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Connecting habitats in European agricultural landscapes: Farmers' spatial preferences for linear wildlife corridors

Fabian Klebl [a,b,*], Jonathan R. Rhodes [c], Kati Häfner [a], Annette Piorr [a]

[a] Leibniz Centre for Agricultural Landscape Research (ZALF), Eberswalder Straße 84, Müncheberg 15374, Germany
[b] Agricultural and Food Policy Group, Albrecht Daniel Thaer Institute of Agricultural and Horticultural Sciences, Humboldt-Universität zu Berlin, Unter den Linden 6, Berlin 10099, Germany
[c] School of Biology and Environmental Science, Queensland University of Technology, Brisbane, Queensland 4000, Australia

HIGHLIGHTS

- Farmers prefer to place measures to minimise disturbance and maximise productivity.
- Landscape characteristics guide farmers' decisions.
- Habitat connectivity is a relevant concept for farmers.
- Local farming traditions and practices are crucial.
- The study results can help to reduce transaction costs by targeting likely adopters.

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ABSTRACT

Habitat fragmentation in agricultural landscapes threatens biodiversity. Enhancing landscape connectivity across cultivated areas requires a thorough understanding of farmers' spatial considerations and their willingness to create semi-natural habitats. We therefore conducted a spatial choice experiment with farmers from ten European countries to assess their preferences for placing linear wildlife habitats (hedgerows and wildflower strips) at the field scale under different scenarios, as well as the role of farm and personal factors. A total of 471 responses were analysed using multinomial logistic regression and generalised linear mixed models. The results indicate that landscape conditions, including field shape, slope, soil quality, and pre-existing landscape features, exert a significant influence on farmers' decisions, as do the size of machinery, cultural regions, attitudes towards biodiversity, and type of intervention. On the other hand, no statistical significance was found for other variables. In general, farmers' choices were driven by a desire to minimise disturbance to field work, optimise productivity, increase biodiversity, and address specific environmental challenges. The insights into farmers' decision-making from this study can inform ecological network planning to reduce transaction costs by preselecting likely adopters, and to mitigate resistance and lower financial compensation by identifying best-fit options aligned with farmers' practices. Integrating these findings into geospatial models could improve predictions of the impact of spatially targeted biodiversity conservation strategies on landscape composition and future biodiversity trends in agricultural areas.

1. Introduction

Habitat fragmentation poses an urgent threat to biodiversity in agricultural areas and is affected by how farmers manage their land (e.g., Haddad et al., 2015; Schlaepfer et al., 2018). The (re)introduction of wildlife corridors on farmland to connect existing habitats is seen as an important means to mitigate negative effects of habitat and species isolation. These corridors can take traditional forms, such as hedgerows, or more contemporary approaches, such as perennial wildflower strips. Yet, there is still limited understanding of farmers' perspectives on landscape connectivity and their decisions to contribute to it.

Hedgerows in particular have demonstrated considerable potential for enhancing habitat connectivity. While the specific effects vary depending on the landscape and species under study, there is evidence that hedgerows in agricultural landscapes act as corridors for numerous species, enabling their movement and gene flow between small, isolated

* Corresponding author at: Eberswalder Straße 84, Müncheberg 15374, Germany.
E-mail address: fabian.klebl@zalf.de (F. Klebl).

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habitat patches (Dondina et al., 2016; Fischer et al., 2013; Gelling et al., 2007; Kratschmer et al., 2024; Liccari et al., 2022; Michel et al., 2006; Moorhouse et al., 2014; Pelletier-Guittier et al., 2020; Portela et al., 2020; Travers et al., 2021; Vasiliev & Greenwood, 2023; Wehling & Diekmann, 2009). Despite the risk that ecological corridors may facilitate the spread of diseases and invasive species (Montgomery et al., 2020), they remain a vital element in landscapes with small habitat patches where populations are unstable and habitat expansion is not feasible (Donaldson et al., 2017).

However, establishing hedgerows requires substantial effort and a long-term commitment from farmers, often spanning multiple decades. As a trade-off, this study also considers perennial wildflower strips for the creation of linear connecting habitats. Although their overall impact on landscape connectivity is not as pronounced as that of hedgerows, they offer continuous resources and refuges for various species, thus supporting their dispersal and survival in otherwise inhospitable agricultural areas (Aviron et al., 2011; Szitár et al., 2022). The strategic spatial placement of these strips by farmers is crucial for developing a comprehensive flowering network across entire landscapes, thereby maximising their ecological benefits (Buhk et al., 2018).

To implement a network of connected habitats in agricultural areas, conservation strategies need to be based on an understanding of what motivates farmers to create these habitats and to connect them to the network. While much is known about farmers' general motivations for adopting biodiversity-friendly practices (Klebl, Feindt, & Piorr, 2024a), to the best of our knowledge, no study has yet assessed where farmers are most likely to place biodiversity measures at the field scale, what influences their underlying decisions, or whether habitat connectivity is a relevant consideration for them.

This study investigates the factors influencing farmers' decisions about the placement of biodiversity measures. Specifically, it examines what drives farmers' choices in the spatial allocation of linear habitats such as hedgerows and flower strips, and how field and landscape characteristics impact their preferences. These questions were addressed through a spatial choice experiment in which farmers responded to hypothetical scenarios. The resulting data were statistically analysed to evaluate the influence of factors related to the farmers and their farms, as well as the hypothetical field and landscape settings.

2. Material and methods

2.1. Study areas and sample

The present study relies on a survey conducted among farmers across several European countries (Fig. 1), representing a diverse range of landscapes, climate conditions, farming systems, and socio-cultural contexts. These countries were selected for their role as hosts of the ecological and socio-economic experimental sites within the SHOWCASE research project (https://showcase-project.eu/). To obtain a representative sample, farmers were randomly recruited through multiple channels, including farmers' associations, NGOs, and local networks.

2.2. Data collection

Farmers were first asked to provide general personal information, including age and educational background, along with detailed farm characteristics, such as farm size, operational focus, average field size, field operations, machinery size, and landscape conditions. Likert scales were employed to evaluate farmers' attitudes towards biodiversity, assessing the importance they attribute to it and its conservation, both in general and in agricultural landscapes.

The survey's core component was a spatial choice experiment aimed at capturing farmers' preferences for allocating biodiversity measures at the field scale. Participants were randomly assigned to one of two groups: one focused on planting a wildflower strip as a temporary

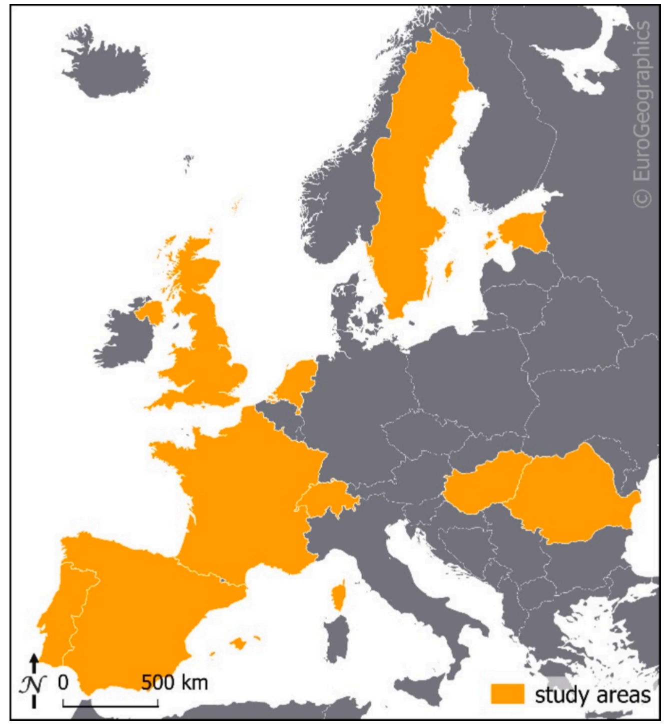


Fig. 1. Overview of study areas: Estonia, France, Hungary, Portugal, Romania, Spain, Sweden, Switzerland, the Netherlands, and the UK.

intervention (minimum width of four metres, lasting at least three years), while the other considered establishing a naturally grown hedgerow as a long-term landscape element (minimum height and width of two metres each).

Respondents were then invited to envision a hypothetical field (or meadow or pasture, depending on their operational focus) that is accessible from all sides. In the baseline scenario, the field was described as being of average size as reported by the farmer, with a rectangular shape, flat surface, and uniform soil quality. In each subsequent scenario, one characteristic was altered while the others remained consistent with the baseline. These alterations included the introduction of a slope, a soil quality gradient, a different field shape, doubling the field size, a prevailing wind direction, as well as varying settings such as proximity to a forest or road, and the presence of existing hedges on neighbouring fields (Table 1).

In each scenario, participants selected their first and second preferences from the available options by clicking on corresponding graphical illustrations and briefly explaining their choice. For example, in the baseline scenario, participants could choose from four options, as shown in Fig. 2. Although second preferences were recorded to gain additional insights, they were excluded from the final analysis as no sound approach was identified to weight or incorporate the second choice in a meaningful way. Further details on the survey can be found in the supplementary material.

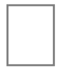
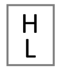
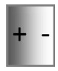
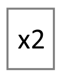
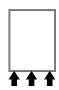
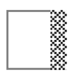
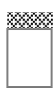
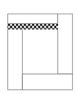
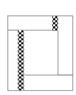
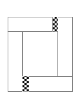
The survey was part of a broader project survey and was designed as an online application, accessible via web browsers and mobile devices. However, in some regions of Romania, where the online format was unsuitable, a printed version was used and completed during workshops organised by local project partners. Data collection occurred between January and October 2023, yielding 471 valid responses.

