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# Agri-environmental Schemes Require Improved Design for Better Outcomes

La conception des programmes agro-environnementaux doit être améliorée pour obtenir de meilleurs résultats

Agrarumweltprogramme erfordern eine verbesserte Konzeption, um bessere Ergebnisse zu erzielen

Chi Nguyen, Uwe Latacz-Lohmann and Nick Hanley

Agri-environmental schemes (AES) are a key instrument of the Common Agricultural Policy, aiming to incentivise landholders to provide environmental public goods on private farmland. The EU has a long history of implementing AES since the early 1990s. However, environmental degradation, biodiversity loss and agricultural emissions continue to rise at an alarming rate with no signs of abating across Member States (Ait Sidhoum *et al.*, 2022; Dupraz and Guyomard, 2019). This raises the question of what inhibits AES from generating significant environmental improvements and achieving the highest potential effectiveness of public spending.

The poor performance of AES has been partly attributed to the adoption of an individual-farm targeting approach for conservation (Limbach *et al.*, 2023). This approach prioritises conservation actions at the individual farm level. However, many environmental public goods and services, such as wildlife corridors, conserved wetlands, riparian zones and water purification services, operate at a landscape level. Their provision benefits from spatial contiguity of conservation activities. Aligning the scale of ecological processes and the scale of conserved farmland targeted by AES is critical for achieving significant environmental improvements (Pe'er *et al.*, 2020). Ample evidence has shown that spatially coordinated conservation efforts at the landscape-level can generate higher ecological gains than

fragmented efforts for many species and for many environmental benefits (Jones *et al.*, 2023). Therefore, the ecological scale at which environmental public goods can be effectively delivered will dictate the preferred scale for policy design and implementation. While conservation agencies could spatially target conservation areas with the highest potential environmental values for enrolment, such spatial targeting does not guarantee the achievement of spatially connected conserved parcels of land, such as those needed for establishing wildlife corridors. This challenge arises from the voluntary participation of landholders in AES: each farmer makes their own decision over whether or not to participate and which parcels to offer.

“ Il n'existe pas de mécanisme unique capable de promouvoir efficacement des mesures de conservation spatialement coordonnées pour toutes les configurations paysagères testées. ”

Motivating landholders to coordinate their conservation efforts using economic incentives is not a simple task. It requires AES to be designed in a way that can address barriers to coordination, such as transaction costs incurred in coordinating conservation efforts, uncertainty about the behaviour of neighbouring landholders, and landholders' lack of knowledge about the ecological gains from spatial coordination (Niemiec *et al.*, 2017).

## Conservation auctions as an incentive mechanism

AES vary in their design and implementation. They can be fixed-rate payment programmes or auction programmes. Conservation auctions have long been advocated as a cost-effective mechanism for allocating conservation contracts to landholders. Competitive bidding could work as a price discovery mechanism, motivating landholders to truthfully reveal their compliance costs for the provision of environmental public goods. This, in turn, reduces the risk of overcompensating landholders for conservation efforts that only generate low environmental benefits. The auction mechanism has been proven to achieve significant cost savings relative to conventional fixed-rate payment mechanisms (Schilizzi and Latacz-Lohmann, 2007). The cost saving for conservation auctions over fixed-rate payments becomes more

pronounced in contexts where a large number of potential landholders participate, there is heterogeneity in landholders' compliance costs, and policymakers have limited information about these costs.

“ Es gibt keinen pauschalen Mechanismus, der räumlich koordinierte Erhaltungsmaßnahmen für alle getesteten Landschaftskonfigurationen wirksam fördern kann. ”

Auctions have been the primary mechanism for conservation contracts in the US and Australia, such as the Conservation Reserve Program and the Bush Tender (Latacz-Lohmann and Schilizzi, 2007). They have also been proposed as one of the design options under the EU regulatory framework for AES (Vergamini *et al.*, 2015). However, there has been limited application of conservation auctions in Europe so far. This is partly due to institutional constraints in implementing an auction mechanism (Primmer, 2017). European policymakers have tended to promote a cooperative environment, rather than a competitive bidding environment among landholders. Moreover, the cost-effectiveness of AES (i.e. achieved environmental benefits per Euro spent, also known as 'value-for-money') has not been the central focus in AES design and implementation in Europe. However, considering the limited public budget for CAP Pillar 2 and the increasing public demand for environmental goods (e.g. biodiversity and clean water), application of auctions for nature conservation should receive more favourable attention in Europe.

