Land Use Policy 160 (2026) 107846

Contents lists available at ScienceDirect

Land Use Policy

journal homepage: www.elsevier.com/locate/landusepol

Private funding for soil health: Private individuals' preferences for ecosystem services and biodiversity certificates

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ARTICLE INFO

Dataset link: Discrete Choice Experiment data on soil health and biodiversity improvements in agriculture

Keywords:
Agriculture
Biodiversity
Blending
Bundling
Discrete choice experiment
Willingness to pay
Soil health

ABSTRACT

Achieving improvements in soil health and biodiversity on agricultural land in the European Union, as outlined in the EU Soil Strategy for 2030 and the EU Biodiversity Strategy for 2030, requires bridging the current funding gap through increased private investment. Yet the funding potential of private individuals remains largely untapped, partly due to a lack of attractive funding opportunities and well-designed incentives. Conducting a Discrete Choice Experiment with 1627 residents in Germany, we elicit private individuals' stated preferences for investing in soil health and biodiversity improvements in agriculture via certificates offered through an existing online marketplace. Respondents exhibit significant mean willingness to pay for the attributes characterising these certificates. Bundling multiple soil management-related ecosystem services and biodiversity improvements into a single certificate increases mean willingness to pay relative to stand-alone improvements, though the magnitude varies due to significant preference heterogeneity. Our results further suggest that blended finance, i.e. combining private and public funding, may stimulate greater private individual participation. A latent class analysis reveals the presence of four segments, with older, less educated and male respondents showing the lowest willingness to pay. This study highlights the untapped potential of mobilising funding from private individuals to enhance soil health and biodiversity in. Our results provide valuable insights for policymakers on designing innovative funding mechanisms aligned with EU agri-environmental policy targets.

1. Introduction

The EU Biodiversity Strategy for 2030 (European Commission, 2020a) and the EU Soil Strategy for 2030 (European Commission, 2021), highlight an accelerating decline in ecosystem services (ES) provided by agricultural soils alongside farmland biodiversity loss. This trend negatively impacts soil health and undermines agricultural soils' capacity to provide ES essential to human well-being such as food security, ecosystem resilience and habitat for biodiversity (Brevik et al., 2018; European Commission, 2020b, 2023; IPBES, 2019). To recognise the value of healthy agricultural soils, the concept of 'soil-related ES' is useful (Paul et al., 2021), as it acknowledges that the provision of ES by soils depends on interactions among multiple ecosystem processes. For example, crop production relies not only on soil properties but also on factors such as sunlight and rainfall. It is also important to distinguish soil-related ES from 'soil management-related ES' to account for the role of soil management (Paul et al., 2021). Management actions – such as ploughing or irrigation, or introducing landscape features like hedgerows, flower strips and grass buffers – affect how soils, in combination with their properties and climatic conditions, supply ES and support biodiversity. While farmers often have an intrinsic motivation to maintain soil health and biodiversity on their land, soil management-related ES and biodiversity possess a "public or quasi-public good character" (Kroeger and Casey, 2007:329). Consequently, farmers face trade-offs, as changes in soil and land management typically entail additional costs (Bartkowski et al., 2020; Schwilch et al., 2018), requiring decisions between environmental preservation, maximising yields, or attempting to balance both.

Within the EU, publicly funded reward schemes – such as the agri-environmental and climate measures (AECM) under the second pillar of the Common Agricultural Policy (CAP) – compensate farmers for soil health- and biodiversity-enhancing measures (Pe'er et al., 2020).

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https://doi.org/10.1016/j.landusepol.2025.107846
Received 29 April 2025; Received in revised form 10 September 2025; Accepted 30 October 2025

Nevertheless, financial resources available through existing EU public funding schemes – such as the CAP – are insufficient (European Commission, 2025; Zu Ermgassen et al., 2025), fail to ensure the preservation of soil management-related ES and biodiversity (Pe'er et al., 2020) and lack the necessary flexibility (Zindler et al., 2024).

Given these limitations, the European Commission's recently published 'Roadmap towards Nature Credits' calls for complementary funding mechanisms (European Commission, 2025). Innovative market-based approaches that attract private funding are envisioned to help bridge the funding gap (IPBES, 2019; Seidl et al., 2024). In this context, ES and biodiversity marketplaces that use certificates as business model have emerged as promising tools to mobilise private funding while providing land managers with additional income streams (Chen et al., 2024; Krause and Matzdorf, 2019; Reed et al., 2022; Wunder et al., 2025). Acting as intermediaries or 'brokers', these platforms connect land managers (suppliers) with buyers interested in improved ES and biodiversity outcomes. In these systems, certificates represent standardised units that are traded on the marketplaces (Chen et al., 2024). Studies using the German online marketplace for nature conservation projects, AgoraNatura (https://agora-natura.de/en/), suggest that such platforms can lower transaction costs, increase accessibility, and ease participation (Chen et al., 2024; Krause and Matzdorf, 2019; see also Meißner and Winter, 2019). Despite their promise, funding raised through these business models remains limited, i.e. demand is low, and most investment originates from companies. Moreover, only a few private-sector initiatives have integrated soil management-related ES into their business models, leaving significant untapped potential to leverage funding for soil health. This is also the case for AgoraNatura, which has predominantly attracted investment from private companies and has only partially incorporated soil management-related ES into its business model. Attracting funding from private individuals – particularly for soil health and biodiversity certificates via online marketplaces such as AgoraNatura – has not yet been studied thoroughly. This presents a timely research gap, especially in light of the European Commission's 'Roadmap towards Nature Credits'. Examining preferences of private individuals for such certificates may not only contribute a new perspective to the literature but also help real world marketplaces attract funding from new customer segments.

To increase private funding and demand, the attractiveness and marketability of soil health and biodiversity certificates must improve. Two frequently discussed mechanisms are 'bundling' and 'stacking'. For a given area of land, bundling combines multiple environmental services within a single certificate (a "bundle"), whereas stacking creates multiple certificates, each for a single environmental service (Deal et al., 2012). In this study, we focus on bundling because it promotes a more holistic approach that manages and delivers multiple ES and biodiversity outcomes simultaneously, rather than isolating single services or outcomes (Deal et al., 2012; Kemkes et al., 2010). This approach recognises their interdependencies and synergies, as these often occur concurrently across a specific area or timeframe (Crouzat et al., 2015; Karimi et al., 2021; Raudsepp-Hearne et al., 2010). Furthermore, bundling can help demonstrate additionality by avoiding that environmental services are remunerated multiple times – or double counted – when they are provided simultaneously through the same environmental measure (Deal et al., 2012). Nevertheless, since bundles are technically a sum of environmental services, their design must be approached with caution. An overall gain within a bundle can mask the loss of a single service, carrying the risk of a net decrease in that specific service. (Drechsler, 2021). Moreover, research shows that private individuals are often unfamiliar with the mutual interdependencies of ES as well as the trade-offs that land managers face when accounting for soil management-related ES (Bartkowski et al., 2022; Schröder et al., 2020; Schulte et al., 2019). This lack of understanding makes it difficult to accurately capture private individuals' preferences for such services (Czajkowski et al., 2015; Lienhoop and Völker, 2016). Bundling soil management-related ES and biodiversity, may help communicate their interdependencies and synergies more effectively, reducing the perceived complexity of ES and making them more tangible to private individuals. Additionally, bundling can benefit land managers interested in offering biodiversity improvements, particularly given the inherent challenges in monetizing biodiversity (Wendland et al., 2010). With the exception of Tienhaara et al. (2020), there is limited knowledge about how bundling soil management-related ES and biodiversity improvements influence private individuals' preferences. Moreover, while some studies combine soil management-related ES (e.g. Bartkowski et al., 2022), they do not specifically focus on the role of bundling.

