frontiers | Frontiers in Environmental Economics

TYPE Brief Research Report
PUBLISHED 12 September 2025
DOI 10.3389/frevc.2025.1648280

OPEN ACCESS

EDITED BY
Vijay Singh Meena,
Indian Agricultural Research Institute (ICAR), India

REVIEWED BY
Daniel Read,
Independent Researcher, Bengaluru, India
Landon Yoder,
Indiana University, United States

*CORRESPONDENCE
Anna Nordén
✉ anna.norden@ju.se

†These authors have contributed equally to this work and share first authorship

RECEIVED 18 July 2025
ACCEPTED 18 August 2025
PUBLISHED 12 September 2025

CITATION
Correa M, Gsottbauer E and Nordén A (2025) Nudging fails to increase conservation actions among farmers.
Front. Environ. Econ. 4:1648280.
doi: 10.3389/frevc.2025.1648280

Nudging fails to increase conservation actions among farmers

Miquel Correa[1,2†], Elisabeth Gsottbauer[3,4,5†] and Anna Nordén[1*†]

[1]Jönköping International Business School (JIBS), Jönköping, Sweden, [2]Xarxa per a la Conservació de la Natura (XCN), Barcelona, Spain, [3]Centre for Sustainbility, Free University of Bozen-Bolzano, Bolzano, Italy, [4]Grantham Research Institute on Climate Change, London School of Economics, London, United Kingdom, [5]Department of Economics, University of Innsbruck, Innsbruck, Austria

This paper presents findings from a randomized field experiment with over 7,200 Swedish farmers, evaluating the effectiveness of a behavioral nudge aimed at increasing engagement with a biodiversity conservation advisory service. The treatment group received a postcard featuring a peer farmer's testimonial and photo, highlighting the ease and benefits of adopting conservation practices. The control group received standard campaign materials from the national farming board. The intervention combined elements of salience, (peer) messenger effects, and social norms, but had no measurable effect on farmers' likelihood of requesting an advisory audit, the key first step toward participation in a new agri-environmental scheme. Exploratory subgroup analysis, however, reveals suggestive evidence that the nudge may have been more effective among female farmers and those already engaged in biodiversity efforts. Overall, these results suggest that behavioral nudges may have limited impact in promoting voluntary uptake of sustainable farming practices. Implications for the design of behavioral interventions in agricultural policy are discussed.

KEYWORDS

biodiversity conservation, information nudge, peer effects, salience, sustainable farming, randomized field experiment

1 Introduction

Biodiversity continues to decline globally, with agricultural expansion and intensification identified as major contributing factors (IPBES, 2019; Jaureguiberri et al., 2022). In addition to protected areas, voluntary agri-environmental schemes have gained recognition as a key policy instrument for promoting biodiversity-friendly practices on private lands (Engel et al., 2008; Hanley et al., 2012; Dessart et al., 2019). These programs offer financial incentives to farmers for implementing conservation measures that support the creation, restoration, or maintenance of wildlife habitats within agricultural landscapes. However, achieving meaningful conservation impacts through such voluntary initiatives hinges critically on reaching adequate farmer participation.

Nudges are increasingly recognized as a potential useful, though not universally effective, tool to promote conservation behavior and environmental stewardship (e.g., Balmford et al., 2021). They work by making pro-environmental actions more salient and intuitive through framing information, simplifying choices, invoking social norms, or reducing psychological frictions (Gsottbauer and Van den Bergh, 2011; Sunstein, 2014). A growing experimental literature tests the effectiveness of behavioral interventions in real-world settings, particularly for household resource conservation. Social norm nudges such as comparing individual behavior to that of neighbors have been shown to reduce energy and water use (Schultz et al., 2007; Allcott, 2011; Ferraro and Price, 2013). Other studies find that salience and information framing, including enhanced utility bills or tailored messages, can increase participation in energy efficiency programs (Allcott, 2011; Gillingham and Tsvetanov, 2019).

With respect to agricultural conservation, studies show that combining financial incentives with nudges can encourage pro-environmental behavior in agricultural settings. For instance, Czap et al. (2015) found that pairing payments with pro-social nudges increased farmers' adoption of riparian buffers. Kuhfuss et al. (2016) demonstrated that framing information effectively helped retain farmers in agri-environmental schemes. Chabé-Ferret et al. (2019) and Ouvrard et al. (2023) reported that information nudges led to greater water-saving behavior among farmers.

However, the evidence is not uniformly positive. Reddy et al. (2020) found that framed messages did not significantly increase participation in a conservation program compared to standard information and in some cases, even discouraged enrollment among farmers who had not yet adopted conservation practices. Similarly, other recent studies on biodiversity and environmental conservation behavior often in collaboration with NGOs report mixed or null effects of message framing (Kidd et al., 2019; Kusmanoff et al., 2020).

Taken together, while nudges can be effective under certain conditions, they are not a universal solution. A study by DellaVigna and Linos (2022), analyzing 126 randomized trials run by government nudge units in the US and UK, found that average treatment effects were often small or null, with little correlation between initial academic pilot studies and outcomes at scale highlighting the importance of context and external validity for behavioral interventions. Other similar recent meta-reviews (e.g., Szaszi et al., 2022; Maier et al., 2022) emphasize similar conclusions including that many nudges produce only modest impacts, and that effects tend to diminish after correcting for publication bias.

