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REVIEW

Improving result-based schemes for nature conservation in agricultural landscapes—challenges and best practices from selected European countries

Nina Hagemann[1] · Charlotte Gerling[2] · Lisanne Hölting[1] · Maria Kernecker[3] · Nonka N. Markova-Nenova[2] · Frank Wätzold[2] · Julian Wendler[1] · Anna F. Cord[1,4]

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Abstract

Result-based payment schemes (RBPS) offer a more flexible, innovative and performance-oriented approach to biodiversity conservation and ecosystem services provision in agricultural landscapes, compared to action-based schemes. However, uptake by farmers remains low, likely due to challenges such as lack of appropriate advice, uncertainties related to monitoring of the results and the risk of not receiving the payment. Since detailed information on the design and monitoring of RBPS is often not available in the scientific literature, we analysed 39 RBPS identified across peer-reviewed studies, grey literature, and websites from Germany, Switzerland, Austria, Ireland, the United Kingdom and Spain. This overview highlights the benefits of implementing RBPS in different European agricultural systems, identifies key design features of current schemes that could enhance adoption and addresses shortcomings such as current limitations in the biodiversity and environmental targets considered, monitoring costs and financing. We also provide an outlook on how to improve RBPS to unlock their full potential, especially in view of increasing uncertainties due to climate change.

Keywords Result-based payment schemes · European agriculture · Nature conservation · Monitoring · Financing

Introduction

Biodiversity loss is one of the most critical challenges of our time (Ceballos et al. 2017). In agricultural landscapes, both the intensification and abandonment of agriculture exacerbate this issue by degrading the quantity and quality of habitats associated with agricultural land use (Mupepele et al. 2021). Farmers are therefore an important group of actors in the conservation of biodiversity (EC 2020). Policies to address the decline of farmland biodiversity exist, such as agri-environmental schemes (AES) in the European Common Agricultural Policy (CAP) (Batáry et al. 2015), or

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✉ Nina Hagemann
nina.hagemann@tu-dresden.de

Charlotte Gerling
Charlotte.Gerling@b-tu.de

Lisanne Hölting
lisanne.hoelting@tu-dresden.de

Maria Kernecker
maria.kernecker@zalf.de

Nonka N. Markova-Nenova
markova@b-tu.de

Frank Wätzold
waetzold@b-tu.de

Julian Wendler
julian.wendler@tu-dresden.de

Anna F. Cord
anna.cord@uni-bonn.de

[1] Chair of Computational Landscape Ecology, TUD Dresden University of Technology, Dresden, Germany

[2] Brandenburg University of Technology Cottbus-Senftenberg, Cottbus, Germany

[3] Research Area "Agricultural Landscape Systems", Leibniz Centre for Agricultural Landscape Research (ZALF), Müncheberg, Germany

[4] Agro-Ecological Modeling Group, Institute of Crop Sciences and Resource Conservation, University of Bonn, Bonn, Germany

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the Conservation Reserve Program within the US Farm Bill (Baylis et al. 2022). AES compensate farmers for voluntarily taking additional environmental or climate-friendly actions that go beyond those required by law. They are well known to and largely accepted by farmers.

The vast majority of AES are action-based, meaning that farmers are paid per unit of land for using certain management practices that promote biodiversity such as restrictions on the timing and frequency of mowing events in grasslands to conserve meadow birds (Wätzold et al. 2016). However, despite some conservation successes (Batáry et al. 2015), action-based AES have been criticised because the prescribed management practices often do not lead to the desired biodiversity outcomes (Kleijn et al. 2011; Pe'er et al. 2019).

Promising alternatives to action-based schemes are so-called result-based payment schemes (RBPS) (Sidemo-Holm et al. 2018), which are also referred to as output-based (Drechsler 2017), result-oriented (Vaino et al. 2021), payment-by-results (Chaplin et al. 2021) or pay-by-results (Burton and Paragahawewa 2011). The EU Biodiversity Strategy 2030, for example, explicitly mentions RBPS as a tool to support sustainable nature and farming (EC 2020) and a number of RBPS already exist in Europe (see Allen et al. (2014) for an overview on the first schemes in the European Union and EFTA countries). However, they are still not widely used in Europe (Byrne et al. 2020). RBPS can be further divided into pure or hybrid RBPS. In pure RBPS, farmers are paid for achieving a specific biodiversity result, such as a certain number of target plant species on their land (Herzon et al. 2018). In hybrid schemes, farmers are paid for achieving certain goals as well, but they must also meet certain minimum management requirements, for which they receive at least a base payment (Herzon et al. 2018). Alternatively, they receive a payment for implementing certain conservation measures and a top-up payment if they reach a specific environmental goal (Elmiger et al. 2023).

RBPS are considered a promising alternative to action-based payments for several reasons (Herzon et al. (2018). Firstly, in action-based schemes, the same conservation measures are typically implemented across a larger region, such as a Federal State in Germany, even if they are only effective in conserving a target (group of) species in certain parts of that region. In RBPS, usually only farmers with land that is in principle suitable for the target species are incentivised to implement conservation measures (Burton and Schwarz 2013; Gerling and Wätzold 2021; Elmiger et al. 2023). Secondly, as the payment is conditional to conservation success of the target species, the effectiveness of the scheme is ensured (Birge et al. 2017). Thirdly, RBPS incentivise farmers to adapt conservation measures to local conditions, for example, by adjusting the timing of mowing to the phenology-dependent breeding season of meadow birds (Gerling et al. 2023). RBPS also provide incentives for farmers to innovate and develop conservation practices that are more effective (thus reducing the risk of failure) and/or less costly (Burton and Paragahawewa 2011; Sidemo-Holm et al. 2018), as such innovation increases their (expected) profit. In summary, RBPS are designed to incentivise farmers to do the right thing in the right place and at the right point in time, thus generally increasing the cost-effectiveness of AES (White and Sadler 2012; Burton and Schwarz 2013; Gerling and Wätzold 2021), with positive outcomes for biodiversity.

