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# Types of collective action problems and farmers' willingness to accept agri-environmental schemes in Switzerland

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ABSTRACT

Over the last years, there has been an increasing interest in the intersection of collective action and payments for ecosystem services. This has been motivated, among other things, by the understanding that spatially coordinated conservation practices can be ecologically more effective. In this study, we propose understanding collective action in the PES context as shaped by three collective action problems: the public good provision problem (i.e., the decision by landholders of whether to participate in a PES program); the coordinated implementation problem (i.e., the decision of landholders who participate in the PES to implement conservation measures in a coordinated fashion); and the externality internalization problem (i.e., the internalization of externalities that PES participants create on neighboring landholders and/or vice-versa). We then explore the extent to which perceptions about those three problems affect participation in PES. For this purpose, we carry out a choice experiment among farmers in the Swiss cantons of Zurich and Aargau. A majority of farmers have pessimistic expectations about the possibility of collective action regardless of whether that serves the provision of ecosystem services (pubic good provision), the coordinated implementation of AES or the internalization of potential externalities. Those with optimistic expectations about the first two problems are more likely to participate in PES. Finally, we find that expectations with regard to the public good provision and coordinated implementation problems interact, i.e., farmers who are optimistic about the willingness of other farmers to participate in PES are also more willing to coordinate in the implementation, and the other way around.

## 1. Introduction

Over the last years, there has been a notable increase of research at the intersection of collective action theory and payments for ecosystem services. This has been motivated by the understanding that the effectiveness of some conservation measures such as those promoting pest control, pollination, biodiversity corridors, or the maintenance of certain landscape elements such as hedge rows or water streams can considerably increase if implemented along certain spatial patterns, i.e., by neighboring landowners (Parkhurst et al. 2002, Parkhurst and Shogren 2007, Banerjee et al. 2012). In the context of agri-environmental schemes (AES), coordination can (i) promote agglomeration effects via the spatial coordination of individual practices (Parkhurst et al. 2002, Warziniack et al. 2007, Gabriel et al. 2010, Schmidtner et al. 2012, Bamière et al. 2013), (ii) contribute to harmonize the different ecological functions of natural resources in heterogeneous landscapes (Davies et al. 2004, Goldman et al. 2007, Ohl et al. 2008), and (iii) tailor conservation measures to local ecological needs while facilitating economies of scale (Uetake 2013).

Effective conservation measures can improve the resilience of ecosystems and land uses. Mäler and Li (2010) characterize resilience as "a kind of insurance against reaching a non-desired state". This insurance is provided by the capacity of ecosystems to absorb disturbances while maintaining their basic structures, functions, and feedbacks (Walker et al. 2004). The higher the level of resilience, the lower the risk of facing losses of biodiversity and ecosystem services in the future. This aligned relationship between resilience and risk reduction gives rise to the idea of determining the insurance value of ecosystem conservation. However, methodological approaches to quantify this insurance value are relatively scarce (Baumgärtner and Strunz 2014, Quaas et al. 2019)

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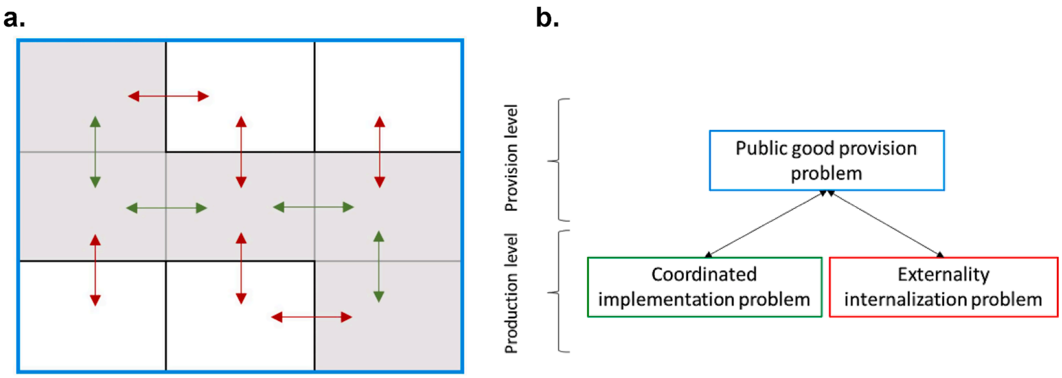


**Fig. 1.** Stylized representation of different levels of collective action problems.
In Fig. 1 graph a, the squares represent agricultural plots, each managed by a different farmer. Green squares represent plots participating in an AES that requires spatial coordination. White squares represent the plots of farmers not willing to participate in the AES (although qualified to do so). The blue square represents the boundaries of collective action at the public good level, i.e., among those qualified to participate in the AES. Green arrows indicate instances of collective action at the AES implementation level, i.e., among those required to coordinate for implementing AES. Red arrows indicate instances of collective action at a second AES implementation level, i.e., resulting from the need to internalize externalities that emerge between those participating in the AES and those not participating in the AES. In graph b, the colors of the green, red and blue boxes correspond to the colors of the green and red arrows and the blue box in graph a, respectively.

and empirical evidence remains fragmented to date (Dörschner and Musshoff 2013, Dallimer et al. 2020, Schaub et al. 2020, Unterberger and Olschewski 2021). Further, current institutional arrangements often do not facilitate the required coordination at the landscape level (Paavola and Primmer 2019).

Coordination for effective conservation at landscape scales requires solving collective action challenges, and this can discourage participation in AES (Villanueva et al. 2015a, Villamayor-Tomas et al. 2019b). In collective conservation ventures, having only one or a few people not complying with agreements can compromise the effectiveness of the project (Christensen et al. 2011). Further, farmers need to communicate, make collective decisions and potentially monitor the proper implementation of those decisions, all of which require time and resources (Goldman et al. 2007). The costs of such activities can be notably high and may sum up to more than 30% of the opportunity costs of participating in AES (Villanueva et al. 2015b).

In this study, we understand coordinated implementation as one among several other tasks that involve collective action challenges among different groups of people, and that are, theoretically, solved in an ordered fashion (Ostrom et al. 1994). Specifically, we understand the coordinated implementation of AES as embedded in a broader collective action problem, i.e., that of participating in the AES (Goldman et al. 2007, Stallman 2011). By the same token, we also foresee collective action problems among farmers who participate in the AES and those who do not, resulting from the need to internalize externalities that AES participants create on non-participants and/or vice-versa (Davies et al. 2004, Kuhfuss et al. 2014, Stallman and James, 2015). Given this framing, our research question is: How do different types of collective action problems and their perceptions affect AES uptake decisions?

To answer this question, we first develop a framework capturing different types of collective action problems in the AES context. Specifically, we build on collective action theory's distinction between prisoner's dilemma and coordination problems, and between the provision and the production of goods and services. As a result, we identify three types of collective action problems: the public good provision, the coordinated implementation and the externality internalization. We then use data from a discrete choice experiment that was carried out as a broader effort to understand the role of economic and social factors in AES uptake among 163 Swiss farmers (Villamayor-Tomas et al. 2019a). The experiment included a "coordinated location" attribute; and the survey comprised several questions capturing expectations of farmers towards the ability to solve the different types of collective action problems. In this study, we focus on the relative importance of the coordination attribute as it interacts with collective action expectations and other attitudinal aspects. Based on a series of descriptive statistics and the analysis of discrete choice models, we find that a considerable majority of farmers has pessimistic expectations about the feasibility of collective action with regard to the three types of collective action problems. However, those with optimistic expectations vis-à-vis public good provision and coordinated implementation are more likely to participate in AES.

## 2. Theory

The factors that expectedly contribute to farmers' uptake of AES are quite diverse. We know that uptake varies with (i) the opportunity costs of implementing the measures (Knowler and Bradshaw 2007, Sattler and Nagel 2010), (ii) the level of monetary compensation that farmers receive (Defrancesco et al. 2008, Santos et al. 2015), (iii) transaction costs (Falconer 2000), (iv) the duration and flexibility of contracts (Christensen et al. 2011), (v) short and long-term dependence on agricultural income, land tenure, farm size and location, and (vi) the availability of off-farm labour (Prager and Posthumus 2010, Lastra-Bravo et al. 2015). Related to economic factors, farmers' characteristics such as age and education are relevant (Hynes and Garvey 2009, Uthes and Matzdorf 2013, Grammatikopoulou et al. 2016). We further know that uptake varies with environmental attitudes and values, information about the conservation programs, and perceptions about costs and environmental threats (Kabii and Horwitz 2006, Prokopy et al. 2008, Schneider et al. 2010, Wauters et al. 2010). Finally, explanations based on social norms build on the premise that farmers do not only care about the economic implications of their decisions but also about their reputation within their community and about what is considered "socially appropriate" (Beedell and Rehman 2000, Chen et al. 2009, Jaeck and Lifran 2009, Sheeder and Lynne 2011, Loft et al. 2019). Despite the notable progress, there is still rudimentary understanding of the mechanisms that explain why those factors have an impact. A focus on said mechanisms may facilitate the synthesis of the knowledge acquired. One such mechanism is the resolution of collective action dilemmas.