This paper examines the effectiveness of a behavioral nudge designed to encourage farmers to engage with a new biodiversity advisory service, an important first step toward participation in an agri-environmental scheme. To do so, we conducted a large-scale randomized field experiment with Swedish farmers. The treatment group received a postcard highlighting the new biodiversity advisory service, framed around a peer farmer's experience and accompanied by his photo and testimonial. Based on the MINDSPACE framework (Dolan et al., 2012), as adapted by Palm-Forster et al. (2019) to agri-environmental contexts, this behavioral nudge combines three elements: salience (the program is the sole focus), messenger effects (the peer farmer as a trusted voice), and social norms (implied peer uptake). The control group received the standard campaign materials distributed by the national farming board, which focused on an existing nutrient management program and only briefly mentioned the new biodiversity service.

Indeed, the intervention builds upon a growing body of research suggesting that personalized, peer-influenced messages can be more persuasive than generic information. In agriculture, for example, Läpple and Kelley (2013) show that farmers are more likely to adopt sustainable practices when they observe their peers doing so. This aligns with Bandura (1977) social learning theory, which emphasizes the role of relatable individuals in shaping behavior through observational learning. Similar mechanisms have been documented outside agriculture: in entrepreneurship, for instance, exposure to successful role models has been shown to influence individuals' decision to start a business (Shapero and Sokol, 1982; Krueger, 1993; Fornahl, 2003; Lafuente et al., 2007). Based on this theoretical foundation and prior empirical evidence, we hypothesize that concentrating the message on the biodiversity advisory service and framing it around a relatable farmer role model will increase the likelihood of farmers requesting an audit.

2 Experimental design

2.1 Setting

For this field experiment, we collaborated with the Swedish Board of Agriculture and the Federation of Swedish Farmers through their advisory program *Greppa Näringen* ("Capture the Nutrients"), which offers free, science-based guidance to Swedish farmers on sustainable agricultural practices, with a focus on nutrient management, environmental protection, and, more recently, biodiversity conservation. The new advisory service for biodiversity conservation (Advisory Module 17A – Biodiversity in Arable Landscapes) is designed for arable farms and includes one advisory visit consisting of a personal meeting with tailored information based on the farmer's specific needs, plus a follow-up visit. It focuses on identifying and enhancing biodiversity potential on and around arable land (excluding permanent pasture). There is no strict lower limit on farm size and eligibility is based on the farm's potential for meaningful biodiversity improvements. The advisor maps key features (e.g., field margins, flowering fallows), proposes at least three prioritized actions, and develops a 3-year plan with estimated costs and expected outcomes.

2.2 Sample

The field experiment targets a sample of 7,285 farmers listed in the program's member database. For an overview of sample composition see Table 1. Farmers become members of *Greppa Näringen* by applying through the program's online portal. While full advisory membership for some advisory modules requires at least 15 livestock units or 50 hectares of farmland, Module 17A – Biodiversity in Arable Landscapes is more broadly accessible to all active farmers with arable land. Smaller farms may also join to receive information materials and participate in group-based advisory events. The experimental sample was stratified by gender, farmland size, organic practices, presence of flowered areas (a common biodiversity measure), region, and production zone, while the main individual-level treatment nudge aimed to encourage uptake of a specialized advisory visit and farm audit. In terms of statistical power, we designed the study assuming an expected baseline uptake rate of 5–10%, based on past enrollment data from previous years and campaigns, and therefore anticipated that our sample size of over 7,000 farmers would be sufficient. Indeed, assuming a rather small effect size

TABLE 1 Sample composition.

Item	Value
Total farmers in experiment	7,285
Control (N)	3,645
Treatment (N)	3,640
Mean age (years)	55.6
Female (%)	6.3
Organic farm (%)	22.0
Has flower strips (%)	7.0
Mean utilized agricultural land (ha)	129

of 0.1 (5% enrollment rate in the control group and 10% in the treated group), expected achieved power would be higher than 0.99.

2.3 Treatment

Farmers in the treatment group received a postcard centered on a peer farmer who had adopted biodiversity-friendly practices. The message emphasized how small, low-cost actions such as sowing flower strips or preserving natural field edges can enhance biodiversity with minimal effort (see Supplementary material). This behavioral nudge incorporated three key elements: salience, by making the biodiversity advisory service the sole focus of the postcard; a messenger effect, by featuring a relatable farmer as the source of the message; and an implied social norm, by presenting biodiversity-friendly practices as achievable and desirable among peers. The framing highlighted ease of implementation, long-term benefits, and a sense of responsibility for future generations. The control group received a structurally similar postcard but with the program's status quo framing, focusing on nutrient management, manure optimization, and the advisory services which has traditionally been the program's emphasis (Supplementary material). Both postcards provided the same advisory service sign-up via a QR code, ensuring that differences in engagement stem from messaging rather than access to information.

The postcards were sent out as part of a Swedish Board of Agriculture communication campaign in April 2022. Farmers could request an audit via a dedicated homepage or through personal advisors. We tracked these solicitations for 12 months to assess the treatment's effectiveness.