Improving the knowledge on designing auctions that promote spatially coordinated conservation actions among landholders is important, particularly for achieving landscape-scale environmental outcomes, such as establishing wildlife corridors and/or stepping stones, (Nguyen *et al.*, 2022). In this paper, we focus on the performance of three alternative coordination-improving mechanisms that could be incorporated into auction design.

### The pros and cons of alternative coordination-improving mechanisms

It is useful to classify mechanisms for improving spatial coordination into bottom-up and top-down approaches. The bottom-up approach, such as landholder-to-landholder communication, relies on the power of peer influence within farming communities to encourage coordination. In contrast, the top-down approach relies on regulatory authorities to implement incentive mechanisms to promote coordination behaviour. Examples include information disclosure policies regarding spatial environmental scoring rules, and the Agglomeration Bonus.

**Landholder-to-landholder communication.** Coordination can be achieved through social interactions. Communication among landholders is expected to foster information sharing about the potential ecological and economic

benefits of coordinated conservation. On the one hand, it helps tackle the problem of incomplete information regarding the behaviour of neighbours and facilitates coordination. In particular, communication enables landholders to discuss their interests in coordinating conservation efforts and devise corresponding bidding strategies regarding which land parcels to offer and at what prices, aiming to optimise their likelihood of winning a contract. On the other hand, communication could promote collusion among landholders, encouraging overbidding behaviour. However, when landholders increase their bids, they encounter a trade-off between potentially gaining more AES payments and facing a higher risk of not winning a contract. Engaging in communication is costly for landholders. Their willingness to do so reflects their willingness to incur private *ex-ante* transaction costs for spatial coordination.

### Disclosure of spatial environmental scoring rule.

The environmental agency incorporates the increase in environmental benefits when adjacent parcels of land from neighbouring landholders are conserved into the scoring rule for evaluating and selecting bids. This reflects the agency's preference for spatially contiguous conservation efforts. Disclosing this information would help landholders to formulate and submit their bids to better align



Countryside in rural Romania (Transilvania).

with the agency's preferences for landscape management. With this information, landholders are expected to be more likely to coordinate with their neighbours on conservation actions, in order to increase the likelihood of their bids being selected. However, disclosing the scoring rule might also intensify overbidding behaviour, since bidders tender higher bids knowing that they are offering a 'high quality' service.

**Agglomeration Bonus.** The Agglomeration Bonus (AB) is a financial incentive explicitly designed to reward spatial coordination of conservation efforts among landholders. The AB is paid to landholders on top of the winning bid amounts if other landholders are contracted to undertake conservation actions on their neighbouring land. This mechanism provides incentives for landholders to coordinate their conservation efforts, resulting in increased connectivity in conserved land. Landholders tend to lower their bids with the expectation of earning a bonus in return. However, it is also possible that uncertainty about neighbours' conservation decisions, and thus the risk of not receiving an AB, might deter landholders from coordinating conservation actions across holdings.

Landscape configuration is important for the effectiveness of coordination mechanisms

By landscape configuration we mean the correlation of opportunity costs (OC) and environmental values (EV). While opportunity costs reflect income forgone from reduced agricultural production, environmental values represent the environmental benefits generated when lands are managed for conservation. The opportunity cost is the minimum price the landholder needs for offering their land for conservation, and the minimum costs for the agency. The environmental value is the gain for society in which the agency is interested. The question is now which of the three mechanisms described above provides the best solution for both parties.

