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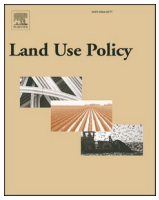

Public participation for a greener Europe: The potential of farmers in biodiversity monitoring☆

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ABSTRACT

This article considers the potential of including farmers in the governance, organization and execution of biodiversity monitoring. More specifically, we consider the opportunities for farmer involvement in biodiversity data collection through an explorative empirical analysis of the governance of biodiversity monitoring activities in agricultural landscapes within the Netherlands. We identify practical obstacles to farmer participation, assess the role of environmental NGOs in this process, and consider the extent to which this data leads to increasingly adaptive land management decisions to promote biodiversity. The governance of agri-environmental subsidy contracts with farmer collectives in the Netherlands, we conclude, could be used as an important vehicle to incentivize both biodiversity data collection and science-based land management decisions.

1. Introduction

Public participation is a core feature – and goal – of European Union environmental law and policy. The Green Deal underlines that active public participation is a prerequisite to the transformative change that it hopes to achieve, and for the solidarity needed for this transition (Green Deal, 2019, p. 2). The parameters of public participation are often set by the legal system, through procedural rights such as access to information, access to justice, and consultation rights (see importantly Aarhus Convention, 1998). The ever-growing need for environmental information, combined with the effects of the digital transformation on data collection, creation and analysis, has made citizen science an ever-more important form of public participation.

Considering the widespread environmental challenges associated with modern agricultural practices, increasing attention is being paid to the prospects of involving farmers as 'citizen scientists' in research on sustainable agriculture (Beza et al., 2017; Ebitu et al., 2021). Citizen science – the active engagement of lay people in scientific research – is a "time-honoured, evolving practice" (Crain, Cooper and Dickinson, 2014, p. 642). Especially participatory data collection, where scientists and laypersons work together to gather observations of nature, has existed for hundreds of years in fields such as astronomy and natural history (Eitzel, 2017; Silvertown, 2009). Apart from including citizens in observations and data collection, more participatory citizen science projects have started to include the active engagement of citizens across the research process (Ebitu et al., 2021).

While agriculture still takes a relatively marginal position within the breadth of citizen science projects carried out across the globe (Ryan et al., 2018), farmers as volunteers in research are increasingly considered a potentially rich resource for exploring sustainable agricultural research questions (Etten et al., 2019; Beza et al., 2017). In fact, the "indigenous and local knowledge" of farmers is increasingly understood as vital to ensuring sustainable agriculture, which requires the "ecosystem management of complex interactions among soil, water,

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plants, animals, climate, and people" (Ebitu et al., 2021, p. 3).

The development of modern sensing technologies, such as smartphones, has further provided new means of involving farmers in citizen science projects (Beza et al., 2017; Dehnen-Schmutz et al., 2016). Similarly, Paulin and others emphasize the importance of incorporating local knowledge and data within ecosystem service models, as a way of capturing locally-relevant spatial and thematic detail (2020). A recent literature review by Ebitu and others already shows various uses of citizen science in agricultural contexts – undertaken by both farmers and citizens – including monitoring soil health, climate adaptation, pests, pollination, and invasive species (2020; Van Rijn et al., 2008). Much less attention has been paid however to their potential role in biodiversity monitoring writ large (Donnely et al., 2014). This means that a potentially important resource in the fight against biodiversity loss, namely farmer's local and intimate knowledge of their lands, goes underused in biodiversity data collection. Increased farmer participation in these citizen science activities could in turn also play a key role in generating new knowledge on effective management practices to maintain and improve biodiversity on agricultural land, as well as the formulation of agricultural policies.

In this article, we underline the potential of including farmers in the governance, organization and execution of biodiversity monitoring; especially biodiversity that does not have a direct relationship with agricultural productivity. More specifically, we consider the opportunities for farmer involvement in biodiversity data collection through an explorative empirical analysis of the governance of biodiversity monitoring activities in agricultural landscapes within the Netherlands. We discuss the current and potential engagement of farmers in citizen science, and provide a brief explorative empirical analysis based on interviews with members of several Dutch environmental NGOs (ENGOs), farmer groups and other stakeholders.

Our focus on the Netherlands is motivated by two main reasons: first, reconciling agriculture and nature is a uniquely challenging exercise in the Netherlands. More than 60% of the country's territory is used for agricultural production, which is for the most part intensive in nature (de Snoo and van der Windt, 2016). Since 1950, average population numbers of all wild mammals, butterflies and birds dependant on Dutch agricultural ecosystems have decreased by half, showing the difficult relationship between intensive agriculture and nature conservation (van Norren et al., 2020). Second, since 2016, the Netherlands has implemented a new agri-environmental scheme that is focused almost exclusively on biodiversity aims *and* envisages an important role for farmer-led monitoring of the effectiveness of agri-environmental land management.

