbors	1	-2	1	1
	19	customers' expectations	0	2	-2	-1
	20	society's expectations	0	0	-2	-1
	21	food provision	1	**3**	0	**-2**
	22	gossip	-4	-2	-3	-3
	23	depend on AES	-2	-2	0	-2
	24	guided by AES	0	-1	-1	-3
	25	others' knowledge	0	**-3**	-1	0
	26	laws & sanctions	-2	-3	**0**	-4
Natural context	*27*	*natural conditions*	*2*	*1*	*3*	*2*
	28	natural influences	2	0	1	0
	29	weather	4	1	4	3
	30	master	1	**-2**	1	1
	31	partner	3	2	2	4
	32	participant	4	-1	0	3
	33	steward	3	0	3	2
	34	apathy	-4	-1	-2	-3

[a] Distinguishing statements ($p < .01$) are marked in bold
[b] Consensus statements ($p > .01$) are given in italics

Next, we characterize each viewpoint shared by farmers in each factor. The numbers in parentheses refer to the statements that potentially influence farmers' soil management (Table 1) and their respective position in the hypothetical *Q sorts* (Table 4). Interviewees are quoted using their internal ID (P 1 – 33).

3.1 Nature Participants (F1)

In the first factor, we see farmers who emphasize their closeness to nature and their keenness to improve their soil management. We thus label them *'Nature Participants'*.

In terms of HNR, these farmers see themselves as part of nature (32: +4), work together with nature (31: +3), feel responsibility for nature (33: +3), and they firmly reject willful ignorance of nature (34: -4). Consequently, this is reflected in their stewardship for future generations (16: +3), as illustrated by one farmer who explains that *"[soil and] farm are only borrowed from future generations"* (P 16). In contrast, profitability is comparatively unimportant for this viewpoint (9: -1), as *"profitability results automatically anyway [from proper soil management]"* (P 29). The focus on nature of *Nature Participants* is underlined by the fact that weather is one of the most critical determinants of their soil management (29: +4), as are the natural conditions of a plot (27: +2). Therefore, proper soil management can even help to mitigate damages by natural influences such as climate change or pests (28: +2).

Compared to the other viewpoints, *Nature Participants* care least about their freedom as farmers when managing their soils (2: -2). Instead, they care more than others about societal expectations of how soil should be managed (20: 0), and less about their reputation, such as gossip (22: -4) or the appearance of their plots (15: -1). Farmers sharing this viewpoint are slightly more positive about trying new things

than others (8: +1) and do not shy away from making investments (12: -3; 13: -1). Consequently, these farmers value experts' knowledge (4: +2) and are neutral about colleagues' experiences (25: 0). To improve their soil management, *Nature Participants* rely less on traditional knowledge than others (5: -1). They are indifferent about AES being useful guidance (24: 0), which they do not see as something that determines their soil management (23: -2).

3.2 Traditional Food Providers (F2)

In the second factor, we see farmers whose view on soil management is influenced by productivism together with a concern for socio-institutional expectations. We thus label them *'Traditional Food Providers'*. Literally all nature-related statements are ranked lower by this group than by any other, indicating that these farmers' HNR are of minor importance for their soil management (30: -2; 31: +2; 32: -1; 33: 0; 34: -1). Correspondingly, the natural conditions of a plot (27: +1), as well as the weather (29: +1), are of little importance to their soil management practices. What matters is to provide food for society (21: +3), as *"the provision of food is something beautiful for every farmer"* (P 11). To do so, *Traditional Food Providers* do not shy away from expensive investments (12: -4) and do not see themselves as time-constrained in their optimal soil management (3: -4).

Social norms and values, however, are more influential to this perspective than to any other: customers' expectations (19: +2) and a responsibility towards employees (14: +2) are important, but not the coordination with neighbors (17: -2). This translates to farmers' care of having tidy and neat plots (15: +4), so that *"[a plot] is also attractive for the eye"* (P 18), and they disagree less than others that they avoid doing things that would cause gossip (22: -2). Thus, gossip is slightly more relevant for them than for others. Moreover, this viewpoint is least influenced by tenure security (11: -3). One interviewee underlines the strong personal norms that characterize this viewpoint, stating that treating all land equally, irrespective of its tenure status, is "*somewhat a little code of honor"* (P 11).