2.3. Data analysis

2.3.1. Data preparation

The dataset contains relatively few missing values, as the choices and most survey questions were mandatory. Missing data, classified as

Table 1
Overview of the scenarios in the spatial choice experiment.

Scenario			Sample
sc00	baseline		F/H
sc01	slope (horizontal gradient)		F/H
sc02	soil quality (horizontal gradient)		F/H
sc03	soil quality (vertical gradient)		F/H
sc04	shape		F
sc05	increase in size		F
sc06	wind		H
sc07	forest		F/H
sc08	forest		F/H
sc09	road		H
sc10	existing hedges		H
sc11	existing hedges		H
sc12	existing hedges		H

The columns present the scenario code and name, along with a graphical illustration, and indicate the sample (wildflower strip (F) or hedgerow (H)) to which the scenario applies.

'missing completely at random', were addressed through the Multivariate Imputation by Chained Equations (MICE) method. Linear predictors were imputed via predictive mean matching, whereas categorical values were estimated using logistic regression. An iterative approach was employed to achieve a final imputation that closely matched the original dataset, utilising the {mice} package (van Buuren & Groothuis-Oudshoorn, 2011) in R version 4.4.1 (R Core Team, 2024). The data density before and after imputation exhibited an almost identical pattern (Fig. A1 in the Appendix A), indicating a high accuracy of the imputed data.

Participants' textual explanations of their choices were translated and categorised. They were not analysed quantitatively due to frequent omissions or irrelevance. Nevertheless, an overview of the most commonly cited reasons is provided, which offers qualitative insights that help to contextualise the decision-making process.

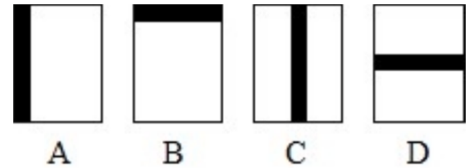


Fig. 2. Choice options in the baseline scenario. The black bar indicates the biodiversity measure in the field.

2.3.2. *Multinomial logistic regression model*

Since the choice options are categorical outcomes with multiple possible categories, we employed a multinomial logistic regression model fitted for each scenario to investigate the relationship between several predictor variables and the response variable (Agresti, 2007). The model can be described as follows:

$$log\left(\frac{\pi_j}{\pi_J}\right) = \beta_{0j} + \beta_{1j}X_1 + \beta_{2j}X_2 \cdots + \beta_{kj}X_k \quad (1)$$

for $j = 1, \cdots, J-1$, where π_j is the probability of the outcome (i.e., the choice) being in category j and π_J in the reference category (J), β_{0j} is the intercept for category j, and β_{ij} are the coefficients for the predictor variables X_i.

As log-odds are unintuitive to interpret, we derived the odds ratio (OR) to estimate the change in the odds of being in a specific category of the outcome variable with a one-unit increase in the predictor variable, relative to the reference category (Hosmer et al., 2013). This is defined as

$$\hat{\theta}_{ij} = e^{\hat{\beta}_{ij}} \quad (2)$$

In formulating the regression models, several variables were found not to significantly enhance the model's explanatory power but to increase its complexity. These variables included farm size, the proportion of owned land to total cultivated land, the operational status of the farm (full-time or part-time), prior implementation of similar interventions (i.e., hedgerows or wildflower strips), farmers' general and agricultural education levels, and farmers' age. Consequently, these factors were excluded from the final models. The variables that provided an explanatory contribution and/or were an important component of the initial assumptions were retained as independent variables and are summarised in Table 2.

Due to a high correlation between the countries and predictor variables, it was impractical to include country as an independent variable. However, regional influences were considered relevant beyond these factors. Therefore, a socio-cultural categorisation was conducted, emphasising major agricultural significance. The regions were defined as Mediterranean farming systems in southern Europe (ES, PT), European countries formerly aligned with the Soviet Union (EE, HU, RO), and western and northern European countries (CH, FR, NL, SE, UK), which served as the reference group.

The regression models are founded on certain key assumptions. All observations in the sample are deemed to be independent and sufficient in number, with at least about ten observations per predictor variable for each outcome category. Categories that did not meet these conditions were excluded.[1] The independence of irrelevant alternatives (IIA) hypothesis was tested using the Hausman-McFadden Test via the mlogit::hmftest() function and was rejected for each variable. The Box-Tidwell test ($p = 0.46$) confirmed the assumption of linearity between

[1] i.e., [scenario code – choice option] sc00-D, sc04-D, sc04-B1, sc06-C/D, sc11-B2.

Table 2
Description of the predictor variables included in the multinomial logistic regression models.

Variable	Description	Values
ATT_BIODIV	attitudes towards biodiversity	Likert scale (1–10)
FIELDSIZE	average field size	[num]
LU	predominant land use of farmland	arable land/grassland
ORGANIC	organic certification	binomial
REGION	regions of cultural, historical, and geophysical similarities relevant for farming	West and North Europe (1), former USSR-aligned countries (2), Mediterranean (3)
SAMPLE	sample allocation	flower strip (F)/hedgerow (H)
RELIEF	topographic relief	flat/hilly
WORKWIDTH	maximum work width of machinery	[num]

continuous predictors and the log-odds of outcome categories.[2]

With a Cox's distance value of 359.4 at 393 degrees of freedom, the model's fit was decided to be satisfactory, suggesting a reasonable alignment between predicted probabilities and observed data. Multicollinearity was assessed using a variance inflation factor (VIF) tolerance of <5, and levels were generally very low.[3] Finally, the approximately symmetric distribution of residuals in each model confirmed the reliability and suitability of the model for analysis.

The calculation of the log-odds for each choice option relative to the predictor variables was primarily based on the {nnet} package, combined with additional tests requiring the {mlogit} package, such as the Hausman-McFadden test. To determine the significance of individual regression coefficients, a Wald test was performed using the {lmtest} package, through which the z statistics were obtained for each parameter. The overall relevance of each variable was assessed using a likelihood-ratio test, which is particularly reliable for small sample sizes (Agresti, 2007).

2.3.3. Generalised linear mixed model (GLMM)

In order to evaluate the impact of different scenarios on the decisions, choices from each scenario were combined with those from the baseline, and a dummy variable (SCENARIO) was introduced to indicate whether a choice occurred under a specific scenario or the baseline conditions. As each respondent provided data for both the scenario and the baseline, which violates the assumption of independent observations, a GLMM was employed. This approach accounted for repeated measures by incorporating random intercepts for each respondent, thereby controlling for individual variability in the analysis (Agresti, 2007).

The logit link function for the log-odds of the selected choice option in a given scenario relative to the baseline is:

$$log\left(\frac{P(Y_{ij}=1)}{1-P(Y_{ij}=1)}\right) = \beta_0 + \beta_1 X_{ij} + \mu_{0i} \tag{3}$$

where Y_{ij} is the binary response variable for the individual i and observation j, β_0 is the fixed intercept, β_1 is the fixed effect coefficient for the predictor X_{ij} (i.e., SCENARIO), and μ_{0i} is the random effect for i, which follows a normal distribution $\mu_{0i}\ N\left(0, \sigma_\mu^2\right)$.

The models were developed using the lme4::glmer() function for testing each choice option (n = 37) against the variable SCENARIO as a fixed effect, with a random effect added for respondent ID. To ensure consistency with the symmetrical baseline conditions, sub-choices relevant only to specific scenarios were aggregated and standardised (e.g., merging the upper (B1) and lower (B2) edge options in the slope scenario into B). Odds ratios were calculated as described above.

[2] The reference values are based on the baseline scenario but were also evaluated under each scenario.

[3] The only exceptions are a moderate collinearity for FIELDSIZE in sc01 (VIF = 6.3), and for WORKWIDTH (VIF = 5.6) and REGION (VIF = 6.9) in sc02. However, this did not substantially affect model performance.

2.4. Limitations and potential bias

A challenge inherent to this study was the relatively limited sample size compared to the number of choice options, which led to some options being rarely selected and subsequently excluded from analysis. Moreover, there is a possibility of misinterpretation in the choice experiment, since some farmers assumed factors such as a north–south alignment or region-specific wind direction. When these assumptions were identified through written responses, the observations were removed from the analysis. However, it is likely that some respondents made implicit assumptions without stating them, which could have influenced the results.

3. Results

3.1. Data overview

Of the 471 farmers who completed the survey, 55 % were primarily engaged in arable farming, 17 % in meadow management, and 28 % in grazing systems. Farm sizes ranged widely from 0.03 ha to 9200 ha, with a median of 70 ha. The majority of respondents (64 %) were full-time farmers who owned most of the land they worked on. The proportion of organic farms in this sample was disproportionately high at 42 %. A detailed overview of the sample and predictor variables is available in the supplementary material.

Decisions on the placement of biodiversity measures showed distinct patterns. Under the baseline conditions (sc00), option A (lengthwise at the edge) was most frequently chosen due to minimal operational disturbance (Fig. 3). This is consistent with placing tramlines lengthwise to avoid obstructing machinery turning at the short edges. Option B (widthwise at the edge) was also popular, as it minimised both disturbance and area used for the measure. Option C (lengthwise in-field) was selected less often, mainly for its potential to promote biodiversity while allowing for lengthwise management. Option D (widthwise in-field) was rarely chosen, typically for dividing the field into separate plots or pasture parcels.