Within the EU, implementing agri-environmental subsidy schemes to incentivize environmentally sustainable land management is mandatory for Member States under the Common Agricultural Policy ('CAP'CA), although discretion exists regarding the design of such schemes at the national level (EU Regulation 2021/2115, art 70/20, art 2). Involving farmers more closely in monitoring the effects of different land management practices may help improve the design and implementation of existing schemes, whose effectiveness is questioned in the literature (Reed et al., 2014; Prager, Reed and Scott, 2012). Moreover, this more active role in problem-definition and problem-solving also represents a key step to a more polycentric governance approach to the implementation of the goals of the European Green Deal (van Zeben, 2021). The EU has expressed a strong commitment to involving citizens in the implementation of the Green Deal through bottom-up initiatives. However, most of these involvements remain abstract. Biodiversity monitoring on agricultural land speaks to very concrete goals of, among others, the Farm to Fork Strategy, and exemplifies an area of potential tension between high-level goals and on the ground lived-experiences. Understanding what obstacles, and facilitators, exist in bringing these two realities together can act as a catalyst for more successful shared problem-solving across governance levels.

The remainder of this article is structured as follows: Section 2 discusses more generally the role of citizen science in biodiversity monitoring; Section 3 sets out the governance of biodiversity monitoring in the Dutch agri-environmental scheme. Section 4 details the methods employed for the explorative study an introduces the case studies. Section 5 presents the results, with Section 6 presenting the analysis and main conclusions.

2. Citizen science and biodiversity monitoring

"In God we trust. All others, bring data." – W. Edwards Deming

Citizen science, in essence, is the active engagement of lay people in scientific research (Irwin, 2018). While there are various definitions of this concept, a particularly helpful one in the context of this article views citizen science as a "research method, aiming for scientific output, […] as public engagement, aiming to establish legitimacy for science and science policy in society, and, as civic mobilization, aiming for legal or political influence in relation to specific issues" (Kasperowski et al., 2017).

There are obvious pitfalls to citizen science, most fundamentally that monitoring environmental conditions can be challenging and may require professional expertise and/or access to privileged information. However, government actors similarly suffer from resource limitations, with limited time, money and expertise leading to persistent monitoring gaps (Kingston et al., 2021). These monitoring gaps can also negatively impact ecosystem management design, since successful ecosystem management is characterized by "continuous testing, monitoring, and adaptive responses acknowledging the inherent uncertainty in complex systems" (Hahn and others 2006 (Hahn et al., 2006, p. 574). Limited consideration by decision-makers of ecosystem management results can in turn lead to the use of standardised policies and models, which are "ill-suited for capturing context-specific spatial and thematic detail" (Paulin et al., 2020, p. 10; Villa et al., 2014).

Involving farmers in citizen science activities may help address these issues by providing an additional 'set of hands' for biodiversity monitoring, while simultaneously equipping farmers with new knowledge and scientific expertise (Miller-Rushing, Primack and Bonney, 2012). It is well-documented that engaging in monitoring activities promotes knowledge and has the potential to strengthen people's environmental awareness (Meschini et al., 2021; Chao et al., 2021). In addition, citizen science activities could provide new avenues for connecting "people and steward organizations with different knowledge systems" (Hahn et al., 2006, p. 574; Olsson and Folke, 2001). In the context of biodiversity monitoring, one could think for instance of linking citizen scientists from organizations such as NGOs with farmers, as a way of sharing expertise and access to monitoring sites (i.e. farms).

However, there are also potential complications of involving farmers in the monitoring of biodiversity. First, it has been found that the high level of professionality and commitment required in carrying out such monitoring often leads to '*free-rider*' problems where some farmers do not, or cannot, meaningfully participate in such activities, while still benefitting from the results and/or subsidies, leading to incomplete and/or unreliable observations (Steinke, van Etten and Zelan, 2017; Beza et al., 2017). Second, there may also be problems with bias in relation to the identification of species, with many observers tending to report only specific species – in the present case likely the species farmers are familiar with. This makes it difficult to assess, and ensure, the reliability of the data collected (Kamp et al., 2016). In this context, it is commonly recognized that supervision by researchers may improve the quality of the collected data (Steinke, van Etten and Zelan, 2017). Third, studies have repeatedly shown that many farmers already face a (very) high workload and stress (Hartman et al., 2003) and may thus not have appetite or even capacity for engaging in additional tasks such as biodiversity monitoring. At the same time, developing new monitoring skills may give rise to the development of new economic spaces and opportunities for additional income generation, which may stimulate

rural economic development (Markantoni and Strijker, 2012). Finally, while the potential linkage of knowledge systems would be fruitful, in practice, forming learning environments that facilitate the development of new knowledge can often be challenging in practice (Danter et al., 2000).

3. Biodiversity monitoring in the Dutch agri-environmental scheme

In 2016, the Dutch government implemented a new model of agri-environmental governance that is unique within the EU. This model delegates key responsibilities for, among others, the coordination and distribution of the state's agri-environmental subsidies among farmers to so-called 'agricultural collectives': groups of farmers and other landowners, organized as certified conservation organizations (Westerink et al., 2020).[2] There are presently forty region-based agricultural collectives in place – covering the entire Dutch countryside - jointly responsible for facilitating localized and area-specific approaches to agri-environmental land management within their region.