Compared to other viewpoints, *Traditional Food Providers* rely strongly on traditional and passed-on knowledge (5: +3) as well as training by professionals (4: +3). In comparison, their education (6: 0) and experiences of colleagues (25: -3) play minor roles. For this viewpoint, their freedom as farmers is of great importance (2: +3). Correspondingly, AES (23: -2) or laws (26: -3) are not of much concern.

3.3 Profit Maximizers (F3)

In the third factor, we see farmers whose view on soil management is influenced by economic considerations. We thus label them *'Profit Maximizers'*. Indeed, economic viability as a driver for soil management is ranked highest by this viewpoint (9: +4). One interviewee brought this to the point: *"the soil is important for profitability […] [and] without profitability, you are gone"* (P 33). Like *Nature Participants*, farmers with this mindset also regard the biophysical conditions of a plot and the weather as significant determinants for their soil management (27: +3; 29: +4;). Concerning farmers' relationship

with nature (i.e., their HNR), *Profit Maximizers* agree most with having responsibility for nature (33: +3), but they do, to a lesser degree than farmers of the other groups, understand themselves as collaborating with nature (31: +2) and they feel least as part of nature (32: 0).

Profit Maximizers are not much influenced by others, such as customers' (19: -2) or societies' (20: -2) expectations, and values such as responsibility for employees (14: -3). One interviewee even commented on the statement of societal expectations (20) that *"they all have no idea – unfortunately"* (P 14). Likewise, coordination with neighbors is not considered necessary at all (17: -4), and passed-on knowledge (5: -1) is less important than their education about or experience with soil management (6: +3). *Profit Maximizers* are, like others, relatively risk-neutral (13: +1) and place less value on the pleasure derived from soil management than others (1: +1).

In contrast to the other groups, *Profit Maximizers* do not disagree that laws and sanctions (26: 0) or agri-environmental schemes (23: 0) influence their soil management. They do not see why time (3: -4) or the distance between a plot and the farmhouse (10: -3) should influence their soil management.

3.4 Pleasure Seekers (F4)

In the fourth factor, we see farmers whose view on soil management is similarly driven by environmental aspects as *Nature Participants*, but who are distinctive in their self-reliance and focus on freedom and pleasure. We thus label them *'Pleasure Seekers'*. Farmers sharing this viewpoint agree strongly that their HNRs are influential for their soil management, such as working together with nature (31: +4) and feeling like a part of nature (32: +3). A second prominent determinant of their soil management is the search for pleasure or joy (1: +4).

In addition, *Pleasure Seekers* value their freedom (2: +2) and do not see their soil management as influenced by laws and governmental sanctions (26: -4) or dependent on AES (23: -2). Coordination with neighbors is also a non-issue (17: -4), as is potential gossip (22: -3). Consequently, this viewpoint sees their own education and experiences (6: +2) as essential for soil management and seeks less training and education by professionals than others (4: -1). This might be related to the fact that that these farmers appear the only ones that feel slightly time-constrained (3: +1).

Moreover, in comparison to the others, this viewpoint is more cautious about making expensive investments (12: 0). According to one interviewee, *"they [other farmers] have to invest over and over again […] the investment is not even repaid, and they have to do the next one. They are stuck in a rat race"* (P 4). This again emphasizes striving for freedom, here from a financial perspective. *Pleasure Seekers* disagree that the provision of food gives meaning to farming and soil management (21: -2).

4 Discussion

The aims of this study were twofold: (a) to gain a deeper understanding of farmers' viewpoints on their soil management in order to (b) support policies that strive to address and crowd-in farmers holding different views. By applying *Q Methodology* with Austrian arable farmers, we identified four different viewpoints related to their soil management.