AES targeting the provision of biodiversity conservation often operate in landscapes where opportunity costs and environmental values are negatively correlated, so that the highest potential ecological benefit tends to be associated with the lowest opportunity costs. For Central Scotland, it was shown that opportunity costs of creating conservation offsets on farmland and two different indicators of farmland biodiversity are negatively correlated, which means that biodiversity gains were higher on land parcels with low opportunity costs (Simpson *et al.*, 2022). Similarly, for Eastern US forest sites, opportunity costs for forest conservation and a range of ecological quality indicators are predominantly negatively spatially correlated, i.e. higher ecological gains were found on low-opportunity cost parcels (Armsworth *et al.*, 2017). In contrast, positive correlations are often found where AES target ecosystem services, such as watershed protection or local pollution (Lundberg *et al.*, 2018). Sarker *et al.* (2008) found that the opportunity costs of setting aside cropping land for riparian vegetation are positively correlated with indicators for water quality in the Lockyer catchment in Southeast Queensland, Australia. This means that high water quality improvements were found on plots which were costly to set aside.

We conducted a series of lab experiments to evaluate the performance of alternative

coordination-improving mechanisms in an auction-type AES in enhancing spatial coordination across different landscape configurations. These include landscapes where opportunity costs and environmental values are negatively correlated, positively correlated, and uncorrelated. Results can be used to guide policymakers in choosing the design of effective coordination incentives for achieving landscape-scale environmental targets. Our work is a prompt response to a recent call for more experimental research to improve the design of the Common Agricultural Policy (Curzi *et al.*, 2022).

Economic experiments to inform policy design

Economic experiments were carried out with 360 agriculture students at Kiel University, Germany. The students participated in a stylised conservation auction where the environmental agency, with a limited budget, selected offers of land retirement from landholders. The environmental objective was to establish wildlife corridors and/or stepping-stones between two fragmented conservation habitats. Box 1 shows the experiment treatments. For the details of the experimental set-up, results, and discussions of each coordination-improving mechanism, the readers can refer to our papers: Nguyen *et al.* (2024); and Nguyen *et al.* (2023) of which this article is a summary.

Box 1: Experimental treatments			
Treatments (Between-subject design)	Spatial correlation of opportunity costs and environmental benefits		
	Uncorrelated	Negative	Positive
No communication (Concealing spatial scoring rule + No communication)	5 sessions	5 sessions	5 sessions
Communication (Concealing spatial scoring rule + Communication)	5 sessions	5 sessions	5 sessions
Disclosing spatial scoring rule (Disclosing spatial scoring rule + Communication)	5 sessions	5 sessions	5 sessions
Agglomeration Bonus (Concealing spatial scoring rule + Communication + Agglomeration Bonus)	5 sessions	5 sessions	5 sessions
Note: Details of the experimental design are provided in Nguyen <i>et al.</i> (2024) and Nguyen <i>et al.</i> (2023).			



How policy performance was measured

- The Mark-up rate indicates how much bidders inflate their bids relative to their opportunity costs. A higher mark-up rate leads to higher costs for the agency and provides landholders with a windfall profit, which is seen as undesirable.
- Spatial coordination is measured by the number of connected parcels selected by the agency. Our experiment was calibrated such that a higher number of connected parcels lead to higher environmental gains for society.
- Cost-effectiveness is computed as average quantity of environmental benefits procured per Euro spent. The agency endeavours to achieve a high environmental benefit with its expenditure. The higher the level of cost-effectiveness, the more environmental benefit can be procured with a given budget.

Results summary

**1. The performance of coordination mechanisms is sensitive to landscape configuration.** For each coordination-improving mechanism, Table 1 shows the colour-coded ranking of each performance criterion

Table 1: The performance of coordination mechanisms is sensitive to landscape configuration				
Performance criteria	Landscape type	Coordination-improving mechanism		
		Communication	Disclosure of spatial environmental scoring rule	Agglomeration Bonus
Mark-up rate	Uncorrelated			
	Negative			
	Positive			
Spatial coordination	Uncorrelated			
	Negative			
	Positive			
Cost-effectiveness	Uncorrelated			
	Negative			
	Positive			

*Note:* Colour-coded ranking of performance criteria across landscape types in each coordination-improving mechanism, ranging from light brown to dark brown, which represent low to high values

across landscape types, ranging from light brown to dark brown, which represent low to high values, respectively. The results suggest that landscape type influences the performance of coordination-improving mechanisms. Regarding *bidding behaviour*, landholders tend to overbid the most in the landscape where opportunity costs and environmental values are negatively correlated (henceforth negative landscape type) when communication or the Agglomeration Bonus (AB) is used to enhance coordination. This could be explained by landholders demanding higher mark-ups on

parcels in high-value zones than those in low-value zones. Such behaviour is reinforced in negative landscapes where high-EV parcels tend to be of low opportunity cost. By contrast, overbidding in high-EV parcels tends to be lower in positive landscapes since these parcels would likely have high opportunity costs. Landholders are likely to extract less gain due to the trade-offs between a higher mark-up and reduced probability of winning the auction. Disclosing the scoring rule resulted in the highest mark-up rates in the positive landscape, followed by the negative and uncorrelated landscapes.