The collectives' responsibility is expressed through their roles in contracting farmers for agri-environmental land management, as well as the coordinating, guiding, paying, inspecting and, if needed, sanctioning of these farmers. Within the collective model, there is a close division of tasks between government actors and the agricultural collectives. This is a major change as compared to the previous subsidy model, which was geared purely on management contracts and governance relationships between the government and individual farmers (Boonstra et al., 2021, p. 20).

The core objective of the Dutch agri-environmental governance model is to contribute to the protection of 68 'target species' that have their habitats in agricultural landscapes, and for which the Netherlands has legally binding protection obligations under the EU Birds and Habitats Directive (Ministerie van Landbouw, 2015). Within the Netherlands, nature policy has been decentralized to the provincial level, meaning that the twelve provinces are responsible for implementing nature policy in their individual constituencies. The provinces form subsidy contracts with the agricultural collective(s) located in their region, based on the available budgets as well as the local priorities in terms of protecting specific target species out of the overarching list of 68 target species. Still, the Dutch national government is ultimately responsible for meeting EU obligations and for setting overarching regulatory frameworks and objectives. Failure to implement or enforce EU objectives can result in financial penalties for the Dutch government (Schoukens and Bastmeijer, 2014; Panara, 2015).

For the 68 target species, the provincial governments are responsible for organizing monitoring of population trends to assess whether the overarching conservation objectives are being met. In the literature, this is referred to as 'policy monitoring' (Boonstra et al., 2021, p. 27). A different, but similarly important, monitoring role has been delegated to the collectives. Since the implementation of the new scheme, the collectives are responsible for assessing the effectiveness of contracted land management at the local level, i.e. whether the right measures have been contracted at the right place, or whether changes should be made. This process is also referred to as 'management monitoring'. A concrete example could be when a farmer receives funding for nest protection, but no nests have been found on that land in the entire year. A collective then could use this information to reconfigure the type of management carried out there for the subsequent year.

While the collectives can also use biodiversity monitoring to make relatively last-minute changes to land management, for instance to extend a contract for nest conservation measures on a parcel where birds are nesting longer than anticipated, the CAP does set important boundaries to such potential changes. As laid down in Implementing Regulation 809/2014 article 14a(5), "the [collective] shall notify the competent authority of each commitment covered by the agri-environment-climate operations no later than 14 calendar days before the commitment is undertaken". As such, the possibilities to respond to biodiversity monitoring findings in a *real-time* manner are relatively constrained.

For the provinces, in turn, monitoring findings of the collectives can prove an important resource to evaluate whether subsidies granted are cost-effective and constitute a prudent use of public funds. The provinces have embedded the collectives' responsibilities in this domain in provincial legislation under the name of 'Program of Requirements' (Bij12, n.d.). While the legal requirements regarding monitoring are relatively broadly formulated, leaving discretion for collectives to organize monitoring in the way they see fit, the rules are not without demands. As article 7b of the Program details, collectives should stipulate in their handbooks a description of how management monitoring will be exercised and subsequently used to improve management practices (BIJ12, 2016, p. 12). Monitoring thus constitutes an essential part of collectives' quality handbooks, which are in turn evaluated by an external certification agency. Without certification, collectives cannot receive government funding. At a broader level, both the collectives, as well as the participating farmers and other stakeholders including the provinces, benefit from reliable and usable data to assess whether existing management practices are effective or should be readjusted (Westerink et al., 2017). Collectives are in principle free to decide on the amount of funds they want to dedicate to management monitoring (SCAN, 2015), although provincial governments may lay down more concrete rules in so-called provincial nature management plans. Provinces may also include specific requirements on biodiversity monitoring in subsidy contracts concluded with agricultural collectives.

To give collectives the necessary guidance on how monitoring could be exercised, monitoring protocols were developed by a networking organization representing all collectives, stipulating protocols for meadow birds, arable birds, and other protected species (SCAN, 2015). These monitoring protocols devote specific attention to the organization of management monitoring. Considering the costs involved in biodiversity monitoring, as the protocol on monitoring arable birds describes, it can be imagined that a collective will primarily aim to engage citizen science volunteers, for instance those involved in (local) nature organizations. To involve such volunteers, as the protocol details, collectives may need to strengthen their collaboration with such organizations in the area. If there are not sufficient people willing to help out, or if this approach cannot generate sufficient data quality, a collective could potentially delegate monitoring to professional environmental research agencies. The protocols do not specifically mention the possibility of involving participating farmers in the monitoring exercises, but do point to possibilities for combining citizen science volunteers and professional agencies.