With RBPS, farmers face the risk of not achieving the desired result. Despite implementing appropriate measures, the target species may not occur on a farmer's land due to factors being beyond their control, such as adverse weather conditions or major phenological and range shifts. This may be one of the reasons for a low uptake of such schemes (Burton and Schwarz 2013) or lead farmers to demanding a risk premium, which increases the overall costs of RBPS (Drechsler 2017). Moreover, monitoring costs of RBPS, in particular if the target species is mobile, can be substantial (Burton and Schwarz 2013, Bartkowski et al. 2021; Elmiger et al. 2023), although they may be acceptable for other targets such as indicator plant species on grassland (Russi et al. 2016).

Previous case studies have examined individual RBPS (Fleury et al. 2015; Wezel et al. 2016; Russi et al. 2016) or have focused on single countries (O´Rourke and Finn 2020, Moran et al. 2021, Vaino et al. 2021). Very few studies provide a broader overview of existing schemes in Europe, but they were either published several years ago and therefore do not cover more recent developments (Allen et al. 2014; Burton and Schwarz 2013; Matzdorf et al. 2014; Herzon et al. 2018) or have a very specific focus, such as the study by Elmiger et al. (2023), which focuses on the selected target species. There is still a gap in the scientific literature on how RBPS are designed and monitored in practice. With this article, we present parts of this grey literature in order to make the knowledge accessible to a wider group of readers.

The overall aim of this study was to analyse existing RBPS from selected European countries—Germany, Austria, Switzerland, the United Kingdom (UK), Ireland and Spain—and to present information on their design, implementation, financing, ecological indicators used and monitoring from a practical perspective. We present a comprehensive synthesis covering schemes implemented since the year 2000, found in both scientific and grey literature as well as websites.

Method

To identify RBPS, we searched websites and peer-reviewed and grey literature covering the period 2000–2022. We started with the Result-Based Payments Network (RBPN)

Table 1 Overview of assessment criteria used in the analysis of the documents

	Main category	Subcategories
1	Name of measure	None
2	Document	Author, Year, Title, Online source, Last date of access
3	Country (region)	None
4	Time span of measure	None
5	Result-based	Yes, No, Others
6	Coordinator of measure	
7	Focus of measure	Arable land, Grassland, Other, Not specified
8	Financing	State, Companies, Private, Other, None, Not specified, Payment/ha, Special features
9	Contractual arrangement	Yes, No, Other, Not specified, comments
10	Auction	Yes, No, Other, Not specified
11	Monitoring	State, Association, Other, None, Not specified, Comments
12	Species groups	Flora, Fauna, Other, Not specified, Comments
13	Number of species	1, < 10, 10 and more, Not specified, Comments
14	Success of measure	Yes, No, Not specified, Comments
15	Cooperative measure	Yes, No, Unclear, Not specified
16	Hectare	
17	Number of farmers	
18	Special features	

(https://www.rbpnetwork.eu/) website and the European Commission's result-based payment fact sheets, which provided the most up-to-date information. We identified the majority of schemes from these sources. The RBPN website, a product of the LIFE TO GRASSLANDS project, is maintained by experts from various countries. Both websites list RBPS for several countries, partly with overlapping information. Detailed information from individual websites was saved as PDFs[1]. Additionally, we included key overview publications (Matzdorf et al. 2014, Pabst et al. 2018, O´Rourke and Finn 2020, Moran et al. 2021) and used a snowballing approach to identify additional schemes.

All schemes found were analysed based on five criteria: (1) time span, (2) land use system, (3) real world implementation, (4) level of detail and (5) language. We excluded schemes that ended prior to the year 2000 and did not focus on arable land or grassland (such as those focused on orchards, heathland and moorland), since our focus was on recent schemes in the major agricultural land use systems in Europe. We only considered schemes which were actually implemented (and not just proposed) and for which information on institutional aspects (e.g. funding, monitoring, relevant biotic/abiotic factors) was available. Finally, only schemes implemented in Germany, Austria, Switzerland, the UK, Ireland and Spain were included, as the authors could only review grey literature and internet sources in German, English and Spanish.

All schemes meeting the criteria were assessed in detail to extract information on target land use (grassland or arable land), design (pure result-based or hybrid), ecological indicators (flora, fauna, other), monitoring and financing. This information is summarised in Table 1 and stored in a database (Supplementary Material S1). To ensure accuracy, another author reviewed all database entries.

Results

Distribution by country and type of scheme

We identified 39 RBPS (Table 2), the majority of which are implemented in Germany (15), followed by Ireland (11), UK (5), Switzerland (4), Austria (3) and Spain (1). Consecutive schemes that build on each other over time, e.g. AranLIFE and Caomhnú Árann—Managing the habitats of the Aran Islands (Ireland, No. 25[2]), are considered a single scheme, even if the design and funding differ slightly. While most of the schemes have been introduced within the last 10 years, some of them have a longer history. One example is the Swiss programme "Proof of ecological performance (PEP)

[1] This European Commission website no longer exists, but as the pages are saved as PDF files, the information is still available, including the date of last access.

[2] Please note that all references with No. followed by a number refer to entries in Table 2.