### 2.1. AES and collective action

In the last years, a fair number of scholars have started to pay attention to the collective action problems that farmers face when participating in PES (Vatn 2010, Muradian and Gómez-Baggethun 2013, Stallman and James, 2015, Hayes et al. 2019). Collective action theory underlies much of this new interest. The theory explains collective action as a function of the ability of individuals to overcome social dilemmas and/or reduce transaction costs (see Hardin, 1968; Ostrom, 1990, and more recently Araral 2014 for the broader debate). Social dilemmas emerge when group interests are at odds with individual interests. Collective action scholars have mostly focused on two situations that involve collective action dilemmas: coordination and prisoner's dilemma problems (Bowles 2009). In *coordination problems*, collective action is hindered by the lack of information or common understanding about the benefits of collective action and the expected behavior of other individuals, i.e., resource users. Users have an individual incentive to coordinate strategies that benefit everyone; however, the transaction costs of obtaining information about others' strategies and building common understanding are considerable. Multiple equilibria exist, which are often Pareto-ranked, and Pareto-inefficient equilibria are likely to occur, potentially creating lock-in situations. In *prisoner's dilemma problems* it is not the lack of information but rather a particular structure of incentives that leads to sub-optimal outcomes. Given a set of payoffs (i.e., costs and benefits), users have a dominant strategy to not cooperate and free ride independently of whether the others cooperate or not. In natural resource management contexts, such situations are represented by the proverbial "Tragedy of the Commons" (Hardin 1968), which has been used both to predict the overexploitation of open access resources and the under-provision of environmental public goods.

### 2.2. AES and the public good provision level of collective action

AES can be understood as involving different levels of collective action (see Fig. 1). At the broader level, there is the cooperation required to provide the ecosystem services targeted by the AES. From a political economy perspective, provision decisions include whether to supply a good or service, and in which qualities and quantities (Ostrom et al. 1994). Ecosystem services often have properties of public goods (e.g., water quality, biodiversity, carbon storage/sequestration) and their provision is usually associated to prisoner's dilemma situations (Stallman 2011). Public goods are enjoyed openly regardless of whether individuals have contributed to their provision and this creates an incentive not to provide them, even if those goods would be largely beneficial to everyone. AES (and PES more broadly) can be understood as a response to the inability of farmers to overcome dilemmas at this level. The ES providers, i.e., landowners, are paid in compensation or reward for an individual effort that generates environmental amenities beyond their private sphere (Vatn 2010, Carmona-Torres et al. 2011). In other words, the rewards are used to reduce incentives to free ride on the provision of environmental public goods from which the public at large, including them, benefits.

Some scholars have explicitly built and tested collective action theory in the PES context with mixed results. For instance, Narloch et al. (2012) shows with experimental data that individual rewards can crowd-in cooperative behavior vis–à-vis the provision of agri-environmental services. Alternatively, Blanco et al. (2018) find, also based on economic experiments, that external rewards do not have a substantial effect on voluntary contributions to an environmental public good; and Muradian (2013) argues that the effects of economic incentives on social dilemmas in the PES context depend on the "social meanings" of said incentives, which are context- and culture-dependent.

### 2.3. AES and the production level of collective action

At a lower level, there is the collective action associated to AES that require coordination among farmers in the implementation or production process. From a political economy perspective, the production of public goods and services involves operational decisions that have to do with how those goods and services are delivered. The effectiveness of some AES, such as those promoting pest control, pollination, biodiversity corridors, or the maintenance of certain landscape elements such as hedge rows or water streams, can considerably increase if produced by neighboring landowners following certain spatial patterns (Parkhurst et al. 2002, Parkhurst and Shogren 2007, Banerjee et al. 2012). Said increased effectiveness is due to the existence of increasing ecological returns to scale, or agglomeration effects (Parkhurst et al. 2002, Schmidtner et al. 2012). Assuming that farmers are already willing to participate in the AES, doing so according to certain spatial or temporal patterns can be understood as a coordination dilemma, i.e., one that confronts farmers with the need of information about the desired pattern and each other's intentions to follow it.

Some economic experiments have addressed the feasibility of promoting agglomeration effects via AES. In a series of pioneering experiments, Parkhurst and colleagues (Parkhurst et al. 2002, Parkhurst and Shogren 2007, Warziniack et al. 2007) tested the effects of an agglomeration bonus mechanism that paid an extra compensation for every acre a landowner retired that borders on any other retired acre. As they found, farmers participating in the no-bonus mechanism always created fragmented habitats, whereas those with the bonus system were able to reach the optimal habitat reserve. In turn, Baneerje and colleagues (Banerjee et al. 2014, Banerjee 2018) explored the effects of information and experience (among other aspects) on spatial coordination under the bonus mechanism in laboratory experiments. They found that coordination increased with information about others' behavior and capacity to coordinate but decreased with experience. Outside of the context of agglomeration effects studies, Rommel and Anggraini (2018) explored spatial coordination of cropping decisions via an experiment with Indonesian farmers and found that leading by example and sanctioning institutions could promote said coordination. Häfner and Piorr (2021) found that farm and farmer characteristics such as the degree of professionalization can notably affect the interest of farmers in coordination conditional on the type of assisting external organization.

Scholars have also explored the coordinated production of ecosystem services conceptually and/or via non-experimental methods. Stallman (2011) analyzed the suitability for collective management of fourteen agricultural-based ES based on ES traits such as (i) whether they benefit farmers directly, (ii) the number of farmers needed to provide the services, (iii) and the potential to bundle the production of different services, among other factors. According to Mills et al. (2011), factors of importance for organizing and delivering collective agri-environment schemes are the pre-existence of social capital among farmers, institutional arrangements that limit group size and allow groups to develop their own solutions and implementation rules, and assistance from facilitators. Emery and Franks (2012) also found certain institutions, such as the scope of farmer involvement to be critical, and additionally highlight the importance of barriers such as the lack of communication, the cultural imperative for independence, and alternative interpretations of risk amongst farmers. Westerink et al. (2017) emphasize the importance of facilitators and point specifically to the role of professional farmer or governmental organizations. The importance of social aspects is also highlighted in Ferranto et al. (2013) and Stallman (2015), who showed that farmers' willingness to cooperate depends on livelihood types, with whom farmers have to cooperate, positive experiences with extension service agents, or membership in community organizations, among other factors. Similar conclusions are reached by del Corso et al. (2017), who found that collective action can work in favor of AES acceptance if used early on to "convince participants that the recommended practices are feasible, reasonable and, in the end, socially acceptable (cognitive legitimation)." (p. 197).

**Table 1**
Attributes of the choice experiment.

| Attributes | Description | Levels |
|---|---|---|
| *Location of trees* | Location of trees along the border of the farm of a neighboring participant. | 1. Coordinated<br>2. Not coordinated |
| *Share of farm* | Percentage of farm dedicated to the measure. | 1. 1%<br>2. 5%<br>3. 10% |
| *Recommendation* | Whether the program has been selected over others by a reference group. | 1. Recommended by farmers<br>2. Recommended by scientists<br>3. No particular recommendation |
| *Payment for action* | Annual individual payment in € per hectare, in addition to the reimbursement of planting costs and other governmental subsidies. | 1. 50<br>2. 100<br>3. 150<br>4. 200 |

**Table 2**
Attitudinal questions as they proxy for sensitiveness to collective action challenges.

| Variable name | Question: From 1 to 5, to which extent do you agree with the following statements…? | Collective action level |
|---|---|---|
| *Neighplant* | *Most of the farmers in this county would be interested in the tree planting measure* | Public good |
| *Neighcoord* | *In case me and my neighbors participated in the measure, coordinating to plant the trees by the same location would be easy* | Implementation: Coordinated location |
| *Neighconsent* | *Obtaining the consent from my neighbors so I could plant the trees by the border of our land would be easy* | Implementation: Border externality |

Additionally, there is the coordination required to internalize externalities that emerge from the production of conservation practices (Davies et al. 2004, Kuhfuss et al. 2014, Stallman and James, 2015). In some situations, such as the implementation of organic agriculture, biological pest control, rewetting of grasslands and peatlands, or the maintenance of certain landscape elements, farmers may affect or may be affected by their neighbors' activities. Externalities can bear on the AES participant for example when transgenic seeds or plant protection substances trespass the field of an AES participant who wants to label their produce as GMO-free or who must comply with regulation regarding cross-pollination. The opposite can be also the case, if hedgerows that are maintained by a farmer in the context of a biodiversity AES host weeds or certain insects and these affect the neighboring plots. Internalizing those external effects requires that farmers coordinate, i.e., share information, consent to each other's actions or even compensate each other.

Designing AES to compensate or prevent the above externalities is challenging. They are not only difficult to predict but may also vary depending on local socio-ecological conditions. Moreover, AES can only coordinate the behavior of those who participate in the programs, i.e., coordination with neighboring non-participants should be tackled on an ad hoc basis and outside the programs. That may explain why this collective action problem has remained relatively unexplored in studies of AES.