2.4 Data

We match our experimental outcome data with administrative records from the member database of the farmers' association. This allows us to enrich our analysis with detailed background characteristics, including age, gender, total farm size, farmland area, organic certification status, and the presence of flowered strips.

TABLE 2 Balance table—descriptive statistics by group.

	Control mean (SE)	Treatment mean (SE)	*P*-value
Female (1 = yes)	0.06 (0.01)	0.06 (0.01)	0.878
Age	55.65 (0.22)	55.65 (0.22)	0.998
Farmland size (ha)	129.44 (2.56)	127.55 (3.8)	0.594
Organic farm (1 = yes)	0.21 (0.01)	0.22 (0.01)	0.442
Has flower strips (1 = yes)	0.07 (0.00)	0.07(0.00)	0.729
Region			
Southern Sweden (Götaland)	0.73 (0.01)	0.72 (0.02)	0.763
Central Sweden (Svealand)	0.22 (0.01)	0.21 (0.02)	0.978
Norther Sweden (Norrland)	0.18 (0.01)	0.07 (0.01)	0.544
Production zone			
Souther Sweden plains	0.33 (0.01)	0.32 (0.01)	0.719
Souther Sweden forests	0.44 (0.01)	0.44 (0.01)	0.792
Central Sweden forests	0.18 (0.01)	0.18 (0.01)	0.905
Norther Sweden forests	0.05 (0.00)	0.05 (0.00)	0.989
N	3,645	3,640	

P-values are derived from two-sided *t*-tests comparing the means between treatment and control groups. For categorical (dummy) variables, the test assesses differences in proportions.

On average, participants are 55.6 years old, 6.3% are female, and manage farms of 129 hectares; 22% are certified organic, and 7% report having flowered areas ($N = 7{,}285$).

To validate the random assignment, we present a balance table (Table 2) comparing baseline characteristics across treatment and control groups. The results confirm that randomization was successful, with no significant differences across observable variables, ensuring that treatment effects can be interpreted causally.

3 Results and discussion

3.1 Main treatment effect

We evaluate the effect of the treatment on our main outcome variable: whether a farmer signed up for an advisory service (a binary variable equal to 1 if adopted, 0 otherwise). Figure 1 presents a bar graph based on all 7,285 observations. In the control group, the advisory uptake rate is 0.49%, while in the treatment group it is not significantly lower at 0.38%, indicating a decrease of 0.11 percentage points. Given the exceptionally low overall uptake, this difference is small and suggests no meaningful treatment effect.

Table 3 presents the regression results evaluating the effect of the behavioral nudge on farmers' decision to sign up for a advisory visit. The main outcome variable is binary and indicates whether a farmer signed up for an advisory visit, coded as one if yes and zero otherwise. In all three model specifications, which include an OLS regression without controls, an OLS regression with controls, and a probit model with

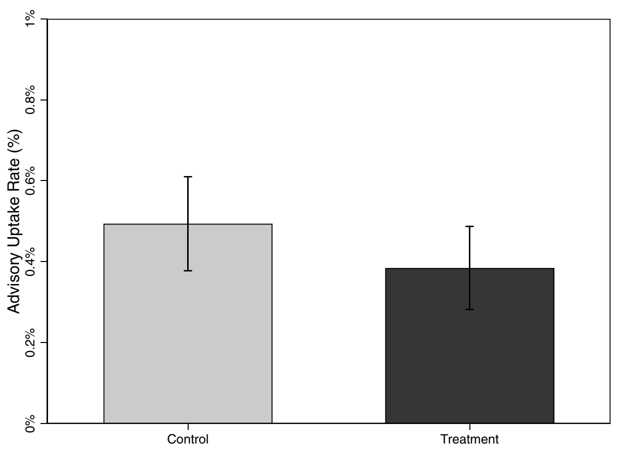

FIGURE 1
Advisory service uptake rates by treatment group. Note that the vertical axis is restricted to the 0–1% range to reflect the extremely low overall uptake rates ranging between 0.38 and 0.49%.

marginal effects, the estimated treatment effect is slightly negative and statistically insignificant. This suggests that receiving the behavioral nudge did not increase the probability of farmers requesting an advisory service. Given the extremely low baseline uptake of 0.49 percent in the control group, the absence of a measurable treatment effect confirms the difficulty of triggering participation in voluntary conservation programs through light-touch interventions.

Among the covariates, two factors emerge as statistically significant. Female farmers are approximately one percentage point more likely to sign up for the advisory service. While this difference is small in absolute terms, it is meaningful relative to the baseline, effectively doubling the likelihood of uptake. This is especially notable given that only around six percent of farmers in the sample are women, suggesting that female farmers may be a more receptive target group for environmental outreach.

Additionally, organic farmers are about 0.8 to 1.5 percentage points more likely to request an advisory visit, depending on the specification. This indicates that those already engaged in sustainable practices are also more likely to participate in further conservation efforts. The finding suggests that voluntary programs may primarily appeal to those who are already environmentally motivated, rather than expanding participation among less engaged segments of the farming population.

Regarding regional differences, farmers in Svealand are slightly more likely to request an advisory visit compared to those in Götaland (reference region—south of Sweden), with this effect reaching statistical significance in the probit model. In contrast, uptake in Norrland does not differ significantly from Götaland. No clear patterns emerge across production zones, indicating that regional affiliation may matter more than agroecological conditions.