4. Methods

The original empirical data collected for this explorative study on the governance of biodiversity monitoring activities in agricultural landscapes within the Netherlands consists of 35 semi-structured, in-depth interviews, carried out between July 2019 and July 2021. We focused on three agricultural collectives, purposively selected to obtain a mix of geographical diversity, size of the collaborative, agricultural context, and agri-environmental focus (see Table 1). Interviews were carried out

[2] In the literature, the terminology used to describe these farmer groups is not always consistent. A government publication published at the outset of the new scheme speaks of 'environmental cooperatives' (Terwan, 2016), while more recent literature refers to 'farmer collectives' (Dik et al., 2021), 'agri-environmental collectives' (Westerink et al., 2017) or 'agricultural collectives' (Barghusen et al., 2021). This latter term is the most literal translation (agrarische collectieven in Dutch) and also more inclusive than for instance 'farmer collectives', since also non-farmer landowners can be a member of a collective. For this reason, this terminology has been used here.

Table 1
Main characteristics of the case studies.

Agricultural collective	Poldernatuur Zeeland	Coöperatie Collectief Hoeksche Waard	Collectief Midden Overijssel
Province	Zeeland	Zuid-Holland	Overijssel
Geographical focus	Province-wide	One of 8 collectives in the province	One of 3 collectives in the province
Membership	350 farmers	90 farmers	400 farmers
Yearly budget	2,2 million	0,6 million	1,3 million
Agricultural context	Predominantly arable land	Mix of arable and grassland	Predominantly grassland
Conservation focus	Mostly arable birds	Arable birds, meadow birds, selection of non-bird species	Mostly meadow birds, also species dry landscape elements

with board members of the three collectives, participating farmers, as well as a range of public and private stakeholders as detailed in annex 1. The interview data collection was complemented with e-mail correspondences with respondents, selected field visits, as well as desk-study research and documentary analysis (Yin, 2017).

The study employed a purposive, non-random sampling technique to select participants for the qualitative study. Through purposive sampling, individuals are identified and selected that are "proficient and well-informed with a phenomenon of interest" (Etikan et al., 2016: 2). Interviews lasted an hour on average and were initially conducted in person (n = 15). Due to the unfolding of the Covid-19 pandemic, interviews were later conducted online, via Zoom or Skype (n = 20). Interview questions covered a range of issues related to the governance of agricultural collectives in the Netherlands, of which we report here data relating to the aspect of biodiversity monitoring. Each individual interview was carried out in Dutch, transcribed, and subsequently translated into English. The textual data was manually coded using an Applied Thematic Analysis ('ATA') (Guest et al., 2011).

Key characteristics of three case studies – *Collectief Poldernatuur Zeeland, Collectief Hoeksche Waard,* and *Collectief Midden Overijssel* – are set out in Table 1. Interview responses were anonymized, giving each respondent an individual ID. To give the necessary context to the IDs, each interviewee involved with *Collectief Poldernatuur Zeeland* is classified with an ID starting with 'PZ', *Coöperatie Collectief Hoeksche Waard* with 'HW', *Collectief Midden Overijssel* with 'MO', and other stakeholders (including policy advisors from different government layers) with 'OS' (annex 1).

5. Results

As explained above, agricultural collectives are required under the Dutch agri-environmental scheme to carry out biodiversity monitoring, to assess whether the right type of land management indeed takes place in the right place. The collectives have a relatively wide margin of discretion in how they fulfill their monitoring requirements. Based on our data we were able to identify three types of monitoring approaches: (1) monitoring *for* the collectives, where ENGO volunteers and/or environmental research agencies carry out monitoring tasks for (members of) the collectives; (2) monitoring *by* farmers, where farmers carry out the monitoring tasks themselves; and (3) monitoring *with* farmers, where farmers and ENGO volunteers carry out monitoring tasks together, in some cases assisted by professional environmental research agencies.

In this section, we discuss these three approaches and their perceived strengths and weaknesses from the perspective of the interviewees, and analyze which ones are most commonly used in each collective. We focus our discussion around two aspects of problem-solving related to biodiversity monitoring: first, the formation of learning environments to *collect* biodiversity data (Section 5.1) and second, the actual *use* of biodiversity data to influence decisions on land management, whether at the level of individual agricultural collectives or broader (provincial) policy levels (Section 5.2).

5.1. Biodiversity data collection

5.1.1. Approach I: Monitoring by ENGOs and professional agencies

Under the first monitoring approach, a collective engages external actors to carry out biodiversity monitoring. Of our case studies, collective *Hoeksche Waard* relies exclusively on this approach, although the exact method of monitoring differs for different types of species. For the monitoring of *meadow bird* populations on open grassland, the collective has contracted a regional ENGO called *Hoekschewaards Landschap.* The collective pays the ENGO for organizing the monitoring of meadow bird on specific locations. For this purpose, the ENGO engages its volunteers, who carry out the monitoring tasks in the field.