## 3. Methods and data

### 3.1. Empirical setting

In this paper, we combine results from a discrete choice experiment (DCE) with survey questions on perceptions and attitudes towards cooperation in the context of AES. In the DCE, respondents were asked to choose one among three options, including two versions of a tree planting program and a no-participation (i.e., opt-out) option. In our study, farmers were invited to (hypothetically) implement a "tree planting measure" (Table 1). The measure fulfilled a series of requirements, including: applicability in different contexts, familiarity for farmers, potential for soil, water and biodiversity conservation, possibility to be used for agricultural production if desired by the farmer, and possibility for coordination across farms/farmers. In the experiment, farmers were asked to decide whether to participate in the program or not twelve times (i.e., choice sets), each with different versions (i.e., alternatives) of the tree planting program. The alternatives were characterized by five attributes, one of which was the annual compensation payment the farmer would receive for planting and maintaining the trees. Our analysis focuses on one of the other four attributes, which described the location of the trees (see Villamayor-Tomas et al., 2019a for an analysis of the full ensemble of attributes). The location of trees could be "coordinated", or "not coordinated" with the neighboring farmer. Coordinated means that the farmer had to plant the trees close to the farm border adjacent to the tree planting area of the neighboring farmer. Not coordinated, in contrast, means that the farmer could plant the trees by the border but without any coordination with the neighboring farmers. Coordination implies higher transaction costs, as described above. Table 1 briefly describes the other three attributes of the experiment, although these are not directly related to coordination and thus not in the focus of this analysis (see Villamayor-Tomas et al., 2019a for details). The experiment included three levels of collective action. First, it included the prisoner's dilemma of whether participating in the tree planting programs, which was expected to contribute to the provision of water, biodiversity or soil conservation services (Plieninger et al. 2012, Muhamad et al. 2014, Barrios et al. 2018), depending on the alternative. Second, the experiment required that those participating in the program plant the trees by the border, which implicitly created an externality risk on their neighbors (e.g., in the form of a higher likelihood of weed concentration and dispersal) and thus the potential need

**Table 3**
Descriptive statistics of survey data (raw data).

| Variables | Survey item | Mean |
|---|---|---|
| **Explanatory** | | |
| Othersplant | Other farmers are interested in participating in the AES (binary transformation; strongly disagree = 0; else = 1) | 0.54 |
| Neighconsent | My neighbors will easily consent to plant the trees by the border (binary transformation; strongly disagree = 0; else = 1) | 0.44 |
| Neighcoor | Coordinating with my neighbors to plant the trees in the same location would be easy (binary transformation; strongly disagree/somewhat disagree = 0; else = 1) | 0.38 |
| **Control** | | |
| Treegood | Trees not for production are particularly good for the environment (binary transformation; strongly disagree/somewhat disagree = 0; else = 1) | 0.71 |
| Treebad | Trees no for production have negative effects on agricultural production (binary transformation; strongly disagree/somewhat disagree = 0; else = 1) | 0.39 |
| Treegroup | Trees not for production can only have a significant effect on the environment if they are grouped (binary transformation; strongly disagree/somewhat disagree = 0; else = 1) | 0.34 |
| Havetree | Have trees not for production in farm? (binary transformation; Yes = 1; No = 0) | 0.81 |
| Farmsize | Spatial extent of cultivable farm area (log ha) | 3.2 |
| Farmdepend | Income that comes from farming activities (%) | 60.3 |
| Numberneigh | Log number of neighbors to the farm | 1.8 |

Note: The distribution of Neighconsent and Othersplant was negatively skewed. See Appendix for descriptive statistics raw data.

to avoid conflicts via coordination. Third, the experiment included the possibility that farmers also need to coordinate to plant the trees by the same location along the border (i.e., the "coordinated location" attribute).

The attitudinal survey aimed to capture farmers' sensitivity towards the first, second and third collective action levels of the experiment (see Table 2). These included farmers' perceptions about: their neighbors' willingness to participate in the program; their neighbors' willingness to coordinate to plant the trees (if participating in the program); and the difficulty to obtain their neighbors' consent to plant the trees by the border.

The DCE was applied in two cantons of Switzerland – Zurich and Aargau (see Fig. A1 in Appendix). In Switzerland, direct payments to farmers are conditioned on the implementation of "Ecological Compensation Areas" (ECA). Contrary to the European EFA regulations, the Swiss regulations require that farmers devote at least 7% of their farm to ECAs and the full direct payment is conditioned on that (in the EU, only 30% of the direct payments depend on compliance with the EFA requirement). ECAs may consist of a variety of biotopes such as extensive grasslands, traditional orchards, hedges, field margin strips, conservation headlands, ditches, stone walls or unpaved roads. Most frequent biotopes included under ECA are low-intensity meadows (49% of ECA area) and extensively used meadows (41%).

Contacts were obtained from public authorities and the surveys were delivered via a letter to 1,500 farmers that included a link to an online survey. The instructions of the survey comprised descriptions of the AES goals and a detailed overview of the tree planting measure and attributes. Special emphasis was put (i) on the possibility to cut the trees down if desired after the end of the program and to reconvert land to the former uses, and (ii) on the complementary nature of the payments, i.e. in addition to any other governmental payments they would receive. More details on the theory behind DCEs, the survey including the DCE, the attributes and the statistical design and the farmer population are explained in Villamayor-Tomas et al. (2019a).

### 3.2. Econometric approach

Our econometric approach consists of two analyses. First, we estimate a conditional logit model with interaction terms (McFadden 1973). In the model, the dependent variable is the choice made by the farmer and the independent variables are the attributes from the DCE. Using the maximum likelihood method, we estimate parameters for the independent variables. These parameters explain the influence of the variables on choosing an AES. The conditional logit model is appropriate here, as the dependent variable is binary (chosen/ not chosen) and commonly used to analyze DCEs[1]. The results explain to what extent the requirement of coordination reduces the willingness to participate. Additionally, we add four interaction terms. The interaction terms are created by multiplying the coordination attribute as well as the alternative-specific constant (a variable reflecting the willingness to participate independently of the attributes) with the survey variables (Table 2). The interaction terms aim to explain the influence of collective action attitudes at the three levels on participation and the willingness to coordinate. Finally, we also include a series of socio-economic and attitudinal control variables (see Table A1 in Appendix).

Second, we analyze the factors that influence serial non-participation in the proposed AES with and without coordination. In a first step, we identify respondents who (i) never opted for an AES, and those who (ii) never opted for an AES with the coordination requirement. We then use these variables as dependent variables in two binary logit models to explain which factors influence opting out. The independent variables in this model are the same as the interaction terms from the conditional logit model.

The first and the second model provide different insights. The conditional logit model shows the additional compensation required so that farmers will participate in the AES. The binary logit model focuses on those who never participate and explores whether coordination had anything to do with those decisions.

## 4. Results

### 4.1. Descriptive results

The number of systematic dropouts (i.e., respondents who never opted for an AES) was relatively high, reaching about 40% of the sample. Also, around 90% of the farmers disagreed with the statement that "most of the farmers in this county would be interested in the tree planting measure" ("Othersplant"; see also Table 3); 78% disagreed with the statement that "obtaining the consent of my neighbors so I could plant trees in the border of our farms would be easy" ("Neighconsent"); and about 60% of the participants disagreed with the statement that "in case me and my neighbors participated in the tree planting measure, coordinating to choose where to plant the trees along the border would be easy" ("Neighcoor").

[1] As this model is well documented and frequently applied in the literature, we do not provide mathematical details on the model properties and estimation procedure. We refer the interested reader to Train (2009) and Hensher et al. (2005).

**Table 4**
Conditional logit regression models explaining willingness to participate (WTP).

| | (1) | (2) | (3) |
|---|---|---|---|
| | Participation interactions | Coordination interactions | Full |
| ASC | −0.750** | −0.594* | −0.757** |
| | (0.362) | (0.332) | (0.374) |
| ASC*Dropout | −20.58*** | −19.58*** | −19.27*** |
| | (0.302) | (0.210) | (0.300) |
| Share of farm | −0.0883*** | −0.0905*** | −0.0898*** |
| | (0.0238) | (0.0242) | (0.0240) |
| Coordinated location | −0.0967 | −0.200** | −0.132 |
| | (0.0833) | (0.0869) | (0.0929) |
| Farmer recommended | 0.372*** | 0.376*** | 0.379*** |
| | (0.0786) | (0.0785) | (0.0803) |
| Scientist recommended | −0.317*** | −0.317*** | −0.322*** |
| | (0.0918) | (0.0912) | (0.0930) |
| Payment | 0.713*** | 0.730*** | 0.729*** |
| | (0.127) | (0.130) | (0.130) |
| ASC*Othersplant | 0.0947 | | −0.185 |
| | (0.373) | | (0.381) |
| ASC*Neighconsent | 0.274 | | 0.324 |
| | (0.330) | | (0.342) |
| ASC*Neighcoord | 0.990*** | | 1.000*** |
| | (0.307) | | (0.368) |
| Coordinated Location*Othersplant | | 0.289 | 0.342* |
| | | (0.189) | (0.178) |
| Coordinated Location*Neighconsent | | 0.0352 | −0.0572 |
| | | (0.147) | (0.138) |
| Coordinated Location*Neighcoord | | 0.271** | −0.00734 |
| | | (0.125) | (0.154) |
| Coordinated Location*Farmdepend | | 0.00498*** | 0.00368* |
| | | (0.00190) | (0.00204) |
| Coordinated Location*Havetrees | | −0.472*** | −0.474** |
| | | (0.177) | (0.217) |
| Observations | 4752 | 4752 | 4752 |
| *AIC* | 1792.6 | 1827.3 | 1791.4 |
| *BIC* | 1902.5 | 1937.2 | 1966.0 |
| Chi squared | 15458.4 | 20249.1 | 13493.6 |
| Log. Lik. Null Model | −1740.2 | −1740.2 | −1740.2 |
| Log. Lik. | −879.3 | −896.6 | −868.7 |

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Note: the control variables (i.e., in interaction with the ASC and the "coordinated location" attribute) that were not significant in any of the models are not displayed to facilitate readability. See Table A3 (Appendix) for full models.

There are some correlations between the three explanatory variables (see Table A2 in Appendix). Farmers who were optimistic about the willingness of other farmers to participate in the tree planting measures ("Othersplant") also tended to believe that obtaining the consent from their neighbors to plant trees by the border ("Neighconsent") or coordinating the location of the trees in case both participated in the program would be easy ("Neighcoor"). Also, both the belief that trees not for production can have beneficial effects on the environment ("Treegood") and having trees not for production ("Havetree") were significantly associated with the three explanatory variables.

### 4.2. Regression results

We estimated three conditional logit models explaining willingness to participate (WTP). The models differ in the number of interaction terms included (Table 4). The full model includes both (i) the interactions between the general willingness to participate (ASC) and the three attitudinal variables under study, and (ii) the interactions between the coordination attribute and the three attitudinal variables. All models include an interaction between the ASC (general willingness to participate) and "Dropout" (whether a farmer systematically dropped out), to control for the behavior of farmers who were unconditionally against participation in any of the offered conservation programs. The other two models include just one set of interactions and are displayed for informative purposes. The analysis here focuses on the full model in the last column.