Before discussing the four viewpoints and our suggested policy implications, we acknowledge the specific context of this study. First, it is essential to remember that while most studies focused on farmers in general, we focused on farmers with cropland only, and thus, excluded livestock farmers. The latter may hold specific viewpoints, given that – at least in Austria – they usually farm in alpine, marginal areas. Whatsoever viewpoint they hold, their soil management differs substantially from that of arable land farmers, not least as pastures and grassland require entirely different measures to prevent erosion or degradation. Second, the socio-ecological and institutional context of farming in Austria differs substantially from countries with other climatic and geographic conditions or countries with other institutional settings and histories (e.g., countries with formerly collectivized agriculture). Consequently, this may not only influence farmers' mindsets but also their approach to farming in general. Nevertheless, and as our comparison will show, parallels exist, allowing us to draw conclusions about the relationships of farmers' mindset and their soil management.

Although the four viewpoints are distinct and differ in fundamental aspects, we found some considerable parallels. The most apparent similarity across all viewpoints is that farmers align their soil management to the biophysical environment of their plots and – all except the *Traditional Food Providers* – place great importance on weather conditions. This is hardly surprising, as farmers are, after all, working closely in and with their natural and biophysical environment (Bielders et al., 2003; Prager and Posthumus, 2011; Tanentzap et al., 2015). Moreover, and confirming Leonhardt et al. (2019), farmers across all viewpoints do not care how long they will continue to farm a plot. Accordingly, farmers do not consider plots that they may have to give up or cease to farm in the future as any different in their soil management. Less obvious, our results reveal that farmers state to be quite resistant to social pressures such as gossip across different viewpoints, except the *Traditional Food Providers*. Also, less anticipated, our study shows that monetary policy instruments such as AES have, according to the interviewees, little influence on farmers' soil management. Although partly discussed in the literature (Gowdy, 2008; Howley et al., 2015), it raises questions about the effectiveness of such monetary policy instruments.

4.1 Ecocentric versus anthropocentric viewpoints on soil management

Apart from the similarities mentioned above, the analysis of the Q sets identified four different mindsets regarding soil management. Some farmers have a close connection with nature and align their soil man-

agement with nature's needs and thus can be considered to share an **ecocentric viewpoint** (*Nature Participants*, *Pleasure Seekers*). Others have a more distant relationship with nature and rather align their soil management with their own needs and goals of producing food or being economically efficient, and therefore share an **anthropocentric viewpoint** (*Traditional Food Providers*, *Profit Maximizers*).

The mindset of ***Nature Participants*** resembles the *Environmental Stewards* described by Brodt, Klonsky and Tourte (2006) and is comparable to the *Environmentalists* (Davies and Hodge, 2007), or the *Diversity-Maintaining* viewpoint (Walder and Kantelhardt, 2018). We found that the respective farmers are keen to improve their soil management, even if investments are expensive. They have a close relationship with nature, care for it, and acknowledge it as a resource that needs to be conserved for future generations (Ryan et al., 2003). Most of our respondents rather disagreed with a guidance effect of AES, i.e., knowledge-provision by AES independently of participation (Wilson and Hart 2001) – the *Nature Participants* neither agreed nor disagreed.

Pleasure Seekers share a combination of environmental and self-centered attributes. Quite distinctly, farmers with this mindset manage their soil with a view to personal enjoyment and pleasure. They value their freedom as farmers and consequently do not adapt their soil management to laws or governmental sanctions. This viewpoint is not commonly described in the literature. However, it shares some aspects of the *Idealist* farming type (Schmitzberger et al., 2005). *Pleasure Seekers* rely strongly on their own experiences. It is, therefore, perhaps not surprising that they not only reject training and extension services as a source of soil management knowledge but are also resistant to external influences such as AES, apart from customers' expectations. Moreover, farmers with this mindset care little about societal expectations, do not coordinate much with neighbors and do not care about gossip. According to previous studies, these observations might be related to these farmers' age (Atari et al., 2009; Burton, 2014; Siebert et al., 2006). Regarding farmers' disregard of society, Mills et al. (2017) suggest that this might be related to public discussions, which often tend to accuse agriculture of unsustainable practices, painting a negative picture of farmers. *Pleasure Seekers* are the only ones that would manage their soil differently if they had extra time. While we cannot draw any conclusions with regard to demographic information due to the qualitative nature of the data collection process, it would be interesting to see whether *Pleasure Seekers* tend to have a particular business approach that is time-consuming (such as direct marketing), or whether they tend to be part-time farmers.

