**An analysis of the empirical evidence on payment for results agri-environment schemes**

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1. **Rationale of the review**

In payment for results agri-environment schemes, farmers/land managers are compensated based on measured or estimated environmental outcomes (such as the number of environmental indicators in their farm/land parcels, abundance of certain species, or the diversity of particular taxonomic groups (Bartkowski *et al.* 2021), rather than being paid for the actions designed to produce similar outcomes (Webel *et al.* 2016). Economists have argued that such schemes have a number of advantages over payment-for-action schemes because they are potentially more cost-effective in providing farmers with the incentive to deliver biodiversity conservation outcomes (Matzdorf *et al.* 2010). Several previous empirical works (Fleury *et al.* 2015; Birge *et al.* 2017; Mack *et al.* 2020) have provided evidence to back up this argument by associating farm biodiversity outcomes with market incentives (Moran *et al.* 2021). Other than cost-effectiveness, payment for results schemes is also characterised by higher flexibility in farmer responses, leading to improved biodiversity outcomes (Sabatier *et al.* 2012; Marie, 2014; Fleury *et al.* 2015), higher participation rates (Groth 2011), and better training of non-experts (Wezel *et al.* 2018). Due to these strengths, there has been a gradual increase in research on payment for results agri-environment schemes (e.g. Birge and Herzon, 2019; Shoyama *et al.* 2021; Chaplin *et al.* 2021), alongside an increase in the use of such schemes in policy.

Most of the new empirical research on these schemes is dominated by work from Europe and in particular countries such as Finland, Germany, France, and United Kingdom. The rest of the studies are from countries such as the USA, Spain, Italy, Sweden, Kenya, Australia, Japan, Slovenia, Switzerland and Austria. Nevertheless, the prevalence of payment for results schemes is still low due to challenges such as difficulties with indicator monitoring and quantification requirements (Bartkowski *et al.* 2021). However, we have no systematic understanding of the broader reasons why uptake of payments by results schemes remains low. To address this knowledge gap, we carried out a synthesis of the existing literature. We only identified two past reviews - the first was by Burton and Schwarz (2013) whose main aim was to demonstrate how participants' behaviour change was associated with the introduction and participation in these schemes. The second was by Moran *et al.* (2021) who synthesised three case studies intending to identify challenges and strengths of the scheme and its future potential in the conservation of high nature value farmland. Even with these two reviews, there is still a need to synthesise up-to-date literature beyond the scope of Burton and Schwarz (2013) and Moran et al. (2021).

Therefore, our study provides a more up-to-date overview of existing literature on the empirical implementation of payment for results schemes.

Our objectives are four-fold:

1. to provide a general overview of the design characteristics of existing payment for results schemes including economic incentives, and
2. to identify the potential risks transferred from buyers (state/government/NGOs) to sellers (farmers/landowners),
3. factors that drive participants to join the scheme, and
4. existing research gaps.

To fulfil these objectives, we found a scoping review approach to be the most relevant method. A scoping review is a systematic literature review approach that seeks to represent, evaluate, and describe the contents of various previous studies to understand the evidence presented while identifying potential knowledge gaps (Arksey and O’Malley, 2005).

**Research questions:**

Besides providing a detailed account of evidence within each study (see supplementary material 1 – excel sheet), we sought to answer the following specific questions:

1. What are the design characteristics (i.e. incentives (intrinsic and extrinsic motivations), type of monitoring, and nature of target indicator species) of payment for results agri-environment schemes?
2. What are the factors that influence farmers/landowners’ participation in payment for results agri-environment schemes?
3. What are the potential risks that buyers transfer to sellers in a payment for results agri-environment schemes?
4. What are the existing knowledge gaps relating to payment for results agri-environment schemes?
5. **Literature search strategy development**

Our search strategy started with breaking down the terms “payment for results” into two main components (see Table 1): ‘payment’ and ‘results’. We then established their meanings in the context of agri-environment schemes without limiting their use to a particular geographical scope or environmental indicator. The definition of ‘agri-environment schemes’ was obtained from the European Environment Agency (EEA). Then we obtained synonyms and alternative terms for payment for results from an extensive literature search of studies addressing these types of agri-environment schemes such as Khalumba *et al.* (2014), Webel *et al.* (2016), Chaplin *et al.* (2021), Bartkowski *et al.* (2021) and Šumrada *et al.* (2021). These studies helped us to establish all keywords and alternative terminologies required in our literature search.