The choices across all scenarios are summarised in Fig. A2 in the Appendix A. In the slope scenario (sc01), options B1 (widthwise at the

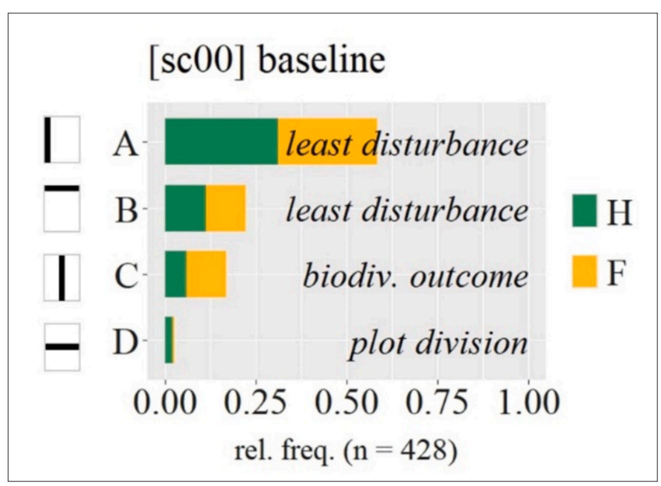


Fig. 3. Relative distribution of farmers' choices for the spatial allocation of hedgerows (H) and wildflower strips (F) in the baseline scenario. The y-axis labels denote the different choice options for each scenario, with graphics representing the biodiversity measure as a black bar in the field. The plot labels show the most frequently cited reasons for each choice.

higher edge) and B2 (widthwise at the lower edge) were most frequently selected due to erosion control concerns. However, the rationales differed: B1 was aimed at preventing run-off water from entering the field, while B2 was chosen to retain water and nutrients within the field. In the wind scenario (sc06), farmers prioritised placing hedgerows to mitigate wind effects, though some avoided wind barriers to ensure proper drying of hay or leaves, or to facilitate wind pollination. In the soil quality scenarios (sc02 and sc03), measures were generally placed in areas with the lowest soil quality. A similar pattern was observed in the forest scenarios (sc07 and sc08), where proximity to the forest was chosen in consideration of reduced productivity from shading.

When integrating the hypothetical field into landscape constellations, many farmers sought to utilise biodiversity habitats as a means of preventing contamination from other fields (sc09-sc12), pollution and noise from roads (sc09), or wildlife entering from the forest (sc07 and sc08). While many farmers intended to increase biodiversity in the forest scenarios, perceptions of the best choice for increasing biodiversity varied. Some preferred options closer to the forest for habitat connectivity, whereas others favoured options farther from the forest, stating that forests already have a high level of biodiversity. In scenarios with existing hedges (sc10-sc12), the most frequently chosen options were those enhancing habitat connectivity and minimising disturbance of field work.

It is worth noting that many farmers assumed scenario characteristics that were not provided, such as a north–south alignment. Consequently, several Estonian farmers placed the hedgerows to the north to avoid shading crops, while Spanish farmers positioned them to the south to shield crops from prevailing hot winds. Although these choices were excluded from the analysis, they offer insights into additional influencing factors.

3.2. The role of field and landscape characteristics

The scenario characteristics had a significant impact on the farmers' choices (Table 3). In sc01, the presence of a slope had a pronounced effect, with an exceptionally high odds ratio observed for widthwise options. In the scenarios related to soil quality, there was a notable shift in choices, as farmers preferred to place measures in areas with lower soil quality.

An increase in field size was clearly associated with higher odds of subdividing the field. Although the results of the wind scenario should be interpreted with caution, there was a strong indication that the odds of implementing hedges widthwise, perpendicular to the wind direction, were substantially higher compared to the baseline scenario.

The presence of forests and roads was found to increase the odds of creating habitats parallel to these features. For example, the odds of planting a hedgerow along the lengthwise edge were 82.3 times higher in the presence of a road. While an existing hedge along the shorter edge of the field (sc10) did not have an significant effect, the opportunity to connect two hedges on neighbouring fields (sc11) increased the odds of choosing the widthwise option by a factor of 3.7.

The final scenario (sc12) differed from the others in that farmers were given the additional option of implementing a continuous hedgerow along both edges to connect existing habitats. In this scenario, the odds of selecting the option that deviated from the standard options A and B increased by a factor of 11.7, despite the higher effort required.

3.3. The impact of farmer and farm attributes

In the baseline scenario (sc00), the region of the farm, farmers' attitudes towards biodiversity, the sample group (hedgerow or flower strip), and the maximum working width significantly influenced the choices (Table 4). Specifically, opting for alternatives to the favoured choice (lengthwise at the edge) was associated with higher odds for farmers from Eastern (Region 2) and Southern Europe (Region 3), highlighting regional differences in preferences. Farmers with strong biodiversity attitudes had lower odds of choosing option B (widthwise at the edge) but higher odds for in-field option C (lengthwise in-field).

Region had the strongest overall effect and was significant across most scenarios (Table 5). Farmers in eastern and southern Europe were more inclined to split plots. For example, in Region 3, the odds of choosing option D (in-field widthwise) in the slope scenario sc01 were 7.7 times higher than in Region 1 (see Table S2 in the supplementary material). These farmers were also less keen on placing measures on low-quality land but had lower odds of selecting options for habitat connectivity. In particular, the odds of choosing the connectivity option E in sc12 were 89 % lower for Region 2 compared to Region 1 (Table S3). Instead, farmers in Regions 2 and 3 preferred the greatest possible distance from existing landscape elements, aiming to distribute the measures more evenly across the landscape.

Furthermore, attitudes towards biodiversity had a significant influence on the choices in the majority of scenarios (Table 5). Farmers with strong attitudes had generally higher odds of choosing in-field options and considerably lower odds of selecting options adjacent to existing habitats (sc07, sc08, sc10, sc11). These farmers also demonstrated a greater willingness to dedicate land to biodiversity interventions to facilitate habitat connectivity (sc12).

The responses to the open-ended questions revealed a number of distinct rationales for the value placed on the interventions. Flower strips were valued for soil fertility, wildlife support, and aesthetics, whereas hedgerows were appreciated for their effect on wind regimes and barrier functions. In the baseline scenario, the odds of placing a hedgerow within the field were 67 % lower compared to flower strips (Table 4). Additionally, hedgerows were most frequently selected to be at right angles to existing habitats such as forests.

Moreover, the size of machinery, expressed as the maximum working width, exerted a considerable influence on the choices under the baseline conditions. In principle, there was a stronger preference for lengthwise options, even within the field, when larger machinery was involved. However, this influence was minimal in other scenarios.

Contrary to our initial expectations, the type of land use (arable or grassland) had a negligible impact on the decisions. Nevertheless, the reasons cited in the open-text field suggest that hedges are often planted as fencing or to protect animals from the sun, pollution, or noise. Organic certification appeared to have only a minor effect, and no significant interaction with field size or topographical relief was observed for the regions in which the farmers worked.

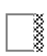
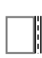
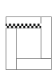
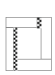
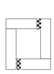
4. Discussion

By exploring farmers' spatial preferences for biodiversity measures, this study sheds light on how both operational and socio-cultural factors influence their choices. The findings emphasise the necessity of designing conservation strategies that are responsive to regional contexts and farmer priorities, thereby fostering practicability and acceptance among farmers. They also open avenues for future research to investigate how spatially informed approaches can enhance habitat connectivity while addressing multiple trade-offs.

4.1. Discussion of results

Previous research has largely concentrated on the role of field, farm, and farmer characteristics on *whether* agri-environmental measures (AEMs) are adopted. The present study extends this discussion by examining *where* these measures are most likely to be placed, shifting the focus from the farm or regional scale to the plot level. Although the respective results are not directly comparable, common patterns

Table 3
Influence of field and landscape characteristics on farmers' preferences for allocating of linear wildlife habitats at the field scale ($N = 471$).

Scenario			Choice			OR	Std. error	z value	Pr(>$\lvert z \rvert$)
sc01	slope		A			0.09	0.27	−8.76	< 0.001***
			B			10.05	0.28	8.34	< 0.001***
			C			0.00	0.99	−10.59	< 0.001***
			D			13033.37	0.88	10.80	< 0.001***
sc02	soil quality		A			3.95	0.20	6.77	< 0.001***
			B[†]						
			C			0.22	0.41	−3.70	< 0.001***
			D			4.10	0.82	1.73	0.084
sc03	soil quality		A			0.07	0.30	−9.03	< 0.001***
			B			16.27	0.31	9.12	< 0.001***
			C			0.00	0.91	−6.39	< 0.001***
			D[†]						
sc04	shape		A			3.69	0.31	4.17	< 0.001***
			B			0.16	0.63	−2.88	0.004**
			C			0.00	2.18	−6.96	< 0.001***
			D			6.36	2.18	0.85	0.395
sc05	size		A			0.32	0.31	−3.76	< 0.001***
			B			1.90	0.58	1.11	0.268
			C			109.33	1.64	2.86	0.004**
			D			6813.31	1.77	4.98	< 0.001***
sc06	wind		A			0.10	0.33	−7.13	< 0.001***
			B[‡]			11.59	0.23	10.44	< 0.001***
			C			0.00	4.26	−3.78	< 0.001***
			D			1.56	0.95	0.47	0.641
sc07	forest		A			1.47	0.20	1.89	0.059
			B			0.68	0.20	−1.89	0.059
sc08	forest		A			0.15	0.22	−8.38	< 0.001***
			B			6.55	0.22	8.38	< 0.001***
sc09	road		A			82.27	1.09	4.03	< 0.001***
			B			0.01	1.10	−4.03	< 0.001***
sc10	existing hedges		A			1.57	0.28	1.62	0.105
			B			0.64	0.28	−1.62	0.105
sc11	existing hedges		A			0.27	0.27	−4.76	< 0.001***
			B			3.69	0.27	4.76	< 0.001***
sc12	existing hedges		A			0.18	0.29	−5.97	< 0.001***
			B			0.45	0.54	−1.49	0.135
			E			11.69	0.40	6.09	< 0.001***

Signif. codes: 0 [***] 0.001 [**] 0.01 [*] 0.05 [.] 0.1 [ ] 1. The columns show the standardised choice options, odds ratios for selecting an option in the scenario compared to the baseline, and significance levels obtained from the GLMMs. Sc12 had the additional option to place a hedgerow at both the long and short edges (choice E) to connect existing hedgerows.