Table 2 Overview of measures, countries and sources

Germany				
	Measure	**Federal State**	**Arable land (AL) or grassland (GL)**	**Sources**
1	Cooperative meadow bird conservation in floodplains of the Bremen basin	Bremen	GL	https://www.bund-bremen.net/fileadmin/bremen/Natur_und_Landschaft/Wiesenvogelschutz/Bericht_Wiesenvoegel_2021.pdf
2	Harrier nest protection	Bavaria	AL	https://ec.europa.eu/environment/nature/rbaps/fiche/harrier-nest-protection-arable-fields-germany-nord_en.htm
3	Management of drinking water catchments	Bavaria	AL and GL	Wezel et al. (2016)
4	Promotion of particularly sustainable practices on permanent grassland: Species	Hesse	GL	https://umwelt.hessen.de/sites/umwelt.hessen.de/files/2021-12/das_wichtigste_im_ueberblick.pdf
5	Coordinated grassland bird protection	Schleswig-Holstein	GL	5a) https://www.rbpnetwork.eu/country-infos/germany/coordinated-grassland-bird-protection-gemeinschaftlicher-wiesenvogelschutz-schleswig-holstein-48/ 5b) Matzdorf et al. (2014) 5c) https://ec.europa.eu/environment/nature/rbaps/fiche/grassland-bird-protection-payments-germany-schlesw_en.htm
6	Harrier nest protection	North Rhine-Westphalia	AL	6a) https://www.rbpnetwork.eu/country-infos/germany/harrier-nest-protection-in-arable-fields-weihenschutz-nordrhein-westfalen-49/ 6b) https://ec.europa.eu/environment/nature/rbaps/fiche/harrier-nest-protection-arable-fields-germany-nord_en.htm
7	Blühendes Steinburg	Schleswig-Holstein	GL	7a) https://ec.europa.eu/environment/nature/rbaps/fiche/programme-bluhendes-steinburg-germany-schleswig-ho_en.htm 7b) Matzdorf et al. (2014) 7c) Groth (2008)
8	Species-rich grassland	Thuringia	GL	Pabst et al. (2018)
9	Result-based grassland use for the conservation of FFH habitat types	Bavaria	GL	Pabst et al. (2018)
10	Preservation of species-rich grassland	Bavaria	GL	Pabst et al. (2018)
11	Species-rich grassland	Lower Saxony	GL	Pabst et al. (2018)
12	Species-rich grassland—results-oriented compensation	Saxony	GL	Pabst et al. (2018)
13	Contract nature conservation species	Rhineland-Palatinate	GL	13a) https://www.rbpnetwork.eu/country-infos/germany/species-rich-grassland-artenreiches-gruenland-kennarten-rheinland-pfalz-35/ 13b) Pabst et al. (2018)
14	Permanent species-rich grassland	Baden-Württemberg	GL	14a) https://www.rbpnetwork.eu/country-infos/germany/species-rich-grassland-artenreiches-dauergruenland-baden-wuerttemberg-47/ 14b) Pabst et al. (2018)
15	Extensive use of the FFH habitat types lowland and mountain meadows	Baden-Württemberg	GL	Pabst et al. (2018)

Table 2 (continued)

Switzerland			
	Measure	**Arable land (AL) or grassland (GL)**	**Sources**
16	Target-oriented biodiversity promotion in the canton of Zurich	AL and GL	16a) https://www.rbpnetwork.eu/country-infos/switzerland/goal-oriented-promotion-of-biodiversity-in-the-canton-of-zurich-28/ 16b) https://zielorientierte-biodiversitaet.ch/projekte
17	Preservation and enhancement of species-rich grassland	GL	https://ec.europa.eu/environment/nature/rbaps/fiche/preservation-and-enhancement-species-rich-grasslan_en.htm
18	Plant biodiversity on Swiss alpine summer pastures	GL	Zabel (2019)
19	Proof of ecological performance and biodiversity payments	AL and GL	https://www.rbpnetwork.eu/country-infos/switzerland/proof-of-ecological-performance-pep-and-biodiversity-payments-54/
Austria			
	Measure	**Arable land (AL) or grassland (GL)**	**Sources**
20	Humus-programme of the ecoregion Kaindorf	AL	https://www.rbpnetwork.eu/country-infos/austria/humus-program-of-the-oekoregion-kaindorf-50/
21	Results-based nature conservation plan	GL	21a) https://www.rbpnetwork.eu/country-infos/austria/results-based-nature-conservation-plan-enp-1/ 21b) https://www.rbpnetwork.eu/media/fachbericht_en_final_klein.pdf
22	"Future earth"	AL and GL	https://www.onfarming.at/inhalt/sortiment-ratgeber/ratgeber/landwirte/ackerbau/dungung/mit-zukunft-erde-humus-aufbauen
Ireland			
	Measure	**Arable land (AL) or grassland (GL)**	**Sources**
23	The Irish breeding curlew EIP	GL	https://www.rbpnetwork.eu/country-infos/ireland/the-irish-breeding-curlew-eip-20/
24	Pearl mussel project/KerryLife freshwater pearl mussel conservation project	AL and GL	24a) https://www.rbpnetwork.eu/country-infos/ireland/pearl-mussel-project-11 24b) O'Callaghan et al. (2020)
25	Caomhnu Arann – Managing the habitats of the Aran Islands	GL	25a) https://www.rbpnetwork.eu/country-infos/ireland/caomhnu-arann-managing-the-habitats-of-the-aran-islands-19/ 25b) McGurn et al. (2020)
26	Protecting farmland pollinators	AL and GL	https://www.rbpnetwork.eu/country-infos/ireland/protecting-farmland-pollinators-17/
27	Allow project: Duhallow farming for Blue Dot catchments	GL	https://www.rbpnetwork.eu/country-infos/ireland/allow-project-duhallow-farming-for-blue-dot-catchments-16/
28	The Burren programme	GL	28a) https://www.rbpnetwork.eu/country-infos/ireland/the-burren-programme-9/ 28b) Dunford and Parr (2020) 28c) Moran et al. (2021)

