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Institutional analysis of actors involved in the governance of innovative contracts for agri-environmental and climate schemes

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ABSTRACT

In this study, we used institutional analysis to investigate the design of innovative contracts for agri-environmental and climate schemes. The aim of such contracts is to better incentivize farmers for the provision of environmental public goods in comparison to current 'mainstream' contracts. For the analysis, we differentiated four contract types: result-based, collective, land tenure, and value chain contracts. To represent each type in the analysis, we selected 19 case examples from six European countries. Cases were identified through a mix of methods, combining literature review, web search, and expert consultation. After a structured data collection based on Ostrom's institutional analysis and development (IAD) framework, we focused our analysis on the involved actors and their roles in contract governance. Our results highlight the great diversity of public, private, and civil actors involved from the local, regional, national or international governance level, each performing one or several critical roles in contract governance. We found that it is highly context-dependent which actors assume certain roles. We also discuss how provision of environmental public goods through the contracts might potentially be impacted by certain roles and their assignment to specific actors.

1. Introduction

Humans crucially depend on ecosystem services (ES) for their well-being (Millennium Ecosystem Assessment, 2005), which include provisioning (food, fiber, etc.), regulating (climate, water regulation, etc.), cultural (landscape aesthetics, cultural heritage, etc.), and supporting ES (habitats and biodiversity). Thereby, most regulating, cultural, and supporting ES can be characterized as environmental public goods for which no functional markets exist (Costanza et al., 2017; de Groot et al., 2012; Vatn, 2010). Due to this market failure, there is only very little incentive for potential providers of such ES, i.e. farmers or other land managers, to actually take efforts to provide them (Swinton et al., 2007; Zhang et al., 2007). Instead, current market mechanisms only reward the production of provisioning services as marketable goods, encouraging intensive agricultural production systems with a low capacity to also provide public-good-type ES (Kragt and Robertson, 2014). This is the main reason why previously largely abundant ES have become so scarce (Millennium Ecosystem Assessment, 2005). There is a strong interdependence between human activities and the state of ecosystems, biodiversity and climate (IPCC, 2022). In Europe, currently only 16% of habitats show a favorable conservation status and the overall target of halting biodiversity loss has not been met so far (European Environment Agency, 2020).

Agri-environmental and climate schemes (AECS), have been an important instrument in national and international policies, such as the EU's Common Agricultural Policy (CAP) (Batáry et al., 2015; Pe'er et al., 2019), to secure public-good-type ES from ecosystems under agricultural management. Conventional AECS can be interpreted as one specific type of payments for ecosystem services (PES), where the government pays farmers, as the ES sellers, on behalf of the direct beneficiaries, the society (Matzdorf et al., 2014; Sattler and Matzdorf, 2013). AECS typically consist of different voluntary measures addressed to certain agro-ecosystems, such as grassland or arable land. It is then up to the farmers if they enter into an AECS and how much land they

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dedicate to a certain measure. Up until now, the success of such AECS to actually increase ES provision has been limited and the low environmental effectiveness has been frequently criticized (Kleijn et al., 2001; Kleijn and Sutherland, 2003; Pe'er et al., 2020).

Reasons for the low environmental effectiveness of current AECS can be found in the institutional design of many AECS (e.g. Latacz-Lohmann and Hodge, 2003). Most take the form of one-size-fits-all contracts rolled out at federal or national scale offering only limited flexibility for farmers in their implementation. They typically prescribe certain land management measures, which are frequently only assumed to provide positive environmental effects. Such action-based 'mainstream' AECS contracts are often neither well-adjusted to the respective regional conditions, nor targeted to the most sensitive areas on the farmland or coordinated among participants at landscape scale, resulting in low ecological effectiveness (Batáry et al., 2015; Cullen et al., 2021; Herzon et al., 2018; Kleijn and Sutherland, 2003; Latacz-Lohmann and Hodge, 2003; Nguyen et al., 2022). Moreover, acceptance among farmers to participate in these AECS is low, not only because of their prescriptive nature, which does not take advantage of farmers' professional experience, local knowledge, and individual skills, but also due to their comparatively low payment rates and high administrative burden (Burton and Paragahawewa, 2011; Pe'er et al., 2017). Furthermore, since mainstream contracts usually use individual contracting between governmental entities and single farmers, they typically do not offer engagement options for other important actors who can also affect the production of ES in a given region (Hodge, 2001; Mack et al., 2020). This can include landowners, non-governmental organizations (NGOs), food processors and retailers, consumers, or residents (Bredemeier et al., 2022).