Another important aspect when aiming to increase private funding and improve current public funding mechanisms is how to better complement the two. The concept of *blending* – a mix of private and public funding – offers a promising approach to efficiently leverage private funding for ES and biodiversity outcomes (Reed et al., 2022). Blending can stimulate private funding by building trust in a marketplace, de-risking funding, lowering transaction costs and demonstrating additionality (Reed et al., 2022; zu Ermgassen et al., 2025). However, if not carefully designed, blending can result in crowding-out effects, where public funding displaces rather than enhances private funding. These effects remain empirically unclear and are highly context-dependent (de Wit and Bekkers, 2016). In the context of a marketplace for soil health and biodiversity certificates, the potential of blending to stimulate funding from private individuals has not been investigated yet. This represents a notable research gap.

To investigate the drivers of private individuals' demand for soil health and biodiversity certificates, we conduct a discrete choice experiment (DCE) examining their willingness-to-pay (WTP). DCEs are a well-established method for eliciting preferences for environmental goods that lack explicit market prices (Mariel et al., 2021). In the context of soil health, previous studies have investigated private individuals' WTP for improvements in soil management-related ES (Bartkowski et al., 2022; Eusse-Villa et al., 2021; Franceschinis et al., 2023; Tienhaara et al., 2020). However, to our knowledge, no studies have examined demand (i.e. WTP) for soil management-related ES and biodiversity improvements within the context of private business models such as certificate schemes. Thus, we seek to answer the question of what factors influence private individuals' WTP for soil health and biodiversity certificates. Specifically, we ask the following research questions:

- RQ1: How does bundling soil management-related ES and biodiversity affect private individuals' WTP?
- RQ2: How does the blending of private and public funding influence private individuals' WTP?

In this study, we use an operating online marketplace for nature conservation projects as the context for the DCE – specifically the platform AgoraNatura, which offers certificates representing environmental improvements on agricultural land. This approach aims to enhance the realism of our study, as it involves a real-world example of a market showcasing genuine financial transactions for ES and biodiversity certificates.

The paper is structured as follows: in chapter two, we describe our methodological approach including our survey and DCE design, data sample, and the empirical strategy for the analysis. Chapter three presents and chapter four discusses the results. Finally, chapter five summarises the results.

2. Method

To investigate preferences for soil health and biodiversity certificates, we conducted a DCE. DCEs are a survey-based method in which respondents are presented with a set of hypothetical alternatives, each featuring varying characteristics, from which they must choose their preferred alternative. Moreover, they are based on Lancaster's consumer theory, which posits that an individual derives the value of a good from its specific characteristics (i.e., from its attributes and levels) rather than from the good per se (Lancaster, 1966). In our case this refers to the utility a respondent obtains from the specific attributes and levels of a certificate when purchasing it. The econometric analysis of DCE-based data follows random utility theory (RUT) to account for unobserved random factors that may influence respondent preferences (McFadden, 1986). As a result, DCEs are useful tools for estimating private individuals' preferences for specific characteristics of a good, or in our case a soil health and biodiversity certificate. By including a price attribute, it is possible to estimate respondents' willingness-to-pay (WTP) for these characteristics (Louviere et al., 2000; Hensher et al., 2015) and the trade-offs they are willing to make between them (Bartkowski et al., 2020; Mariel, et al., 2021; Schulze et al., 2024).

2.1. DCE design – attribute and level selection

In our study, we framed the DCE scenarios as nature conservation projects in agriculture aimed at improving soil health and biodiversity. By choosing their preferred hypothetical alternative, respondents were able to indicate whether they would financially support these projects by purchasing certificates via the online marketplace AgoraNatura. Moreover, these alternatives were characterized by different attributes and levels, including a selection of specific soil management-related ES and biodiversity improvements, their bundles, and varying amounts of governmental support for these projects (i.e. public funding). The initial selection of our attributes and levels was guided by relevant literature and expert opinions in the field. Additionally, suggestions for the scenarios were obtained through participatory research conducted during the development of the AgoraNatura. Ultimately, we selected four attributes: 1) soil management-related ES 2) biodiversity, 3) funding, and 4) price.

The levels for the soil management-related ES attribute were selected based on Paul et al. (2021), who further developed the Common International Classification of Ecosystem Services (CICES) (Young and Potschin, 2018) with regards to soils. They defined, among other things, a subset of soil management-related ES. To verify our selection of soil management-related ES-levels, we subsequently conducted an expert interview. As a result, we selected the following three soil-management related ES levels: erosion control (CICES code: 2.2.1.1), pest control (CICES code: 2.2.3.1) and chemical composition of atmosphere and oceans (CICES code: 2.2.6.1) which refers to soil-carbon sequestration. Erosion control was included because approximately 61 %-73 % of agricultural soils in the EU are affected by it, with adverse effects for soil health. Pest control was selected because improved pest regulation by agricultural soils can reduce the use of environmentally harmful pesticide – an issue which we assumed private individuals would be at least somewhat familiar with. Soil-carbon sequestration was included because higher soil-carbon content contributes to improvements in both pest control and erosion control (European Commission, 2023). In the survey and DCE, we labelled the attribute "soil services" to enhance comprehensibility for respondents. The selection of biodiversity levels took inspiration from biodiversity improvements offered on AgoraNatura. Moreover, we wanted to ensure that the selected biodiversity indicators have mutual positive synergies for the soil management-related ES levels. We ultimately selected the following three biodiversity indicators[1]: 1) plant diversity, 2) animal diversity, and 3) pollination (CICES code: 2.2.2.1). We also considered genetic diversity, as used by AgoraNatura, but we did not include it in our DCE following expert consultations and indications from our focus groups discussions that it might be difficult to communicate to respondents. Moreover, we took into account that the selected biodiversity indicators could be improved by the same management measures that improve the selected soil management-related ES. This way, we aimed to further improve the realism of our bundling approach.

Using the work of Reed et al. (2022) as inspiration, the levels for the funding attribute were selected. These authors conducted a comparative analysis of existing or close to market ecosystem markets in Europe. Here we came across a funding mechanism called *'trigger funds'* which we found suitable to test the effects of blending on leveraging private funding. Trigger funds release public funding for a specific project only "if a certain level of private investment can be secured within a particular time frame" (Reed et al.:20). In our context, this meant informing respondents that the financing of a certificate could be subsidised by government funding, with each project potentially receiving different levels of funding. For instance, 30 % funding would mean that 30 % of the overall project costs are covered by the government, and 70 % must be covered by private funding (sold certificates). Moreover, we explained that the government would only provide funding if all project certificates were sold via AgoraNatura. We chose this mechanism because it has the potential to minimise crowding-out effects that public funding may have on private funding, as well as to demonstrate additionality. Finally, we selected the following three levels of public finding: 0 %, 15 %, 30 % and 45 %. These levels were based on expert opinion, with the goal of keeping the share of public funding below 50 % of overall project costs, in line with our approach to complement private with public funding, and not vice versa.

Lastly, we included a price attribute representing the cost of a certificate to measure respondents' WTP. Each certificate represented 100 m^2 of land and one year of project duration, drawing inspiration from the actual certificate prices of AgoraNatura. As a result, we selected the following levels: €5, €10, €25, €50, €75 and €100. The attributes and their levels are summarised in Table 1.

2.2. Survey design

Our survey was designed to provide respondents with sufficient information to make well-informed choices in the DCE, while also gathering additional data to contextualize their choices and test for anomalies. Part 1 gathered information on respondents' previous engagement with environmental projects, such as financial support for nature conservation or donations for environmental organizations. Part

Table 1
Summary of attributes and levels.