According to the full model, the coefficient of the ASC is negative and significant, meaning that there is a general reluctance of farmers to participate in the conservation programs. Also, the coefficient of the "coordinated location" attribute has a negative effect. This means that farmers are more reluctant to participate in the conservation programs when these require coordinated implementation (i.e., coordinated location of trees). However, the effect is statistically not significant. The coefficients of other attributes had the expected sign (Villamayor-Tomas et al., 2019a).

The coefficient of the interaction term "ASC*Neighcoor" is significant and positive, meaning that farmers who believe that coordinating with their neighbors to implement the tree planting measure would be relatively easy are more likely to participate in the program. This is the case regardless of whether the program requires coordinated

**Table 5**
Binary logit regression of systematic drop-out participants.

| | (1) | (2) |
|---|---|---|
| | Dropped out in all choice sets | Dropped out in all choice sets or never chose coordinated location program |
| Othersplant | −0.971* | −1.596*** |
| | (0.545) | (0.557) |
| Neighconsent | −0.693 | −0.589 |
| | (0.536) | (0.542) |
| Neighcoor | −0.788* | −1.283*** |
| | (0.470) | (0.476) |
| Farmdepend | 0.0130* | 0.00387 |
| | (0.00714) | (0.00749) |
| Constant | 0.105 | 0.417 |
| | (1.257) | (1.276) |
| Observations | 132 | 132 |
| *AIC* | 162.4 | 152.7 |
| *BIC* | 194.2 | 184.4 |
| Chi squared | 39.50 | 52.14 |
| Log. Lik. Null Model | −89.97 | −91.43 |
| Log. Lik. | −70.22 | −65.37 |

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Note: Control variables that were not significant in any of the models are not displayed to facilitate readability. See Table A4 (Appendix) for full models

implementation or not. The difference between the “ASC” and “ASC*Neighcoor” coefficients is positive, meaning that those farmers may be willing to participate in the programs even in the absence of payments.

The coefficient of the interaction term “Coordinated Location*Othersplant” is significant and positive, meaning that the general resistance of farmers to participate in programs that require coordinated implementation is ameliorated by the belief that other farmers will participate in the program. In other words, farmers who believe that other farmers will participate in the program are less resistant to be involved in coordinated implementation.

Among the control variables, only the interaction terms of “Coordinated Location*Farmdepend” and “Coordinated location*Havetrees” is significant. The positive effect of the first interaction indicates that the more a farmer’s income depends on farming activities the more he/she will be willing to participate in coordinated implementation programs. The negative effect of the second interaction indicates that farmers who already have trees not for production in their farms are more reluctant to participate in coordinated implementation programs than otherwise.

Model 1 in Table 5 displays the results of an exploratory analysis of participants who systematically opted out (i.e., who did not choose any of the two conservation programs in all twelve choice sets), regardless of whether programs included coordinated implementation or not. According to the model, both “Othersplant” and “Neighcoor” are negatively related to systematic drop out behavior. In other words, farmers who are optimistic about other farmers’ interest in the tree planting measure and those who believe that coordinated implementation of the program would be easy were less frequently opposed to participating in the program than otherwise. Alternatively, dependence on farm income (“Farmdepend”) is positively related to systematic drop out and significant, meaning that dependence on farming makes farmers more likely to unconditionally reject any of the offered conservation programs. These three variables were the only among all ten survey variables included in the study that turned out to be significant. Model 2 includes participants who never choose a program that required coordination. Expectedly, the effects of “Othersplant” and “Neighcoor” are even stronger, meaning that the belief that others would participate in the program or that coordinated implementation would be easy also constitutes a difference between those who are systematically opposed to coordination and those who are less so.

## 5. Discussion

### 5.1. The importance of collective action expectations

As shown in Section 4.1, an overwhelming majority of the participants in the experiment has low expectations about the willingness of their neighbors to act collectively in the context of AES. Also, the systematic drop-out models show that, among all the potentially relevant variables (both attributes and survey variables), only those related to collective action expectations have explanatory power (i.e., farmers with low expectations are more likely to systematically drop out). These findings support the general understanding that collective action barriers are not trivial and tend to discourage participation in AES programs (Villanueva et al. 2015b, Villamayor-Tomas et al. 2019a), which throws a rather pessimistic view to the potential of AES to promote insurance services at the landscape scale (Zandersen et al. 2021).

An important policy implication of the above is the interest that policy makers invest more efforts to accommodate and modulate collective action expectations, e.g., via information campaigns or nudges that highlight the advantages of collective over individual measures. Policy makers can certainly provide support to farmers to coordinate and mediate conflicts – especially in cases where trust among farmers is low (Westerink et al. 2017, Häfner and Piorr 2021). However, our results indicate that without additional efforts to address disbeliefs in successful collective action, the uptake of collective AES might remain low.

On a brighter side, our results also show that coordination is not an unsurmountable barrier to participation in AES programs. The conditional logit models show that the negative impact of coordinated implementation on willingness to participate is only present among certain types of participants, i.e., those who are not optimistic about the willingness of others to participate in conservation programs at large. Indeed, among those who are optimistic, the coordinated implementation feature appears to be an incentive rather than a disincentive. This is also important from a policy perspective. Previous studies have pointed to the importance of investing in trust-building and cognitive legitimization processes in the context of collective AES (Del Corso et al. 2017). As suggested by our results, those investments could be done at the expense of lower payments without major losses in uptake.

Also importantly, a comparison of the "Havetrees" variable across the drop out and WTP models indicates that farmers who have trees on their land (either because they planted or just kept them from the previous landholder) would rather participate on their own than in a coordinated fashion with their neighbors. This finding qualifies expectations that environmental stewardship and interest in coordinated AES are associated. As mentioned in the introduction, one of the main justifications for the spatial coordination of conservation measures is the potential to increase their ecological effectiveness. Thus, farmers interested in environmental conservation (or just willing to maximize the ecological impact of their conservation efforts) should be interested in coordinated programs (Kuhfuss et al. 2014, Banerjee and Hanley 2015). Our results, however, suggest that this is not necessarily the case. It is possible that those farmers have expectations about the willingness of others to conserve or coordinate and in turn prefer to implement the measures on their own. Conservation programs shall pay attention to this possibility in order not to crowd out the environmental stewardship of such farmers. In the end, cross-boundary coordination is not the only way to facilitate agglomeration effects, as these can be achieved also within farms.

The above findings have again important policy implications. In the Netherlands, AES are exclusively administered through collectives, even for environmental goals that could be effectively pursued at farm level (e.g., soil protection). There is an ongoing policy debate about extending coordinated schemes following the Dutch model to other European countries (Martinéz et al. 2019). Although there may be administrative benefits from the collective implementation of AES at large, transplanting the Dutch model to other contexts would still carry the risk that farmers who are skeptical about others' willingness to coordinate drop out and reduce their overall engagement in land stewardship. The Dutch model is successful because it is flexible, inclusive, and accommodates for a heterogeneous farm population as well as regional variation (Bouma et al. 2020) Our results suggest that the successful implementation of models like the Dutch will critically depend on how they address farmers that are generally keen on environmental conservation practices and ecological effectiveness but remain skeptical about the possibility to coordinate with others.

Overall, our findings confirm previous research pointing to the importance of better understanding collective action beliefs (e.g., expectations about the willingness of others to coordinate and the benefits of it) in the context of collaborative management endeavors (Lubell 2005). We are not aware of other choice experiments testing the role of said beliefs in the context of collective AES. Thus, our findings regarding the low expectations of farmers about others' willingness to coordinate need to be taken with caution. As mentioned in the literature review section, studies to date have shown the importance of information (Banerjee et al., 2012, 2014) leadership and sanctions (Rommel and Anggraini 2018), and farm and farmer characteristics (Häfner and Piorr, 2021) on the "appetite" of farmers for coordination. A natural next step should therefore explore how those characteristics interact with collective action beliefs. Also, evidence from a wider diversity of contexts would help. Our findings are based on a regional case study and valid for a specific set of AES only. Ultimately, as evidence cumulates, meta-analyses on the matter (as in e.g., Mamine et al. 2020) would be promising, too.

### *5.2. Towards a multi-level collective action model of AES uptake decisions*

Our findings point to (i) the existence of collective action problems at different levels of the AES participation process (i.e., the provision and production levels), and (ii) the interest of understanding the influence of strategic behavior and associated factors (e.g., incentives, as well as attitudes) on AES uptake (Stallman 2011, Dessart et al. 2019). Although the generality of participants in our study show pessimistic expectations about collective action, these vary notably with the level of collective action. Expectations at the public good provision level (i.e., expectations about other farmers' WTP in the AES) are by far the most pessimistic ones, while expectations at the production level are less so. Expectations about coordinated implementation are the least pessimistic, followed by expectations about the internalization of externalities. Also, the impact of collective action expectations on systematic drop-out behavior varies depending on the collective action problem. As shown in the drop-out models, pessimistic expectations about collective action have large explanatory power with regard to the public good provision and coordinated implementation problems, but not with regard to the externality internalization problem. This aligns with the findings from the WTP models, which show the importance of expectations on the former two but not on the latter.

As pointed out by collective action scholars interested in community-based natural resource management, resource users need to solve certain collective action problems before addressing others (Ostrom et al. 1994). For example, water users in an irrigation system first need to communicate with each other (first order problem), then create water allocation rules (second order problem), and afterwards implement a system to enforce rule compliance (third order problem) (Villamayor-Tomas 2017). Our findings emphasize the interest of distinguishing between the public good provision and the coordinated implementation problem, but also indicate strong interrelations among these two problems, and the difficulty to assess which one preempts the other. In theory, farmers first need to decide whether to participate in the AES (first order, public good problem) and only then they may consider whether to coordinate to put the AES into practice (second order, coordinated implementation problem). In practice, however, things seem to be more complex. In many AES programs (including the programs in our experiment) farmers are confronted with both collective action problems at once (i.e., in one decision).