**Table 1: Definition of key terms in payment for results agri-environment schemes context**

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| --- | --- | --- |
| **Term** | **Definition** | **Source (s)** |
| Payment | The amount of compensation that a land manager/farmer receives for achieving a certain set of species mix or amount of measurable contaminant | Chaplin *et al.* (2021)  Webel *et al.* (2016) |
| Results | Are the quantifiable and the identifiable species mix or mineral components for which farmer/land manager receive compensation for. Results in agri-environment schemes are also referred to as indicators e.g., vascular plants, n-Nitrate, and proxies (e.g., nests) for mobile species such as birds | Bartkowski *et al.* (2021)  Webel *et al.* (2016) |
| Agri-environment schemes | Agri-environment schemes are the programs that government (s) has set up to help farmers to participate in biodiversity conservation through the adoption of environmentally friendly farm practices | EEA, (2021) |

**2.1 Database search process**

We carried out literature searches using two databases, Scopus and Web of Science. Scopus database holds papers of satisfactory quality in diverse specialties: natural sciences and social sciences while Web of Science is the most reliable worldwide citation database (McNicholas *et al.* 2022). We limited our search to English papers with no particular restriction to geographical scope and publication date. During the database search process, we use Boolean “OR” and “AND” to combine the different keywords that we developed from the literature. In the event keywords had multiple endings e.g. agri-environme**nt** or agri-environment**al,** we used the asterisk (\*) sign to shorten such words. To limit our search to the keywords provided, we used the double quotation marks “…”. Table 2 shows a summary of our search words combinations.

**Table 2: Keywords and search strings**

|  |  |
| --- | --- |
| **Payment for results** | **Agri-environment schemes** |
| “payments for results\*” OR “payment for results”, OR “result-oriented”, OR “outcome-oriented” OR “performance-based”, OR “performance based”, OR “payment-by-results  ” OR “success-driven” | AND  agri-environment OR  payment for services OR  agri-environ\* OR  payments OR  payment ecosystem services |

* 1. **Data screening and inclusion criteria**

All relevant articles were transferred from the databases to online endnote software. The first step was to remove duplicates. We further screened relevant articles based on titles and abstracts followed by an in-depth review of full texts. The studies that we selected for review had to meet the following criteria. First, they had to be from a peer-reviewed journal and in the English language. Second, they had to have findings achieved from a qualitative or quantitative analysis of secondary or primary data on payment for results agri-environment schemes case studies. Third, they had to state or imply a potential buyer and seller of ecosystem services. Fourth, we also included studies on the intrinsic (beliefs, attitudes, and perceptions) or extrinsic (monetary incentives, subsidies, in-kind payments) motivations that influence people to participate in a payment for results schemes. We excluded systematic reviews, book chapters, reports, editorials, commentaries, and studies not focusing on the empirical application of payment for results or indicating an environmental indicator and or unrelated to agri-environment schemes.

**2.4 Data extraction process**

Our data extraction process was comprehensive and was made up of five key parts. The first part contained data on the study characteristics fields such as: the name of the first author, year of publication, title, the objective of the study, study type, study area, and data type etc. The second part contained payment for results scheme design characteristics namely: suppliers, buyers, indicator selection criteria, indicator name, the average population of indicators, minimum indicator value to qualify compensation, payment type, and rate, how the compensation was calculated, payment mechanism per unit of biodiversity and scheme acceptability etc. The third part had data on the actual land management practices, the desired land management changes, implied/indication of cost-effectiveness and ecological efficiency. The fourth part contained a summary of the findings, strengths, and weaknesses of the study. The final part had a summary of research gaps for each study and a reference list. We provide a detailed summary of these data in an excel sheet (see supplementary material- an excel sheet).

**2.5 Data analysis strategy**

We analysed extracted data using descriptive statistics and drew interpretations and conclusions from pooling together themes from different studies.