Stripcropping in Lower Saxony, Germany © Uwe Holst.

In terms of *spatial coordination*, our results indicate that in landscapes where costs and benefits are negatively correlated, the level of spatial coordination of conservation efforts is likely to be lower than in the other landscape types. This is because landholders tend to be reluctant to offer their low-EV parcels that are critical locations for the establishment of corridors, as these parcels are also high-cost parcels in the negative landscape type.

“ There is no one-size-fits-all mechanism that can effectively promote spatially coordinated conservation actions for all landscape configurations tested. ”

Compared to the two other landscape types, achieving *cost-effective conservation outcomes* is more challenging in the negative landscape

configuration. For the two coordination mechanisms, communication and AB, cost-effectiveness was found to be lowest in the negative landscape type. The mechanism of information disclosure resulted in the lowest cost-effectiveness in the uncorrelated landscape. This is partly driven by the highest mark-up rates and the lowest level of spatial coordination, making this type of coordination-improving mechanism particularly unsuitable for use in landscapes where environmental values and opportunity costs are negatively correlated.

**2. Communication enhances spatial coordination and cost-effectiveness in all landscape types.** This can be seen from Table 2, mapping out how each coordination mechanism affects policy performance in each landscape type. Green boxes indicate the landscape types where the corresponding coordination mechanisms work, while yellow boxes signal potentially counteractive effects. The positive effect of communication (compared to no communication) is especially pronounced in the negative and positive landscape types. Results are less clear in the uncorrelated

landscape, where communication resulted in higher mark-ups. However, cost-effectiveness was higher when communication was permitted because the higher mark-ups were more than offset by the higher environmental gain generated.

**3. Disclosure of the spatial environmental scoring rule works well in the uncorrelated and negative landscape types but is counterproductive in landscapes where environmental values and costs are positively correlated.** Our results lend experimental support to the positive effect of disclosing the spatial scoring rule particularly in the uncorrelated landscape: it reduces rent seeking, enhances spatial coordination and improves cost-effectiveness. We found the same effect in the negative landscape type, but it was not as salient as in the uncorrelated landscape. Specifically, we observed a slightly reduced mark-up rate and increased spatial coordination but no improvement in cost-effectiveness. Unexpectedly, revealing the spatial scoring rule accelerated overbidding in the positive landscape type, reduced spatial coordination, and had an insignificant effect on cost-effectiveness.

Table 2: How the three coordination-improving mechanisms achieved their goals					
Coordination-improving mechanism	Benchmark Treatment	Performance criteria	Uncorrelated Landscape	Negative Landscape	Positive Landscape
<b>Communication</b> (Concealing spatial scoring rule, but allowing communication)	<b>No-communication</b> (Concealing spatial scoring rule, no communication)	Mark-up rate	Increase	Decrease	Insignificance
		Spatial Coordination	Insignificance	<b>Increase</b>	<b>Increase</b>
<b>Disclosure of spatial environmental scoring rule</b> (Disclosing spatial scoring rule + Communication)	<b>Communication</b> (Concealing spatial scoring rule, but allowing communication)	Cost-effectiveness	<b>Improve</b>	<b>Improve</b>	<b>Improve</b>
		Mark-up rate	Decrease	Decrease	Increase
<b>Agglomeration Bonus</b> (Concealing spatial scoring rule + Communication + Agglomeration Bonus)	<b>Communication</b> (Concealing spatial scoring rule, but allowing communication)	Spatial Coordination	<b>Increase</b>	<b>Increase</b>	Decrease
		Cost-effectiveness	<b>Improve</b>	Insignificance	Insignificance
		Mark-up rate	Decrease	Decrease	Decrease
		Spatial Coordination	Decrease	Insignificance	<b>Increase</b>
		Cost-effectiveness	Deteriorate	Deteriorate	Insignificance





Flowering plot, Lower Saxony, Germany © Tania Runge.