Despite the null average effect, the described covariate patterns point to some underlying heterogeneity. These findings raise a crucial question: did the behavioral nudge work better for specific subgroups, even if the average treatment effect is zero?

TABLE 3 Main analysis.

	(1) OLS	(2) OLS	(3) Probit
	Sign-up advice	Sign-up advice	Sign-up advice
Behavioral nudge	−0.001	−0.000	−0.023
	(0.002)	(0.002)	(0.148)
Female respondent		0.010***	0.425**
		(0.004)	(0.215)
Farmer age		−0.000**	−0.013**
		(0.000)	(0.006)
Utilized agricultural land (ha)		0.000	0.000
		(0.000)	(0.001)
Organic farm (1 = yes)		0.008***	0.535***
		(0.002)	(0.160)
Has flower strips (1 = yes)		0.005	0.382
		(0.004)	(0.259)
Region			
Norther Sweden (Norrland)		−0.002	0.000
		(0.008)	(.)
Central Sweden (Svealand)		0.010**	0.444**
		(0.004)	(0.222)
Production zone			
Central Sweden forests		−0.003	−0.069
		(0.005)	(0.276)
Souther Sweden plains		0.002	0.211
		(0.002)	(0.184)
Norther Sweden forests		−0.002	0.000
		(0.009)	(.)
Constant	0.005***	0.010**	−2.355***
	(0.001)	(0.005)	(0.372)
R2	0.000	0.008	
Observations	7,285	5,440	5,099

Standard errors in parentheses. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$. Column (1) shows estimates from a linear probability model without controls. Column (2) includes controls for gender, age, farmland size, organic certification, flower strips, macro region, and production zone. Column (3) reports marginal effects from a probit model with the same controls. The reference categories are Southern Sweden (Götaland) and Southern Sweden forests, which represent the largest macro region and production zone in the sample, respectively.

3.2 Heterogenous treatment effects

Figure 2 shows interaction effects between the treatment and key farm and farmer characteristics. Table 4 summarizes the significant interactions. While most interaction effects are statistically insignificant, the direction and magnitude of the estimates provide suggestive patterns. The interaction between treatment and being female is positive, consistent with the idea that

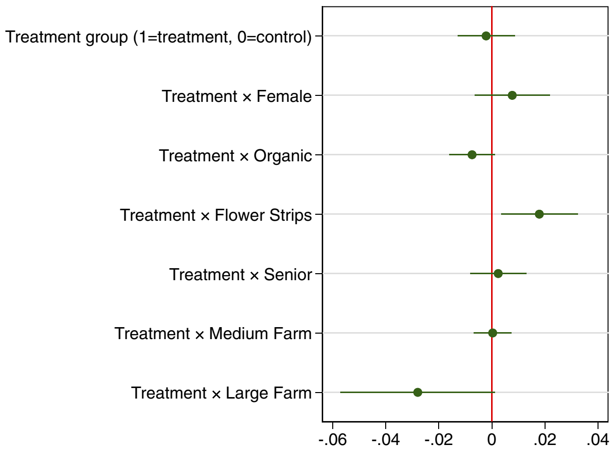

FIGURE 2
Heterogenous treatment effects. Note that estimates are interaction coefficients from an OLS regression of a binary indicator for requesting an advisory visit on treatment interacted separately with the demographic variables, controlling for main effects of these variables, macro-region fixed effects, and production area fixed effects. The vertical line at zero indicates no differential effect. N = 5,651; standard errors are clustered at the individual level.

female farmers may respond more favorably to behavioral outreach than their male counterparts. However, the confidence interval includes zero, and the effect is not statistically distinguishable from the control group. Interestingly, the interaction between treatment and organic status is negative, suggesting that the nudge may have been less effective or even counterproductive for organic farmers. This finding is somewhat surprising given their higher overall propensity to sign up for advisory services. One possible explanation is a boomerang effect (Byrne and Hart, 2009), where the message may have failed to recognize their existing commitment to organic practices. The interaction effect for farmers with flower strips is positive and statistically significant, suggesting that the treatment was particularly effective for this group. Farmers who establish flower strips often do so voluntarily and at their own cost, reflecting a strong intrinsic motivation toward conservation practices. This may increase their receptivity to behavioral messages that emphasize social norms or peer action. Additional heterogeneity appears when examining farm size. The treatment was notably less effective for large farms, with the interaction estimate suggesting a substantially reduced responsiveness compared to small farms. This may reflect structural or behavioral differences among larger operations, such as more formalized decision-making processes.

Taken together, the results suggest that while the behavioral nudge had no measurable average effect overall, there are clear signs of differential responses across farmer subgroups. Higher baseline uptake among female and organic farmers, combined with variation in responsiveness by gender, flower stripes, farm type, and size, highlights the value of more targeted outreach. Light-touch interventions may have limited impact at scale but could be considerably more effective when tailored to the motivations and characteristics of specific target groups.

TABLE 4 Significant interaction effects.