**3.Results**

Our search using different combinations of our keywords in Web of Science and Scopus gave us a total of 785 articles out of which 30 articles met our set criteria for inclusion in our review. Studies selected for this review were published between 2006 – 2021 and were carried out in 15 different countries (Finland, Germany, the USA, France, England, Spain, Italy, Sweden, Kenya, Australia, Ireland, Japan, Slovenia, Austria and Switzerland) most of which are in Europe. Over half of the studies (60%) were purely on grassland habitats plus 7% additional studies on grassland and or water catchments and woodland habitats. Grasslands are not only important for biodiversity conservation e.g. red-listed vascular plants (Matzdorf *et al.* 2008) but are a source of fodder (Birge *et al.* 2017) and home to birds e.g., lapwings (Sabatier *et al.* 2012). The underlying reason behind the wide application of payment for results agri-environment schemes in grassland habitats is the relative ease of identifying and measuring indicator species and the potential for extensive management by local communities (Sabatier *et al.* 2012; Birge *et al.* 2017). There are fewer studies on watersheds (7%), forests (7%), soil (7%), and woodland (3%) habitats among others.

Total number of articles identified after using our search terms (n = 785)

Articles selected after removal of duplicates, commentaries, books and book chapters and studies with no link to agri-environment schemes (n = 95)

Articles (n = 152) were excluded because there was no mention of payment for results or any information relevant to this type of agri-environment schemes

Abstract and titles after exclusion of articles with no mention of payment for results or any relevant information to this regard (n = 59)

Full text articles were excluded because:

* They did not include any secondary or primary data and,
* Did not mention any measurable environmental indicators as scheme outcomes
* No identifiable buyers and sellers of ecosystem services/goods or
* No mention of payments or intrinsic motives

Full-text screening and number of empirical studies included in our review (n = 30)

Total number of studies that had relevance to agri-environment schemes (n = 247)

**Figure 1: Flow diagram demonstrating our search strategy and study selection**

**3.1** **Payment for results agri-environment scheme design characteristics**

The suppliers of conservation credits in the payment for results schemes identified in this review are either farmer/landowners who sell their credits directly to the government. The credits supplied are in form of indicator plants (Birge e*t al.* 2017) and grass species (Groth, 2011), indicator pollutant concentration i.e. n-Nitrate (Maille and Collins, 2011), proxy indicators for birds and reptiles (Sabatier *et al.* 2012) or units of environmental good e.g. permanent grassland with no brushwood (Hasund, 2013). For plants and grass species to qualify as indicators in payment for results scheme design the selected species had to (i) occur in large numbers in the selected habitat, (ii) be easy for farmers/landowners and paying representatives to identify and measure using simple methods, (iii) be harmless or non-invasive species that are also important to farmers/landowners, and (iv) prove to be reliable indicators that are adapted to the specified habitats (Wittig *et al.* 2006; Matzdorf *et al.* 2008; Matzdort and Lorenz, 2010; Birge *et al.* 2017; Chaplin *et al.* 2021; Ruas *et al.* 2021). However, the requirement to have easily identifiable and measurable indicators is difficult as it restricts the number of species that can be conserved at a time to only a few particularly for rare/threatened species (Kaiser *et al.* 2010). Further, striking a balance between biodiversity goals and the importance of the indicators to farmers is also a challenge (Matzdorf *et al.* 2008).

The most common mineral component used as an indicator pollutant is the n-Nitrate dissolved in water or fixed in the soil as part of soil carbon content (Maille and Collins, 2011; Webel *et al.* 2016; Ferro *et al.* 2018). n-Nitrate is a pollutant that could occur naturally or result from N-leaching due to the use of nitrogen fertilizers in cultivated lands (Maille and Collins, 2011; Ferro *et al.* 2018). However, the use of n-Nitrate as an indicator has its challenges because there is a time lag between its occurrence and its detection in streams (Maille and Collins, 2011). In terms of animals, we found payment schemes designed to monitor, protect and relate vegetation changes to birds and reptiles’ population providing an opportunity for improved land management practices (Sabatier *et al.* 2012). These species are mobile and as such proxies such as nests for birds and indicator plant species for reptiles are used (Lindenmayer *et al.* 2012). Still, payment for results schemes for mobile species is difficult to implement because they may require the involvement of several landowners leading to heavy monitoring costs and free-riding concerns (Sabatier *et al.* 2012).