#### **4. The Agglomeration Bonus is an expensive and largely ineffective coordination mechanism when applied in the context of an auction.**

Our experimental results suggest that the AB is likely to do the opposite of what it is designed to do: it deteriorates spatial coordination in the uncorrelated and negative landscapes. The likely cause of this finding is that, with a fixed budget, the AB payment means fewer contracts can be awarded, *ceteris paribus*. In addition to the counterproductive effect on coordination, the AB was found to be an expensive incentive mechanism in all three landscape types. Given a tight budget constraint, policymakers should therefore consider adopting the AB with great caution, especially in the uncorrelated and negative landscape type. It is only in the positive landscape that the AB seems to hold potential for promoting spatial coordination.

#### **Take-home messages for AES design**

Integrating a landscape-level environmental approach into the

design of AES has been identified as an important step forward in achieving more effective delivery of environmental goods and services on European farmland (Barral and Detang-Dessendre, 2023). Landscape configurations (spatial correlations between opportunity costs and environmental values) influence how coordination-improving mechanisms should be designed. Unfortunately, there is no one-size-fits-all mechanism that can effectively promote spatially coordinated conservation actions for all landscape configurations tested. The use of a bottom-up approach (i.e. landholder-to-landholder communication or peer influence) is likely to improve AES performance at landscape scale. However, the low willingness of landholders to incur communication costs might be a significant hurdle that challenges the effectiveness of the bottom-up approach. Specifically, the likelihood of not having a sufficient critical mass of landholders who take initiative to interact with their neighbours tends to be higher in landscapes where opportunity costs and environmental values are negatively correlated. If no institutions (such as the Dutch

conservation collectives) exist that can take on the role of coordinator, employing an external facilitator may be a remedy to the problem.

Disclosure of the spatial environmental scoring rule can play a pivotal role in promoting spatial coordination. Given the knowledge about how auction outcomes in different landscape configurations are highly sensitive to the choice of coordination-improving mechanisms, policymakers should be cautious in their adoption to avoid undesirable outcomes. Particularly, the disclosure of spatial environmental scoring rules could be an effective solution to enhance spatial coordination in the uncorrelated and negative landscape types. However, such an information disclosure policy could backfire on landscape-level management goals in landscapes where opportunity costs and environmental values are positively correlated. Our results warn against the use of the Agglomeration Bonus in the context of a conservation auction. Although it may encourage coordination in the positive landscape, it is likely to have counterproductive effects in the uncorrelated and negative landscape. In all landscape types the AB lowers

the cost-effectiveness of conservation. Whether these findings also hold for an AB offered as part of a fixed-rate scheme (rather than an auction) is the subject of further investigation. A final conclusion from this work is that it may be worthwhile for policy designers to invest time and resources into acquainting themselves with the

specific type of landscape they are dealing with, such as a negative landscape type in Central Scotland. Equipped with such knowledge, they would be in a better position to make informed decisions about which coordination mechanism would effectively promote landscape-scale environmental outcomes.

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# Summary


## Agri-environmental Schemes Require Improved Design for Better Outcomes

 Advocacy for a shift from an individual farm-level to a landscape-level approach in agri-environmental policy is a focal point in the reform of the Common Agricultural Policy. Such a shift aims to address spatial mismatches between ecological processes and targeted environmental outcomes, and to harness potential ecological gains from spatial coordination. However, there remains limited understanding of how to design effective mechanisms aimed at encouraging coordination among landholders. Do landscape configurations influence the effectiveness of coordination mechanisms? This article aims to assess the effectiveness of alternative coordination mechanisms incorporated in the design of a conservation auction across alternative landscape configurations, that is, in terms of the spatial relationship between some measure of environmental benefit – such as wild bird species diversity – and the profitability of farmland. These mechanisms include landholder-to-landholder communication, disclosure of spatial environmental scoring rules, and the Agglomeration Bonus. We used lab experiments to evaluate these options. Our results suggest that there is no panacea for promoting landscape-level environmental outcomes. Communication proves capable of significantly facilitating coordination, whilst information disclosure policies can serve as an effective coordination mechanism in multiple landscape types. By contrast, the Agglomeration Bonus was only found to effectively promote coordination in a positively correlated landscape type. It leads to lower cost-effectiveness in all landscape types.