For these reasons there is increasing interest in exploring more innovative contractual models for AECS, which aim to overcome the lack in environmental effectiveness of mainstream contracts and try to better incentivize farmers for the provision of environmental public goods. This includes result-based (e.g. Chaplin et al., 2021; Herzon et al., 2018; Mack et al., 2020; Ruas et al., 2021), collective (e.g. Barghusen et al., 2021; Franks and Mc Gloin, 2007; van Dijk et al., 2015; Westerink et al., 2017; Zaga-Mendez et al., 2021), land tenure (e.g. Benez-Secanho and Dwivedi, 2020; Curran et al., 2016; Eder et al., 2021; Jackson et al., 2021; Tseng et al., 2021), and value chain contracts (e.g. Cao et al., 2020; Haggar, 2013; Krause and Matzdorf, 2019; Manyise and Dentoni, 2021). Such contracts are also highly relevant for the further development of the EU's CAP (Pe'er et al., 2014, 2019, 2020), with the EU calling for in-depth research on the four above mentioned contract types in its 2018 work program Horizon 2020.[2]

All four contract types have their specific merits and limitations (for more details, please see Section 2). But what they have in common is that they get more complex compared to mainstream AECS in terms of i) the number and types of actors involved and ii) what roles these actors assume for the governance of the contracts (e.g. Westerink et al., 2017). This is the key assumption we start from. In the case of result-based contracts this might be additional actors needed for the monitoring and the design of suitable indicators (e.g. Birge et al., 2017). In collective contracts this may concern a coordinator who mediates between numerous contracted parties and a contractor. In land tenure contracts the land owner becomes involved as a contract partner. Finally, in value chain contracts, actors might join for developing a product label. This sets all four contract types apart from mainstream AECS contracts, where typically only farmers and different governmental entities are involved. To advance knowledge in the field of innovation studies and to better understand the interaction among the diverse actors involved and how they share responsibilities in the governance of the contracts, more research on actors composition and their roles in innovative contracts is called for (Fischer and Newig, 2016; Hauck et al., 2020).

Against this background, the objective of this study is to undertake a detailed analysis of existing case examples which represent the four contract types with regard to the actors involved and their different roles in contract governance. Although many existing examples are still small-scale, have limited participant numbers, or have been introduced rather recently with less than 10 years of experience, they can offer valuable insight on which participation options they offer to different actors, how these actors can share responsibilities and how this might potentially affect the performance of such schemes.

We use institutional analysis to investigate the contracts. It is an appropriate lens to study environmental governance, since institutional settings shape the individual behavior and the cooperation of governance actors (Bisaro et al., 2018; Ostrom, 2005; Roggero et al., 2018). For an in-depth analysis we compile an inventory of the involved actors and consider their performed roles (de Haan and Rotmans, 2018; Mossberg et al., 2018). Actors can be individuals, groups of individuals, or organizations which can be associated with different societal spheres, i.e. public, private, or civil (cf. Delmas and Young, 2009), and which can be active at different governance levels, i.e. local, regional, national or international (Geels, 2011; Newig and Fritsch, 2009). Roles can be understood as a set of recognizable activities used by an actor to address recurring situations (Wittmayer et al., 2017). How actors assume certain roles is strongly influenced by the context conditions (Mossberg et al., 2018).

Our results will contribute to innovative contract design in two ways: Firstly, they can be helpful for improving the institutional design of existing contracts. For instance, promoting the sharing of roles among actors can be used as a strategy to boost learning effects among different types of actors (cf. Westerink et al., 2017). Secondly, for new contracts, our results can inform decisions on who to include in contract design right from the start and who to consider for the adoption of specific roles. For instance, tactic involvement of science partners to support the monitoring role can be used to overcome the challenge of finding suitable indicators for result-based contracts (Chaplin et al., 2021; Ruas et al., 2021). Studies have also shown that farmers can play a vital role in monitoring (de Vries et al., 2019).