[†] The models sc02_B and sc03_D were unidentifiable due to a lack of shared IDs, indicating that the data variability was insufficient to estimate the model parameters.

[‡] The model sc06_B encountered boundary singular fits. Applying a log-gamma prior ($\alpha = 2$, $\lambda = 0.001$) to the random effects did not resolve the issue, which indicates insufficient data for reliable estimation.

Table 4
Influence of selected variables on farmers' preferences for allocating linear wildlife habitats in the baseline scenario (n = 417).

sc00 [baseline]							
Variable		Choice	OR	Std. error	z value	Pr(>|z|)	Pr(>Chisq)
(Intercept)		B	2.90	0.65	1.65	0.100	
		C	0.01	1.02	−4.19	< 0.001***	
ATT_BIODIV		B	0.76	0.07	−4.20	< 0.001***	< 0.001***
		C	1.22	0.10	2.00	0.046*	
FIELDSIZE		B	1.00	0.01	−0.26	0.795	0.946
		C	1.00	0.01	−0.26	0.799	
LU_GRASS		B	1.26	0.28	0.81	0.415	0.711
		C	1.00	0.01	−0.26	0.799	
ORGANIC		B	0.91	0.28	−0.32	0.749	0.215
		C	1.64	0.31	1.59	0.111	
REGION2		B	2.20	0.34	2.33	0.020*	0.003**
		C	3.88	0.39	3.46	< 0.001***	
REGION3		B	1.30	0.33	0.81	0.419	
		C	2.66	0.42	2.35	0.019*	
RELIEF_HILL		B	1.46	0.27	1.39	0.165	0.217
		C	1.52	0.31	1.35	0.176	
SAMPLE_H		B	0.75	0.26	−1.13	0.257	0.014*
		C	0.44	0.30	−2.83	0.005**	
WORKWIDTH		B	0.98	0.02	−0.91	0.364	0.012**
		C	1.06	0.02	2.68	0.007**	

Reference choice: long edge . Signif. codes: 0 [***] 0.001 [**] 0.01 [*] 0.05 [.] 0.1 [ ] 1, based on the Wald test (Pr(>|z|)) for each choice and the likelihood ratio test for the variables (Pr(>Chisq)).

Table 5
Result of likelihood ratio tests estimating the influence of parameters in the scenario-specific models (N = 471).

	ATT_BIODIV	FIELDSIZE	LU	ORGANIC	REGION	RELIEF	SAMPLE	WORKWIDTH
sc00	< 0.001***	0.946	0.711	0.215	0.003**	0.217	0.014*	0.012**
sc01	< 0.001***	0.110	0.185	0.122	< 0.001***	0.450	0.022*	0.139
sc02	0.068	0.167	0.633	0.564	< 0.001***	0.717	0.044*	0.090
sc03	0.003**	0.231	0.361	0.286	< 0.001***	0.995	0.044*	0.061
sc04	< 0.001***	0.180	0.002**	0.022*	0.048*	0.214		0.445
sc05	0.002**	0.730	0.637	0.421	0.629	0.985		0.073
sc06	0.884	0.644	0.873	0.127	0.007**	0.206		0.199
sc07	< 0.001***	0.479	0.425	< 0.001***	< 0.001***	0.832	< 0.001***	0.574
sc08	0.003**	0.173	0.963	0.007**	0.007**	0.677	0.018*	0.606
sc09	0.036*	0.289	0.958	0.413	0.011*	0.700		0.606
sc10	0.008**	0.328	0.995	0.827	0.063	0.186		0.899
sc11	0.130	0.794	0.696	0.660	0.003**	0.123		0.374
sc12	< 0.001***	0.759	0.239	0.243	0.018*	0.621		0.092

Pr(>Chisq). Signif. codes: 0 [***] 0.001 [**] 0.01 [*] 0.05 [.] 0.1 [ ] 1.

emerge, indicating underlying similarities in the factors driving these decisions.

The results imply that farmers' decisions regarding the placement of biodiversity measures are an expression of their efforts to balance productivity, operational efficiency, and the promotion of biodiversity through enhanced landscape connectivity. The specific landscape characteristics, machinery size, regional cultural factors, and individual attitudes towards biodiversity strongly influence these decisions. Key field parameters, such as slope, soil quality, field size, and proximity to existing landscape features, further guide the spatial allocation at the field scale.

There is a notable tendency for farmers to favour lengthwise placement of biodiversity measures, especially when using large machinery. This preference is consistent with the typical arrangement of tractor tramlines in rectangular fields (Mederle & Bernhardt, 2017), where widthwise obstacles impede the turning of machinery. Lengthwise management is not only agronomically efficient but also offers ecological advantages, as it reduces headlands, where soil disturbance and compaction negatively affect invertebrate abundance (Carlesso et al., 2022). However, the preference for placing wildlife habitats lengthwise along tramlines appears to be counterbalanced by field-specific characteristics in other scenarios.

Farmers consistently target areas of lower soil quality for AEM uptake, a pattern supported by earlier studies (Borsotto et al., 2008; Hynes & Garvey, 2009; Paulus et al., 2022; Rois-Díaz et al., 2018; Russi et al., 2016; Wool et al., 2023). Additionally, previous research has shown that concerns about soil erosion are a strong motivator for AEM adoption (Früh-Müller et al., 2019; van Herzele et al., 2013). The present study underscores the relevance of slopes and the associated risk of soil erosion, which are important factors in the spatial alignment of interventions at the plot level.

At the field scale, farmers' hedgerow placement exemplifies how they weigh operational trade-offs against environmental priorities, particularly in response to specific landscape features. Farmers expressed a clear preference for locating interventions near forests, which is in line with Paulus et al. (2022) who observed a greater likelihood of AEM adoption near woody features. Furthermore, when given the opportunity to link hedgerows to existing semi-natural habitats, farmers adjusted their choices for the benefit of biodiversity. This suggests a sensitivity to habitat connectivity and the environmental impact of measures, with the prospect of continuing habitats outweighing the desire to minimise disturbance in management practices. Similarly, Früh-Müller et al. (2019) reported a higher uptake of AEMs in German regions where habitat fragmentation is a pressing concern.

Alongside field and landscape attributes, farmers' personal characteristics are central to their decision-making. Numerous studies have demonstrated that positive attitudes towards biodiversity and nature in general increase farmers' willingness to implement biodiversity-friendly farming measures (see Klebl, Feindt, & Piorr, 2024a). This study adds that farmers with strong pro-biodiversity attitudes were more inclined to accept placement options that might complicate plot cultivation, prioritising conservation objectives over ease of operation.

The impact of regional specificities as an overarching factor further emphasises the personal and contextual dimension of farmers' behaviour. The absence of collinearity between the predictor variable REGION and the characteristics of farms and farmers indicates that socio-cultural environments exert a considerable influence on farmers' decisions beyond farm structural factors. This may be attributed to regional habits and farming traditions, which significantly shape individual agricultural practices (Pavlis et al., 2016; Rois-Díaz et al., 2018), illustrating the importance of understanding the socio-cultural contexts behind these choices.

While these results offer valuable insights into farmers' preferences, it is crucial to recognise the potential disparity between stated preferences and actual behaviour. Previous studies suggest that hypothetical scenarios, such as those applied in this study, can overestimate the participant's willingness to act (e.g., Brownstone & Small, 2005; De Corte et al., 2021; Urama & Hodge, 2006). Nonetheless, the results reveal clear choice patterns and highlight trade-offs that are relevant in the design of targeted policies and interventions aimed at linking wildlife habitats.

4.2. Policy implications

There is a particular need for spatial planning at the landscape scale to enhance habitat connectivity (Pe'er et al., 2020; Pe'er et al., 2022). Establishing a network of continuing hedgerows is considered a viable means of achieving this in European landscapes and should be a focus of policy efforts (Moorhouse et al., 2014; Staley et al., 2023). One key instrument of such policies is the provision of incentives to landowners (Cameron et al., 2022), which could be incorporated into the European Union's Common Agricultural Policy (CAP).

So far, evidence points to the conclusion that the CAP has not been effective in increasing landscape connectivity (Pardo et al., 2020). Despite the critical importance of spatially coordinating linear landscape features, the CAP Strategic Plans of the current legislation (2023–27) do not systematically address the spatial component in its instruments, i.e. the AEMs, now referred to as agri-environment-climate measures (AECMs), Good Agricultural and Environmental Conditions (GAEC), or eco-schemes (European Commission et al., 2023). This means that farmers are usually compensated for performing certain measures but, with some exceptions such as buffer strips, the specific placement within the field is not taken into account.