## La conception des programmes agro-environnementaux doit être améliorée pour obtenir de meilleurs résultats

 Le plaidoyer en faveur du passage d'une approche de l'échelle individuelle à une approche à l'échelle du paysage dans la politique agroenvironnementale est un point central de la réforme de la politique agricole commune. Un tel changement vise à remédier aux inadéquations spatiales entre les processus écologiques et les résultats environnementaux ciblés, et à exploiter les gains écologiques potentiels issus de la coordination spatiale. Cependant, la compréhension de la manière de concevoir des mécanismes efficaces pour encourager la coordination entre les propriétaires fonciers reste limitée. Les configurations paysagères influencent-elles l'efficacité des mécanismes de coordination? Cet article vise à évaluer l'efficacité des mécanismes de coordination alternatifs incorporés dans la conception d'une vente aux enchères de mesures de conservation à travers des configurations paysagères alternatives, définies en termes de corrélation spatiale entre les avantages environnementaux et les coûts d'opportunité. Ces mécanismes comprennent la communication entre propriétaires fonciers, la divulgation des règles de notation environnementale spatiale et un bonus d'agglomération. Nous avons utilisé des expériences en laboratoire pour évaluer ces options. Nos résultats suggèrent qu'il n'existe pas de panacée pour promouvoir des résultats environnementaux à l'échelle du paysage. La communication s'avère capable de faciliter considérablement la coordination, tandis que les politiques de divulgation d'informations peuvent servir de mécanisme de coordination efficace dans de multiples types de paysages. En revanche, le bonus d'agglomération ne favorise efficacement la coordination que dans un seul type de paysage et conduit à une rentabilité moindre dans tous les types de paysages.

## Agrarumweltprogramme erfordern eine verbesserte Konzeption, um bessere Ergebnisse zu erzielen

 Ein Schwerpunkt der Reform der Gemeinsamen Agrarpolitik ist das Befürworten einer Verlagerung von einem individuellen zu einem landschaftsbezogenen Ansatz in der Agrarumweltpolitik. Eine solche Verlagerung soll räumliche Missverhältnisse zwischen ökologischen Prozessen und angestrebten Umweltergebnissen angehen und potenzielle ökologische Vorteile einer räumlichen Koordinierung nutzen. Es gibt jedoch kaum Erkenntnisse darüber, wie Mechanismen zur Förderung der Koordinierung zwischen Landbesitzenden wirksam gestaltet werden können. Beeinflusst die Konfiguration der Landschaft die Wirksamkeit der Koordinierungsmechanismen? Das Ziel dieses Artikels ist es, die Wirksamkeit alternativer Koordinationsmechanismen zu bewerten, die in das Design einer Naturschutzauktion über verschiedene Landschaftskonfigurationen hinweg integriert wurden, definiert hinsichtlich der räumlichen Korrelation zwischen Umweltnutzen und Opportunitätskosten. Diese Mechanismen umfassen die Kommunikation zwischen den Landbesitzenden, die Offenlegung der Bestimmungen der räumlichen Umweltbewertung und den Agglomerationsbonus. Wir haben diese Optionen in Laborexperimenten bewertet. Unsere Ergebnisse deuten darauf hin, dass es kein Allheilmittel zur Förderung von Umweltergebnissen auf Landschaftsebene gibt. Kommunikation erweist sich als geeignet, die Koordinierung erheblich zu erleichtern, während eine Politik der Offenlegung von Informationen als wirksamer Koordinierungsmechanismus bei verschiedenen Landschaftstypen dienen kann. Im Gegensatz dazu wurde festgestellt, dass der Agglomerationsbonus die Koordinierung nur bei einem einzigen Landschaftstyp wirksam fördert. Er führt bei allen Landschaftstypen zu einer geringeren Kosteneffizienz.