Table 2 (continued)

29	Hen harrier project	GL	29a) https://www.rbpnetwork.eu/country-infos/ireland/hen-harrier-project-10/ 29b) Moran et al. (2021)
30	Blackstairs farming futures	GL	https://www.rbpnetwork.eu/country-infos/ireland/blackstairs-farming-futures-12/
31	The bride project	AL and GL	https://www.rbpnetwork.eu/country-infos/ireland/the-bride-project-13/
32	RBAPS project	AL and GL	32a) https://www.rbpnetwork.eu/country-infos/ireland/rbaps-project-7/ 32b) Moran et al. (2021) 32c) Byrne et al. (2020)
33	The national parks and wildlife service (NPWS) farm plan scheme	GL	Bleasdale and O´Donoghue (2020)
United Kingdom			
	Measure	**Arable land (AL) or grassland (GL)**	**Sources**
34	Developing results-based approaches to payments on common land in Wales	GL	https://www.rbpnetwork.eu/country-infos/united-kingdom/developing-results-based-approaches-to-payments-on-common-land-in-wales-58/
35	Shared steps for common grazings	GL	https://www.rbpnetwork.eu/country-infos/united-kingdom/shared-steps-for-common-grazings-57/
36	National trust payment for outcomes trial, Llyn, Wales	AL and GL	https://www.rbpnetwork.eu/country-infos/united-kingdom/national-trust-payment-for-outcomes-trial-llyn-wales-39/
37	National trust payment for outcomes trial, Yorkshire Dales	AL and GL	https://www.rbpnetwork.eu/country-infos/united-kingdom/national-trust-payment-for-outcomes-trial-yorkshire-dales-38/
38	RBPS for biodiversity on arable and upland grassland systems in England	AL and GL	38a) https://www.rbpnetwork.eu/country-infos/united-kingdom/rbps-for-biodiversity-on-arable-and-upland-grassland-systems-in-england-29/ 38b) Chaplin et al. (2019)
Spain			
	Measure	**Arable land (AL) or grassland (GL)**	**Sources**
39	RBAPS in Navarra—mosaic perennial crops	GL	https://www.rbpnetwork.eu/country-infos/spain/rbaps-in-navarra-mosaic-perennial-crops-33/

and biodiversity payments" (No. 19), which dates back to 1998.

Of the identified schemes, 23 were purely result-based and 16 were hybrid. Hybrid schemes were particularly common in Ireland. In Austria, the UK and Spain, all schemes were purely result-based, while in Germany, the majority of schemes were purely result-based and the vast majority of them focused on grasslands (Fig. 1).

Number of participating farmers and size of implementation area

While information on participation levels was not available for all schemes, the number of farmers participating varied significantly, ranging from just a few to thousands. The lowest number of farmers participating was found for the "National trust payment for outcomes trial, Llyn Wales" (UK, No. 36) with only three farmers, followed by the "Target-oriented biodiversity promotion in the canton of Zurich" (Switzerland, No. 16) with 25 farmers and the "Cooperative meadow bird conservation in floodplains of the Bremen basin" (Germany, No. 1) with 37 farmers. The highest numbers were mentioned for the "Hen harrier scheme" in Ireland (No. 29) with 1600 farmers and the "Permanent species-rich grassland programme" (Germany, No. 14) with more than 2000 farmers for the former AES programme period (2014–2022) and a total of about 4800 participating farmers since its introduction in the year 2000.

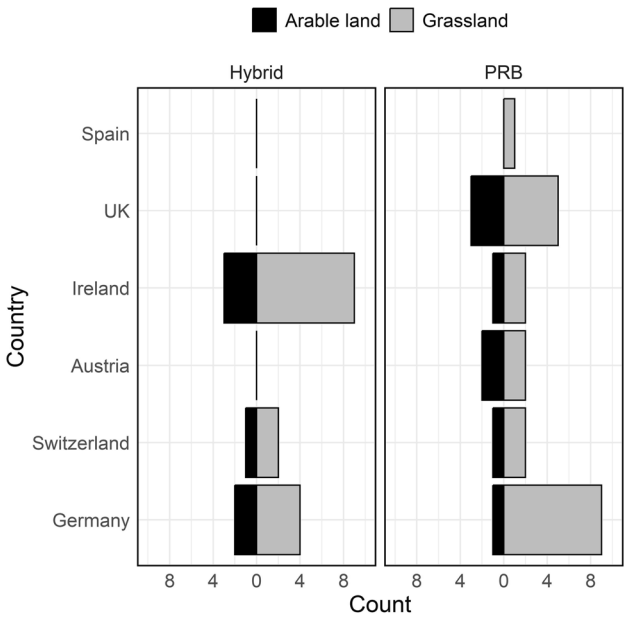

Fig. 1 Number of identified pure result-based (PRP) and hybrid RBPS on arable and grassland

The "Shared steps for common grazings" scheme (UK, No. 35), which covered about 500,000 hectares, and the "Harrier nest protection" (Germany, No. 2), with about 180,000 hectares, were identified as the two schemes with the largest area of implementation. The smallest areas were found for the pilot scheme "Results-based agri-environment payment scheme (RBAPS)" (Ireland, No. 32), which covered only about 260 hectares, and the "Cooperative meadow bird conservation in floodplains of the Bremen basin" (Germany, No. 1) with 290 hectares. However, the size of the area did not always correspond to the number of farmers involved. Even with few participating farmers, large areas may be managed with RBPS, while many farmers may manage only a small area under the scheme.