In our experiment, we found that farmers who are optimistic about the willingness of other famers to participate in an AES (public good provision problem), are also eager to coordinate in the production of the scheme. However, we also found that farmers who are optimistic about the possibility to produce the services in a coordinated fashion (coordinated production problem) are more eager to participate in any AES program at large. The strong correlations between expectations on the different types collective action problems (see Section 4.1) indicates that said expectations may be part of a broader attitude towards collaboration (confounding or latent variable). The correlations, however, are not very large, thus, it is also possible that we are dealing with different types of decision makers (farmers that are more concerned about the public good provision problem, and farmers that are more concerned about the coordinated production problem). Further research should disentangle these particularities.

Finally, there are some aspects of our study design that could be associated to our findings. The survey question that assessed expectations about coordinated implementation implicitly presumed that neighbors were actually willing to participate in the AES. Thus, farmers may have reported low expectations just because they did not believe that farmers would participate in the AES in the first place. Similarly, the attribute of "coordinated location" in the experiment also presumed that at least one neighbor (and maybe a number of them) would also be participating, and this might have been hard to believe for some of the farmers. Also, we decided not to explicitly mention the possibility of externalities among participants and non-participants in the instructions of the experiment since we already had a question addressing this in the post-experiment survey; whether this affected our results about (the lower relevance of) externality internalization expectations is unclear. Finally, it is also important to recognize that standard choice experiments like ours do not allow for communication or deliberation among farmers, which is a critical contributor of cooperation.

### 5.3. Methodical implication: Discrete Choice Experiments as a complement to economic experiments?

A large portion of the economic literature has relied on incentivized economic experiments to study collective action problems in the context of sustainable farming practices (Colen et al. 2016). Incentivized economic experiments can explicitly account for the existence of strategic interactions and social dilemmas among resource users at different scales. At the global and national scales (e.g., for the provision of national or global public goods such as carbon sequestration) interactions among users exist (every climate change mitigation action counts) but are not very salient to the users. However, at a smaller scale, e.g., within a farming community or a water catchment, interactions are much more salient. The effects of farmers' decisions on the provision of local public goods such as plant protection or wetland maintenance can be particularly immediate and visible. By the same token, the potential for spatial coordination as well as the existence of positive and negative externalities across farms are rather evident. At this scale, common pool resource and public good experiments can be useful, particularly if they incorporate spatial aspects, for instance by placing participants in networks or on grids and/or targeting neighboring relationships (e.g., Parkhurst and Shogren 2007 in the AES context; or Janssen et al. 2011 in the natural resource management context).

In many instances – and arguably especially in industrialized and high-income countries – the study of strategic interactions via economic experiments is empirically challenging. It is financially costly, and it usually requires that participants are in the same place at the same time or that they are at least connected online. Adding a spatial dimension, creates additional challenges in terms of programming, feedback, dynamics, and comprehension. Additionally, there is the challenge of recruiting participants, e.g., farmers. Farmers specifically have relatively high opportunity costs, which has often resulted in small samples, increasing the risk of false inferences and underpowered study designs, especially if expected effect sizes are small.

Discrete choice experiments can address some of the above problems. Farmers can answer a survey individually (not everyone has to be present at the same time), and no incentives contingent on behavior are needed. Compared to incentivized economic experiments, it is often also easier to introduce participants to the context and to mitigate concerns about artificiality and over-simplification often brought up against such experiments. In a DCE, the involved trade-offs are often not obvious to the respondents, which can also mitigate strategic response bias. In addition, cheap talk scripts and budget reminders can alleviate hypothetical bias. Efficient designs informed by good priors, can ensure high statistical power. Often, there are five or more choice sets a respondent is confronted with, generating additional data. In conclusion, DCEs may complement economic experiments not only as a valuation method but also as a tool to investigate strategic decision-making under simplified assumptions as we have demonstrated with this study.

## 6. Conclusions

In this study, we have tested the influence of collective action problems on AES uptake by distinguishing those problems in different regards: (i) the public good provision problem, which manifests in the decision of farmers of whether to participate in an AES or not; (ii) the coordinated production problem, which occurs, for example, when conservation practices need to follow certain spatial patterns across borders; and (iii) the externality production problem, which emerges when farmers (i.e., those who participate in AES and those who do not) need to internalize externalities related to the AES requirements. Given this framing, our research question was: How do collective action problems at different levels affect AES uptake decisions? To answer this question, we carried a choice experiment and post-experimental survey among 163 Swiss farmers. The experiment included a "coordinated location" attribute and the survey included several questions aiming at capturing expectations of participants towards the feasibility of collective action vis–à-vis the public good, coordinated implementation and externality problems.

Our first take home message is that farmers' expectations about others' interest in collective action should not be taken for granted. We find that a considerable majority of farmers has pessimistic expectations about the feasibility of collective action regardless of the type of collective action problem. On the one hand, this constitutes an unfertile ground, if the goal of future conservation policies schemes is to promote participation in collective AES. On the other hand, better understanding the causes of those expectations and broader "collective action beliefs" (which include also expectations about the benefits of collective action) could shed light on ways to pave the way for participation. This is especially important in case AES aim at enhancing resilience at the landscape scale, thereby providing insurance against a loss of biodiversity and ecosystem services (Quaas et al. 2019).

Our second take home message is that the distinction of types of collective action problems can be useful to understand the potential of collective AES and collective action beliefs more systematically. We find that pessimistic expectations about public good provisioning and coordinated implementation have substantial explanatory power of systematic drop-out behavior (farmers who decided not to participate in any AES program, regardless of their features and compensation). This illustrates that said expectations and associated collective action problems play a critical role in the decisions of certain farmers (40% in our sample). Policies that reassure these farmers that other farmers are willing to participate and/or to coordinate the implementation of the schemes may thus considerably contribute to enhance participation.

Also, we find that optimistic collective action expectations at the public good and coordinated implementation levels contribute to AES uptake in their own ways but also interact. Farmers who are optimistic about collective public good provision would participate in coordinated AES even in the absence of extra compensation; and farmers with optimistic expectations about coordinated implementation are also eager to participate in AES at large.

As a final note, this study illustrates the interest of moving forward with a behavioral perspective on agri-environmental policy that takes into account strategic decision making in general, and norms and expectations about others' behavior in particular. Despite the momentum for analyzing non-economic motivations and "neighborhood effects" in the study of AES (Kuhfuss et al. 2016, Chabé-Ferret et al. 2019, Le Coent et al. 2021), little research has looked at the role of those factors and other behavioral aspects (such as expectations and beliefs) when the AES require coordinated implementation. Further research should build on our findings and focus more systematically, for example, on whether there are different types of farmers depending on said behavioral aspects. Scholars should also clarify the decision-making process that explains uptake in the context of multi-level collective action problems (i.e., whether there is an ordering of collective action problems across the provision and production levels, and/or within the production level). Scholars could also amend, qualify or further develop our classification of collective action problems in the AES context. As pointed out here, we believe choice experiments offer much potential to address strategic decision-making aspects of collective AES uptake. One way forward could be to include more sophisticated pre- and/or post-experiment survey protocols (e.g., that include for example risk assessment or trust games). Another way forward would include integrating behavioral aspects in the choice alternatives as done in Villamayor-Tomas et al. (2019a) or in the sampling of subjects. As it is usually the case in social sciences there is much to learn from other research programs. In our view, a clear reference here would be the behavioral literature on public good and common pool resource experiments (Henrich et al. 2001, Cárdenas and Ostrom 2004, Castillo and Saysel 2005, Basurto et al. 2016).

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## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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**Table A1**
Descriptive statistics (raw data)

| Variables | Mean | SD | Min | Max |
|---|---|---|---|---|
| **Explanatory** | | | | |
| Othersplant | 1.62 | 0.64 | 1 | 4 |
| Neighconsent | 1.57 | 0.75 | 1 | 4 |
| Neighcoor | 2.12 | 0.91 | 1 | 4 |
| **Control** | | | | 4 |
| Treegood | 2.81 | 0.8 | 1 | 4 |
| Treebad | 2.3 | 0.86 | 1 | 4 |
| Treegroup | 2.15 | 2.15 | 1 | 4 |
| Havetree | 1.78 | 0.73 | 1 | 4 |
| Farmsize | 37.87 | 100.5 | 5 | 1196 |
| Farmdepend | 60.31 | 31.8 | 0 | 100 |
| Numberneigh | 9 | 9 | 1 | 80 |

**Table A2**
Correlation coefficients among explanatory (italics) and control survey variables

| | *1* | *2* | *3* | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| *1.Othersplant* | 1 | | | | | | | | | |
| *2.Neighconsent* | 0.649* | 1 | | | | | | | | |
| *3.Neighcoor* | 0.380* | 0.373* | 1 | | | | | | | |
| 4.Treegood | 0.207* | 0.199 | 0.186* | 1 | | | | | | |
| 5.Treebad | -0.015 | -0.018 | -0.117* | -0.321* | 1 | | | | | |
| 6.Treegroup | 0.007 | 0.099* | 0.016 | 0.018 | 0.171* | 1 | | | | |
| 7.Havetree | 0.167 | 0.146* | 0.233* | 0.132* | 0.022 | -0.018 | 1 | | | |
| 8.Farmsize | -0.135* | -0.030 | 0.076* | 0.041 | 0.050 | -0.064* | 0.105* | 1 | | |
| 9.Farmdepend | -0.144* | -0.121* | -0.029 | 0.066* | 0.012 | 0.001 | 0.101* | 0.315* | 1 | |
| 10.Numberneigh | -0.115* | -0.138* | -0.106* | -0.084* | -0.039 | -0.071* | -0.042 | 0.321* | 0.191* | 1 |