For our analysis we pose three research questions (RQ):

RQ1: Who are the key **actors** involved in the analyzed contracts?

RQ2: Which critical **roles** do these actors perform in contract governance?

RQ3: Are there recognizable patterns regarding **which actors** perform **which roles**?

The paper is structured as follows: In Section 2, we describe the four contract types in more detail. In Section 3, we present our analytical approach and framework. In Section 4, we describe the methods used for case selection, data collection, and data analysis. In Section 5, we present the results according to the three RQs. In Section 6, we discuss the results in light of other studies and elaborate on the question how different roles and the assignment of roles to certain actors possibly favor environmental public goods provision. We conclude in Section 7.

2. Innovative contracts for AECS

In this section we introduce the four innovative contract types for AECS: result-based, collective, land tenure and value chain contracts in more detail, highlighting how they differ from current mainstream AECS contracts.

In result-based contracts, payment is made conditional on actual environmental outcomes, but farmers are typically free in the choice of the land management measures to achieve them (Burton and Schwarz, 2013; Herzon et al., 2018; Matzdorf and Lorenz, 2010; Pe'er et al., 2020). This is in contrast to mainstream AECS contracts, where

[2] To investigate innovative contracts, three EU-Horizon 2020 research and innovation actions with an overall budget of 15 million Euro have been launched in 2019: CONSOLE (https://console-project.eu), EFFECT (https://project-effect.eu) and Contracts2.0 (https://www.project-contracts20.eu). The research presented in this paper relates to the Contracts2.0-project.

measures are fixed and payment is based on measures' implementation costs. Advantages of result-based contracts include that they encourage farmers to actively engage with the environmental goals of the AECS as a prerequisite to decide on most suitable measures. In this way, farmers take responsibility and feel ownership for the results (Herzon et al., 2018; Zabel and Holm-Müller, 2008). A design with different payment levels can motivate farmers to stepwise increase their ambitions (Dunford and Parr, 2020). By providing flexibility to farmers in the delivery of the desired outcomes, result-based contracts call on their professional skills and individual knowledge (Klimek et al., 2008) to induce further innovation (Engel, 2016). However, there is a risk of non-delivery of the desired outcomes due to external factors which farmers cannot influence (e.g. weather, predation). To lower the risk, a combination of action- and result-based contracts is proposed to avoid that farmers receive no rewards at all (Derissen and Quaas, 2013). To define the payment level in result-based contracts, monitoring of results is crucial, which requires knowledgeable actors to undertake this role and advise on the choice of suitable indicators (Birge et al., 2017; Burton and Schwarz, 2013; Chaplin et al., 2021; Herzon et al., 2018). Monitoring is also a factor which increases the cost of contracts (Engel, 2016).

In collective contracts, land management measures are spatially coordinated among involved farmers with the aim to target measures to the most suitable areas in the landscape (Nguyen et al., 2022; Pe'er et al., 2020; Reed et al., 2017; Westerink et al., 2017). This is different from mainstream AECS contracts, where measures can be very scattered across the landscape and are implemented individually and uncoordinated by single farmers. As farmers can often pick from a catalog of measures, where payment levels increase with the choice of more environmentally ambitious measures, they still have leeway to choose the ones best suited for their farm. Agglomeration bonuses can be used to boost uptake among farmers (Krämer and Wätzold, 2018; Nguyen et al., 2022). Long-term social interactions among participants support social capital as well as the capabilities of the group to self-organize, learn from each other, resolve conflicts and develop a strong sense of ownership for the scheme (Barghusen et al., 2021; de Vries et al., 2019; Prager and McKee, 2015; Westerink et al., 2017). Certain context conditions might promote collective contracts, such as when common land is collectively managed. Challenges are linked to an increase in transaction cost, at least initially, which arise from the coordination, especially if participant numbers are high (Tacconi, 2012). A trusted intermediary who takes on the coordination and liaises with the funding bodies can help to lower cost (Barghusen et al., 2021). Transaction costs decrease once the group professionalizes and develops effective routines and strategies. A certain level of trust between key actors might be a precondition to initiate the contract (Westerink et al., 2017). Liability is another issue which needs resolving, i.e. if the individual farmer or the whole group is to be sanctioned when single participants do not comply with established rules. Collective contracts might also not agree with farmers who strongly identify themselves as autonomous entrepreneurs (Riley et al., 2018; van Dijk et al., 2016). Participation options for farmers can be limited by certain requirements they have to fulfill to join (e.g. land must be located inside a designated area, minimum area of land necessary to enroll).