Biodiversity and environmental targets and indicators

Across all countries, schemes that did not address flora or fauna were very rare (only three out of the total 39 schemes, Fig. 2): The "Humus-programme of the ecoregion Kaindorf" (Austria, No. 20) and the "Future earth" scheme (Austria, No. 22) used humus content and carbon storage in soils as indicator, whereas the scheme "Management of drinking water catchments" (Germany, No. 3) used nitrogen concentration in the soil as an indicator. In terms of biodiversity indicators, plant target species predominated, although there were notable differences between countries. In Germany, 10 out of 15 schemes focused on plant, while four focused on birds. In Switzerland and the UK, flora indicators dominated as well. In Ireland, the majority of target species were fauna, such as macroinvertebrates, ground-nesting farmland birds, frogs, bats or pearl mussels (as target species for freshwater ecosystems within agricultural landscapes). In Spain and Austria, flora and fauna were used as indicators, with Austria also considering carbon storage in soil. The "National trust payment for outcomes trial, Yorkshire Dales" (UK, No. 37) targeted flora, fauna and soil. Most schemes focused on species typical of the region that can contribute to the protection of relevant habitats. Highly endangered species were rarely targeted. Most schemes, especially pure result-based schemes in Germany, rewarded only the presence or absence of target species (or, in the case of birds, their nests) from a species indicator list.

Only for the schemes "Target-oriented biodiversity promotion in the canton of Zurich" (Switzerland, No. 16), "Protecting Farmland Pollinators" (Ireland, No. 26) and the "Result-Based Agri-Environment Payment Scheme (RBAPS) Pilot" (Ireland, No. 32) were the frequency of occurrence, number, cover or abundance of species recorded. In some countries such as Ireland and the UK, a wider range of indicators, such as the existence of a management plan

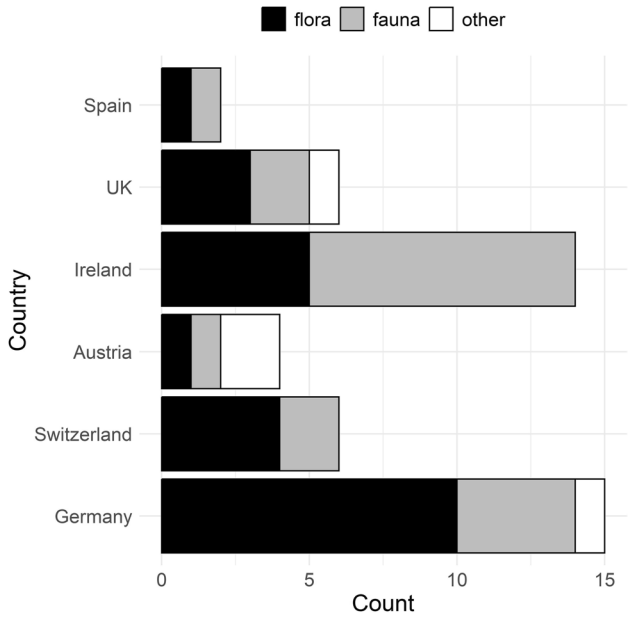

Fig. 2 Number of schemes addressing flora, fauna or other indicators

for the area under the scheme or the extent of anthropogenic activities, was considered to define the payment level. The scorecards used for monitoring in these cases comprised various outcome indicators serving as proxies for biodiversity or the ecological integrity of an area. They usually came with monitoring manuals and were designed for farmers to monitor their own land (e.g. Bride Project EIP 2021).

Advisory services and monitoring

We identified a range of administrative and monitoring approaches that were used differing between, but also within countries. Some schemes provided advice to farmers before they signed up for the scheme, including the development of farm-specific management plans, as well as intensive, on-going support throughout the scheme. One example was the "Caomhnu Arann – managing the habitats of the Aran Islands" (Ireland, No. 25) program. Such advice helps address challenges and technical issues or find alternative approaches to reach the biodiversity or environmental target thus motivating farmers to participate. Other forms of advice included training in monitoring techniques, as in the "Result-Based Agri-Environment Payment Scheme (RBAPS) Pilot" (Ireland, No. 32), and support with paperwork, such as in the Burren program (Ireland, No. 28). In the case of the "Harrier nest protection" (Germany, No. 6), the Working Group for Biological Environmental Protection in the District of Soest negotiated annual payment rates for the farmers, finalised contracts, supported paperwork and provided monitoring services.

All schemes reviewed required reporting monitoring results, but the extent of reporting varied. Some schemes, such as the "Burren programme" (Ireland, No. 28), only asked for a few simple declaration forms to reduce the administrative burden, while others required detailed reporting on specific management such as mowing regime or field sizes. Responsibility for monitoring also differed: in some schemes, farmers self-monitored, while in others, public authorities, freelancers or companies conducted the monitoring. In Ireland, farmers and farm advisors used scorecards for (self)monitoring. In the "Results-based nature conservation plan" (Austria, No. 21), freelancers were hired. In some schemes, such as the result-based AES in Germany, plant species were monitored by farmers, but were additionally controlled by state bodies under official CAP audits. For schemes targeting soil parameters, e.g. the Austrian schemes No. 20 and No. 22, soil samples had to be sent to laboratories.