* $p < 0.05$
n=147

**Table A3**
Conditional logit regression (all interactions displayed)

| | (1) | (2) | (3) |
|---|---|---|---|
| | Participation interactions | Coordination interactions | Full |
| ASC | -0.750** | -0.594* | -0.757** |
| | (0.362) | (0.332) | (0.374) |
| ASC*Dropout | -20.58*** | -19.58*** | -19.27*** |
| | (0.302) | (0.210) | (0.300) |
| Share of farm | -0.0883*** | -0.0905*** | -0.0898*** |
| | (0.0238) | (0.0242) | (0.0240) |
| Coordinated location | -0.0967 | -0.200** | -0.132 |
| | (0.0833) | (0.0869) | (0.0929) |
| Farmer recommended | 0.372*** | 0.376*** | 0.379*** |
| | (0.0786) | (0.0785) | (0.0803) |
| Scientist recommended | -0.317*** | -0.317*** | -0.322*** |
| | (0.0918) | (0.0912) | (0.0930) |
| Payment | 0.713*** | 0.730*** | 0.729*** |
| | (0.127) | (0.130) | (0.130) |
| ASC*Othersplant | 0.0947 | | -0.185 |
| | (0.373) | | (0.381) |
| ASC*Neighconsent | 0.274 | | 0.324 |
| | (0.330) | | (0.342) |
| ASC*Neighcoord | 0.990*** | | 1.000*** |

(*continued on next page*)

**Table A4**
Conditional logit regression without drop-outs (all variables displayed)

| | (1) | (2) |
|---|---|---|
| | Dropped out in all choice sets | Dropped out in all choice sets or never chose coordinated location program |
| Othersplant | -1.596*** | -0.971* |
| | (0.557) | (0.545) |
| Neighconsent | -0.589 | -0.693 |
| | (0.542) | (0.536) |
| Neighcoor | -1.283*** | -0.788* |
| | (0.476) | (0.470) |
| Farmsize | 0.0471 | -0.130 |
| | (0.400) | (0.405) |
| Farmdepend | 0.00387 | 0.0130* |
| | (0.00749) | (0.00714) |
| Numberneigh | 0.346 | 0.362 |
| | (0.333) | (0.310) |
| Havetrees | 0.512 | 0.0237 |
| | (0.591) | (0.555) |
| Treegood | -0.586 | -0.802 |
| | (0.540) | (0.505) |
| Treebad | 0.0180 | -0.0570 |
| | (0.504) | (0.484) |
| Treegroup | 0.501 | 0.615 |
| | (0.471) | (0.456) |
| Constant | 0.417 | 0.105 |
| | (1.276) | (1.257) |
| Observations | 132 | 132 |
| *AIC* | 152.7 | 162.4 |
| *BIC* | 184.4 | 194.2 |
| Chi squared | 52.14 | 39.50 |
| Log. Lik. Null Model | -91.43 | -89.97 |
| Log. Lik. | -65.37 | -70.22 |

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Note: Farmsize and Numberneigh are the log of the original variables to avoid disproportionate effect of outliers.

**Table A3** (*continued*)

| | (1) | (2) | (3) |
|---|---|---|---|
| | Participation interactions | Coordination interactions | Full |
| | (0.307) | | (0.368) |
| ASC*Farmsize | -0.187 | | -0.247 |
| | (0.140) | | (0.175) |
| ASC*Farmdepend | 0.00736 | | 0.00438 |
| | (0.00455) | | (0.00498) |
| ASC*Numberneigh | -0.230 | | -0.137 |
| | (0.303) | | (0.332) |
| ASC*Havetree | -0.379 | | 0.0405 |
| | (0.421) | | (0.508) |
| ASC*Treegood | -0.145 | | -0.0966 |
| | (0.409) | | (0.466) |
| ASC*Treebad | -0.306 | | -0.379 |
| | (0.331) | | (0.366) |
| ASC*Treegroup | -0.388 | | -0.434 |
| | (0.310) | | (0.351) |
| Coordinated Location*Othersplant | | 0.289 | 0.342* |
| | | (0.189) | (0.178) |
| Coordinated Location*Neighconsent | | 0.0352 | -0.0572 |
| | | (0.147) | (0.138) |
| Coordinated Location*Neighcoord | | 0.271** | -0.00734 |
| | | (0.125) | (0.154) |
| Coordinated Location*Farmsize | | -0.00532 | 0.0730 |
| | | (0.0779) | (0.102) |
| Coordinated Location*Farmdepend | | 0.00498*** | 0.00368* |
| | | (0.00190) | (0.00204) |
| Coordinated Location*Numberneigh | | -0.149 | -0.113 |
| | | (0.116) | (0.125) |
| Coordinated Location*Havetrees | | -0.472*** | -0.474** |
| | | (0.177) | (0.217) |
| Coordinated Location*Treegood | | -0.0884 | -0.0638 |
| | | (0.109) | (0.121) |
| Coordinated Location*Treebad | | -0.0267 | 0.0767 |
| | | (0.119) | (0.124) |
| Coordinated Location*Treegroup | | -0.0627 | 0.0503 |
| | | (0.123) | (0.137) |
| Observations | 4752 | 4752 | 4752 |
| *AIC* | 1792.6 | 1827.3 | 1791.4 |
| *BIC* | 1902.5 | 1937.2 | 1966.0 |
| Chi squared | 15458.4 | 20249.1 | 13493.6 |
| Log. Lik. Null Model | -1740.2 | -1740.2 | -1740.2 |
| Log. Lik. | -879.3 | -896.6 | -868.7 |

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Note: Farmsize and Numberneigh are the log of the original variables to avoid disproportionate effect of outliers.

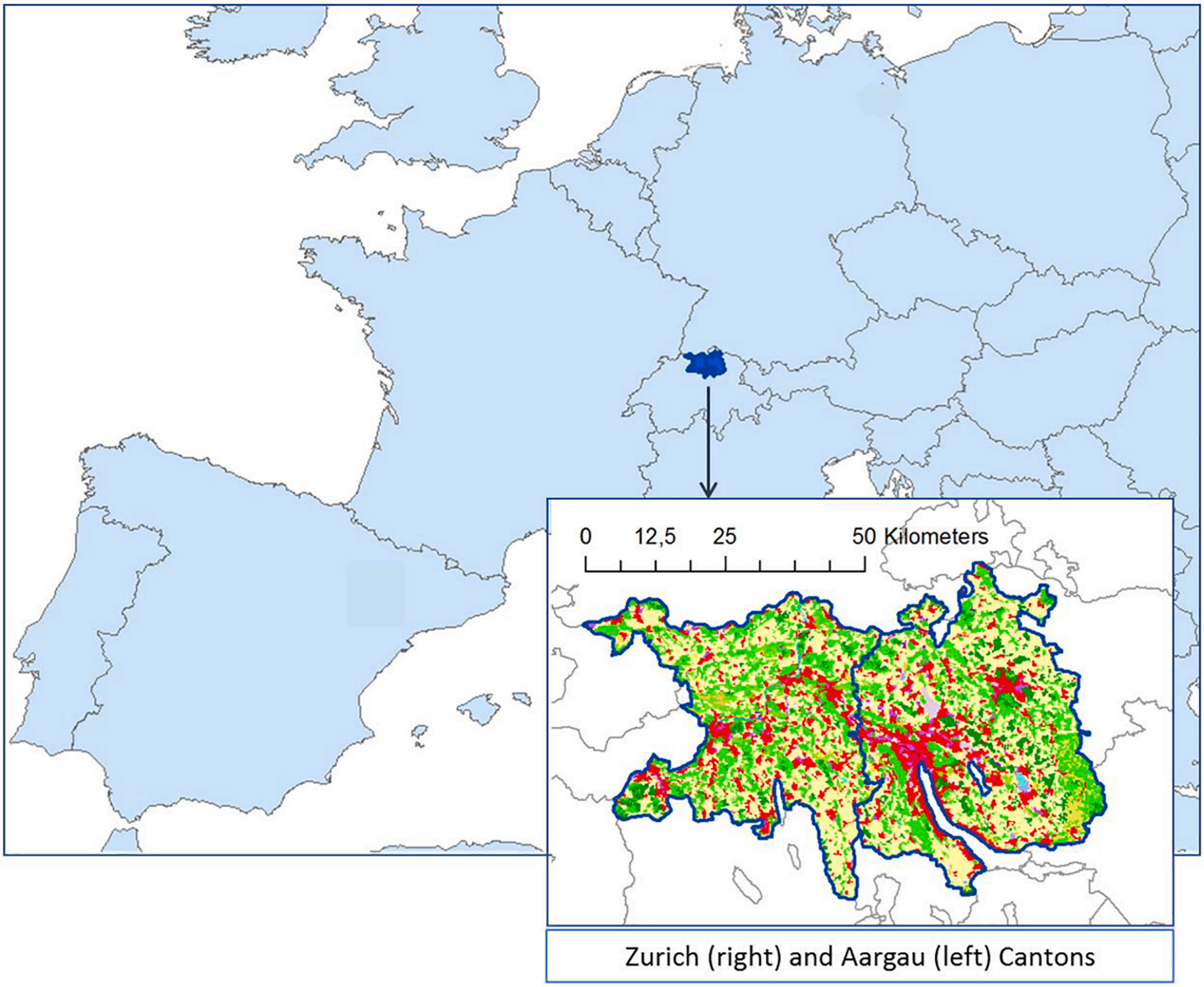


**Fig. A1.** Location of sampling sites: cantons of Zurich and Aargau, Switzerland. Note: Colors represent different land uses, adapted from CORINE Land Cover dataset: [red] constructed, [dark green] forest, [light green] grassland, [light yellow] arable land.