Attribute name	Levels (coding)
Soil services	No improvement (reference)
	Erosion control (dummy)
	Pest control (dummy)
	Soil-carbon storage (dummy)
	Erosion control and pest control (dummy)
	Erosion control and soil-carbon storage (dummy)
	Pest control and soil-carbon storage (dummy)
	Erosion control, pest control and soil-carbon storage (dummy)
Biodiversity	No improvement (reference)
	Plant diversity (dummy)
	Animal diversity (dummy)
	Pollination (dummy)
	Plant diversity and animal diversity (dummy)
	Plant diversity and pollination (dummy)
	Animal diversity and pollination (dummy)
	Plant diversity, animal diversity and pollination (dummy)
Funding	0 % (reference)
	15 % (dummy)
	30 % (dummy)
	45 % (dummy)
Price per certificate (100 m^2/year)	€5, €10, €25, €50, €75 or €100 (continuous)

[1] We do not assign a CICES code to our levels of plant diversity and animal diversity as they have no specific CICES code assigned unless for genetic material or nutrition but rather are acknowledged to support a number of regulation and maintenance services (Young and Potschin, 2018).

2 focused on respondents' perception of the importance of healthy agriculture soils and biodiversity for their own well-being, as well as their consumption behaviour regarding environmentally friendly produced food products. Part 2 also introduced the three soil management-related ES and biodiversity indicators included in the DCE. Part 3 introduced the online marketplace AgoraNatura and its role in facilitating private funding in agricultural nature conservation projects. Part 4 described the DCE, including the attributes, their respective levels, and the procedure. To reduce hypothetical bias, we used cheap talk, a repeated opt out reminder (ROOR) and the standard budget reminder (Alemu and Olsen, 2018; Börger et al., 2025; Cummings and Taylor, 1999). Part 5 consisted of follow-up questions designed to put respondents' choices during the DCE into context. Finally, *part 6* contained socio-demographic questions.

To improve our survey, we gathered feedback on its complexity and length through three separate focus group discussions. The discussions indicated that participants understood the presented attributes and their levels, and that these attributes are relevant for investigating preferences for soil health and biodiversity certificates. Furthermore, the feedback enabled us to assess the survey's length, determine the number of choice sets that could be presented to respondents, refine the attribute descriptions, and restructure the survey. We then developed our experimental design using the software Ngene (ChoiceMetrics, 2012). Following the literature in the DCE design (Mariel et al., 2021; Johnston et al., 2017; Scarpa and Rose, 2008) and incorporating input from the focus group discussions, we generated 24 choice sets based on a D-efficient fractional factorial design. These were divided into three blocks, where each respondent was presented with eight choice sets, and each choice set containing two alternatives and a status quo option. Priors for the design were generated from a pilot study involving 300 respondents. Before implementing the design in the main survey, we conducted simulation exercises using various sample sizes to assess the stability of the design in terms of its predictive ability on the priors used. Fig. 1 below shows an example of a choice set translated from German to English.

2.3. Data collection and sample

The final version of the survey was distributed online in October 2024 by the market research firm Kantar (https://www.kantar.com/de) to an existing online panel of German residents (i.e. private individuals), a target group the online marketplace AgoraNatura has thus far struggled to attract funding from. The survey was programmed using SurveyEngine software (https://surveyengine.com). In total, we received 1703 complete responses. Of these, ten were excluded for entering invalid postal codes, and three were excluded due to ambiguous postal codes corresponding to multiple German federal states. Table 2 provides some basic characteristics of the sample. The sample is representative of the German population in terms of age, gender, education, household size, and number of inhabitants by federal states (see Table A.1 in the Appendix A).

2.4. Empirical strategy

To analyse respondents' stated preferences for soil health and biodiversity certificates, and to calculate their respective WTP, we employ a random parameter logit model, estimated using the WTP-space (RP – MXL) specification – following Train and Weeks (2005) and Scarpa et al. (2008).

Applied to DCEs, RUT posits that in a given choice situation *t*, respondent *n* derives utility *U* by selecting alternative *r from M* available options, which is specified as:

$$U_{nrt} = - \quad \alpha_n p_{nrt} + \beta_n^{'} x_{nrt} + \epsilon_{nrt}, \tag{1}$$

where p_{nrt} is the price attribute with coefficient α_n, and x_{nrt} represents a vector of non-price attributes with associated coefficients $\beta_n^{'}$. The term ϵ_{nrt} represents the error term. As the variance of the error term may differ across respondents, we define $Var(\epsilon_{nrt}) = s_n^2(\pi^2/6)$, where s_n represents the scale parameter for respondent *n*. Dividing Eq. 1 by the scale parameter, we get:

$$U_{nrt} = - \quad (\alpha_n/s_n) \quad p_{nrt} + (\beta_n/s_n)' x_{nrt} + \epsilon_{nrt}. \tag{2}$$

Defining $\lambda_n = (\alpha_n/s_n)$ and $c_n = (\beta_n/s_n)$ simplifies Eq. (2) to:

$$U_{nrt} = \quad - \quad \lambda_n p_{nrt} + c_n^{'} x_{nrt} + \epsilon_{nrt} \tag{3}$$

where we assume ϵ_{nrt} to be independently and identically distributed (i.i.d.) with a Type 1 extreme value distribution. Eq. (3) expresses individuals' utility in preference space.

To express the above equation in WTP-space, the ratio of the non-price to price coefficients needs to be defined. That is, $w_n = (c_n/\lambda_n)$, which means $c_n = \lambda_n w_n$. Thus, utility in WTP space can be expressed as:

$$U_{nrt} = \quad - \quad \lambda_n p_{nrt} + (\lambda_n w_n)^{'} x_{nrt} + \quad \epsilon_{nrt}. \tag{4}$$

Choice models specified in WTP-space have become state-of-the art in the DCE literature due to their ability to provide more realistic behavioural explanations compared to models in preference space, particularly when the aim is to derive policy-relevant WTP estimates (Alemu and Olsen, 2018; Mariel et al., 2021).

The RP – MXL in WTP-space can capture preference heterogeneity across respondents by treating attribute parameters as random parameters, thereby "allowing for unobserved heterogeneity in the estimated parameters" (Mariel et al., 2021:67). We define $\lambda_n = \; - \exp(v_n)$, where v_n represents the unobserved random component of the price coefficient (see also Scarpa et al.,2008). Given that β stands for all random parameters estimated within the WTP-space model, Eq. (4) can be rewritten as:

$$U_{nrt} = V_{nrt}(\beta_n, x_{nrt}) + \epsilon_{nrt}, \tag{5}$$

where V_{nr} represents the indirect utility function, consisting of the attributes of the available alternatives, that is, $V_{nr} = \beta_n^{'} x_{nrt}$. Assuming that a price increase has a strict negative effect on utility, we specify a lognormal distribution for the price coefficient (λ_n). For the non-price attribute coefficients, we assume a normal distribution to allow for both negative and positive preferences, as suggested by the focus group discussions. The probability that respondent *n* selects alternative *r* from *M* available options choice scenario *t* is given by:

$$P_{nr} = \int \left(\frac{\exp(\beta_n^{'} X_{nrt})}{\sum_m^M \exp(\beta' X_{ntm})} \right) f(\beta) d\beta, \tag{6}$$

where the estimated coefficients β' differ across respondents and follow the density function $f(\beta)$ (Train, 2003).

Eq. (6) is estimated using a simulated maximum log-likelihood function due to the absence of a closed-form solution (Scarpa et al., 2008). The estimation was conducted using the Apollo package in R (Hess and Palma, 2019). For the random parameters, we used 2000 Sobol draws, which yielded globally stable parameter estimates and model performance, as increasing the number of draws did not alter the results. Starting values for the estimation were obtained from a simple multinomial logit model and Apollo's starting value search functions. In both cases, the results remained stable, allowing us to rule out the influence of varying starting value. A total of 63 respondents were excluded from the analysis due to protest responses. To be categorised as protester, respondents had to both (i) choose the status-quo alternative for all eight choice sets; (ii) select one of a specified set of options in a follow-up question only presented to those who consistently chose the status-quo alternative. Ultimately, the final sample used for analysis consisted of 1627 respondents.