Financing and administrative effort

RBPS can be financed by the state or by private funders such as companies, foundations, associations or individuals. Our findings indicate that the vast majority of schemes were state-financed (Fig. 3). Some German schemes were exclusively financed by the Federal States, such as the "Coordinated grassland bird protection" in Schleswig-Holstein (No. 5). During 2014–2020, 56 million € were allocated to 23 EIP projects in Ireland (DAFM 2019). The EIP operational groups that receive additional EU support were pilot projects that explicitly focused on the interaction of different

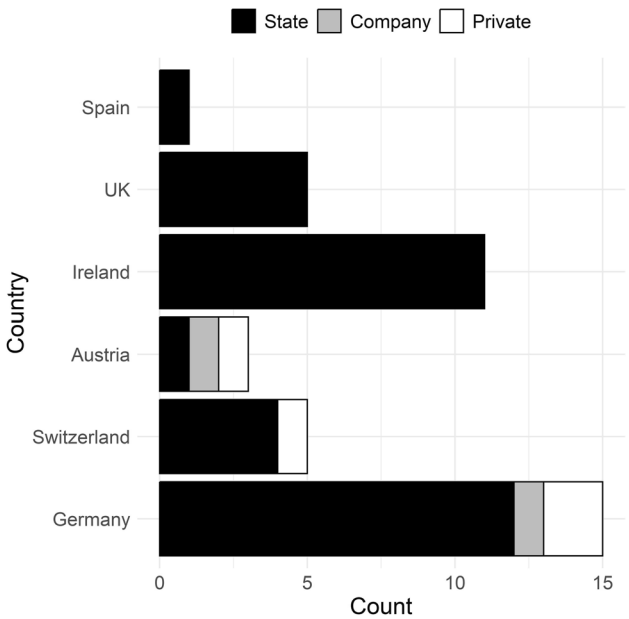

Fig. 3 Financial sources of schemes identified in this study

stakeholder groups to discuss and develop schemes together and to examine the administrative burden involved. As another example from Ireland, funding from LIFE projects was used for testing and developing new schemes, allowing administrations and farmers to jointly assess the administrative effort and required costs.

An example of a privately funded scheme is the "Blühendes Steinburg" (Germany, No. 7), where the Foundation for Nature Conservation Schleswig-Holstein provided 10,000 € annually for target species on grassland. The Swiss scheme "Preservation and enhancement of species-rich grassland" (No. 17) was predominantly state-financed, with only 20% of the overall budget coming from private funds. Two Austrian schemes ("Future earth", No. 22 and "Humus-programme of the ecoregion Kaindorf", Nr. 20) were financed through carbon certificates that can be bought by companies or individuals.

A specific example of public company funding were the water utilities "Stadtwerke Augsburg and Königsbrunn", who compensate farmers for reducing the nitrate levels on their fields (Germany, No. 3). The individual payments differed widely between schemes. For example, 50 € was paid for each nest found or 25 € for protecting nests during mowing in the scheme "Cooperative meadow bird conservation in floodplains of the Bremen basin" (Germany, No. 1). In Austrias "Humus-programme of the ecoregion Kaindorf" (No. 20), 30 € were paid per ton of carbon stored.

Scheme success

For most schemes considered in this study, there was no external evaluation, so a comprehensive and objective assessment of the schemes was not possible. However, for several schemes, self-assessments were provided by the respective projects, and the majority of them reported positive ecological effects. Examples included the "Caomhnú Arann – Managing the habitats of the Aran Islands" (Ireland, No. 25) scheme, where the quality of habitats improved, as evidenced by the scorecards. The "Cooperative meadow bird conservation in floodplains of the Bremen basin" (Germany, No. 1) led to increasing bird populations for curlew (), black-tailed godwit (*Limosa limosa* L.) and common redshank (*Tringa totanus* L.). Plots under the "The National Parks and Wildlife Service (NPWS) Farm Plan Scheme" program (Ireland, No. 33) showed a higher environmental performance in the winter feeding of birds compared to control plots outside the scheme. Only for the two "Harrier nest protection" schemes (Germany, Nos. 2 and 6) were population decreases reported for some species, despite the introduction of the schemes. However, further research is needed for most schemes to better understand the relationships between population trends and the schemes. Declines might have been even more severe without these schemes, but other factors unrelated to land use and management also need to be considered.

Besides the ecological success of several schemes, a positive attitude and increasing trust of farmers towards nature conservation schemes ("Coordinated grassland bird protection", Germany, No. 5), increasing uptake of schemes ("Contract nature conservation species", Germany, No. 13) and increasing income support and support from advisors ("The National Parks and Wildlife Service (NPWS) Farm Plan Scheme", Ireland, No. 33) were reported. A quote from the Austrian "Results-based nature conservation plan" (Austria, No. 21b: 20) illustrated the role of advice: "It was found that field visits, on which objectives were defined and evaluated and farmers received individual guidance, were of primary importance to the success of ENP. While this does require corresponding efforts put into consultation and training, the knowledge gained by farmers creates a sustainable impact and is applied to future farming practices – in part regardless of potential subsidies". Finally, with the increasing demand for carbon certificates the "Humus-programme of the ecoregion Kaindorf" can be regarded as successful (Austria, No. 20).

Flexibility

We found additional information in a few schemes that points to other potential success factors for RBPS including positive framing of the schemes and options for flexibility. The Burren Programme (Ireland, No. 28) "focusses on rewarding positive activity rather than compensating farmers to avoid negative activities" (Dunford and Parr 2020: 85).

Experiences from the Irish National Parks and Wildlife Service (NPWS) Farm Plan Scheme (Ireland, No. 33) showed that some farmers felt delighted and proud of their contribution to the scheme. While RBPS offered a great deal of flexibility regarding management practices, they were usually not very flexible in terms of the time by which results had to be achieved (i.e. monitoring date). However, the KerryLIFE (Ireland, No. 24) project showed how flexibility can be introduced. In cases where targets of a measure were not achieved, payments were withheld until the measure was completed (O'Callaghan et al. 2020). The approach reduced the pressure on farmers and could therefore increase the acceptability and uptake of schemes.