To motivate farmers to participate in payment for results scheme, different incentives are included during the design process which can either be intrinsic or extrinsic. Intrinsic motivations include moral reasons, personal beliefs, and positive attitudes toward conservation (Russi *et al.* 2016). Extrinsic incentives include cash or in-kind payments offered to sellers of conservation credits based on the number of indicator species (Wittig *et al.* 2006; Birge *et al.* 2017) or the number of indicator proxies (Chaplin *et al.* 2021) or the amount of n-Nitrate reduced in water (Maille and Collins, 2011) or fixed in soil (Colombo *et al.* 2018) or units of public good provided (Hasund, 2013). Cash payments are either uniform premiums (Berke *et al.* 2008; Chaplin *et al.* 2021) or heterogenous bonus payments (Fleury *et al.* 2015; Wezel *et al.* 2018; Mack *et al.* 2020). The amount paid is calculated based on opportunity costs of forgone agricultural income (Maille and Collins, 2011; Mack *et al.* 2020) or suggested randomly through uniform or discriminatory price auctions (Growth, 2011; Khalumba *et al.* 2014).

Further, the design of payment for results scheme also includes a compliance component for verifying and validating the results being compensated for. The most common measure of compliance is self-monitoring of indicator species (Kaiser *et al.* 2010; Birge *et al.* 2017; Mack *et al.* 2020; Chaplin *et al.* 2021) or in occasional cases external monitoring by paying agencies (Lindenmayer *et al.* 2012; Webel *et al.* 2016; Khalumba *et al.* 2014; Kaiser *et al.* 2019). However, there are challenges on the verification of results that can arise from inadequate self-reporting (Birge *et al.* 2017) or high costs associated with external monitoring which are unsustainable due to constrained budgets (Lindenmayer *et al.* 2012).

**3.2** **Factors determining farmer participation in payment for results agri-environment schemes**

Several factors motivate farmers to join the payment for results scheme. They can be classified as: (i) farmer/landowner-specific, (ii) indicator-specific and (iii) targeted farm/land-specific characteristics. Farmer/landowner-specific characteristics include latent variables such as attitude towards conservation, risk perceptions (Birge *et al.* 2017; Schroeder *et al.* 2013), personal beliefs and ethical motives (Russi *et al.* 2016). Farmers’ risk perception and complexity of the scheme determines whether they join and accept to fulfil its requirement or not (Schroeder *et al.* 2013). For instance, farmers will join the scheme if they perceive that generating biodiversity outcomes will raise the profile of their unproductive farms (Birge and Herzon, 2019). Risk-averse farmers are likely to participate in a scheme if they receive professional advice on its importance or guidance (Matzdorf and Lorenz, 2010; Schroeder *et al.* 2013) or when more than the minimum number of species threshold for compensation occurs in their farms (Birge and Herzon, 2019). The level of the risk of joining the scheme or not is also determined on what is defined as an indicator and if it is hard to manage (Schroeder *et al.* 2013). Other factors include socioeconomic characteristics such as age and education - where younger and more educated farmers/landowners have a higher likelihood of participating in a result-oriented scheme (Mack *et al.* 2020).

Indicator-specific characteristics consist of three main traits - the importance of the species to farmers/landowners (e.g. pasture for livestock) and conservationists (e.g. threatened species), the population or abundance of the species in question (Wittig *et al.* 2006) and the challenge of managing them (Schroeder et al., 2013). For the farm-specific characteristics, its use is important. For instance, if it’s used for grazing purposes, the suggested changes in grazing time and intensity determine whether farmers join the scheme or not because it may contradict their grazing goals (Sabatier *et al.* 2012). The proximity of the public goods being conserved to farmers is also important. For instance, if it is a forest, distance and accessibility of forest benefits and farming activities around forested areas determine participation rates (Khalumba *et al.* 2014). The size of the farm also matters because it determines the amount of administration (Colombo *et al.* 2018) and monitoring costs of enrolled farms and the measures that need to be put in place to reduce them (Lindenmayer *et al.* 2012).