Collective Hoeksche Waard also initially requested the same ENGO to carry out biodiversity monitoring of *arable birds* in arable landscape types, particularly in field margins. The ENGO did not have sufficient capacity to monitor the field margins, particularly as it experiences difficulties in attracting sufficient volunteers to carry out more intensive monitoring tasks. This issue, according to a coordinator of the ENGO, threatens the future involvement of the ENGO in biodiversity monitoring more generally [HW7].

To ensure arable bird populations would still be monitored, the collective subsequently commissioned an environmental research agency to assess populations and habitats of the Grey Partridge and other arable birds (Godijn, 2020). This agency had, however, a "very different price tag" [HW1] compared to when an ENGO would carry out the monitoring, increasing the financial strain involved.

The collective has consciously chosen not to involve participating farmers in any of the monitoring activities, stating that such additional tasks – beyond carrying out contracted agri-environmental land management – would be a burden to farmers and could act as a barrier for farmers to participate in agri-environmental land management in the first place [HW1; HW2].

Reflecting on the current biodiversity monitoring approach taken, respondents emphasized that monitoring is important, but costly. The director of CCHW added that: "we would like to monitor everything, but it costs an enormous amount of time and money" [HW1]. In addition, the trade-off between monitoring and other activities was repeatedly mentioned by interviewees, noting for instance how increased monitoring can go at the expense of being able to contract additional agri-environmental land management by farmers [HW1; HW2].

5.1.2. Approach II: monitoring by farmers

Collective *Poldernatuur Zeeland* has adopted an approach to biodiversity monitoring where farmers participating in the agri-environmental scheme are required to carry out different monitoring rounds over the course of year, for example by counting Grey Partridges in field margins alongsides their land. The results of this exercise are submitted to an ecologist commissioned by the collective, who is responsible for analysing the findings and writing up a report. Giving farmers a formal role in the monitoring of species was felt by the collective to constitute an important instrument not only to amass biodiversity data, but also to stimulate attitude changes among farmers: "a way to raise awareness among [the farmers]. It was the same for me; you learn you are doing it for the birds, and not for the money. That we really have to accomplish something, you know?" [PZ1].

Requiring farmers to conduct monitoring activities was also said to reduce biodiversity monitoring costs. In the interviews, it became clear that at the start of the new Dutch agri-environmental scheme in 2016, the collective was not aware that the costs for monitoring would have to be carried by the collective. The collective's board members felt that the subsidies should go as much as possible to the farmers themselves, and not towards matters like paying a third party to carry out monitoring

tasks [PZ1]. Similar points were raised by the policy officer of the province, who stated that "because we have a relatively limited amount of provincial agri-environmental funds, there is also a limited amount for the collective to spend on things such as monitoring" [OS11]. A representative of a local ENGO that works with the collective reflected however that: "I believe it is a matter of prioritization. There are limited subsidies, and what you spend on monitoring and providing guidance, you cannot pay the farmers. If you want to pay the farmers as much as possible, that will be at the expense of other things" [MO6].

However, issues of reliability of collected data also came to the fore in interviews, specifically that "most farmers do not have the knowledge or time to do [data collection]" [PZ1]. A participating farmer emphasized that monitoring is simply very challenging: "the birds that you are familiar with are not so difficult… I regularly pass by the field margins, but if you don't know a specific type of bird and you see them fly away, that can be quite hard in terms of monitoring" [PZ4]. The predominant types of arable birds that farmers were asked to monitor were further described as being "much more diffuse and elusive [to monitor]" than for instance meadow birds [OS11].

In order to bridge existing knowledge gaps, the collective has created laminated flyers that all participating farmers get, and which they can bring into the field when carrying out monitoring tasks [PZ2]. There are two flyers: one including photos of in total sixteen farmland species that are target species for the collective as well as the province, and one flyer with more detailed information on four core target species – including their habitats, sounds, behaviour and breeding periods. While such flyers may help address lack of knowledge, it does not address the problem of time and prioritization. As the collective's secretary stressed:

> "When it comes to the cultivation of sugar beets, farmers also conduct monitoring tasks to assess the occurrence of crop diseases. They conduct those tasks seriously, because such diseases have a direct consequence for their earnings. Whether a farmer says there are two or there are six Partridges, however, has no financial consequences for them. So that is a point of concern for us" [PZ1].

Similarly, the province's policy officer concluded that: "generally, the locations where biodiversity monitoring is done well are those where there is a strong cooperation between local ENGOs with volunteers that can help the participating farmers" [OS11]. Presently, the geographic areas in which such cooperation takes place are very diffuse, however, and this depends on the formation of local partnerships. The collective has recognized this added value, stating that it is seeking ways to further promote the cooperation by linking farmers with local ENGO volunteers, although further concrete steps to achieve this still need to be taken [PZ1].