In contrast to the two ecocentric viewpoints, the ***Traditional Food Providers*** appear to be least connected to nature. Farmers with this mindset share strong traits of tradition, a focus on food production, and consider their relationship with nature less important than any other viewpoint. Other studies discuss similar viewpoints, such as *Production Maximizers* (O'Rourke et al., 2012) or *Yield Optimizers* (Schmitzberger et al., 2005), all of which put production or agribusiness ideals (Burton and Wilson, 2006) above nature conservation or environmental ideals. They understand themselves as important actors who provide food for society and in the interviews often referred to the need for providing nutrition for an ever-growing world population. In addition, these farmers strive to live up to what is traditionally

perceived by many as a ‘good’ farmer in terms of aesthetics: they aim to have aesthetically well-maintained plots, which is believed to communicate land-use skills (Burton, 2004). As a result, *Traditional Food Providers* might be attracted by practices they consider as aesthetically pleasing or relevant for ‘agricultural productivism’ (Burton, 2004; Carlisle, 2016). Moreover, *Traditional Food Providers* are open to acquiring new soil management practices. They take passed on knowledge as a starting point or rely on their own first-hand experience (Carlisle, 2016) but are willing to learn more through training and extension services.

Among all four viewpoints, the ***Profit Maximizers*** have the most definite focus on their farms' efficiency and economic viability. This viewpoint resembles the *Commodity Conservationists*, identified among arable farmers in the UK (Davies and Hodge, 2007). Farmers with this mindset do consider their relationship with nature important but act on this relationship by focusing on economic considerations in their soil management. They appear to be the only ones in our sample who do not reject policies and regulations as being relevant for their soil management. This supports the argument of Pavlis et al. (2016) that economic motivations and income benefits are the primary motive for (some) farmers to participate in AES. However, it could also mean that these business-oriented farmers come closer to conflict with legal minimum requirements, which is why they consider the legal standards more critical than other farmers. Since Profit Maximizers consider nature's impact on farm's profit and soil's functionality, farmers with this mindset are most straightforward to access by policies that address both these attributes: focus on economic considerations, but stressing a practice's benefits for soil conservation.

4.2 A suggested policy mix to reflect the plurality of farmers

In the following and based on our results, we suggest considering a bundle of policy instruments to reflect an inclusive governance perspective. As farmers’ viewpoints are not directly observable and policymakers need to treat all farmers equally, only a mix of policies can address and crowd-in all mindsets. Moreover, due to the nature of our research design, we do not know the actual soil management of our interviewees and if and to what degree it is socially suboptimal. Therefore, our recommendations point to the need for a policy mix but do not indicate if the policies implemented in Austria are adequate to address soil conservation on the farms analyzed.

In line with Dessart et al. (2019), who recommend a mix of policies based on voluntary and mandatory adoption of soil conservation, we suggest a combination of the five policy categories, as shown in Figure 2. Albeit not an outcome of systematic policy analysis, the five suggested policy categories integrate the knowledge and insights that we gathered during the whole research process: literature review, interviews with stakeholders from public authorities (ministry of agriculture, agricultural county administration), extension services (chamber of agriculture), and an environmental NGO, as well as the post-sorting interviews with respondents of the *Q Methodology*.