There is potential for the widespread introduction of an agglomeration bonus that rewards additional payments for AECMs when linking a semi-natural habitat to an existing one (Parkhurst et al., 2002), or agglomeration/threshold payments when farmers cooperate to contribute to habitat connectivity (Drechsler et al., 2010; Nguyen et al., 2022; Wätzold & Drechsler, 2014). These instruments are relatively easy to implement and offer pragmatic options. Yet, we also advocate for more targeted approaches derived from ecological network planning, which may prove more impactful in connecting specific habitats to complement these broad schemes.

The spatial coordination and implementation of planning-based strategies requires active collaboration between a range of stakeholders. Engaging farmers, government and public agencies, and conservation NGOs is central to developing a shared vision and effectively designing ecological networks (Keeley et al., 2018). Fostering cooperation among farmers and communities can further advance these efforts (McKenzie et al., 2013; Pe'er et al., 2022; Westerink et al., 2017), as collaborative initiatives have been shown to substantially enrich farmland biodiversity, notably in terms of butterfly and bird populations, which is largely attributed to an increase in landscape connectivity (Meier et al., 2024).

Coordinated collaborative approaches are likely to deliver more significant environmental outcomes than individual actions, but they are associated with higher transaction costs. Although these types of schemes may prove even more cost-efficient at larger scales (Niemi et al., 2024), they must comply with international subsidy regulations set by the World Trade Organization (WTO). In response to this, it has been proposed to redirect financial resources from established management-based schemes to collaborative agri-environmental schemes (McKenzie et al., 2013). Moreover, policy frameworks such as the CAP have been criticised for failing to address structural disincentives to collaboration, including land tenure arrangements that often conflict with the duration of AECMs (Leventon et al., 2017). These misalignments are of particular relevance for permanent landscape features such as hedgerows, where both tenants and landowners need to be involved in conservation agreements.

Beyond financial compensation, the creation of platforms for knowledge exchange and coordination between farmers, biodiversity advisors, and policy designers is crucial for evaluating regional socio-cultural conditions and navigating farm operational and ecological objectives. Leventon et al. (2019) advocate for governance systems aligned with ecological scales that complement existing structures. This would entail the formation of a landscape-scale decision-making forum comprising diverse stakeholders to collaboratively develop conservation plans for a defined landscape. However, the authors acknowledge that these systems would require a fundamental reorganisation of current power structures and responsibilities.

Such platforms can also play a critical role in amplifying attitudes towards biodiversity that relate to farmers' values. The results of this study indicate that environmental values and the concept of landscape connectivity resonate with many farmers across different regions, farm types, and farm sizes, as shown by their choices reflecting concerns about the broader ecological impact of plot-scale interventions. We therefore recommend greater investments in communicating the value of farmers' potential to contribute to ecosystem health and the natural environment in general. While conveying knowledge of ecosystem services derived from biodiversity interventions is important, previous research suggests that addressing farmers' connections to the land, for instance by emphasising the region-specific cultural meaning of hedgerows, can be more effective in securing long-term commitment to biodiversity-enhancing measures (Klebl et al., 2024b).

Table 6
Parameters proposed for consideration when simulating farmers' decisions to allocate linear wildlife habitats.

Parameter	Preference	Motivation
–	lengthwise edge	ease of management
slope	widthwise edge	reduction of runoff and erosion
soil quality	low-quality land	least impact on yield
wind regime	windward edge	crop protection
cardinal directions	northern/southern edge	climate- and crop-specific shading
landscape structure	connection to habitats/ along roads, forests, fields	biodiversity enhancement/ protection from pollution and wildlife
regional habitats and traditions	region-specific	agricultural and aesthetic preferences

For strategies targeting ecological networks to be successful in terms of both biodiversity conservation and financial efficiency, Mossman et al. (2015) specify the need for sufficient information on the distribution of taxa. This is particularly pertinent in the context of ex-ante assessments designed to identify the most efficient way to connect habitats and to ensure that corridors contribute to the expansion of target species (Beier et al., 2011; Brodie et al., 2016). Although prioritising the shortest distance between fragmented habitats as the most cost-effective solution is a plausible strategy, we emphasise the consideration that the true costs of implementation include compensation payments to landowners or −managers, as also mentioned by Beier et al. (2011) and Mossman et al. (2015).

Understanding landowners' motivations and preferences is therefore crucial for cost-effectiveness and practicality of conservation strategies. This stems from the assumption that the greater the deviation of a planned activity from farmers' preferences, the higher the financial compensation required to encourage participation. In this way, the insights of the study could help to estimate the costs of achieving connectivity. Linking woodland on a hill to a forest in a valley, for example, may be more costly than establishing corridors parallel to contour lines due to erosion concerns. Furthermore, corridors along roads are likely to be a low-cost solution, but potential trade-offs such as pollution, noise, and increased roadkill risks must be carefully weighed.

The integration of predicted behavioural outcomes of stakeholders into biogeographical and spatial ecological models can be a powerful tool for identifying least-effort strategies and improving fine-grained regional connectivity maps (Beier et al., 2011). Such methods can enable practitioners to target stakeholders who are most likely to implement wildlife corridors on their land. However, Bergsten and Zetterberg (2013) highlighted the lack of a systematic approach in planning ecological networks. Our results could provide one component in developing these strategies. To this end, we propose to incorporate the parameters outlined in Table 6 into spatial network planning.

4.3. Research outlook

The practical relevance of the study for ecological network planning reflects the need for research-driven analytical foundations to inform decision-making and implementation. For this purpose, approaches such as agent-based modelling have been recommended to simulate animal movement and behaviour at the human-environment interface, with interdisciplinary approaches being most effective (McLane et al., 2011). By conceptualising farmers and biodiversity as distinct agents, models can estimate the impact of different policy strategies on farmer behaviour and biodiversity outcome (e.g., Dai et al., 2020; Djenontin et al., 2022; Valbuena et al., 2010), and can be parameterised with the variables identified in this study.

A potential key question to be addressed through such models is which spatial arrangements of biodiversity corridors enhance habitat connectivity at least cost while meeting farmers' operational needs. This could involve a multi-stage approach: discrete choice experiments to quantify the financial compensation required to implement different corridor scenarios and spatial modelling to simulate cost-effective corridor configurations within a sample region.

Beyond evaluating cost-effective arrangements, estimating the ecological impact of different configurations is essential for understanding trade-offs between economic costs and ecological effectiveness, thus helping to determine the most viable options for habitat connectivity. The findings of this study can strengthen both newly developed and existing models of ecological network planning, such as the Pareto-based approach proposed by Groot et al. (2010), which balances ecological coherence, landscape character, and implementation and maintenance costs. Integrating social factors with ecological indicators would improve the predictive power of these models for assessing trade-offs and ecological outcomes.

While hedgerows, perennial wildflower strips, and other wildlife corridors are widely recognised for promoting biodiversity, water retention, pollination, soil protection, and soil carbon sequestration (e.g., Holden et al., 2019; Kratschmer et al., 2024; Montgomery et al., 2020; Sutter et al., 2018; Van Vooren et al., 2017), they may act as vectors for the spread of diseases and invasive species (Montgomery et al., 2020), demanding careful planning and management (Wilkerson, 2014). However, in light of the ongoing decline of existing corridors and the growing fragmentation of habitats in Europe (Arnaiz-Schmitz et al., 2018; EEA et al., 2011; Van Den Berge et al., 2019), it remains questionable whether these risks outweigh the substantial benefits of (re) connecting fragmented habitats. Nevertheless, incorporating relevant risks into modelling approaches is recommended to ensure balanced and reliable conservation planning.

Such refined models may serve as the basis for the development of practical tools to support decision-making by extension services, government agencies, and practitioners. To further extend their impact, future research could investigate which specific policy incentives deliver the greatest environmental benefits at the lowest cost. This has the potential to inform the design of policy initiatives that are effective and responsive to the needs of farmers.

5. Conclusions

This study shows that farmers' decisions on the spatial distribution of biodiversity measures are shaped by their intrinsic motivations and practical considerations. While farmers seek to optimise productivity and minimise disturbance to field work, they also place importance on habitat connectivity. The significant impact of regional factors and local landscape characteristics on their decisions underscores the need for region-specific conservation plans. Understanding farmers' priorities and tailoring efforts to specific socio-cultural practices and regional conditions can increase their acceptance and effectiveness.

There is an opportunity for policy schemes, such as those under the CAP, to better integrate interventions that contribute to habitat connectivity. Incentives, including the agglomeration bonus, can encourage farmers to link habitats, but broader, ecologically grounded, and locally adapted solutions are considered to be more fruitful. It is therefore recommended for policy designers to strategically address the spatial aspects of conservation measures to improve landscape connectivity.

Effective practical conservation relies on active stakeholder engagement and collaboration among farmers. Collaborative initiatives would benefit from region-specific ecological guidance to enrich farmland biodiversity at the landscape scale. It is expected that greater attention paid to the ecological and cultural value of biodiversity measures will further promote long-term commitment and the sustainability of conservation practices.

These findings also point to potential research pathways for future studies in ecological and economic modelling and conservation planning. Integrating farmer preferences into modelling approaches offers a viable means of predicting the costs and impacts of policies on landscape connectivity, thereby providing valuable insights into the relationship between farmer behaviour and ecological outcomes. This could result in more comprehensive yet targeted methods that align with both ecological objectives and farmers' concerns.