Interaction with...	Significant ($p < 0.05$)	Sign	*P*-value
Female	No	(+)	0.289
Organic farm	No †	(–)	0.088
Has flower strips	**Yes**	(+)	0.015
Senior	No	(+)	0.659
Farm size -Medium	No	(≈0)	0.934
Farm size - Large	No †	(–)	0.060

"Yes" indicates a statistically significant interaction ($p < 0.05$) between treatment and the listed characteristic on the probability of requesting an advisory visit. "†" denotes marginal significance ($0.05 \leq p < 0.10$). Signs indicate the direction of the interaction coefficient from the model: *c.treatment##i.[subgroup]*, controlling for age, gender, farm size, organic status, flower strips, macro region, and production zone (N = 5,651). Full coefficients and CIs are reported in Figure 2.

3.3 Mechanisms

The absence of a measurable treatment effect in our field experiment raises questions about why a seemingly well-designed behavioral nudge failed to influence behavior. We interpret this outcome through two main mechanisms: behavioral inertia and limited salience.

Although the intervention removed material and logistical barriers as participation was free, required only a QR code scan, and was framed through a peer endorsement, it still demanded a shift in attention and intention. Farmers had to initiate a new action: requesting a biodiversity audit. In practice, even small steps can be crowded out by more immediate and familiar tasks. In such settings, default behavior prevails not due to resistance, but because of inertia or inattention (Samuelson and Zeckhauser, 1988). In farming contexts, the opportunity cost of attention is high. Even simple offers may be dismissed when perceived benefits are indirect or long-term. Relatedly, studies in similar contexts such as Reddy et al. (2020) and Oyinbo and Hansson (2024) have found that framed messages and advisory tools often fail to shift conservation behavior, pointing to information avoidance, low perceived relevance, or even psychological reactance as potential barriers.

In our case, the low uptake only 32 of 7,285 farmers (0.44%) requested a visit suggests not just a weak treatment, but a high threshold for action. This likely reflects behavioral inertia, limited salience of the advisory offer and broader economic and political conditions. While the message was designed to be noticeable and easy to act upon, it may not have cut through the noise of competing demands or conveyed sufficient urgency. At the time the information was sent, the agricultural sector was grappling with global disruptions caused by the COVID-19 pandemic, energy market volatility as well as the fertilizer price shock following the Ukraine-Russia war, and rising inflation in general. These crises likely reinforced farmers' focus on core business activities, leaving little cognitive or financial room to engage with voluntary environmental commitments that may have appeared secondary or non-essential (Stern, 2005).

4 Policy implementation

Our findings have direct implications for the design and implementation of conservation policy. The null effect of our intervention underscores that simply transplanting successful behavioral strategies from other domains into agriculture may yield disappointing results unless the unique structural and behavioral constraints of farming are considered. In particular, the high opportunity costs of farmers' attention and time mean that voluntary conservation behaviors are unlikely to be triggered by light-touch messages alone. Even when interventions are salient and easy to act on, they must compete with pressing operational, financial, and regulatory demands that dominate farmers' daily decision-making.

In our setting, the high opportunity costs associated with participating in voluntary conservation programs likely reduced responsiveness to the intervention. When the target behavior demands substantial effort such as reallocating time, attention, and resources away from core farming activities, light-touch nudges tend to lose much of their impact. This is consistent with recent evidence showing that even strong defaults are less effective when the desired outcome requires sustained engagement or considerable effort (Behlen et al., 2023). These high-effort contexts also highlight the relevance of underlying economic incentives. The literature offers mixed evidence on whether moral or social norm nudges complement or substitute for financial rewards, but studies in resource conservation show that behavioral messages often only gain traction when paired with substantial changes in marginal costs (e.g., Brent and Wichman, 2022). For biodiversity conservation, where private economic returns are often minimal, this suggest that nudges should be embedded in a broader policy design that reduces opportunity costs, for instance by offering trainings to integrate conservation actions into existing workflows or even offering more immediate, tangible incentives such as subsidies. Without such alignment, even well-crafted behavioral messages risk being ignored.

Another policy implication emerging from our results is the value of personalizing nudges. Our heterogeneous effects suggest that certain subgroups respond somewhat more favorably to our behavioral nudge including messasging. This supports a growing policy literature advocating for segmentation and tailored communication, in which message framing, messengers, and channels are adapted to the characteristics, motivations, and constraints of specific subgroups (Bryan et al., 2021). In practice, this could mean developing targeted campaigns for already conservation-minded farmers, while designing different interventions potentially with stronger economic incentives for less-engaged groups.

Finally, our findings reinforce a growing argument for shifting from nudging to boosting (Hertwig et al., 2025). While nudges leverage cognitive biases to steer decisions, boosts aim to build lasting capacities and motivations to act. In agricultural conservation, boosting could include training programs to support farmers in developing biodiversity management skills or providing digital tools to help them self-assess and monitor biodiversity outcomes. These measures can help address some of the structural barriers identified in our study and may contribute to fostering more sustained pro-environmental behavior. From a policy perspective, combining such capacity-building approaches with targeted incentives could create more lasting conservation outcomes.

5 Conclusion

This study evaluates the effectiveness of a behavioral nudge aimed at promoting participation in a biodiversity advisory service among Swedish farmers, a key first step toward agri-environmental scheme adoption. The intervention, grounded in behavioral science combined (peer) messenger effects, salience, and social norms. A peer farmer served as the central figure, delivering a testimonial to enhance relatability and trust.