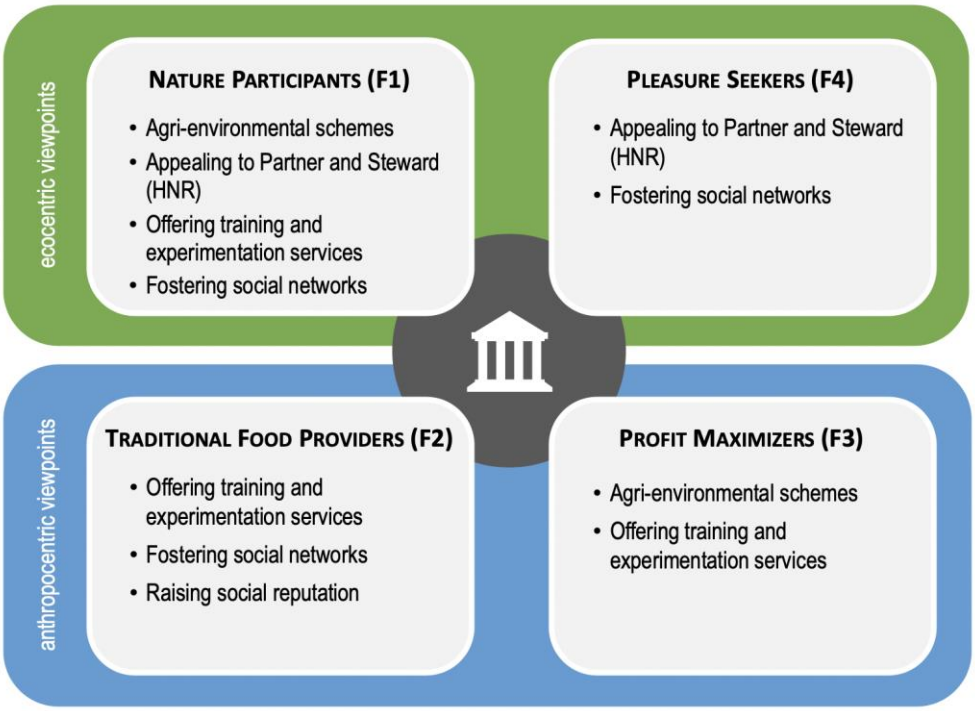

Figure 2: Policy categories aligned with the four mindsets

4.2.1 Agri-environmental schemes

We examined two potential effects of AES, and find evidence that both apply to a limited extent. First, AES can have a direct behavioral effect for *Profit Maximizers* and an indirect behavioral effect through knowledge transfer for *Nature Participants*. However, farmers of the two other groups do not see AES as an essential factor for their soil management. We see two potential explanations for this. First, Austria has chosen an AES strategy that is "broad and shallow", i.e., attractive to many farmers, but with less targeted environmental impact than "narrow and deep" schemes (Zimmermann and Britz, 2016). As a result, farmers' production systems may, especially in marginal areas, comply with AES requirements a priori. This may encourage farmers to sign up for the scheme without requiring them to change their soil management. Consequently, such farmers do not consider AES schemes as influencing their behavior. Second, AES have a long history in Austria, and farmers may thus have changed their soil management long ago. Thus, this AES supported soil management is already internalized and habitual, and thus farmers may not consider it to be influenced by AES. The literature is, however, ambiguous – while some question the long-term effect of AES in shifting farmers' attitudes towards more "green thinking" (Karali et al., 2014), others have found evidence that AES can induce attitudinal changes across participating farmers (Mason and Holmes, 2015; Riley, 2016). Whatever the effect might be, some farmers mentioned in the interviews that they started to recognize the value of policy-induced soil management practices after implementing it. Thus, the participation in AES induced a shift towards more environmentally friendly attitudes for some. Nevertheless, we suggest complementing AES with the following

policy instruments, in order to reduce their dominance in agricultural policy strategies and potentially induce more profound behavioral changes.

4.2.2 Appealing to Partner and Steward (HNR)

Our study confirms that individuals (in our case farmers) hold multiple HNR (Figure 3), as suggested by Flint et al. (2013). Similar to Yoshida et al. (2018), we find that the majority of farmers agree with the rather ecocentric HNR concepts such as the *Partner*, the *Steward*, and, although more ambiguous, the *Participant*. In contrast to previous studies, we find that our interviewed farmers can relate to the HNR concept of the *Master*, as set-out in its theoretical foundation (Muhar and Böck, 2017). So far, however, in most empirical HNR studies, the *Master* mostly got rejected by study participants (Braito et al., 2017; de Groot et al., 2011); or was found to a lesser, weaker extent (Yoshida et al., 2018). We assume that farmers are more aware than the overall population of their potential to "master" nature – simply due to being a farmer whose job is shaping nature.