In addition to preference heterogeneity across respondents, we analyse segment-based heterogeneity using a latent class model (LCM). As indicated by Glenk and Colombo (2011), LCMs are useful for

Which nature conservation project do you choose?

	Nature conservation project 1	Nature conservation project 2	Status quo
Soil services	Erosion control Soil-carbon storage	Pest control Soil-carbon storage	No improvements
Biodiversity	Plant diversity Animal diversity	Pollination	No improvements
Funding	15% through governmental funding 85% through sold certificates	30% through governmental funding 70% through sold certificates	No funding
Price per certificate (100m^2/year)	€50	€25	0€
Your choice			

Fig. 1. Example choice set.

Table 2
Descriptive statistics of sample (n = 1703).

Variable	Sample
Age	
Mean	49.5
Gender	
Female	50.4 %
Male	49.4 %
Diverse	0.1 %
Education	
Below Abitur[a]	48 %
Abitur or equivalent	26 %
Higher education	26 %
Household income per month(net)	
Below €1000	13 %
€1000 - €1500	18 %
€1500 - €2000	15 %
€2000 - €2500	16 %
€2500 - €3500	18 %
€3500 - €5000	14 %
above €5000	6 %
Main residence in Germany	
Baden-Württemberg	11 %
Bavaria	14 %
Berlin	6 %
Brandenburg	4 %
Bremen	0.9 %
Hamburg	3 %
Hesse	6 %
Mecklenburg-Vorpommern	2 %
Lower Saxony	12 %
North Rhine-Westphalia	18 %
Rhineland-Palatinate	5 %
Saarland	0.8 %
Saxony	6 %
Saxony-Anhalt	3 %
Schleswig-Holstein	3 %
Thuringia	2 %
NA[b]	0.8 %
Environmental organisations	
Currently donating to environmental organisation	32.4 %
Currently a member of an environmental organisation	13.7 %

Note: [a] 'Abitur' is a German high school diploma allowing you to pursue a degree in higher education. [b] NA = not applicable.

explaining the origins of preference heterogeneity. The LCM is a probabilistic model that estimates a respondent's probability of belonging to a predefined class (Boxall and Adamowicz, 2002, Mariel et al., 2021), thereby allowing us to examine whether respondents who share similar characteristics also tend to exhibit similar preferences. In the LCM, we included the following respondent characteristics[2]: age, gender, level of education and likelihood of purchasing environmentally certified goods. The class probability reflects the probability of a respondent belonging to a particular class, conditional on these characteristics. Similar to the RP-MXL model, the LCM was also estimated using the Apollo package in R (Hess and Palma, 2019). Further details on the specification of the LCM are provided in Appendix B.

3. Results

In the following we first present results from the RP-MXL model in WTP-space, followed by the results from the LCM, to address our research questions on how bundling soil management-related ES and biodiversity improvements, as well as blending private and public funding, affect private individuals' WTP for soil health and biodiversity certificates.

3.1. *WTP for single and bundles of soil management-related ES and biodiversity improvements*

Results from the RP-MXL model are presented in Table 3, showing the estimated mean WTP for soil management-related ES and biodiversity improvements. We note that preference heterogeneity is mainly observed for attributes representing bundled improvements, as indicated by their statistically significant standard deviation estimates. As a robustness check, we treated the insignificant standard deviation parameters as non-random and re-estimated the model. The results remained unchanged. Respondents exhibit a strong negative mean WTP for the status-quo option, indicating strong support for our choice sets. Among the single soil management-related ES improvements, the highest mean WTP is associated with pest control (€46.5/certificate),

[2] We tested a model that included income as a covariate; however, its inclusion did not yield a more parsimonious model in terms of interpretability and meaningfulness of the results. Moreover, including income did not affect class membership.

Table 3
WTP estimates from RP-MXL in WTP-space.

Parameter	Estimate
Mean WTP estimates (€/certificate)	
Alternative specific constant (status quo)	−124.5 (13.6)***
Erosion control	41.4 (3.1)***
Pest control	46.5 (4.0)***
Soil-carbon storage	22.5 (4.7)***
Erosion control and pest control	47.4 (4.8)***
Erosion control and soil-carbon storage	64.9 (3.6)***
Pest control and soil-carbon storage	72.4 (3.5)***
Erosion control, pest control and soil-carbon storage	74.2 (4.2)***
Plant diversity	54.3 (4.9)***
Animal diversity	54.5 (4.8)***
Pollination	38.0 (4.7)***
Plant diversity and animal diversity	68.9 (4.9)***
Plant diversity and pollination	62.2 (4.5)***
Animal diversity and pollination	68.4 (5.2)***
Animal diversity, plant diversity and pollination	80.7 (4.9)***
15 % of project costs covered by public funds.	13.2 (2.7)***
30 % of project costs covered by public funds	14.8 (3.4)***
45 % of project costs covered by public funds	15.9 (2.3)***
Log(price)	3.896 (0.079)***
Standard deviations	
Alternative specific constant (status quo)	168.7 (14.4)***
Erosion control	0.362 (0.517)
Pest control	0.694 (0.546)
Soil-carbon storage	52.223 (5.819)***
Erosion control and pest control	0.283 (0.486)
Erosion control and soil-carbon storage	0.172 (0.891)
Pest control and soil-carbon storage	0.043 (0.280)
Erosion control, pest control and soil-carbon storage	44.888 (7.359)***
Plant diversity	1.019 (0.653)
Animal diversity	5.396 (4.145)
Pollination	2.851 (2.025)
Plant diversity and animal diversity	20.268 (6.149)***
Plant diversity and pollination	22.197 (6.269)***
Animal diversity and pollination	0.038 (1.294)
Animal diversity, plant diversity and pollination	37.584 (8.481)***
15 % of project costs covered by public funds	0.553 (0.333)
30 % of project costs covered by public funds	0.649 (0.764)
45 % of project costs covered by public funds	0.231 (0.270)
Log(price)	0.528 (0.074)***
Model statistics	
Number of individuals	1627
Number of total observations	13016
Adjusted R-squared	0.166
Log-likelihood (null)	−14299.5
Log-likelihood (final)	−10632.1

Note: Standard errors are in parentheses. '***' denotes statistical significance at 5 % level or lower. Price is lognormally distributed. The estimated WTP values for ecosystem service and biodiversity attributes are relative to the reference level "No improvement," while for the funding attribute, they are relative to 0 % funding. Mean price can be calculated as $Mean_{price} = (-1) * \exp\left(\beta_{price} + \frac{\sigma^2}{2}\right)$, where β_{price} is the coefficient of the mean and σ is the coefficient of the standard deviation. It is multiplied by (–1), as price is expected to affect individuals' utility negatively according to theoretical predictions.

followed by erosion control (€41.4/certificate) and soil-carbon storage (€22.5/certificate). This suggests that respondents are willing to pay for improvements in pest control, erosion control and soil-carbon storage compared to maintaining the current state. Notably, the standard deviation estimate for soil-carbon storage indicates high preference heterogeneity among respondents in contrast to the pest control and erosion control levels. Regarding bundles of soil management-related ES improvements – addressing our RQ1 – mean WTP increases across all bundles compared to single ES improvements. Respondents are willing to pay approximately €65/certificate for a bundle combining soil-carbon storage with erosion control, and around €72/certificate when bundling soil-carbon storage with pest control, both compared to no improvements. These values represent a substantial increase relative to the single improvement of soil-carbon storage. Noteworthy, bundling all three soil management-related ES (erosion control, pest control and soil-carbon storage) leads to the highest mean WTP, at approximately €75/certificate, compared to single soil management-related ES and other respective bundles. This indicates that respondents exhibit the strongest preference for certificates that provide all three soil management-related ES simultaneously. Though, it is important to note that the difference in mean WTP between this "full" bundle and the other soil management-related ES bundles may not be statistically significant. The standard deviation estimate for this full bundle suggests significant preference heterogeneity. However, given that utility is additive, we acknowledge diminishing marginal utility of bundling soil management-related ES. Except for the two bundles of erosion control and soil-carbon storage as well as pest control and soil-carbon storage, the mean WTPs for the other bundles are lower than the sum of the respective mean WTPs for single soil management-related ES. In this context, we also note that the sum of all three mean WTPs for single soil management-related ES exceeds our highest price level per certificate.