CRediT authorship contribution statement

Fabian Klebl: Writing – review & editing, Writing – original draft, Visualization, Validation, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Jonathan R. Rhodes:** Writing – original draft, Validation, Supervision, Methodology, Formal analysis. **Kati Häfner:** Project administration, Investigation, Data curation. **Annette Piorr:** Supervision, Project administration, Funding acquisition, 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.

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Appendix A

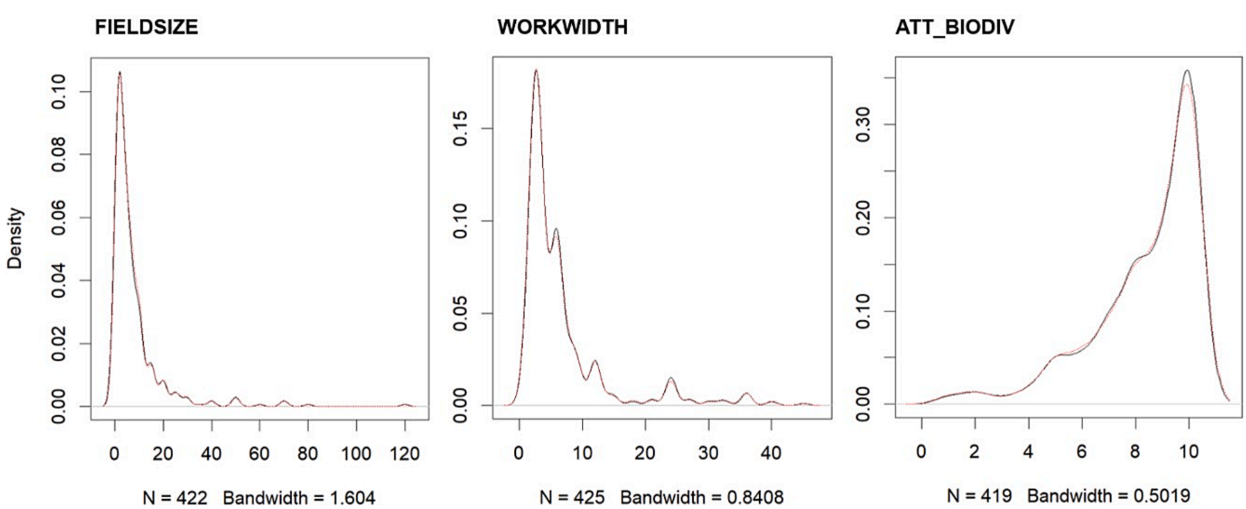

Fig. A1. Data density fit for the original data set with missing values (black line) and the data set after imputation (red line).

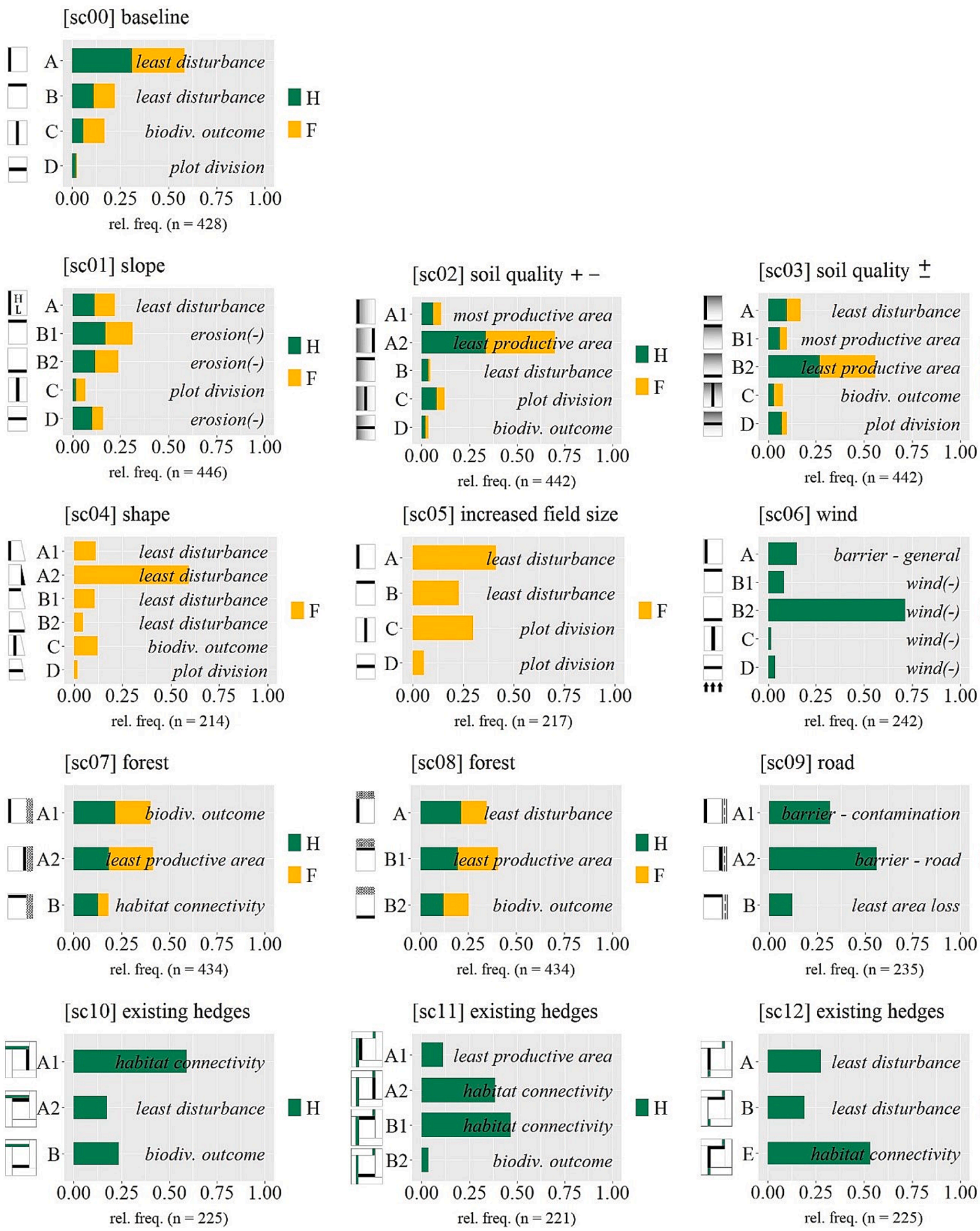

Fig. A2. Relative distribution of farmers' choices for the spatial allocation of hedgerows (H) and wildflower strips (F) under various scenarios, each differing from the baseline scenario [sc00] by a single parameter. The y-axis labels denote the different choice options for each scenario, with graphics representing the biodiversity measure as a black bar in the field. The plot labels show the most frequently cited reasons for each choice.

Appendix B. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.landurbplan.2025.105325.

Data availability

All survey data will be made accessible as part of the publication of the overall projectsurvey results.

References

Agresti, A. (2007). *An introduction to categorical data analysis* (2nd edition). Hoboken, USA: John Wiley & Sons.

Arnaiz-Schmitz, C., Herrero-Jáuregui, C., & Schmitz, M. F. (2018). Losing a heritage hedgerow landscape. Biocultural diversity conservation in a changing social-ecological Mediterranean system. *Science of the Total Environment, 637*, 374–384. https://doi.org/10.1016/j.scitotenv.2018.04.413

Aviron, S., Herzog, F., Klaus, I., Schüpbach, B., & Jeanneret, P. (2011). Effects of wildflower strip quality, quantity, and connectivity on butterfly diversity in a Swiss arable landscape. *Restoration Ecology, 19*(4), 500–508. https://doi.org/10.1111/j.1526-100X.2010.00649.x

Beier, P., Spencer, W., Baldwin, R. F., & McRae, B. H. (2011). Toward best practices for developing regional connectivity maps. *Conservation Biology, 25*(5), 879–892. https://doi.org/10.1111/j.1523-1739.2011.01716.x

Bergsten, A., & Zetterberg, A. (2013). To model the landscape as a network: A practitioner's perspective. *Landscape and Urban Planning, 119*, 35–43. https://doi.org/10.1016/j.landurbplan.2013.06.009

Borsotto, P., Henke, R., Macrì, M. C., & Salvioni, C. (2008). Participation in rural landscape conservation schemes in Italy. *Landscape Research, 33*(3), 347–363. https://doi.org/10.1080/01426390802046044

Brodie, J. F., Paxton, M., Nagulendran, K., Balamurugan, G., Clements, G. R., Reynolds, G., Jain, A., & Hon, J. (2016). Connecting science, policy, and implementation for landscape-scale habitat connectivity. *Conservation Biology, 30*(5), 950–961. https://doi.org/10.1111/cobi.12667

Brownstone, D., & Small, K. A. (2005). Valuing time and reliability: Assessing the evidence from road pricing demonstrations. *Transportation Research Part a: Policy and Practice, 39*(4), 279–293. https://doi.org/10.1016/j.tra.2004.11.001

Buhk, C., Oppermann, R., Schanowski, A., Bleil, R., Lüdemann, J., & Maus, C. (2018). Flower strip networks offer promising long term effects on pollinator species richness in intensively cultivated agricultural areas. *BMC Ecology, 18*, 1–13. https://doi.org/10.1186/s12898-018-0210-z