Despite these theoretical strengths, our results indicate no significant increase in advisory uptake. In fact, the intervention slightly reduced sign-up rates compared to the standard information materials. These findings suggest that, in this context, the behavioral nudge was ineffective or possibly counterproductive.

This result contributes to a growing body of mixed evidence on behavioral interventions in agricultural conservation. While some studies report positive effects of combining nudges with financial incentives (Czap et al., 2015; Kuhfuss et al., 2016), or show modest success in promoting resource-saving behavior (Chabé-Ferret et al., 2019; Ouvrard et al., 2023), others demonstrate null or even negative effects from similar framing efforts (Reddy et al., 2020; Kidd et al., 2019; Kusmanoff et al., 2020). Our study reinforces this ambiguity and emphasizes the importance of context. Timing (and attention) likely played a role in the observed null effects. Acute economic pressures may have overwhelmed the motivational power of the nudge, especially for farmers with lower baseline engagement or capacity to respond. It is also evident that agriculture is a high opportunity cost setting, where competing demands and long planning cycles are likely to reduce the likelihood that light-touch behavioral interventions alone will shift behavior.

Furthermore, our findings point to some heterogeneity in how farmers respond to behavioral nudges, even when average treatment effects are null. This aligns with a growing literature suggesting that nudges are not universally effective but work selectively depending on context and population subgrups (DellaVigna and Linos, 2022; Szaszi et al., 2022). In our study, the nudge was most effective for farmers with flower strips, likely reflecting their intrinsic conservation motives. Female farmers responded somewhat more positively, though not significantly, while organic farmers appeared less responsive or even counter-influenced. These patterns suggest that nudges may be more effective among already motivated subgroups, raising questions about their role in reaching less engaged populations. As such, we call for more targeted behavioral interventions, potentially informed by segmentation or machine learning approaches (e.g., Bryan et al., 2021), which may enhance their effectiveness by tailoring nudges to receptive subgroups.

We would like to acknowledge several limitations of our study. First, the two postcard versions which we used also differed in several visual and design aspects, including color QR code presentation. These design differences may have independently influenced recipient perceptions and responses, complicating attribution of treatment effects. Prior research has shown that visual framing (Salazar et al., 2021, 2022), photovisualization techniques (Schattman et al., 2019, 2020), and even small design features can significantly affect engagement with pro-environmental messages. We therefore believe that future research could employ factorial or A/B testing designs to more precisely isolate the effects of such individual visual elements concerning message presentation.

Furthermore, future research should not only address these design-related issues of messaging as much as its personalization but also investigate the potential effectiveness of boosting approaches such as targeted training programs in high-opportunity-cost settings like farming, particularly when combined with financial incentives. While there is already substantial literature on nudging and on incentives separately, there is comparatively little evidence on how capacity-building measures such as peer-to-peer training or digital decision-support toolsinteract with targeted financial incentives to influence conservation behavior. Longitudinal and experimental studies could help determine not only whether these combinations work, but also whether they produce lasting conservation outcomes (rather than one-time actions) in high-opportunity-cost settings like farming. We believe that systematic comparisons of different capacity-building elements and incentive structures would provide valuable guidance for designing scalable and cost-effective agricultural conservation policies.

In conclusion, our findings suggest that nudges alone are insufficient for driving behavioral change in high-stakes, low-incentive settings like biodiversity conservation. Rather than applying one-size-fits-all behavioral messages, greater effectiveness may be achieved through targeted as well as a combination with more heavy-handed approaches. These could include combining nudges with financial incentives and focusing more on personalized outreach. Future interventions should also carefully consider heterogeneity among farmers, including gender, farm size, and past conservation engagement, as these may mediate responsiveness to behavioral prompts and interventions more general.

Data availability statement

The datasets presented in this study can be found in online repositories. The names of the repository/repositories and accession number(s) can be found in the article/Supplementary material.

Ethics statement

The studies involving humans were approved by the Swedish Ethical Review Authority (Etikprövningsmyndigheten: 2023-01890-01). Board for Ethical Questions in Science of the University of Innsbruck, Certificate of good standard 92/2021. Documents available here: DOI 10.17605/OSF.IO/SZCQF. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation was not required from the participants or the participants' legal guardians/next of kin in accordance with the national legislation and institutional requirements.

Author contributions

MC: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing. EG: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Visualization, Writing – original draft, Writing – review & editing. AN: Conceptualization, Data curation, Funding acquisition, Investigation, Methodology, Project administration, Writing – original draft, Writing – review & editing.

Funding

The author(s) declare that financial support was received for the research and/or publication of this article. This research was funded by the Swedish Research Council (2021-02267).

Acknowledgments

We are grateful for the funding of this project from the Swedish Research Council. This work was supported by Greppa Näringen managers at the Swedish Board of Agriculture, especially Emma Hjelm, Stina Olofsson, and Karin Hugosson.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declare that Gen AI was used in the creation of this manuscript. The author(s) used OpenAI's ChatGPT (version GPT-4, accessed via chat.openai.com) to improve the clarity and language of the manuscript and to assist in writing Stata codes for figure generation. All outputs were critically reviewed, verified, and edited by the author(s) to ensure factual accuracy and appropriate interpretation.