Discussion and recommendations

Our findings indicate significant variation among identified RBPS. However, this diversity allows us to make recommendations for future schemes. Our analysis also revealed certain obstacles to the further ecological success of RBPS, comprising limited taxonomic coverage, lack of land and

monitoring effort, especially for mobile species. We discuss our findings in the context of current literature, derive recommendations for future schemes, discuss the adaptability of schemes to other regions or countries and indicate future research needs.

Key features of successful result-based payment schemes

In addition to financial attractiveness, we identified the following key characteristics of successful RBPS.

Adaptation to site- or region-specific conditions From a social perspective, schemes targeting site- or region-specific challenges have the advantage that farmers are more likely to culturally identify with the scheme and support its implementation. For example, promoting the results-based "Flowering Meadows" scheme widely throughout France allowed it to be positively viewed (Fleury et al. 2015). Another example are competitions between farmers for the "most beautiful" flowering meadows in Southern Germany, targeting a conservation goal that aligns with a shared local/regional cultural understanding of what "beautiful" landscapes look like (e.g. BUND 2023). So-called meadow championships take place also in other German Federal States and European countries (see Table 1 in Oppermann et al. 2017).

Training and advice Our analysis showed that several schemes included some kind of training or options for farmers to receive advice. However, the amount and intensity of support differed largely between schemes. Byrne et al. (2020) found that adequate training and guidance for farmers are crucial for the successful implementation of RBPS, since they often require specific knowledge about the focal species and their habitat requirements.

From the literature, we know that peer-to-peer advice between farmers, especially those with (long-term) experience with RBPS, is important (Allen et al. 2014). Naaf et al. (2024) showed that managers of large mixed farms are important for passing on information and advising other farmers regarding AES. Such sharing of experiences on control or requirements of local conditions (soil, flora, fauna) provides farmers with valuable opportunities to observe RBPS in real-world settings.

Hybrid schemes We identified a total of 16 hybrid schemes in Germany, Switzerland and Ireland. These schemes reduced the financial risk for farmers by basing payments not only on meeting the biodiversity or environmental targets, which may not always be achieved, but also on implementing certain management practices or developing a management plan which farmers can control themselves. We found that especially hybrid schemes were well received by the farmers. Byrne et al. (2020) pointed to another advantage of hybrid schemes: for biodiversity conservation or restoration, an initial, non-productive investment, in addition to the RBPS, can lead to improved biodiversity outcomes. The challenge is to find the "right" set of additional indicators (not too broad and easy to reach, but also not too specific and hard to reach) and payments (not too high or low).

Challenges that have to be addressed

Administration costs With our findings, we illustrate that several aspects have to be considered when setting biodiversity targets for RBPS (cf. Table 1). Both pure and hybrid RBPS induce administrative effort. This includes time and human resources, including training of farmers or employment of advisors, who act as intermediaries between farmers and administration.

The efforts related to the design and implementation of RBPS are also addressed in the current literature: Berkhout et al. (2018, p. 28), for example, summarise the challenges of administration for implementing targeted measures: "The more targeted and specific payments are, the more burdensome the administration, monitoring and control are likely to become". While this may not be the case for all RBPS, this issue needs to be considered especially when using result-based approaches with more complex biodiversity indicators that require training and advice for administrative staff and farmers. Providing advisors with both agronomic and ecological background and knowledge about on-farm biodiversity management and respective AES/RBPS will be crucial to meet this challenge. A prime example are training programs for on-farm biodiversity advisors as provided by AGRIDEA (2024).

The monitoring effort of RBPS could be reduced in the future when novel approaches combining monitoring by drones (Torresani et al. 2023; Schöttker et al. 2022), thermal imagery (Scholten et al. 2019) or passive acoustic devices (Markova-Nenova et al. 2023) with artificial intelligence (AI) tools are further developed to support monitoring (Kühl et al. 2020; Wägele et al. 2022). Such novel approaches need to be further tested (e.g. fed with more data; Gallmann et al. 2022) and will require farmers and advisors to also become familiar with them, requiring extra time and training so that they can make use of them. Additionally, challenges related to privacy persist in using such technologies, which is crucial for ensuring farmer acceptance (e.g. Wiseman et al. 2019). Some research has already been conducted to address the topic of data protection in agriculture in general (see, for example, Ryan et al. 2023), but specific studies on acceptance of monitoring technologies for RBPS are still missing.

In their review, Elmiger et al. (2023) found that in almost all German RBPS, farmers themselves assessed the outcome

on their fields, which can be supported by ecologists, nature conservationists or other intermediaries. In Austria, a program exists in which farmers, after completing a biodiversity observation training (Naturschutzmonitoring 2022), monitored their fields for certain species selected in cooperation with ecologists, and regularly submitted their observations.

These examples show that self-monitoring by farmers, along with the integration of advisors or other experts as intermediaries, can reduce the workload of public administrations. At the same time, self-monitoring allows farmers to observe the outcomes of their practices, building their awareness for certain species and their habitats. This, in many cases,, further motivates them to adapt their farming practices and participate in conservation efforts.

Taxonomic and farming system biases We found that most schemes targeted the presence of indicator species from a list. While this is an efficient way to reduce the multidimensional nature of biodiversity to a simple, easily communicable and understandable level (Dröschmeister and Sukopp 2009), the complexity of ecosystems should not be neglected (Dale and Beyeler 2001). Plants have been the primary focus in most schemes to date. Since they grow in specific locations (although possibly at different times of the year) with suitable conditions supported by targeted management practices, their monitoring is relatively easy and reliable. Additionally, many farmers are familiar with plants (being potential weeds), which facilitates self-reporting. Plants are considered good indicator species for overall biodiversity, as changes in their abundance, distribution and frequency of occurrence can affect the entire ecosystem (Whittaker 1972). From a trophic perspective, plants are primary producers crucial for habitat quality and structure (Chapin et al. 2011).