**3.3 Transaction costs transferred from buyers to sellers in payments for results schemes**

The implementation of the payment for results scheme is associated with the transfer of transaction costs from buyers to sellers of conservation credits. For instance, self-reporting and monitoring of compliance (Matzdorf and Lorenz, 2010) are associated with the opportunity costs of time especially if the self-appraisal and reporting overlap with other farming activities (Chaplin *et al.* 2021). It is also associated with bureaucracy arising from limited buyer administration and monitoring of schemes leaving the responsibility of controlling results (Wezel *et al.* 2018) in the hands of sellers which also comes with opportunity costs of time. Further, in agricultural habitats, farmers directly bear the production risks of factors beyond their control such as droughts or floods which negatively impact ecological outcomes (Klimek *et al.* 2008) leading to loss of financial support (Matzdorf and Lorenz, 2010). Extra transaction costs could also be incurred by farmers through knowledge transfer and extensions services on the identification and measurement of indicators as the practice demands guidance from specialists (Berke *et al.* 2008). Sellers have no guarantee of frequent knowledge transfer because there is no clear strategy to ensure that local authorities and advisory services provide the required training at all times at the cost of buyers (Mack *et al.* 2020). Furthermore, the buyer is more interested in ensuring the scientific goals of the scheme are met and does not fully consider if these goals conflict with those of the sellers (Ruas *et al.* 2021). This is evident as the buyer expects sellers to change well-established processes and procedures and engage in massive uptake of new improvements which delays and prolongs the timing of delivering results for potential payments (Schroeder *et al.* 2013).

**4. Knowledge gaps and future outlook**

There are several research gaps that we identified from our review. There is little research that determines whether existing schemes strike a good balance between self-monitoring, external inspection, and farm-level heterogeneity of biodiversity (Birge *et al.* 2017; Birge and Herzon, 2019). Furthermore, evidence is still lacking on the extent to which external monitoring costs can be minimized and their effect on ecological outcomes, and the overall cost-effectiveness of schemes (Lindenmayer *et al.* 2012). There is also a knowledge gap resulting from the limited communication between stakeholders (Matzdorf and Lorenz, 2010) and whether capacity-building should be treated as a necessity (Birge *et al.* 2017) to promote sustainable farming systems (Colombo *et al.* 2018). Further, farmers' expectations change over time and there is limited evidence to show how these expectations can be monitored and how their change may affect biodiversity outcomes and the sustainability of the scheme (Chaplin *et al.* 2021).

In terms of indicator identification and measurement, there is limited research that targets more inclusive species dominance beyond birds, reptiles, and vascular plant species (Höft *et al.* 2010) in farms/land. More specifically, data limitations are evident, and more research is required to build a more complete list of indicator species as many species remain understudied in this context, leading to a focus on better known, easier to record groups with better data availability such as birds, butterflies or ground beetles (Lund, 2002; Simamore *et al.* 2021). The implementation of single species schemes though common, is ineffective as they only represent a proportion of biodiversity and thus there is need for research focusing on groups of taxa and other species on the targeted conservation area (see also Lund, 2002). Most of the existing result-based schemes are based on an indicator selection criterion that require species to be detectable and easily identifiable taxonomically, limiting the number of eligible species considered for conservation (Matzdorf *et al.* 2008; Kaiser *et al.* 2010). Due to this, some taxonomic groups are excluded which could affect the effectiveness of the scheme and lead to complexities around the identifiability of such species by landowners, measurement for compensation and biodiversity results verification. Further, most of the existing results-based schemes focus on the identification of species at farm level without considering taxa that span across several farms as it is assumed that some scheme participants may free-ride and the success of the scheme may be compromised (e.g. see Sabatier *et al.* 2012). There is, therefore, a need to do more research to understand how species that routinely use more than one habitat or are mobile across many properties can cost-effectively be conserved and monitored under a payment for results scheme. Additionally, if the effectiveness of the scheme and the amount of compensation to participating landowners is based on biotic quality, then more research is required to determine the effect of other factors influencing environmental quality (Kaiser *et al.* 2019).

In all the studies we reviewed, there was only one study on n-Nitrate reduction whose authors claimed successful implementation of the scheme due to cooperation between stakeholders in the design and contract definition (Webel *et al.* 2016). However, in the schemes that failed to meet the set biodiversity goals such as Russi *et al.* (2016) in the grasslands of Baden-Württemberg, there was no follow-up evidence to show a successful up-take of recommendations to further correct design errors. Finally, when it comes to the succession of land enrolled in the scheme managed by older farmers/landowners, there is limited knowledge of what happens to the abandoned land by deceased farmers/landowners and the strategy for its continued management (Shoyama *et al.* 2021).

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