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## Appendix

## References

Araral, E., 2014. Ostrom, Hardin and the commons: a critical appreciation and a revisionist view. Environ. Sci. Policy 36, 11–23.

Bamière, L., David, M., Vermont, B., 2013. Agri-environmental policies for biodiversity when the spatial pattern of the reserve matters. Ecol. Econ. 85, 97–104.

Banerjee, S., 2018. Improving spatial coordination rates under the agglomeration bonus scheme: a laboratory experiment with a pecuniary and a Non-Pecuniary Mechanism (NUDGE). Am. J. Agric. Econ. 100 (1), 172–197.

Banerjee, S., Hanley, N., 2015. The effects of peer group information and group size on spatial coordination in agri-environment schemes: a laboratory experimental study of the Agglomeration Bonus. In: 17th Annual BIOECON Conference Biodiversity, Ecosystem Services and Sustainability. King's College, Cambridge, England.

Banerjee, S., Kwasnica, A.M., Shortle, J.S., 2012. Agglomeration bonus in small and large local networks: A laboratory examination of spatial coordination. Ecol. Econ. 84, 142–152.

Banerjee, S., Vries, F.P., Hanley, N., Soest, D.P., 2014. The impact of information provision on agglomeration bonus performance: an experimental study on local networks. Am. J. Agric. Econ. 96 (4), 1009–1029.

Barrios, E., Valencia, V., Jonsson, M., Brauman, A., Hairiah, K., Mortimer, P.E., Okubo, S., 2018. Contribution of trees to the conservation of biodiversity and ecosystem services in agricultural landscapes. Int. J. Biodiversity Sci., Ecosyst. Serv. Manage. 14 (1), 1–16.

Basurto, X., Blanco, E., Nenadovic, M., Vollan, B., 2016. Integrating simultaneous prosocial and antisocial behavior into theories of collective action. Sci. Adv. 2 (3), e1501220. https://doi.org/10.1126/sciadv.1501220.

Baumgärtner, S., Strunz, S., 2014. The economic insurance value of ecosystem resilience. Ecol. Econ. 101, 21–32.

Beedell, J., Rehman, T., 2000. Using social-psychology models to understand farmers' conservation behaviour. J. Rural Stud. 16 (1), 117–127.

Blanco, E., Haller, T., Walker, J.M., 2018. Provision of environmental public goods: unconditional and conditional donations from outsiders. J. Environ. Econ. Manage. 92, 815–831.

Bouma, J.A., Nguyen, T.T.B., van der Heijden, E., Dijk, J.J., 2020. Analysing group contract design using a threshold public goods experiment. Eur. Rev. Agric. Econ. 47 (3), 1250–1275.

Bowles, S., 2009. Microeconomics: Behavior, Institutions, and Evolution. Princeton University Press.

Cárdenas, J.-C., Ostrom, E., 2004. What do people bring into the game? Experiments in the field about cooperation in the commons. Agric. Syst. 82 (3), 307–326.

Carmona-Torres, C., Parra-López, C., Groot, J.C.J., Rossing, W.A.H., 2011. Collective action for multi-scale environmental management: achieving landscape policy objectives through cooperation of local resource managers. Landscape Urban Plann. 103 (1), 24–33.

Castillo, D., Saysel, A.K., 2005. Simulation of common pool resource field experiments: a behavioral model of collective action. Ecol. Econ. 55 (3), 420–436.