Any alternative text (alt text) provided alongside figures in this article has been generated by Frontiers with the support of artificial intelligence and reasonable efforts have been made to ensure accuracy, including review by the authors wherever possible. If you identify any issues, please contact us.

Publisher's note

All claims expressed in this article are solely those of the authors and do not necessarily represent those of

Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/frevc.2025.1648280/full#supplementary-material

References

Allcott, H. (2011). Social norms and energy conservation. *J. Public Econ.* 95, 1082–1095. doi: 10.1016/j.jpubeco.2011.03.003

Balmford, A., Bradbury, R., Bauer, J., Broad, S., Burgess, G., Burgman, M., et al. (2021). Making more effective use of human behavioural science in conservation interventions. *Biol. Conserv*. 261:109256. doi: 10.1016/j.biocon.2021.109256

Bandura, A. (1977). Self-efficacy: toward a unifying theory of behavioral change. *Psychol. Rev*, 84, 191–215. doi: 10.1037/0033-295X.84.2.191

Behlen, L., Himmler, O., and Jäckle, R. (2023). Defaults and effortful tasks. *Exp. Econ.* 26, 1022–1059. doi: 10.1007/s10683-023-09808-8

Brent, D. A., and Wichman, C. J. (2022). *Do Behavioral Nudges Interact With Prevailing Economic Incentives? Pairing Experimental and Quasi-Experimental Evidence From Water Consumption*. Working Paper. SSRN. doi: 10.2139/ssrn.4162438

Bryan, C. J., Tipton, E., and Yeager, D. S. (2021). Behavioural science is unlikely to change the world without a heterogeneity revolution. *Nat. Hum. Behav.* 5, 980–989. doi: 10.1038/s41562-021-01143-3

Byrne, S., and Hart, P. S. (2009). The boomerang effect a synthesis of findings and a preliminary theoretical framework. *Ann. Int. Commun. Assoc.* 33, 3–37. doi: 10.1080/23808985.2009.11679083

Chabé-Ferret, S., Le Coent, P., Reynaud, A., Subervie, J., and Lepercq, D. (2019). Can we nudge farmers into saving water? *Evidence from a randomized experiment. Eur. Rev. Agric. Econ.* 46, 393–416. doi: 10.1093/erae/jbz022

Czap, N. V., Czap, H. J., Lynne, G. D., and Burbach, M. E. (2015). Walk in my shoes: nudging for empathy conservation. *Ecol. Econ.* 118, 147–158. doi: 10.1016/j.ecolecon.2015.07.010

DellaVigna, S., and Linos, E. (2022). RCTs to scale: comprehensive evidence from two nudge units. *Econometrica* 90, 81–116. doi: 10.3982/ECTA18709

Dessart, F. J., Barreiro-Hurlé, J., and van Bavel, R. (2019). Behavioral factors affecting the adoption of sustainable farming practices: a policy-oriented review. *Eur. Rev. Agric. Econ.* 46, 417–471. doi: 10.1093/erae/jbz019

Dolan, P., Hallsworth, M., Halpern, D., King, D., Metcalfe, R., and Vlaev, I. (2012). Influencing behaviour: the mindspace way. *J. Econ. Psychol.* 33, 264–277. doi: 10.1016/j.joep.2011.10.009

Engel, S., Pagiola, S., and Wunder, S. (2008). Designing payments for environmental services in theory and practice: an overview of the issues. *Ecol. Econ.* 65, 663–674. doi: 10.1016/j.ecolecon.2008.03.011

Ferraro, P., and Price, M. (2013). Using non-pecuniary strategies to influence behavior: evidence from a large-scale field experiment. *Rev. Econ. Statis.* 95, 64–73. doi: 10.1162/REST_a_00344

Fornahl, D. (2003). "Entrepreneurial activities in a regional context," in *Cooperation, Networks and Institutions in Regional Innovation Systems*, eds. D. Fornahl and T. Brenner (Northampton: Edward Elgar), 38–57. doi: 10.4337/9781035304752.00010

Gillingham, K., and Tsvetanov, T. (2019). Nudging energy efficiency audits: evidence from a field experiment. *J. Environ. Econ. Manage.* 90, 303–316. doi: 10.1016/j.jeem.2018.06.009

Gsottbauer, E., and Van den Bergh, J. (2011). Environmental policy theory given bounded rationality and other-regarding preferences. *Environ. Resour. Econ.* 49, 263–304. doi: 10.1007/s10640-010-9433-y

Hanley, N., Banerjee, S., Lennox, G. D., and Armsworth, P. R. (2012). How should we incentivize private landowners to 'produce' more biodiversity? *Oxford Rev. Econ. Policy* 28, 93–113. doi: 10.1093/oxrep/grs002

Hertwig, R., Michie, S., West, R., and Reicher, S. (2025). Moving from nudging to boosting: empowering behaviour change to address global challenges. *Behav. Public Policy* 1–12. doi: 10.1017/bpp.2025.9

IPBES (2019). *Global Assessment Report of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. Bonn, Germany: IPBES Secretariat*. 1144.