Different taxa have been used as fauna indicators in the RBPS identified in this review, namely birds (the only animal indicator group used in Germany), mammals, amphibians, frogs and bats (mentioned here in order of decreasing frequency of use as target group). Birds are not only charismatic, but are especially useful indicators of environmental change, as they respond to changes in habitat quality and availability (Furness et al. 1993). Some schemes also focused on nests of ground-breeding birds, which avoids the risk of detecting bird individuals due to spill-over effects from adjacent land. For direct monitoring of birds, the use of new technologies such as passive acoustic monitoring can improve monitoring efficiency (Markova-Nenova et al. 2023).

In line with Elmiger et al. (2023), we found more RBPS result–based schemes for grassland (72%) than for cropland (28%). Elmiger et al. (2023) limited their analysis to scientific literature only and found that of the 16 publications analysed, 12 focused on biodiversity conservation on grassland, one on arable land, one on hedgerows and two on whole farms. Grasslands, especially High Nature Value (HNV), typically have higher ecological value and are more ecologically sensitive than croplands. They often support diverse plant and animal species and deliver multiple ecosystem services (Schils et al. 2022). Further, the agricultural use of species-rich extensive grassland generally has a low profitability. RBPS as an additional income source may therefore provide financial incentives to encourage landowners to preserve these grasslands. Nevertheless, indicators and RBPS for arable land should be given greater consideration in the future.

Financing Our analysis shows that state-financed schemes clearly dominated. Only a few schemes were privately financed, mainly by associations. One reason is that state bodies, in the case of AES the EU and its member states, typically have more financial resources available. Further, conservation foundations and other conservation associations often prefer buying land for conservation directly instead of paying farmers for RBPS (McMorran and Glass 2013; Schöttker et al. 2016). For example, the Stiftung Naturschutz Schleswig–Holstein, a large conservation agency in northern Germany, focuses largely on buying land for conservation. This approach has been found to be cost-effective in the long run (Schöttker and Wätzold 2018). However, financing schemes could be advantageous when land cannot be purchased due to financial constraints or unwillingness of landowners to sell. In such cases, RBPS or individually negotiated contracts may present viable options for conservation agencies.

Result-based payment schemes under climate change

We identified incentives for and challenges in designing and implementing RBPS, but their potential to address future farmland biodiversity conservation under climate change remains uncertain. This question is increasingly relevant globally (see, for example, Fitzsimons and Cooke 2021), with climate change being a major driver of today's biodiversity crisis along with land use change (Heller and Zavaleta 2009; Newbold 2018; Dasgupta 2021). Conservation measures (Ando and Mallory 2012; Pecl et al. 2017; Reside et al. 2018) and locations of new protected areas (Oliver et al. 2016) must consider this, with changes in species ranges being already observed across all trophic levels.

With respect to RBPS, climate change requires farmers to adapt their conservation measures accordingly and to only participate if their land is, and will remain, suitable for the species throughout the contract period (Gerling and Wätzold 2021). By contrast, in action-based schemes, farmers will continue to receive the payment even if the land or measures are no longer suitable under new climatic conditions.

Adapting action-based AES to climate change would hence require formal, bureaucratic adaptation processes by policy makers, while this adaptation is incentivised "automatically" in RBP. At the same time, climate change increases the probability of extreme weather events such as droughts, floods and extreme temperature fluctuations, which may prevent conservation success—and hence the farmer from receiving the payment—even if the "right" conservation measures were implemented. These factors thus make RBPS less attractive to farmers under climate change. Previous research has shown that action-based AES are more cost-effective under conditions of high environmental uncertainty (Derissen and Quaas 2013). Overall, we expect RBPS to become an increasingly important option for conservation due to their incentives for adapting conservation sites and measures. Incorporating effective ways to reduce farmers' risk in RBPS will be crucial in this, making collaborations with ecologists and advisor services particularly important for farmers.

Conclusion

This review identified a number of promising examples of RBPS. Notably, some Irish schemes can be seen as innovative showcase models using a hybrid approach and a monitoring system with scorecards, surpassing the classic species-focused indicator approach and giving farmers autonomy in their own assessments. The direct transferability of these approaches may be hindered by various factors including differences in environmental challenges or differing farming systems and associated traditions (Dunford and Parr 2020). Cultural differences could also play a role, as previous work has shown that broader cultural ideas about conservation influence the compatibility of programs with different farming regions (e.g. Burton et al. 2008). However, these arguments do not mean that elements of the monitoring used in Irish schemes, such as using a point system tailored to local conditions, cannot be adapted to and successfully be implemented in other regions. We identified research gaps regarding RBPS which target more complex biodiversity or ecosystem-level indicators as well mobile species. Further research is needed on how to best make use of new monitoring workflows, such as AI-based species identification, and their potential to reduce costs. This could allow RBPS to be extended to cases where monitoring is still too expensive today. Climate change is likely to make RBPs an important conservation option due to their incentives for adapting measures. Incorporating effective ways to reduce farmers' risk under such uncertainty will be crucial and requires more research. This includes work on suitable advisory services and modifications in the calculation of the real costs of schemes, especially opportunity costs (e.g. Baaken 2022) and transaction costs (e.g. Bartkowski et al. 2021). We will need to better understand how farmers' attitudes towards RBPS change over time, especially in cases where ecological responses (e.g. habitat conditions) are slow (Chaplin et al. 2019). Given that many RBPS, including those covered in this review, are not well represented in the scientific literature, we call for close cooperation between science and practice to maximise the potential of RBPS for biodiversity conservation.

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