Cameron, D. R., Schloss, C. A., Theobald, D. M., & Morrison, S. A. (2022). A framework to select strategies for conserving and restoring habitat connectivity in complex landscapes. *Conservation Science and Practice, 4*(6), Article e12698. https://doi.org/10.1111/csp2.12698

Carlesso, L., Beadle, A., Cook, S. M., Hartwell, G., Mead, A., Ritz, K., Sparkes, D., Wu, L., & Murray, P. J. (2022). Impacts of field margin orientation on populations of soil-dwelling invertebrates in relation to the direction and intensity of field traffic. *Soil Use and Management, 38*(1), 1015–1032. https://doi.org/10.1111/sum.12768

Dai, E., Ma, L., Yang, W., Wang, Y., Yin, L.e., & Tong, M. (2020). Agent-based model of land system: Theory, application and modelling framework. *Journal of Geographical Sciences, 30*, 1555–1570. https://doi.org/10.1007/s11442-020-1799-3

De Corte, K., Cairns, J., & Grieve, R. (2021). Stated versus revealed preferences: An approach to reduce bias. *Health Economics, 30*(5), 1095–1123. https://doi.org/10.1002/hec.4246

Djenontin, I. N. S., Ligmann-Zielinska, A., & Zulu, L. C. (2022). Landscape-scale effects of farmers' restoration decision making and investments in central Malawi: An agent-based modeling approach. *Journal of Land Use Science, 17*(1), 281–306. https://doi.org/10.1080/1747423X.2022.2076948

Donaldson, L., Wilson, R. J., & Maclean, I. M. D. (2017). Old concepts, new challenges: Adapting landscape-scale conservation to the twenty-first century. *Biodiversity and Conservation, 26*, 527–552. https://doi.org/10.1007/s10531-016-1257-9

Dondina, O., Kataoka, L., Orioli, V., & Bani, L. (2016). How to manage hedgerows as effective ecological corridors for mammals: A two-species approach. *Agriculture, Ecosystems & Environment, 231*, 283–290. https://doi.org/10.1016/j.agee.2016.07.005

Drechsler, M., Wätzold, F., Johst, K., & Shogren, J. F. (2010). An agglomeration payment for cost-effective biodiversity conservation in spatially structured landscapes. *Resource and Energy Economics, 32*(2), 261–275. https://doi.org/10.1016/j.reseneeco.2009.11.015

EEA, Schwick, C., Madriñán, L., Kienast, F., Jaeger, J., & Soukup, T. (2011). *Landscape fragmentation in Europe – Joint EEA-FOEN report. European Environment Agency*. https://doi.org/10.2800/78322

European Commission, Directorate-General for Agriculture and Rural Development, Chartier, O., Krüger, T., Folkeson Lillo, C., Valli, C., Jongeneel, R., Selten, M., van Asseldonk, M., Avis, K., Rouillard, J., Underwood, E., Parissaki, M., Bertolozzi, D., & Devot, A. (2023). *Mapping and analysis of CAP strategic plans – Assessment of joint efforts for 2023-2027*. Publications Office of the European Union. https://doi.org/10.2762/71556.

Fischer, C., Schlinkert, H., Ludwig, M., Holzschuh, A., Gallé, R., Tscharntke, T., & Batáry, P. (2013). The impact of hedge-forest connectivity and microhabitat conditions on spider and carabid beetle assemblages in agricultural landscapes. *Journal of Insect Conservation, 17*, 1027–1038. https://doi.org/10.1007/s10841-013-9586-4

Früh-Müller, A., Bach, M., Breuer, L., Hotes, S., Koellner, T., Krippes, C., & Wolters, V. (2019). The use of agri-environmental measures to address environmental pressures in Germany: Spatial mismatches and options for improvement. *Land Use Policy, 84*, 347–362. https://doi.org/10.1016/j.landusepol.2018.10.049

Gelling, M., Macdonald, D. W., & Mathews, F. (2007). Are hedgerows the route to increased farmland small mammal density? Use of hedgerows in British pastoral habitats. *Landscape Ecology, 22*, 1019–1032.

Groot, J. C. J., Jellema, A., & Rossing, W. A. H. (2010). Designing a hedgerow network in a multifunctional agricultural landscape: Balancing trade-offs among ecological quality, landscape character and implementation costs. *European Journal of Agronomy, 32*(1), 112–119. https://doi.org/10.1016/j.eja.2009.07.002

Haddad, N. M., Brudvig, L. A., Clobert, J., Davies, K. F., Gonzalez, A., Holt, R. D., Lovejoy, T. E., Sexton, J. O., Austin, M. P., & Collins, C. D. (2015). Habitat fragmentation and its lasting impact on Earth's ecosystems. *Science Advances, 1*(2), Article e1500052. https://doi.org/10.1126/sciadv.1500052

Holden, J., Grayson, R. P., Berdeni, D., Bird, S., Chapman, P. J., Edmondson, J. L., Firbank, L. G., Helgason, T., Hodson, M. E., & Hunt, S. F. (2019). The role of hedgerows in soil functioning within agricultural landscapes. *Agriculture, Ecosystems & Environment, 273*, 1–12. https://doi.org/10.1016/j.agee.2018.11.027

Hosmer, D. W., Jr, Lemeshow, S., & Sturdivant, R. X. (2013). *Applied logistic regression.* Hoboken, USA: John Wiley & Sons.

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. *Journal of Agricultural Economics, 60*(3), 546–562. https://doi.org/10.1111/j.1477-9552.2009.00210.x

Keeley, A. T. H., Basson, G., Cameron, D. R., Heller, N. E., Huber, P. R., Schloss, C. A., Thorne, J. H., & Merenlender, A. M. (2018). Making habitat connectivity a reality. *Conservation Biology, 32*(6), 1221–1232. https://doi.org/10.1111/cobi.13158

Klebl, F., Feindt, P. H., & Piorr, A. (2024a). Farmers' behavioural determinants of on-farm biodiversity management in Europe: A systematic review. *Agriculture and Human Values, 41*(2), 831–861. https://doi.org/10.1007/s10460-023-10505-8

Klebl, F., Parisi, A., Häfner, K., Adler, A., Barreiro, S., Bodea, F. V., Brönnimann, V., de Vries, J. P., Dos Santos, A., Hood, A. S., Melts, I., Popa, R., Vajna, F., Velado-Alonso, E., & Kernecker, M. L. (2024b). How values and perceptions shape farmers' biodiversity management: Insights from ten European countries. *Biological Conservation, 291*, Article 110496. https://doi.org/10.1016/j.biocon.2024.110496

Kratschmer, S., Hauer, J., Zaller, J. G., Dürr, A., & Weninger, T. (2024). Hedgerow structural diversity is key to promoting biodiversity and ecosystem services: A systematic review of Central European studies. *Basic and Applied Ecology*. https://doi.org/10.1016/j.baae.2024.04.010

Leventon, J., Schaal, T., Velten, S., Dänhardt, J., Fischer, J., Abson, D. J., & Newig, J. (2017). Collaboration or fragmentation? Biodiversity management through the common agricultural policy. *Land Use Policy, 64*, 1–12. https://doi.org/10.1016/j.landusepol.2017.02.009

Leventon, J., Schaal, T., Velten, S., Loos, J., Fischer, J., & Newig, J. (2019). Landscape-scale biodiversity governance: Scenarios for reshaping spaces of governance. *Environmental Policy and Governance, 29*(3), 170–184. https://doi.org/10.1002/eet.1845

Liccari, F., Boscutti, F., Bacaro, G., & Sigura, M. (2022). Connectivity, landscape structure, and plant diversity across agricultural landscapes: Novel insight into effective ecological network planning. *Journal of Environmental Management, 317*, Article 115358. https://doi.org/10.1016/j.jenvman.2022.115358

McKenzie, A. J., Emery, S. B., Franks, J. R., & Whittingham, M. J. (2013). Landscape-scale conservation: Collaborative agri-environment schemes could benefit both biodiversity and ecosystem services, but will farmers be willing to participate? *Journal of Applied Ecology, 50*(5), 1274–1280. https://doi.org/10.1111/1365-2664.12122

McLane, A. J., Semeniuk, C., McDermid, G. J., & Marceau, D. J. (2011). The role of agent-based models in wildlife ecology and management. *Ecological Modelling, 222*(8), 1544–1556. https://doi.org/10.1016/j.ecolmodel.2011.01.020

Mederle, M., & Bernhardt, H. (2017). Influences and Decision Criteria on Infield-Logistics in German Agricultural Farms. *Chemical Engineering Transactions, 58*, 307–312. https://doi.org/10.3303/CET1758052

Meier, E. S., Lüscher, G., Herzog, F., & Knop, E. (2024). Collaborative approaches at the landscape scale increase the benefits of agri-environmental measures for farmland biodiversity. *Agriculture, Ecosystems & Environment, 367*, Article 108948. https://doi.org/10.1016/j.agee.2024.108948

Michel, N., Burel, F., & Butet, A. (2006). How does landscape use influence small mammal diversity, abundance and biomass in hedgerow networks of farming landscapes? *Acta Oecologica, 30*(1), 11–20. https://doi.org/10.1016/j.actao.2005.12.006

Montgomery, I., Caruso, T., & Reid, N. (2020). Hedgerows as ecosystems: Service delivery, management, and restoration. *Annual Review of Ecology, Evolution, and Systematics, 51*(1), 81–102. https://doi.org/10.1146/annurev-ecolsys-012120-100346