Jaureguiberri, P., Titeux, N., Wiemers, M., Bowler, D. E., Coscieme, L., Golden, A. S., et al. (2022). The direct drivers of recent global anthropogenic biodiversity loss. *Sci. Adv*. 8:eabm9982. doi: 10.1126/sciadv.abm9982

Kidd, L. R., Garrard, G., Bekessy, S., Mills, M., Camilleri, A., Fidler, F., et al. (2019). Messaging matters: a systematic review of the conservation messaging literature. *Biol. Conserv.* 236, 92–99. doi: 10.1016/j.biocon.2019.05.020

Krueger, N. (1993). The impact of prior entrepreneurial exposure on perceptions of new venture feasibility and desirability. *Entrepreneurship Theory Pract.* 18, 5–21. doi: 10.1177/104225879301800101

Kuhfuss, L., Préget, R., Thoyer, S., Hanley, N., Le Coent, P., and Désolé, M. (2016). Nudges, social norms, and permanence in agri-environmental schemes. *Land Econ.* 92, 641–655. doi: 10.3368/le.92.4.641

Kusmanoff, A., Fidler, F., Gordon, A., Garrard, G., and Bekessy, S. (2020). Five lessons to guide more effective biodiversity conservation message framing. *Conserv. Biol.* 34, 1131–1141. doi: 10.1111/cobi.13482

Lafuente, E., Vaillant, Y., and Rialp, J. (2007). Regional differences in the influence of role models: comparing the entrepreneurial process of rural catalonia. *Reg. Stud.* 41, 779–796. doi: 10.1080/00343400601120247

Läpple, D., and Kelley, H. (2013). Understanding the uptake of organic farming: accounting for heterogeneities among Irish farmers. *Ecol. Econ.* 88, 11–19. doi: 10.1016/j.ecolecon.2012.12.025

Maier, M., Bartoš, F., Stanley, T. D., Shanks, D. R., Harris, A. J., Wagenmakers, E. J., et al. (2022). No evidence for nudging after adjusting for publication bias. *Proc. Natl. Acad. Sci.* 119:e2200300119. doi: 10.1073/pnas.2200300119

Ouvrard, B., Préget, R., Reynaud, A., and Tuffery, L. (2023). Nudging and subsidising farmers to foster smart water meter adoption. *Eur. Rev. Agric. Econ.* 50, 1178–1226. doi: 10.1093/erae/jbad013

Oyinbo, O., and Hansson, H. (2024). Information provision and preferences for more sustainable dairy farming: choice experimental evidence from Sweden. *Agric. Resour. Econ. Rev.* 53, 119–143. doi: 10.1017/age.2023.33

Palm-Forster, L., Ferraro, P., Janusch, N., Vossler, C., and Messer, K. (2019). Behavioral and experimental agri-environmental research: methodological challenges, literature gaps and recommendations. *Environ. Resour. Econ.* 73, 719–742. doi: 10.1007/s10640-019-00342-x

Reddy, S., Wardropper, C., Weigel, C., Masuda, Y., Harden, S., Ranjan, P., et al. (2020). Conservation behavior and effects of economic and environmental message frames. *Conserv. Lett.* 13:e12750. doi: 10.1111/conl.12750

Salazar, G., Monroe, M. C., Ennes, M., Jones, J. A., and Veríssimo, D. (2022). Testing the influence of visual framing on engagement and pro-environmental action. *Conserv. Sci. Pract.* 4:e12812. doi: 10.1111/csp2.12812

Salazar, G., Neves, J., Alves, V., Silva, B., and Veríssimo, D. (2021). Picturing donations: do images influence conservation fundraising?. *PLoS One* 16:e0251882. doi: 10.1371/journal.pone.0251882

Samuelson, W., and Zeckhauser, R. (1988). Status quo bias in decision making. *J. Risk Uncertainty* 1, 7–59. doi: 10.1007/BF00055564

Schattman, R. E., Hurley, S., and Caswell, M. (2019). Now i see: photovisualization to support agricultural climate adaptation. *Soc. Nat. Resour.* 32, 222–228. doi: 10.1080/08941920.2018.1530819

Schattman, R. E., Hurley, S. E., Greenleaf, H. L., Niles, M. T., and Caswell, M. (2020). Visualizing climate change adaptation: an effective tool for agricultural outreach?. *Weather Clim. Soc.* 12, 47–61. doi: 10.1175/WCAS-D-19-0049.1

Schultz, P. W., Nolan, J., Cialdini, R., Goldstein, N., and Griskevicius, V. (2007). The constructive, destructive, and reconstructive power of social norms. *Psychol. Sci.* 18, 429–434. doi: 10.1111/j.1467-9280.2007.01917.x

Shapero, A., and Sokol, L. (1982). "The social dimensions of entrepreneurship," in *Encyclopedia of Entrepreneurship*, eds. C. A. Kent, D. L. Sexton, and K. H. Vesper (Englewood Cliffs, NJ: Prentice-Hall), 72–90.

Stern, P. C. (2005). Understanding individuals' environmentally significant behavior. *Envtl. L. Rep.* 35:10785.

Sunstein, C. (2014). Nudging: a very short guide. *J. Consum. Policy* 37, 583–588. doi: 10.1007/s10603-014-9273-1

Szaszi, B., Higney, A., Charlton, A., Gelman, A., Ziano, I., Aczel, B., et al. (2022). No reason to expect large and consistent effects of nudge interventions. *Proc. Natl. Acad. Sci.* 119:e2200732119. doi: 10.1073/pnas.2200732119