5.1.3. Approach III: Collaborative monitoring by ENGOs and farmers

Collective *Midden Overijssel* has relied on a third approach most heavily, where farmers engage in monitoring together with volunteers from ENGOs. The collective has predominantly worked with local ENGO *Natuur & Milieu Overijssel*, with volunteers of this ENGO taking the lead on monitoring, while participating farmers are also actively involved. As explained by the collective's director: "the ENGO volunteers ask the farmers to join them when they are monitoring biodiversity. They show you things and teach you loads, things that we have not been educated in as farmers" [MO1]. This was echoed by the coordinator of the local ENGO:

> "One of our goals is to bring farmers and citizens closer together. Through monitoring, our volunteers gain more insight into the reality of the farmer and the issues they face in practice, and farmers gain more insight in nature. You really let them communicate at the local level, which works much, much better than talking about nature in general policy documents." [MO6]

Here, monitoring was thus very much considered a reciprocal effort between ENGO volunteers and farmers. At the same time, the ENGO noted that it had aimed to broaden such monitoring to a broader set of landscape types, but that this had not yet been successful, and that the total monitoring effort is still limited [MO6]. The involvement of farmers in monitoring is also voluntary, meaning the forming of partnerships between ENGOs and farmers in monitoring depends on farmers' willingness to be involved.

An example of how difficult it can be to organize effective collaboration between farmers and ENGOs in regards to biodiversity monitoring was found in the case of Collective *Poldernatuur Zeeland*. Within this collective, farmers carry out the bulk of the research, but in certain cases ENGOs are also included to bring in additional ecological expertise. One of the interviewed farmers noted a possible drawback of engaging external parties to carry out monitoring: "these volunteers usually want to do it on their own, so you do get the monitoring data at the end, but you haven't learned anything. So I would still prefer to monitor myself" [PZ4].

5.2. The use of monitoring data in land management decisions

The second element of shared problem-solving that we consider is the extent to which biodiversity data is used to inform decisions on agri-environmental land management.

For the Hoeksche Waard collective, monitoring findings were found to provide an important input for decisions on whether land management for meadow birds is proving effective or whether adjustments are needed. Monitoring data is also used to make relatively last-minute changes to land management; for instance, if findings show that meadow birds are still nesting on a specific parcel beyond a farmers' contracted period for nest protection, the collective may decide to pay the farmer an additional sum of money to extend this period. However, the coordinator of the local ENGO interviewed did voice concerns about the limited flexibility of existing subsidy rules, which does not sufficiently allow the adaptation of management practices to ecological needs.[3] For example: "you should be able to check for birds an hour before a farmer starts mowing, not a week or so in advance. That is a critical point, but apparently that is a requirement based on EU rules" [HW7].

In relation to the monitoring of field margins for *arable birds*, it was first explained by the collective's director that, as the final monitoring report of the environmental research agency that has been commissioned is still in the making, no major changes have been made to existing land management [HW1]. From the perspective of the ENGO, more continuous attention should be paid to whether land management takes place in the most effective locations: "if you carry out land management for the Grey Partridge in areas where there are no birds, the functionality will be very low. There's a tension there" [HW7].

Within *Poldernatuur Zeeland*, we found, decisions on agri-environmental land management are based primarily on agricultural considerations, not biodiversity monitoring data: "we cannot simply move measures to different parcels, because there will normally be crops there. It is different for meadow bird focused land management on open grassland, but we don't follow the birds in the way that they do, because you simply cannot on arable land" [PZ2].

In addition, the collective wants to respect the terms of the subsidy contract concluded with a participating farmer, which stipulate, typically for a typically six-year period, the types of agri-environmental land management that will be carried out, and on what exact location. Asking a farmer to adapt the land management or location thereof could thus mean going against the terms of the subsidy contract. One of the farmer-members did voice that the choice to maintain these contract terms

[3] As explained above, Implementing Regulation 809/2014 lists that collectives have to notify the competent authority (in the case of the Netherlands this is the Netherlands Enterprise Organization, 'RVO'), two weeks in advance of commitments that will be undertaken by farmers.

strictly does have implications for the effectiveness of the land management engaged: "Only field margins geared towards Grey Partridges were possible on my land, so that is what I did. But I have not seen any Partridges here in a long time. So you can create the perfect habitats, but if they are not in the proximity, they are not going to come" [PZ4].

Within collective Midden Overijssel, the degree to which monitoring data can feed back into decisions on land management was found to be hampered by the relatively limited amount of biodiversity data collected in the first place. In this context, the local ENGO questioned whether monitoring responsibilities should have been delegated to the collective:

> "Perhaps it would have been better if they had said: 'maybe let someone else be responsible for monitoring for now, instead of us wanting to do everything ourselves'. Because they have been given a lot of responsibility, or taken, depending on how you look at it" [MO6].

Interestingly, the collective has recently started experimenting with a new approach of using biodiversity data, namely providing farmers with customized, binding advice on the mowing dates to be adhered to each year, based on monitoring data collected on meadow bird populations in the previous year. This should serve as a more direct means of ensuring monitoring directly feeds into land management decisions on the ground [MO1]. This novel approach is however still in its early stages, and also depends on continued and intensified monitoring exercises, making it difficult to draw conclusions as to its effectiveness for improving decision-making on land management.