Moorhouse, T. P., Palmer, S. C. F., Travis, J. M. J., & Macdonald, D. W. (2014). Hugging the hedges: Might agri-environment manipulations affect landscape permeability for hedgehogs? *Biological Conservation, 176*, 109–116. https://doi.org/10.1016/j.biocon.2014.05.015

Mossman, H. L., Panter, C. J., & Dolman, P. M. (2015). Modelling biodiversity distribution in agricultural landscapes to support ecological network planning. *Landscape and Urban Planning, 141*, 59–67. https://doi.org/10.1016/j.landurbplan.2015.04.010

Nguyen, C., Latacz-Lohmann, U., Hanley, N., Schilizzi, S., & Iftekhar, S. (2022). Spatial Coordination Incentives for landscape-scale environmental management: A systematic review. *Land Use Policy, 114*, Article 105936. https://doi.org/10.1016/j.landusepol.2021.105936

Niemi, J., Mattila, T., & Seppälä, J. (2024). Rewetting on agricultural peatlands can offer cost effective greenhouse gas reduction at the national level. *Land Use Policy, 146*, Article 107329. https://doi.org/10.1016/j.landusepol.2024.107329

Pardo, A., Rolo, V., Concepción, E. D., Díaz, M., Kazakova, Y., Stefanova, V., Marsden, K., Brandt, K., Jay, M., & Piskol, S. (2020). To what extent does the European common agricultural policy affect key landscape determinants of biodiversity? *Environmental Science & Policy, 114*, 595–605. https://doi.org/10.1016/j.envsci.2020.09.023

Parkhurst, G. M., Shogren, J. F., Bastian, C., Kivi, P., Donner, J., & Smith, R. B. (2002). Agglomeration bonus: an incentive mechanism to reunite fragmented habitat for biodiversity conservation. *Ecological economics, 41*(2), 305–328. https://doi.org/10.1016/S0921-8009(02)00036-8

Paulus, A., Hagemann, N., Baaken, M. C., Roilo, S., Alarcón-Segura, V., Cord, A. F., & Beckmann, M. (2022). Landscape context and farm characteristics are key to farmers' adoption of agri-environmental schemes. *Land Use Policy, 121*, Article 106320. https://doi.org/10.1016/j.landusepol.2022.106320

Pavlis, E. S., Terkenli, T. S., Kristensen, S. B., Busck, A. G., & Cosor, G. L. (2016). Patterns of agri-environmental scheme participation in Europe: Indicative trends from selected case studies. *Land Use Policy, 57*, 800–812. https://doi.org/10.1016/j.landusepol.2015.09.024

Pe'er, G., Bonn, A., Bruelheide, H., Dieker, P., Eisenhauer, N., Feindt, P. H., Hagedorn, G., Hansjürgens, B., Herzon, I., & Lomba, Â. (2020). Action needed for the EU Common Agricultural Policy to address sustainability challenges. *People and Nature, 2*(2), 305–316. https://doi.org/10.1002/pan3.10080

Pe'er, G., Finn, J. A., Díaz, M., Birkenstock, M., Lakner, S., Röder, N., Kazakova, Y., Šumrada, T., Bezák, P., & Concepción, E. D. (2022). How can the European Common Agricultural Policy help halt biodiversity loss? Recommendations by over 300 experts. *Conservation Letters, 15*(6), Article e12901. https://doi.org/10.1111/conl.12901

Pelletier-Guittier, C., Théau, J., & Dupras, J. (2020). Use of hedgerows by mammals in an intensive agricultural landscape. *Agriculture, Ecosystems & Environment, 302*, Article 107079. https://doi.org/10.1016/j.agee.2020.107079

Portela, M. B., Rodrigues, E. I., de Sousa Rodrigues Filho, C. A. S. R., Rezende, C. F., & de Oliveira, T. S. (2020). Do ecological corridors increase the abundance of soil fauna? *Écoscience, 27*(1), 45–57. https://doi.org/10.1080/11956860.2019.1690933

R Core Team. (2024). *R: A Language and Environment for Statistical Computing* [Computer software]. https://www.R-project.org/.

Rois-Díaz, M., Lovric, N., Lovric, M., Ferreiro-Domínguez, N., Mosquera-Losada, M. R., Herder, M., Graves, A., Palma, J., Paulo, J. A., Pisanelli, A., Smith, J., Moreno, G., García, S., Varga, A., Pantera, A., Mirck, J., & Burgess, P. (2018). Farmers' reasoning behind the uptake of agroforestry practices: Evidence from multiple case-studies across Europe. *Agroforestry Systems, 92*(4), 811–828. https://doi.org/10.1007/s10457-017-0139-9

Russi, D., Margue, H., Oppermann, R., & Keenleyside, C. (2016). Result-based agri-environment measures: Market-based instruments, incentives or rewards? The case of Baden-Württemberg. *Land Use Policy, 54*, 69–77. https://doi.org/10.1016/j.landusepol.2016.01.012

Schlaepfer, D. R., Braschler, B., Rusterholz, H.-P., & Baur, B. (2018). Genetic effects of anthropogenic habitat fragmentation on remnant animal and plant populations: A meta-analysis. *Ecosphere, 9*(10), Article e02488. https://doi.org/10.1002/ecs2.2488

Staley, J. T., Wolton, R., & Norton, L. R. (2023). Improving and expanding hedgerows—Recommendations for a semi-natural habitat in agricultural landscapes. *Ecological Solutions and Evidence, 4*(1), Article e12209. https://doi.org/10.1002/2688-8319.12209

Sutter, L., Albrecht, M., & Jeanneret, P. (2018). Landscape greening and local creation of wildflower strips and hedgerows promote multiple ecosystem services. *Journal of Applied Ecology, 55*(2), 612–620. https://doi.org/10.1111/1365-2664.12977

Szitár, K., Deák, B., Halassy, M., Steffen, C., & Batáry, P. (2022). Combination of organic farming and flower strips in agricultural landscapes–A feasible method to maximise functional diversity of plant traits related to pollination. *Global Ecology and Conservation, 38*, Article e02229. https://doi.org/10.1016/j.gecco.2022.e02229

Travers, E., Härdtle, W., & Matthies, D. (2021). Corridors as a tool for linking habitats–Shortcomings and perspectives for plant conservation. *Journal for Nature Conservation, 60*, Article 125974. https://doi.org/10.1016/j.jnc.2021.125974

Urama, K. C., & Hodge, I. D. (2006). Are stated preferences convergent with revealed preferences? *Empirical evidence from Nigeria. Ecological Economics, 59*(1), 24–37. https://doi.org/10.1016/j.ecolecon.2005.09.022

Valbuena, D., Verburg, P. H., Bregt, A. K., & Ligtenberg, A. (2010). An agent-based approach to model land-use change at a regional scale. *Landscape Ecology, 25*, 185–199. https://doi.org/10.1007/s10980-009-9380-6

van Buuren, S., & Groothuis-Oudshoorn, K. (2011). mice: Multivariate imputation by chained equations in R. *Journal of Statistical Software, 45*(3), 1–67. https://doi.org/10.18637/jss.v045.i03.

Van Den Berge, S., Tessens, S., Baeten, L., Vanderschaeve, C., & Verheyen, K. (2019). Contrasting vegetation change (1974–2015) in hedgerows and forests in an intensively used agricultural landscape. *Applied Vegetation Science, 22*(2), 269–281. https://doi.org/10.1111/avsc.12424

van Herzele, A., Gobin, A., van Gossum, P., Acosta, L., Waas, T., Dendoncker, N., & Henry de Frahan, B. (2013). Effort for money? Farmers' rationale for participation in agri-environment measures with different implementation complexity. *Journal of Environmental Management, 131*, 110–120. https://doi.org/10.1016/j.jenvman.2013.09.030

Van Vooren, L., Reubens, B., Broekx, S., de Frenne, P., Nelissen, V., Pardon, P., & Verheyen, K. (2017). Ecosystem service delivery of agri-environment measures: A synthesis for hedgerows and grass strips on arable land. *Agriculture, Ecosystems & Environment, 244*, 32–51. https://doi.org/10.1016/j.agee.2017.04.015

Vasiliev, D., & Greenwood, S. (2023). The role of landscape connectivity in maintaining pollinator biodiversity needs reconsideration. *Biodiversity and Conservation, 32*(12), 3765–3790. https://doi.org/10.1007/s10531-023-02667-y

Wätzold, F., & Drechsler, M. (2014). Agglomeration payment, agglomeration bonus or homogeneous payment? *Resource and Energy Economics, 37*, 85–101. https://doi.org/10.1016/j.reseneeco.2013.11.011

Wehling, S., & Diekmann, M. (2009). Importance of hedgerows as habitat corridors for forest plants in agricultural landscapes. *Biological Conservation, 142*(11), 2522–2530. https://doi.org/10.1016/j.biocon.2009.05.023

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. https://doi.org/10.1016/j.landusepol.2017.09.002

Wilkerson, M. L. (2014). Using hedgerows as model linkages to examine non-native plant patterns. *Agriculture, Ecosystems & Environment, 192*, 38–46. https://doi.org/10.1016/j.agee.2014.03.044

Wool, R., Breckenridge, G., Ziv, G., & Gosal, A. S. (2023). Delineating the spatial drivers of agri-environment scheme adoption at field and farm levels. *Journal of Environmental Management, 348*, Article 119407. https://doi.org/10.1016/j.jenvman.2023.119407