Our study further confirms that individuals' (in our case farmers') relationship with nature is an essential behavioral determinant (in our case of soil management), as suggested by Braito et al. (2017). Therefore, we recommend policymakers to be sensitive to the HNR concepts in their policy framing, in order to avoid secondary effects of attracting or deterring certain individuals. For instance, a purely business-oriented policy framing would correspond to the HNR concept of *Apathy*, which implies that farmers do not relate to nature and which was rejected by all viewpoints in our study (Figure 3).

However, we are aware that framing policies in terms of HNR is a complicated endeavor, and policies with unidirectional framings, such as addressing only one HNR type, run the risk of excluding other HNR orientations. Therefore, based on our results (Figure 3), we recommend the following strategy. First, policymakers should consider the diverse array of HNR in framing the policy's message to reflect that farmers hold multiple HNR. Second, we suggest appealing to the benefits particular practices have for nature and farmers' more ecocentric HNR concepts of the *Steward* or *Partner*, which, according to our results, would crowd-in all farmers.

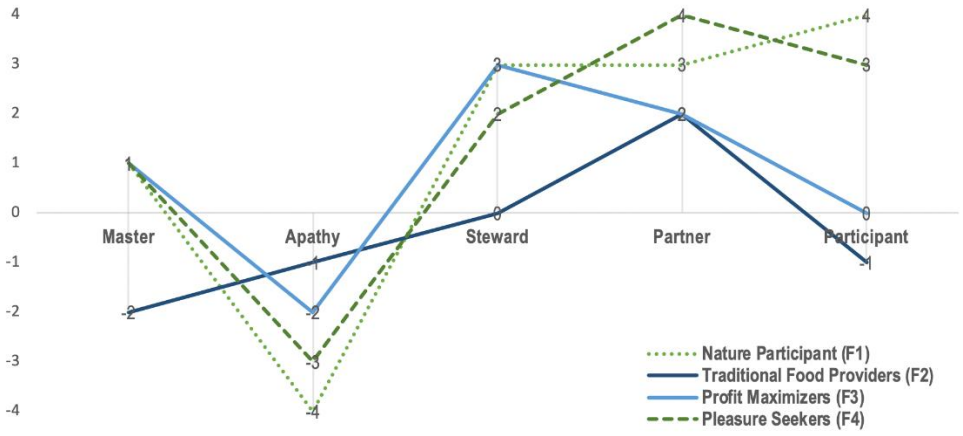

Figure 3: (Dis-)agreement with HNRs among the four viewpoints on soil management

4.2.3 Offering training and experimentation services

Another insight from this study is that training services are likely a promising way of encouraging farmers' soil conservation behavior. Our groups of farmers are, in general, willing to expand their knowledge and adopt different information channels. Passed-on knowledge about soil management serves in some cases as a starting point, while for others it is their previous education and experience. Almost all farmers are keen to expand their knowledge on soil management through training, whether for the sake of nature or for improving their economic efficiency. Thus, extension services are natural instruments to spread innovative and sustainable soil management practices, and could, for instance, be complemented by voluntary on farm-experiments, where farmers share hands-on knowledge. Given that many AES require applicants to attend training courses anyway (BMLFUW, 2017), training services for those farmers not participating in AES appear beneficial. Making training services attractive to all farmers may be challenging (Knierim et al., 2017), but good-practice examples exist (Ingram and Mills, 2019). In this regard, it could be wise to complement traditional approaches with internet-based services, smartphone-apps, or social media platforms to attract farmers that may be less inclined by traditional communication or training channels. According to Mills et al. (2019), Twitter could be used, for instance, to support on-farm experiential learning and adaptation.

4.2.4 Fostering social networks

Previous research has stressed the importance of social networks for the adoption of soil conservation practices (Coughenour, 2003) and has highlighted the importance of early adopters for the diffusion of practices in a region (Morton and McGuire, 2011; NWF (National Wildlife Federation), 2012). Targetti et al. (2019), for instance, acknowledge social networks among farmers as a catalyst for efficient adoption of environmentally-friendly practices.