6. Discussion and conclusion

Farmers as citizen scientists are increasingly considered a potentially rich resource in answering sustainable agricultural research questions (Etten et al., 2019; Beza et al., 2017). Yet, thus far little attention has been paid to their potential role in generating new knowledge on effective management practices to maintain and improve biodiversity on agricultural land. Through a case study of farmer-led agri-environmental collectives in the Netherlands, we considered the opportunities for farmer involvement in the governance, organization and execution of biodiversity data collection, followed by an analysis of the impact of this data on land management decisions.

Our empirical work shows that the governance processes in the Dutch agri-environmental scheme allow a wide margin of discretion to agricultural collectives to realize biodiversity monitoring. While provincial governments interviewed feel that the amount of monitoring conducted is currently too limited, they do not actively steer collectives towards increased monitoring. We identified three main approaches to monitoring used by the collectives: monitoring by ENGOs and/or environmental research agencies; monitoring by participating farmers; and monitoring by farmers and ENGOs together – sometimes assisted by environmental agencies in the analysis of biodiversity data and writing up of reports.

All three approaches have their own strengths and weaknesses, as was found. With respect to the first method, we saw how one collective – Collective Hoeksche Waard – has chosen to rely on this method as it helps them create reliable data for a relatively affordable price, especially in the case of monitoring by volunteers of the local ENGO. However, it is becoming increasingly difficult for the ENGO to attract volunteer citizen scientists, which has made the collective resort to an environmental research agency to carry out additional monitoring tasks, which was argued to be a costly change. The collective intentionally chose not to engage its farmer members in monitoring tasks, as it was felt that this would overburden the farmer-members and reduce their willingness to participate in agri-environmental land management.

Poldernatuur Zeeland, by contrast, has chosen to rely mostly on the second method, in which participating farmers carry out monitoring tasks. This was described by interviewees as an effective way of raising environmental awareness among farmers, a finding that is in line with current citizen science literature (Meschini et al., 2021; Chao et al., 2021). However, common complications of involving farmers in the monitoring of biodiversity were also noted, including free-rider issues and knowledge gaps (Steinke et al., 2017; Beza et al., 2017; Kamp et al., 2016). We discussed how collectives can use, for instance, training sessions or biodiversity flyers to mitigate such issues. For future research, it would be interesting to assess how effective these methods are, or whether more intensive training is needed.

In this context, one of the interviewees noted that the best ecological data collection tends to result from collaborations between ENGOs (with ecological know-how) and farmers (with local know-how and access to the land). This model has been implemented in a limited way within Poldernatuur Zeeland, and increasingly Collective Midden Overijssel. The findings within these collectives highlighted the potential value of using biodiversity monitoring as a means of building joint learning environments that include farmers and ENGO members. Such learning environments can promote the creation of new knowledge on the effectiveness of agri-environmental land management , based on the (observed) occurrence of species. Moreover, our findings suggest that these learning environments could help provide ENGO volunteers with a better understanding into the reality of farmers, and could in turn give farmers access to ecological know-how of EGNO volunteers. Finally, these collaborations may help overcome the significant distrust that has been found to exist between farmer communities and ENGOs (Kingston et al., 2021).

As noted in the literature, successful ecosystem management is characterized not only by continuous and effective monitoring, but also by adaptive responses that incorporate the findings of these monitoring activities (Hahn and others 2006). In our analysis, we found that all collectives struggle to carry out biodiversity monitoring tasks due to the limited funding available and the diffuse nature of species to be monitored. Even when monitoring is carried out effectively, the collectives encounter practical difficulties in adapting their land management policies in light of agricultural productivity considerations. We did not find any clear connection between increased participation of farmers in biodiversity monitoring on the one hand, and the incorporation of resulting ecological knowledge into agri-environmental land management on the other.

To enhance both the collection and use of biodiversity monitoring data, in the Dutch context, explicating the collectives' responsibilities regarding monitoring in their subsidy contracts with the provinces could be a fruitful approach. If these expectations cannot be met by the collectives within their current budgets, provincial governments should consider increasing the budgets, or requiring collectives to set aside fixed amounts for monitoring. In addition, by encouraging cooperation between collectives and local actors such as ENGOs, for example through subsidies, monitoring could be made more reliable and effective, while reducing transaction costs. To allow for further adaptive changes to land management based on monitoring findings, EU subsidy rules would have to be changed so as to accommodate changes to contracted management in *real-time*. Collected biodiversity data could then be used as justification for such changes to ensure transparency of subsidy use.

While this was not the primary focus of our analysis, our findings indicate that the practice of linking farmers with ENGO volunteers in biodiversity monitoring activities could have positive impacts on the commitment and intrinsic motivation of farmers to engage in agri-environmental land management. Kingston and others (2021) have already shown that farmers are generally more willing to work together with ENGOs who have a strong link to the local region in which the farmers are located, and that have a solid understanding of a farmers' reality. Collaboration on monitoring activities may be an effective way to boost the shared problem-solving potential on the part of ENGOs and farmers. Future research on ways to promote effective collaboration may consider these findings to find more effective methods (Hoffman et al., 2007; Schuttler et al., 2018).