Turning to biodiversity improvements, we observe that for single improvements, respondents are willing to pay an additional €38-€55 per certificate to achieve improvements in plant diversity, animal diversity and pollination. Moreover, bundling biodiversity enhances respondents' mean WTP, particularly for pollination. The mean WTP increases when pollination is bundled with plant diversity (€62.2/certificate) or with animal diversity (€68.4/certificate). As with soil-management-related ES, the bundle including all three biodiversity improvements (plant diversity, animal diversity and pollination) receives the highest mean WTP. Respondents are willing to pay an additional €81/certificate for these combined improvements compared to no improvements. Notably, all biodiversity bundles except for the bundle of animal diversity and pollination show significant standard deviations, indicating strong preference heterogeneity among respondents. Again, we acknowledge diminishing marginal utility of bundling biodiversity. The mean WTPs for all bundles are lower than the sum of the respective mean WTPs for single biodiversity improvements. Furthermore, we again note that the sum of all three mean WTPs for single biodiversity improvements exceeds our highest price level per certificate.

For some attribute levels we observe preference heterogeneity across respondents which may indicate the presence of segment-based heterogeneity. As shown in Table 5, the highest mean WTP for bundled soil management-related ES and biodiversity improvements is observed in class 1, reinforcing the important role of bundling in influencing private individuals' mean WTP. The weighted mean WTP values further support these findings. With a probability of 39 % respondents belong to this class, which we refer to as "Passive but ardent environmentalists" as these respondents exhibit positive and significant WTP values for all soil management-related ES and biodiversity improvements without focusing on a specific subset. This class is likely characterized by younger respondents who select environmentally labelled products when shopping. Class 2, to which respondents belong with a probability of 13 %, is generally less receptive to the proposed improvements, as they show positive mean WTP for maintaining the status quo. Their highest mean WTP values are associated with two bundled biodiversity improvements, again highlighting the importance of bundling – even among respondents with relatively low support for our suggested certificates. This class tends to consist of older, less educated males who are more likely to purchase products that are not environmentally labelled. Class 3, to which respondents belong with a probability of 28 %, demonstrates significant preferences for soil management-related ES and biodiversity improvements but are not sensitive to the price attribute (see Table 4), rendering their WTP estimates insignificant. Class 4, to which respondents belong with a probability of around 20 %, shows significant positive mean WTP for bundled soil management-related ES and biodiversity improvements. These respondents can be described as price-sensitive, as they have the highest absolute value of the price coefficient. As a result, their mean WTPs are lower compared to Class 1

Table 4
Preference estimates from LCM.

Parameters	Class 1	Class 2	Class 3	Class 4
Choice model	Passive but ardent environmentalists	Older and less educated individuals	Price-insensitive individuals	Price-sensitive individuals
Alternative specific constant (status quo)	−0.877 (0.169)***	0.847 (0.357)**	−1.589 (1.013)	−1.315 (0.435)***
Erosion control	0.717 (0.099)***	0.286 (0.230)	0.963 (0.168)***	1.863 (0.724)***
Pest control	0.832 (0.112)***	0.568 (0.249)**	1.728 (0.266)***	1.343 (0.403)***
Soil-carbon storage	0.663 (0.120)***	0.497 (0.260)*	1.111 (0.201)***	0.503 (0.522)
Erosion control and pest control	1.023 (0.126) ***	0.259 (0.341)	1.329 (0.299)***	1.999 (0.482)***
Erosion control and soil-carbon storage	0.962 (0.180)***	−1.924 (1.184)	1.781 (0.300)***	1.968 (0.850)**
Pest control and soil-carbon storage	0.918 (0.157)***	0.492 (0.357)	1.853 (0.283)***	1.756 (0.686)***
Erosion control, pest control and soil-carbon storage	1.104 (0.171)***	0.561 (0.556)	2.169 (0.328)***	2.224 (0.738)***
Plant diversity	0.757 (0.116)***	0.343 (0.327)	2.096 (0.338)***	1.904 (0.629)***
Animal diversity	0.816 (0.151)***	0.396 (0.331)	2.264 (0.431)***	1.337 (0.449)***
Pollination	0.624 (0.124)***	0.237 (0.316)	1.549 (0.308)***	1.144 (0.421)***
Plant diversity and animal diversity	1.191 (0.133)***	1.745 (0.289)***	2.938 (0.383)***	0.864 (0.395)**
Plant diversity and pollination	0.942 (0.152)***	0.944 (0.269)***	2.505 (0.429)***	0.772 (0.592)
Animal diversity and pollination	1.024 (0.134)***	1.064 (0.228)***	2.395 (0.335)***	1.358 (0.601)**
Animal diversity, plant diversity and pollination	1.265 (0.186)***	0.282 (0.465)	3.693 (0.536)***	1.209 (0.654)*
15 % of project costs covered by public funds	0.222 (0.068)***	−0.302 (0.236)	0.504 (0.121)***	0.556 (0.473)
30 % of project costs covered by public funds	0.423 (0.092)***	0.141 (0.203)	0.721 (0.195)***	0.826 (0.374)**
45 % of project costs covered by public funds	0.346 (0.092)***	0.308 (0.212)	0.692 (0.186)***	0.664 (0.380)*
Price	−0.016 (0.002)***	−0.063 (0.011)***	0.003 (0.003)	−0.096 (0.013)***
Class membership model				
Constant	1.128 (0.374)***	−0.191 (0.438)	0.0342 (0.414)	
Age in years	−0.017 (0.005)***	0.011 (0.006)*	−0.009 (0.005)*	
Gender (= 1 if female)	−0.262 (0.181)	−0.350 (0.209)*	−0.288 (0.172)*	
Education (= 1 if higher education)	−0.075 (0.202)	−0.510 (0.257)**	0.039 (0.186)	
Choose environmental labelled products (= 1 if yes)	0.615 (0.248)***	−0.732 (0.2359***	0.986 (0.261)***	
Model statistics				
Class probability	0.39	0.13	0.28	0.20
Number of individuals	1627			
Number of total observations	13016			
Adjusted R-squared	0.2601			
Log-likelihood (null)	−14299.5			
Log-likelihood (final)	−9375.9			

Note: Standard errors are in parentheses. '*' denotes statistical significance at 10 % level, '**' denotes statistical significance at 5 % level, and '***' denotes statistical significance at 1 % level. The estimated preference parameters for ecosystem service and biodiversity attributes are relative to the reference level "No improvement," while for the funding attribute, they are relative to 0 % funding

across all attributes and even lower than Class 2 for some bundled biodiversity improvements.

3.2. Blending

In this section, we address RQ2 concerning whether blending influences private individuals' mean WTP. We find that respondents prefer higher levels of public funding for certificates. But the increase in mean WTP is modest as the share of public funding rises – 15 % public funding (€13.2/certificate), 30 % public funding (€14.8/certificate), and 45 % public funding (€15.9/certificate) (Table 3). A closer look at the LCM in Table 5 reveals similar patterns in class 1 (the largest class) where respondents show stronger preferences for public funding covering 30 % and 45 % of the project costs. Notably, in class 1, mean WTP peaks at the 30 % funding level before declining at 45 %. Estimates for class 2 and 4 are statistically insignificant, except for the 30 % and 45 % funding levels in class 4, where mean WTPs are significantly lower compared to class 1. In class 4, we also observe a decrease in mean WTP from 30 % to 45 % public funding. The class-weighted mean WTP values also confirm that respondents' WTP decreases after peaking at 30 % public funding.