However, in our study, all viewpoints share a rejection of coordination with neighbors, except when it comes to avoiding adverse impacts. And while the appearance of plots to others matters somewhat to some groups of farmers, judgment in the form of gossip is considered irrelevant by most viewpoints. Regarding farming communities, the experiences of colleagues are considered somewhat irrelevant by two viewpoints, and the *Nature Participants* and *Pleasure Seekers* are indifferent. However, to address these two groups, it may still be helpful to use social networks, as they may be difficult to reach otherwise. Moreover, *Nature Participants* may play a unique role as early adopters of new technologies and soil management practices who can share their knowledge. Relevant policies worth mentioning include organized settings for group learning such as regular meetings on soil erosion as currently organized by Austrian extension services, or study groups of interested farmers, supervised and supported by local extension agents. Collaborative AES as suggested by Prager et al. (2012), Prager (2015) and McKenzie et al. (2013) may be another option.

In this regard, it could be beneficial to make use of farmers' social contacts and their already existing networks. In our study, for instance, *Traditional Food Providers* take their customers and employees

into account when managing their soils. Thus, appealing to the positive effects, e.g., in communication with these stakeholders, that soil management practices may have, could resonate with some farmers. This links with the following point, addressing farmers' reputation in society.

4.2.5 Raising social reputation

With regards to meeting expectations of society in their soil management, the farmers of our study largely responded as unwilling or indifferent. Several farmers commented on this statement that they feel like *"society often has absolutely no idea what we farmers do*" (P 7), or that "*society expects so much and has no idea*" (P 14). Others shared that they feel like farming has a wrongly negative reputation. Both are reasons for not caring about society's expectations. Thus, there appears to be a divide and lack of understanding between farmers and society that prevents farmers from taking society's interests into account. However, previous research has shown that norms have the potential to actively inform farmers' pro-environmental behavior (Fang et al., 2018; Mills et al., 2017). Raising farmers' social reputation, enabling communication between both sides, and thus closing the observed cleavage between some farmers and broad society might then help to make such society-averse farmers again reachable through social norms – at least those who are not primarily driven by their strive for freedom and independence. Thus, as some farmers were found to undertake pro-environmental land-use practices because they felt obligated to do so, and as it contributes positively to their societal image (Mills et al., 2017), this approach might also appeal to farmers with pro-societal norms.

Feasible ways to strengthen farmers' reputation are advertisement campaigns. In Austria, this is, for example, done by an agency that is also responsible for agricultural market research, quality control, and AES payment administration. Farmer-led approaches include offering farm visits to the general public or for schools, farmers visiting schools to talk about their approach to farming, and extension agencies providing online information and teaching materials to teachers and the interested public.

5 Conclusions

With this study, we aimed to identify farmers' viewpoints on their soil management. Ultimately, this helped us to derive applicable policy recommendations that consider the plurality of farmers' motivations across contexts. We unraveled the pluralism of farmers' viewpoints on soil management among Austrian arable farmers in the Austrian (and European) policy context by applying *Q Methodology*. We adapted existing and helpful categorizations and frameworks and derived our own operationalization of the vast number of behavioral determinants that influence farmers' soil management.

Our study shows that farmers are a very diverse group. They consider nature and society next to – and sometimes over – outputs and income, and they differ in their preferences and priorities. We have identified some of these preferences that are shared by groups of farmers, such as stewardship for nature, or personal pleasure and freedom.

We identified four distinct viewpoints on soil management among Austrian farmers, two of which can be considered ecocentric, while the other two tend to be anthropocentric. Using these different viewpoints or mindsets as a starting point, we then related five different policy strategies to these groups. We suggest that only a mix of policy approaches might achieve the target of addressing all farmers' mindsets, and by doing so, avoid adverse effects of excluding or crowding out farmers. As for future studies, we suggest acknowledging viewpoints such as that of *Traditional Food Providers* and *Pleasure Seekers*. Both viewpoints are distinct from the other viewpoints, but less commonly described in the literature and, thus, might merit more attention.

Due to the nature of *Q Methodology*, we cannot draw any conclusions concerning the prevalence of these viewpoints in the general farmer population, and neither can we provide suggestions on how to identify these groups based on demographics. Since these are questions of interest, a follow-up quantitative study would be of great use. Nevertheless, we have made a first step in characterizing Austrian crop farmers and identifying the range of viewpoints among them, such that future research and soil conservation policies can build upon our foundation.

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