A further important step in the generalizability of results concerns further study of farmer groups. Our sample consists mainly of farmers already participating in agri-environmental land management. This may mean that the participants are inherently more interested in environmental matters and contributing to citizen science activities on this topic. Involving farmers that do not participate in agri-environmental schemes, or do not possess particularly strong pro-environmental convictions, may prove much more difficult. Future empirical research focusing on these groups would strengthen the fit of policy recommendations across all farmers.

Data Availability

Data will be made available on request.

Annex 1. : Qualitative data and anonymized IDs[4]

(a)Respondents linked to the case studies.

Case study	Description	ID	Data type	Date
Poldernatuur Zeeland ('PZ')	Board secretary collective / director local group	PZ1	Interview (phone)	10 February 2020
	Project coordinator	PZ2	Interview (phone); Interview (Zoom)	16 October 2020; 4 June 2021
	Field inspector / participating farmer 2	PZ3	Interview (phone)	20 November 2020
	Participating farmer 1 / board member local ANV	PZ4	Interview (Zoom)	11 February 2021
	Coordinator local ENGO *Het Zeeuwse Landschap*	PZ5	Interview (in person); field visit (Partridge project site, Zeeland)	10 January 2020
	Local organic farmer, not participating in the collective (located outside of demarcated area)	PZ6	Interview (phone)	14 November 2019
Collective Hoeksche Waard ('HW')	Director collective	HW1	Interview (in person)	6 January 2020; 10 June 2021
	Field coordinator / inspector 1	HW2	Interview (in person)	16 January 2020
	Field coordinator / inspector 2	HW3	Interview + field visit (open grassland) / field visit (inspections open arable land)	30 June 2020; 13 August 2021.
	Participating farmer 1	HW4	Interview (in person)	10 January 2020
	Participating farmer 2	HW5	Interview (in person)	24 August 2020
	Participating farmer 3	HW6	Interview (in person)	6 January 2020
	Coordinator local ENGO *Hoekschewaards Landschap*	HW7	Interview (in person)	27 August 2020
	Ex participantcollective	HW8	Interview (phone)	29 March 2021
	Akkerbelt pilot participants meeting (n = 7)	n/a	Focus group (in person)	14 July 2020
	Stakeholders meeting (n = 15)	n/a	Focus group (in person)	23 July 2020
	Collective participants meeting (n = 13)	n/a	Focus group (in person)	22 July 2020
Collective Midden Overijssel ('MO')	Director collective	MO1	Interview (phone) / interview (Zoom)	20 January 2021; 1 February 2021
	Inspector collective	MO2	Interview (phone)	10 May 2021
	Secretary local ANV / coordinator meadow bird group	MO3	Interview (phone)	31 March 2021
	Participating farmer 1	MO4	Interview (phone)	11 November 2019
	Participating farmer 2 / coordinator local ANV	MO5	Interview (Zoom)	6 April 2021
	Coordinator local ENGO *Natuur & Milieu Overijssel*	MO6	Interview (Zoom)	6 April 2021
	Local farmer, not participating in the collective	MO7	Interview (in person)	July 2019

Other stakeholders ('OS').

Actor	Role	ID	Data type	Date
Ministry of agriculture, nature & fisheries	Senior policy advisor AES	OS1	Interview (Zoom)	10 December 2020
	Senior policy advisor AES	OS2	Field visit Burren, Ireland (in person)	3–5 January 2020
RVO (paying & inspection body AES)	Advisor EU implementation	OS3	Interview (in person)	8 January 2020
	Senior advisor	OS4	Field visit Burren, Ireland (in person)	3–5 January 2020
	Senior advisor agriculture	OS5	Field visit Burren, Ireland (in person)	3–5 January 2020
NVWA (inspection body AES)	Senior inspector	OS6	Interview (Zoom)	10 November 2020
	Coordinator	OS7	Interview (Zoom)	10 November 2020
BIJ12 (governmental assisting body AES)	Advisor AES	OS8	Interview (Zoom)	18 December 2019
Certificering SNL (certification body collectives)	Board member	OS9	Interview (Zoom)	21 July 2020
Boerennatuur (network organization collectives)	Director	OS10	Interview (in person)	15 January 2020
Province Zeeland	Senior policy advisor AES	OS11		21 January 2021

(*continued on next page*)

[4] Note: AES refers to agri-environmental scheme.

(*continued*)

Actor	Role	ID	Data type	Date
			Interview (Zoom, with written input from second Policy advisor)	
Province South-Holland	Policy advisor farmland birds / AES	OS12	Interview (Zoom)	23 February 2021
Province Overijssel	Senior policy advisor AES	OS13	Interview (Zoom)	8 April 2021

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