Chabé-Ferret, S., Le Coënt, P., Reynaud, A., Subervie, J., Lepercq, D., 2019. Can we nudge farmers into saving water? Evidence from a randomised experiment. Eur. Rev. Agric. Econ. 46 (3), 393–416.
Chen, X., Lupi, F., He, G., Liu, J., 2009. Linking social norms to efficient conservation investment in payments for ecosystem services. Proc. Natl. Acad. Sci. 106 (28), 11812–11817.
Christensen, T., Pedersen, A.B., Nielsen, H.O., Mørkbak, M.R., Hasler, B., Denver, S., 2011. Determinants of farmers' willingness to participate in subsidy schemes for pesticide-free buffer zones—a choice experiment study. Ecol. Econ. 70 (8), 1558–1564.
Colen, L., Gomez y Paloma, S., Latacz-Lohmann, U., Lefebvre, M., Préget, R., Thoyer, S., 2016. Economic experiments as a tool for agricultural policy evaluation: insights from the European CAP. Canadian Journal of Agricultural Economics/Revue canadienne d'agroeconomie 64 (4), 667–694.
Dallimer, M., Martin-Ortega, J., Rendon, O., Afionis, S., Bark, R., Gordon, I.J., Paavola, J., 2020. Taking stock of the empirical evidence on the insurance value of ecosystems. Ecol. Econ. 167, 106451.
Davies, B., Blackstock, K., Brown, K., Shannon, P., 2004. Challenges in Creating Local Agri-Environmental Cooperation Action Amongst Farmers and other Stakeholders. The Macaulay Institute, Aberdeen.
Defrancesco, E., Gatto, P., Runge, F., Trestini, S., 2008. Factors affecting farmers' participation in agri-environmental measures: a northern italian perspective. J. Agric. Econ. 59 (1), 114–131.
Del Corso, J.-P., Nguyen, T.D.P.G., Kephaliacos, C., 2017. Acceptance of a payment for ecosystem services scheme: the decisive influence of collective action. Environ. Values 26 (2), 177–202.
Dessart, F.J., Barreiro-Hurlé, J., van Bavel, R., 2019. Behavioural factors affecting the adoption of sustainable farming practices: a policy-oriented review. Eur. Rev. Agric. Econ. 46 (3), 417–471.
Dörschner, T., Musshoff, O., 2013. Cost-oriented evaluation of ecosystem services under consideration ofincome risks and risk attitudes of farmers. J. Environ. Manage. 127, 249–254.
Falconer, K., 2000. Farm-level constraints on agri-environmental scheme participation: a transactional perspective. J. Rural Stud. 16 (3), 379–394.
Ferranto, S., Huntsinger, L., Getz, C., Lahiff, M., Stewart, W., Nakamura, G., Kelly, M., 2013. Management without borders? A survey of landowner practices and attitudes toward cross-boundary cooperation. Society Natural Resour. 26 (9), 1082–1100.
Gabriel, D., Sait, S.M., Hodgson, J.A., Schmutz, U., Kunin, W.E., Benton, T.G., 2010. Scale matters: the impact of organic farming on biodiversity at different spatial scales. Ecol. Lett. 13 (7), 858–869.
Goldman, R.L., Thompson, B.H., Daily, G.C., 2007. Institutional incentives for managing the landscape: inducing cooperation for the production of ecosystem services. Ecol. Econ. 64 (2), 333–343.
Grammatikopoulou, I., Pouta, E., Myyrä, S., 2016. Exploring the determinants for adopting water conservation measures. What is the tendency of landowners when the resource is already at risk? J. Environ. Plann. Manage. 59 (6), 993–1014.
Häfner, K., Piorr, A., 2021. Farmers' perception of co-ordinating institutions in agri-environmental measures – the example of peatland management for the provision of public goods on a landscape scale. Land Use Policy 107, 104947. https://doi.org/10.1016/j.landusepol.2020.104947.
Hardin, G., 1968. The tragedy of the commons. Science 162 (5364), 1243–1248.
Hayes, T., Grillos, T., Bremer, L.L., Murtinho, F., Shapiro, E., 2019. Collective PES: More than the sum of individual incentives. Environ. Sci. Policy 102, 1–8.
Henrich, J., Boyd, R., Bowles, S., Camerer, C., Fehr, E., Gintis, H., McElreath, R., 2001. In search of Homo economicus: behavioral experiments in 15 small-scale societies. American Econ. Rev. 91 (2), 73–78.
Hensher, D.A., Rose, J.M., Greene, W.H., 2005. Applied Choice Analysis: A Primer. Cambridge University Press.
Hynes, S., Garvey, E., 2009. Modelling farmers' participation in an agri-environmental scheme using panel data: an application to the rural environment protection scheme in Ireland. J. Agric. Econ. 60 (3), 546–562.
Jaeck, M., Lifran, R., 2009. Preferences, Norms and Constraints in farmers' agro-ecological choices. Case study using a choice experiments survey in the Rhone River Delta, France. Universtiy of Montpellier, LAMETA.
Janssen, M.A., Anderies, J.M., Cardenas, J.-C., 2011. Head-enders as stationary bandits in asymmetric commons: comparing irrigation experiments in the laboratory and the field. Ecol. Econ. 70 (9), 1590–1598.
Kabii, T., Horwitz, P., 2006. A review of landholder motivations and determinants for participation in conservation covenanting programmes. Environ. Conserv. 33 (1), 11–20.
Knowler, D., Bradshaw, B., 2007. Farmers' adoption of conservation agriculture: a review and synthesis of recent research. Food Policy 32 (1), 25–48.
Kuhfuss, L., Preget, R., Thoyer, S., 2014. Préférences individuelles et incitations collectives: quels contrats agroenvironnementaux pour la réduction des herbicides par les viticulteurs? Revue d'Études en Agriculture et Environnement 95 (01), 111–143.
Kuhfuss, L., Préget, R., Thoyer, S., Hanley, N., Coent, P.L., Désolé, M., 2016. Nudges, social norms, and permanence in agri-environmental schemes. Land Econ. 92 (4), 641–655.
Lastra-Bravo, X.B., Hubbard, C., Garrod, G., Tolón-Becerra, A., 2015. What drives farmers' participation in EU agri-environmental schemes?: Results from a qualitative meta-analysis. Environ. Sci. Policy 54, 1–9.
Le Coent, P., Preget, R., Thoyer, S., 2021. Farmers follow the herd: A theoretical model on social norms and payments for environmental services. Environ. Resour. Econ. 78, 287–306.
Loft, L., Gehrig, S., Le, D.N., Rommel, J., 2019. Effectiveness and equity of payments for ecosystem services: real-effort experiments with Vietnamese land users. Land Use Policy 86, 218–228.
Lubell, M., 2005. Do watershed partnerships enhance beliefs conducive to collective action? In: Sabatier, P.A., Focht, W., Lubell, M., Trachtenberg, Z., Vedlitz, A., Matlock, M. (Eds.), Swimming Upstream: Collaborative Approaches to Watershed Management. The MIT Press, Cambridge, MA, pp. 201–232.
Mäler, K.-G., Li, C.-Z., 2010. Measuring sustainability under regime shift uncertainty: a resilience pricing approach. Environ. Dev. 15 (6), 707–719.
Mamine, F., Fares, M., Minviel, J.J., 2020. Contract design for adoption of agrienvironmental practices: A meta-analysis of discrete choice experiments. Ecol. Econ. 176, 106721.
Martinéz, J., Weingarten, P., Balmann, A., Birner, R., Christen, O., Gauly, M., Grethe, H., Latacz-Lohmann, U., Nieberg, H., Pischetsrieder, M., 2019. Administrative simplification of the EU Common Agricultural Policy-possibilities, approaches and constraints. Berichte über Landwirtschaft-Zeitschrift für Agrarpolitik und Landwirtschaft.
McFadden, D., 1973. Conditional logit analysis of qualitative choice behavior.
Mills, J., Gibbon, D., Ingram, J., Reed, M., Short, C., Dwyer, J., 2011. Organising collective action for effective environmental management and social learning in Wales. J. Agric. Educ. Extension 17 (1), 69–83.
Muhamad, D., Okubo, S., Harashina, K., Parikesit, B.G., Takeuchi, K., 2014. Living close to forests enhances people[U+05F3]s perception of ecosystem services in a forest-agricultural landscape of West Java, Indonesia. Ecosyst. Serv. 8, 197–206.
Muradian, R., 2013. Payments for ecosystem services as incentives for collective action. Society Natural Resour. 26 (10), 1155–1169.
Muradian, R., and E. Gómez-Baggethun. 2013. The Institutional Dimension of "Market-Based Instruments" for Governing Ecosystem Services: Introduction to the Special Issue. Society & Natural Resources 26(10):1113–1121.
Narloch, U., Pascual, U., Drucker, A.G., 2012. Collective action dynamics under external rewards: experimental insights from Andean farming communities. World Dev. 40 (10), 2096–2107.
Ohl, C., Drechsler, M., Johst, K., Wätzold, F., 2008. Compensation payments for habitat heterogeneity: existence, efficiency, and fairness considerations. Ecol. Econ. 67 (2), 162–174.
Ostrom, E., 1990. Governing the Commons: The Evolution of Institutions for Collective Action. Cambridge University Press, Cambridge, MA.
Ostrom, E., Gardner, R., Walker, J., 1994. Rules, Games and Common Pool Resources. Michigan University Press, Michigan.
Paavola, J., Primmer, E., 2019. Governing the provision of insurance value from ecosystems. Ecol. Econ. 164, 106346. https://doi.org/10.1016/j.ecolecon.2019.06.001.
Parkhurst, G.M., Shogren, J.F., Bastian, C., Kivi, P., Donner, J., Smith, R.B.W., 2002. Agglomeration bonus: an incentive mechanism to reunite fragmented habitat for biodiversity conservation. Ecol. Econ. 41 (2), 305–328.
Parkhurst, G.M., Shogren, J.F., 2007. Spatial incentives to coordinate contiguous habitat. Ecol. Econ. 64 (2), 344–355.
Plieninger, T., Schleyer, C., Mantel, M., Hostert, P., 2012. Is there a forest transition outside forests? Trajectories of farm trees and effects on ecosystem services in an agricultural landscape in Eastern Germany. Land Use Policy 29 (1), 233–243.
Prager, K., Posthumus, H., 2010. Socio-economic factors influencing farmers' adoption of soil conservation practices in Europe. Human Dimen. Soil Water Conserv. 203–223.
Prokopy, L.S., Floress, K., Klotthor-Weinkauf, D., Baumgart-Getz, A., 2008. Determinants of agricultural best management practice adoption: evidence from the literature. J. Soil Water Conserv. 63 (5), 300–311.
Quaas, M., Baumgärtner, S., De Lara, M., 2019. Insurance value of natural capital. Ecol. Econ. 165, 106388. https://doi.org/10.1016/j.ecolecon.2019.106388.
Rommel, J., Anggraini, E., 2018. Spatially explicit framed field experiments on ecosystem services governance. Ecosyst. Serv. 34, 201–205.
Santos, R., Clemente, P., Brouwer, R., Antunes, P., Pinto, R., 2015. Landowner preferences for agri-environmental agreements to conserve the montado ecosystem in Portugal. Ecol. Econ. 118, 159–167.
Sattler, C., Nagel, U.J., 2010. Factors affecting farmers' acceptance of conservation measures—a case study from north-eastern Germany. Land Use Policy 27 (1), 70–77.
Schaub, S., Buchmann, N., Lüscher, A., Finger, R., 2020. Economic benefits from plant species diversity in intensively managed grasslands. Ecol. Econ. 168, 106488. https://doi.org/10.1016/j.ecolecon.2019.106488.
Schmidtner, E., Lippert, C., Engler, B., Häring, A.M., Aurbacher, J., Dabbert, S., 2012. Spatial distribution of organic farming in Germany: does neighbourhood matter? Eur. Rev. Agric. Econ. 39 (4), 661–683.
Schneider, F., Ledermann, T., Fry, P., Rist, S., 2010. Soil conservation in Swiss agriculture—approaching abstract and symbolic meanings in farmers' life-worlds. Land Use Policy 27 (2), 332–339.
Sheeder, R.J., Lynne, G.D., 2011. Empathy-conditioned conservation:"Walking in the shoes of others" as a conservation farmer. Land Econ. 87 (3), 433–452.
Stallman, H.R., 2011. Ecosystem services in agriculture: determining suitability for provision by collective management. Ecol. Econ. 71, 131–139.
Stallman, H.R., James, H.S., 2015. Determinants affecting farmers' willingness to cooperate to control pests. Ecol. Econ. 117, 182–192.
Train, K.E., 2009. Discrete Choice Methods with Simulation. Cambridge University Press, Cambridge MA, Page Identity.
Uetake, T., 2013. Managing Agri-environmental Commons through Collective Action: Lessons from OECD Countries. 14th Global Conference of the International Association for the Study of the Commons.

Unterberger, C., Olschewski, R., 2021. Determining the insurance value of ecosystems: a discrete choice study on natural hazard protection by forests. Ecol. Econ. 180, 106866. https://doi.org/10.1016/j.ecolecon.2020.106866.
Uthes, S., Matzdorf, B., 2013. Studies on Agri-environmental Measures: a Survey of the Literature. Environ. Manage. 51 (1), 251–266.
Vatn, A., 2010. An institutional analysis of payments for environmental services. Ecol. Econ. 69 (6), 1245–1252.
Villamayor-Tomas, S., 2017. Disturbance features, coordination and cooperation: an institutional economics analysis of adaptations in the Spanish irrigation sector. J. Inst. Econ. 1–26.
Villamayor-Tomas, S., Sagebiel, J., Olschewski, R., 2019a. Bringing the neighbors in: A choice experiment on the influence of coordination and social norms on farmers' willingness to accept agro-environmental schemes across Europe. Land Use Policy 84, 200–215.
Villamayor-Tomas, S., Thiel, A., Amblard, L., Zikos, D., Blanco, E., 2019b. Diagnosing the role of the state for local collective action: types of action situations and policy instruments. Environ. Sci. Policy 97, 44–57.
Villanueva, A., Gómez-Limón, J.A., Arriaza, M., Rodríguez-Entrena, M., 2015a. Assessment of greening and collective participation in the context of agri-environmental schemes: The case of Andalusian irrigated olive groves. Span. J. Agric. Res. 13 (4), 3.
Villanueva, A.J., Gómez-Limón, J.A., Arriaza, M., Rodríguez-Entrena, M., 2015b. The design of agri-environmental schemes: Farmers' preferences in southern Spain. Land Use Policy 46, 142–154.
Walker, B., Holling, C.S., Carpenter, S., Kinzig, A.P., 2004. Resilience, adaptability and transformability in social–ecological systems. Ecol. Soc. 9 (2), 5.
Warziniack, T., Shogren, J.F., Parkhurst, G., 2007. Creating contiguous forest habitat: an experimental examination on incentives and communication. J. Forest Econ. 13 (2-3), 191–207.
Wauters, E., Bielders, C., Poesen, J., Govers, G., Mathijs, E., 2010. Adoption of soil conservation practices in Belgium: an examination of the theory of planned behaviour in the agri-environmental domain. Land Use Policy 27 (1), 86–94.
Westerink, J., Jongeneel, R., Polman, N., Prager, K., Franks, J., Dupraz, P., Mettepenningen, E., 2017. Collaborative governance arrangements to deliver spatially coordinated agri-environmental management. Land Use Policy 69, 176–192.
Zandersen, M., Oddershede, J.S., Pedersen, A.B., Nielsen, H.Ø., Termansen, M., 2021. Nature based solutions for climate adaptation - paying farmers for flood control. Ecol. Econ. 179, 106705. https://doi.org/10.1016/j.ecolecon.2020.106705.