4. Discussion

Making a novel contribution to the literature, we examine private individuals' WTP for soil health and biodiversity certificates, characterised by bundling and blending, using an online marketplace in the study design. Below, we discuss our results in relation to existing literature, provide policy implications and consider limitations of our study.

4.1. WTP for single soil management-related ES and biodiversity improvements

Only few studies simultaneously consider both single soil management-related ES and biodiversity improvements in agriculture in the context of private individuals' WTP (Bartkowski et al., 2022). For single improvements such as erosion control (€41.4/certificate) and soil-carbon storage (€22.5/certificate), our findings generally exceed previously reported estimates. For instance, Colombo et al. (2005) observed a mean WTP of €17.42 to €22.88 per additional square kilometre of land treated for erosion control in Spain. Similarly, Almansa et al. (2012) found a positive WTP for erosion control in Spain, although they did not report exact values. Regarding soil-carbon storage, Bartkowski et al. (2022) reported a mean WTP of €13/year per household in Germany. Comparable figures were found by Eusse-Villa et al. (2021) and Franceschinis et al. (2022), who reported €13.36/year and €14.89/year, respectively, in Italy. Glenk and Colombo (2011) reported £ 10/year per percentage of net emission reduction in Scotland. Some studies have found higher estimates than ours: Tienhaara et al. (2020) reported a WTP of €31.81 to €44.66/year for reducing overall agricultural emission in Finland, while Franceschinis et al. (2023) reported €25, 45 per sequestered ton of carbon per hectare per year. For single biodiversity improvements, we find higher mean WTP estimates (€54.3 for plant diversity and €54.4 for animal diversity) compared to Colombo et al. (2005), who reported €14.92 to €17.76 per additional square kilometre of similar improvements in Spain. Notably, Tienhaara et al. (2020) found a decreasing WTP for animal diversity (€75.71/year to €39.38/year) as the size of protected areas and number of species

Table 5
Mean WTP estimates from LCM (€/certificate).

Parameters	Class 1 Passive but ardent environmentalists	Class 2 Older and less educated individuals	Class 3 Price-insensitive individuals	Class 4 Price-sensitive individuals	Class-weighted mean WTP
Alternative specific constant (status quo)	−54.6 (15.229)***	13.4 (5.866)**		−13.7 (4.821)***	−22.292
Erosion control	44.6 (6.424)***	4.5 (3.746)		19.4(7.006)***	21.274
Pest control	51.8 (7.179)***	8.9 (3.552)***		13.9 (3.708)***	24.139
Soil-carbon storage	41.3 (7.156)***	7.8 (3.857)**		5.2 (5.470)	18.161
Erosion control and pest control	63.7 (8.364)***	4.1 (5.054)		20.8 (3.886)***	29.003
Erosion control and soil-carbon storage	59.9 (8.123)***	−30.4 (20.774)		20.4 (8.724) **	27.441
Pest control and soil-carbon storage	57.1 (7.377)***	7.8 (5.622)		18.3 (7.545)***	25.929
Erosion control, pest control and soil-carbon storage	68.7 (8.440)***	8.9 (9.062)		23.1 (6.700)***	31.413
Plant diversity	47.1 (6.460)***	5.4 (4.997)		19.8 (7.078)***	22.329
Animal diversity	50.7 (6.890)***	6.3 (5.041)		13.9 (4.672)***	22.553
Pollination	38.8 (6.466)***	3.7 (4.707)		11.9 (4.096)***	17.512
Plant diversity and animal diversity	74.1 (8.473)***	27.6 (5.339)***		8.9 (4.087)**	34.267
Plant diversity and pollination	58.6 (8.122)***	14.9 (4.010)***		8.0 (6.117)	24.791
Animal diversity and pollination	63.7 (7.962)***	16.8 (4.125)***		14.1 (6.859)**	29.847
Animal diversity, plant diversity and pollination	78.7 (9.473)***	4.5 (7.012)		12.6 (6.983)*	33.213
15 % of project costs covered by public funds	13.8 (4.293)***	−4.8 (4.041)		5.8 (4.771)	5.382
30 % of project costs covered by public funds	26.3 (6.852)***	2.2 (3.049)		8.6 (3.632)***	11.977
45 % of project costs covered by public funds	21.5 (6.086)***	4.9 (3.215)		6.9 (3.718)*	9.765
Class probability	0.39	0.13	0.28	0.20	

Note:: Standard errors are in parentheses. '*' denotes statistical significance at 10 % level, '**' denotes statistical significance at 5 % level, and '***' denotes statistical significance at 1 % level. The mean WTP estimates for class 3 are not statistically significant (price insensitive) and are therefore not reported. The class-weighted mean WTP values are derived using only the significant WTP estimates from each class. The estimated WTP values for ecosystem service and biodiversity attributes are relative to the reference level "No improvement," while for the funding attribute, they are relative to 0 % funding.

increased, placing our estimate (€54.5/certificate) within their observed range. Nevertheless, differences in units of environmental improvements, study designs, geographical and policy contexts, and payment vehicles limit direct comparability of our results.

4.2. WTP for bundled soil management-related ES and biodiversity improvements

Previous literature addressing bundling soil management-related ES and biodiversity improvements in agriculture, such as Tienhaara et al. (2020), differs methodologically from our study. They treated bundled improvements as separate attributes within a choice alternative, estimating WTP for each improvement. In contrast, we treated bundles as single attribute levels, enabling direct comparisons between single versus bundled improvements. To our knowledge, we are the first to apply this approach, thus contributing to calls for a more holistic view of ES and biodiversity management in agriculture (Raudsepp-Hearne et al., 2010).

Our findings indicate significant positive effects of bundling. Bundles containing three soil management-related ES (€74.2/certificate) or biodiversity improvements (€80.7/certificate) show the highest mean WTP. At the same time, we observe significant preference heterogeneity across respondents, suggesting that not all private individuals are willing to make the same financial commitments – a finding also reported by Bartkowski et al. (2022) and Franceschinis et al. (2022). Specifically, respondents who are likely to be older and less educated, as well as those who appear price-sensitive, show lower mean WTP across attributes compared to younger respondents who purchase environmentally labelled products. Empirical evidence for these findings is mixed. Some studies find that WTP for soil health improvements decreases with age (Areal, 2024; Dimal and Jetten, 2020). Similarly, research from related fields such as organic food consumption, supports our findings that WTP increases with education and decreases with age (Aertsens et al., 2009; Hjelmar, 2011; Zander and Feucht, 2018). However, Franceschinis et al. (2023) found that WTP for soil-carbon storage increased among older and less educated respondents. Another notable finding concerning bundling is the effect of combining soil-carbon storage with another soil management-related ES. This bundling substantially increases the mean WTP for soil-carbon storage, which otherwise shows the lowest stand-alone mean WTP. A potential explanation for this could be declining public trust in the credibility of carbon certificates, as widely reported in media, questioning whether these certificates truly deliver the carbon sequestration they claim (Cochet, 2024; Fischer and Knuth, 2023; Greenfield, 2023; Klotsikas et al., 2023; Thambi, 2024) – a scepticism also supported by academic research (West et al., 2020, 2023).

Our results in most cases suggest a diminishing marginal utility for bundling. This is interesting from both the supply and demand side of certificates. While bundles generally received higher mean WTP, theoretically, stacking would attract higher overall private funding. For example, across our sample, the sum of mean WTP for single soil management-related ES improvements is approximately €110, whereas the bundle of all three improvements is €74/certificate. Similarly, the sum of mean WTP for single biodiversity improvements is approximately €146, while the bundle of all three improvements is €81/certificate. However, for the demand side, stacking carries the risk for buyers of paying higher prices for less valuable certificates. On the supply side, farmers could potentially double count their efforts, which contradicts the concept of additionality and is likely to be criticised by buyers (von Hase and Cassin, 2018; Robertson et al., 2014; Wunder et al., 2025). In this context, we cautiously note that some of our estimates might be affected by overestimation (Glenk et al., 2024). In both our RP-MXL model as well as in class 1 of our LCM, the mean WTP estimates for the combination of the attribute levels assumed to yield the highest utility – three soil management-related ES, three biodiversity indicators, and 45 % public funding – exceeds our highest price level per certificate (€100). Nevertheless, we emphasise that, to date, soil-management-related ES such as erosion control and pest control have not been available on AgoraNatura. Since price levels were inspired by previously offered certificates, prices in the past may have been lower than what private individuals would be willing to pay once these services are included.

4.3. Blending

Our second primary objective was to investigate whether blending public and private funding could leverage private individuals' funding for certificates. Inspired by Reed et al. (2022), who highlight the potential of blending to attract private investments, we find that blending does indeed encourage private individuals to increase funding. However, the mean WTP estimates suggest that, on average, the marginal effect of increased blending on mean WTP is relatively modest. Although blending positively influences private individuals' WTP, the modest increases suggest that public funding is a secondary driver compared to the intrinsic value of soil management-related ES and biodiversity improvements. Notably, in the RP-MXL the increase in mean WTP when public funding rises from 30 % to 45 % is minimal while in the LCM models mean WTP appears to peak at 30 % of public funding. One possible explanation is that higher public funding may crowd out private funding – an effect noted in previous literature and described as context-dependent (de Wit and Bekkers, 2016; Reed et al., 2022). Additionally, we may carefully discuss this finding in light of Rondeau and List (2008), who made similar observations in the context of charitable donations for public goods. They report that 'matching donations' (i.e. a leadership donor commits to match contributions made by others) tend to trigger lower levels of contributions from non-leadership donors in contrast to 'challenge donations', in which the leadership donor pledges a fixed amount irrespective of others' contributions. In our study, some respondents may somewhat perceive the increase in public funding from 30 % to 45 % as a form of matching donations. As such, our findings complement existing literature by highlighting the importance of carefully designing blended finance mechanisms when seeking to mobilise private funding.

Furthermore, it is worth discussing that when we generally speak about increasing private funding for public goods such as biodiversity, the general debate usually focuses on private funding from companies or financial institutions. Moreover, such investors usually call for public funding to be "necessary to catalyse market opportunities through direct subsidies for projects attempting to enter nascent nature markets and derisking investments in these projects" (Zu Ermgassen et al., 2025). While we do argue in favour of the potential of public funding being able to leverage private funding, we do observe that private individuals' mean WTP does not seem to depend as much on public funding or at least its relative increase doesn't.

4.4. Policy implications

The implications of our study with regards to enhancing private funding for soil health and biodiversity improvements in agriculture are manifold. First, we align with a growing body of literature suggesting private individuals in Germany are willing to invest into soil health (e.g. Bartkowski et al., 2022) and biodiversity improvements on agricultural land. This may showcase public support for the EU's Soil Strategy (European Commission, 2021) and the Biodiversity Strategy for 2030 (European Commission, 2020b). Additionally, our results highlight the need for researchers and policymakers to further recognise the importance of soil health (Bartkowski et al., 2021, 2022; Montanarella and Panagos, 2021) and biodiversity (Hasler et al., 2022; Pe'er et al., 2022) in agri-environmental policy.

Second, policymakers may recognise that bundling soil health and biodiversity improvements addresses societal demand for their simultaneous provision and has the potential to increase private funding. Indeed, our results suggests that stacking could attract greater overall private funding. However, beyond its theoretical shortcomings, real-world applications of stacking have not been successful, particularly with regards to additionality and ecological outcomes (von Hase and Cassin, 2018; Wunder et al., 2025). Moreover, the observed preference heterogeneity for bundled soil health and biodiversity improvements highlights that, while policymakers should acknowledge societal demand for bundling, they should ensure the availability of diverse bundles to maximise funding potential.

Third, blending has the potential to leverage private funding for soil health and biodiversity certificates in agriculture. However, funding levels should be carefully calibrated to avoid crowding-out effects. Our results show that 'more is not always better' – beyond a certain point, higher public funding can displace private funding. This insight is especially relevant for policymakers seeking to allocate funds efficiently. The United Kingdom ecosystem markets and European peatland markets (Reed et al., 2022) serve as useful examples. In particular, trigger funds – as employed in our research design – may effectively stimulate private funding while mitigating crowding-out effects. For marketplaces offering soil health and biodiversity certificates, our findings suggest that promoting 'blended certificates' could attract greater private funding. Online marketplaces, such as AgoraNatura, might, for example, feature these certificates prominently on their website or run targeted campaigns tailored to different customer segments: younger individuals could be reached via social media, price-sensitive consumers through price comparison websites, and older individuals through traditional print media. However, formulating well-designed marketing strategies to help marketplaces scale lies beyond the scope of this study but represents an important area for future research.

Nonetheless, our results are a one-time observation. To further validate our study, it would be highly beneficial to repeat our study in the future. In particular, a longitudinal study gathering panel data could observe potential behavioural change (Fetene et al., 2014). Additionally, to reduce and analyse hypothetical bias in our results, greater insights could be gained comparing them with revealed preferences – i.e. real payment scenarios – either from a DCE or real market data once online marketplaces, such as AgoraNatura, have scaled. Future studies could also investigate whether preferences of private individuals for investing in soil health and biodiversity improvements in agriculture vary across federal states in Germany. Applying our study to other EU countries would help us assess the potential of scaling soil health and biodiversity certificates at the EU-level by shedding light on country-specific private individuals' preferences. This could further inform policymakers currently developing the European Commission's 'Roadmap towards Nature Credits'. Finally, we acknowledge the importance and conceptual distinction of environmental attitudes and concerns, and behaviour in the context of private individuals' WTP for soil health and biodiversity certificates (Cicatiello et al., 2020). While we included a variable related to the likelihood of purchasing environmentally certified goods in our LCM to examine class membership probabilities, we did not expand the model to address the distinct roles of attitudes and behaviours due to the already large number of parameters being estimated and to maintain focus on our research questions. Given the significance of such behavioural factors and their distinction, we recommend that future studies explore this aspect.

5. Conclusion

This study provides empirical evidence on private individuals' WTP for soil health and biodiversity certificates in Germany. Our findings highlight the potential for mobilising funding from private individuals, thereby reinforcing public support for the EU Soil and Biodiversity Strategies for 2030. Moreover, we find that bundling soil health and biodiversity improvements has the potential to significantly increase private individuals' mean WTP. However, preference heterogeneity exists among respondent groups, emphasizing the need for targeted policy interventions. Furthermore, our results suggest that blending public and private funding has the potential to leverage private individuals' funding, but excessive public funding (beyond 30 %) may trigger crowding-out effects. Thus, policymakers should carefully design blended financing mechanisms to maximise private individuals' participation. Lastly, online marketplaces for certificates representing environmental improvements on agricultural land may offer a promising tool to facilitate such funding. Despite these strong results, limitations remain. Future research may engage in revealed preference studies and real-market comparisons to further inform policymakers in designing innovative funding mechanisms aligned with EU soil health and agri-environmental policy targets.

CRediT authorship contribution statement

Mohammed Hussen Alemu: Writing – review & editing, Software, Methodology, Formal analysis, Data curation. **Ferdinand Lang:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Cheng Chen:** Writing – review & editing, Supervision, Resources, Project administration, Investigation, Funding acquisition, Conceptualization. **Bettina Matzdorf:** Writing – review & editing, Supervision, Resources, Project administration, Funding acquisition, Conceptualization. **Thomas Lundhede:** Writing – review & editing, Methodology, Investigation, Conceptualization. **Søren Bøye Olsen:** Writing – review & editing, Methodology, Investigation, Conceptualization.

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.

Acknowledgements

This work was supported by the European Union's Horizon Europe research and innovation program within the project NOVASOIL (Grant agreement no 101091268). Lastly, the authors are immensely thankful to participants of our focus groups and pre-tests. Moreover, we are very grateful for insightful discussions conducted with soil scientists of the Leibniz Centre for Agricultural Landscape Research (ZALF) as well as scientists and practitioners behind the online marketplace AgoraNatura who gave crucial feedback during the design of our experiment.

Appendix – A

Table A.1
Representativeness of study sample in relation to Germany

Variable	Study sample	National sample	Chi-square test	p-values
Age (year 2023)[a]			0,007948714	0,999812
18–19	2,23 %	2,00 %		
20–39	29,83 %	24,30 %		
40–59	33,29 %	27,00 %		
60–79	33,18 %	22,80 %		
Gender (year 2023)[b]			6,43549E−05	0,993599
Female	50,44 %	50,67 %		
Male	49,44 %	49,32 %		
Education (year 2019)[c]			0,067934673	0,966603
Below Abitur	48 %	58,60 %		
Abitur or equivalent	26 %	34 %		
Higher education	26 %	18,50 %		
Household size (year 2023)[d]			0,092463059	0,998964
1 person	26,78 %	41,10 %		
2 people	40,52 %	33,50 %		
3 people	17,56 %	11,90 %		
4 people	10,16 %	9,50 %		
5 people and more	4,99 %	3,90 %		
Geographical distribution (year 2023)[e]			0,048623973	1
Baden-Württemberg	11,00 %	13,46 %		
Bavaria	14,00 %	15,79 %		
Berlin	6,00 %	4,39 %		
Brandenburg	4,00 %	3,06 %		
Bremen	0,90 %	0,84 %		
Hamburg	3,00 %	2,23 %		
Hesse	6 %	7,50 %		
Mecklenburg-Vorpommern	2,00 %	1,89 %		
Lower Saxony	12,00 %	9,59 %		
North Rhine-Westphalia	18,00 %	21,59 %		
Rhineland-Palatinate	5,00 %	4,95 %		
Saarland	0,80 %	1,22 %		
Saxony	6,00 %	4,85 %		
Saxony-Anhalt	3,00 %	2,58 %		
Schleswig-Holstein	3,00 %	3,53 %		
Thuringia	2,00 %	2,53 %		
NA[a]	0,5 %			

Note: The chi-square test was applied to assess the representativeness of the study by comparing the observed distribution of the variables listed in the table with their distribution in the reference population (i.e. Germany). [a] NA = not applicable

[a] Source national sample: Destatis (2025a)
[b] Source national sample: Destatis (2025b)
[c] Source national sample: Destatis (2020)
[d] Source national sample: Destatis (2024)
[e] Source national sample: Destatis (2025c)

Appendix – B

Specification of Latent Class Model:

Following Boxall and Adamowicz (2002) and Glenk and Colombo (2011), the probability of respondent n selecting alternative r from M available options is conditional on membership in class s:

$$P_{nr|s} = \frac{\exp(\beta_s X_{nr})}{\sum_{m=1}^{M} \exp(\beta_s X_{nm})} s = 1, \quad \ldots, \quad S, \tag{7}$$

where the parameter vector of class s is represented by β_s and associated with X_{nr}, the vector of explanatory attributes. The probability of respondent n belonging to class s is then defined as:

$$P_{ns} = \frac{\exp(\alpha_s Z_n)}{\sum_{s=1}^{S} \exp(\alpha_s Z_n)} s = 1, \quad \ldots, \quad S, \quad \alpha_s = 0. \tag{8}$$

This represents a multinomial logit model in which class membership probabilities are determined by individual-specific characteristics Z_n. To ensure model identification, the parameter vector for the S^{th} class is normalized to zero (Greene, 2003).

The overall probability of respondent n choosing alternative r is given by:

$$P_n(r) = \sum_{s=1}^{S} \left[\frac{\exp(\alpha_s Z_n)}{\sum_{s=1}^{S} \exp(\alpha_s Z_n)} \right] \left[\frac{\exp(\beta_s X_{nr})}{\sum_{m=1}^{M} \exp(\beta_s X_{nm})} \right] s = 1, \quad \ldots, \quad S, \quad \alpha_s = 0. \tag{9}$$

where the first term in brackets denotes the probability of an individual belonging to class s, while the second term represents the probability of selecting alternative r, given membership in class s.

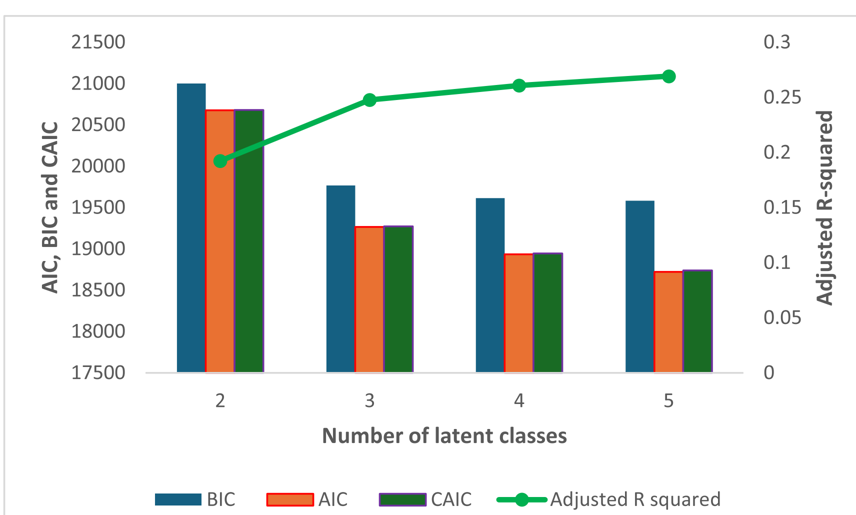
The LCM requires identifying the optimal number of classes, which is typically determined by evaluating model selection criteria such as the Akaike information criterion (AIC), Bayesian information criterion (BIC), the Consistent AIC (CAIC), and adjusted R-squared (Nylund et al., 2007). As shown in Table B.1 and Figure B.1, an LCM with four classes appeared to be the most suitable as the percentage differences in the AIC, BIC, CAIC, and adjusted R-squared became minimal beyond the three-class model. The selection of the number of latent classes was further guided by the statistical significance of parameters, as well as the overall interpretability and meaningfulness the resulting classes (Glenk et al., 2012; Scarpa and Thiene, 2005, 2011).

Table B.1
Number of classes and goodness of fit measures

Classes	#parametrs	LL	Adjusted R squared	BIC	AIC	CAIC			
2	43	−10296.43	0.1924	21000.25	20678.87	20681.26	DBIC	DAIC	DCAIC
3	67	−9566.73	0.2477	19768.21	19267.46	19273.31	5.866787	6.825373	6.80787
4	91	−9375.92	0.2609	19613.96	18933.84	18944.76	0.780293	1.73152	1.704706
5	115	−9246.55	0.2693	19582.6	18723.09	18740.76	0.159886	1.113086	1.076796

Note: LL = log-likelihood value, BIC = Bayesian Information Criteria, AIC = Akaike's Information Criteria, CAIC = corrected-AIC, and D = differences in percent

Figure B.1
Number of latent classes with information criteria. Note: BIC = Bayesian Information Criteria, AIC = Akaike's Information Criteria, CAIC = corrected-AIC



Data availability

Discrete Choice Experiment data on soil health and biodiversity improvements in agriculture (BonaRes Repository)

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