In land tenure contracts, specifications regarding favorable land management measures to support ES provision are integrated into land lease agreements by the landowner (Agrawal et al., 2014; Robinson et al., 2018; Tseng et al., 2021). Farmers who accept such lease agreements are then either paid indirectly through reduced or waived land rents or directly based on measures' implementation costs. Specifications can pertain to the whole farming system (e.g. leases are only given to certified organic farms) or even get tied to certain characteristics of the farmers (leases reserved for 'young' farmers). Land tenure contracts offer a means for landowners to incentivize and reward the sustainable use of the land they lease to others (cf. Daedlow et al., 2018; Fraser, 2004; Leonhardt et al., 2019; Robinson et al., 2018; Tseng et al., 2021). In contrast to their active role in land tenure contracts, landowners are typically not involved in the design of mainstream AECS contracts. Depending on the property rights associated with the land (e.g. private, public, communal, cf. Tseng et al., 2021), a range of landowners are in a position to formulate land-tenure contracts (e.g. private landowners, governmental/state authorities, municipalities). They define which property rights are affected by the specifications (e.g. right to access, withdraw, appropriate, cf. Schlager and Ostrom, 1992; Sikor et al., 2017). Land-tenure contracts can last in perpetuity when the specifications are linked to the land title as conservation easements (cf. Benez-Secanho and Dwivedi, 2020). In this case, they are passed on when the land is leased or bought by another party. Easements have the challenge that they can be met with resistance from land owners, because they reduce the possible future uses of the land. However, easements have considerable potential, particularly when it comes to ecosystems which require long-term conservation efforts, such as wetlands.

In value chain contracts, actors along the value chain, such as food processors, retailers, or consumers, initiate contract design to incentivize farmers for more environmentally-friendly farming (Cao et al., 2020; Manyise and Dentoni, 2021; Thorlakson et al., 2018). These types of contracts often include product labeling and certification as a strategy to convey the applied ecological standards (Grunert et al., 2014). In contrast to mainstream AECS contracts, value chain contracts tap into private funding. Value chain contracts also represent the only type which directly involves customers as the final ES buyers, offering the opportunity to raise their environmental awareness. Direct communication channels between farmers and consumers can be opened through direct marketing, by involving them as volunteers into farm operations or certification processes (e.g. through participatory guarantee system, cf. Nelson et al., 2015), or if farmers ask them to pre-finance farm production which is then tailored to their preferences. Advantages for value-chain partners include that they can improve their image and reputation, set themselves apart from their competitors, or proactively influence government regulations intended to raise legal standards. The risk of green-washing is one challenge linked to value-chain contracts (cf. Krause and Matzdorf, 2019). To establish credibility, it is therefore relevant to make transparent how standards are defined and controlled. One important difference to the above-mentioned contract types is that value chain contracts offer only an indirect approach to incentivize public-good-type ES as jointly produced 'by-products' of the environmentally-friendly production of the marketed provisioning ES.

3. Analytical approach and framework

For our analytical approach we choose a three step procedure as indicated in our analytical framework (Fig. 1).

In the first step, we identify potential case examples and assign them to the different contract types. To do so, we apply the following criteria for each contract type, considering the payment mode, how land use measures are defined, and which additional actors become involved:

We assign case examples to the result-based contract type, if payment from the ES buyer to the ES seller is made conditional upon the actual delivery of the contracted public-good-type ES in a certain quality or quantity and farmers have free choice to decide which land management measures to use, or if payment is layered, i.e. a basis payment (this can be an action-based payment, requiring certain land management measures to be implemented), is topped-up with additional payments when pre-defined higher levels of delivery of the contracted public-good-type ES are achieved.

We assign case examples to the collective contract type, if the land management measures, through which certain public-good-type ES are secured, require collective action by multiple actors, whose efforts are then coordinated and spatially targeted at landscape scale, in many cases supported by a third party who functions as an intermediary between the other actors.

We assign case examples to the land tenure contract type, if landowners are involved as third parties from the supply side, who specify in

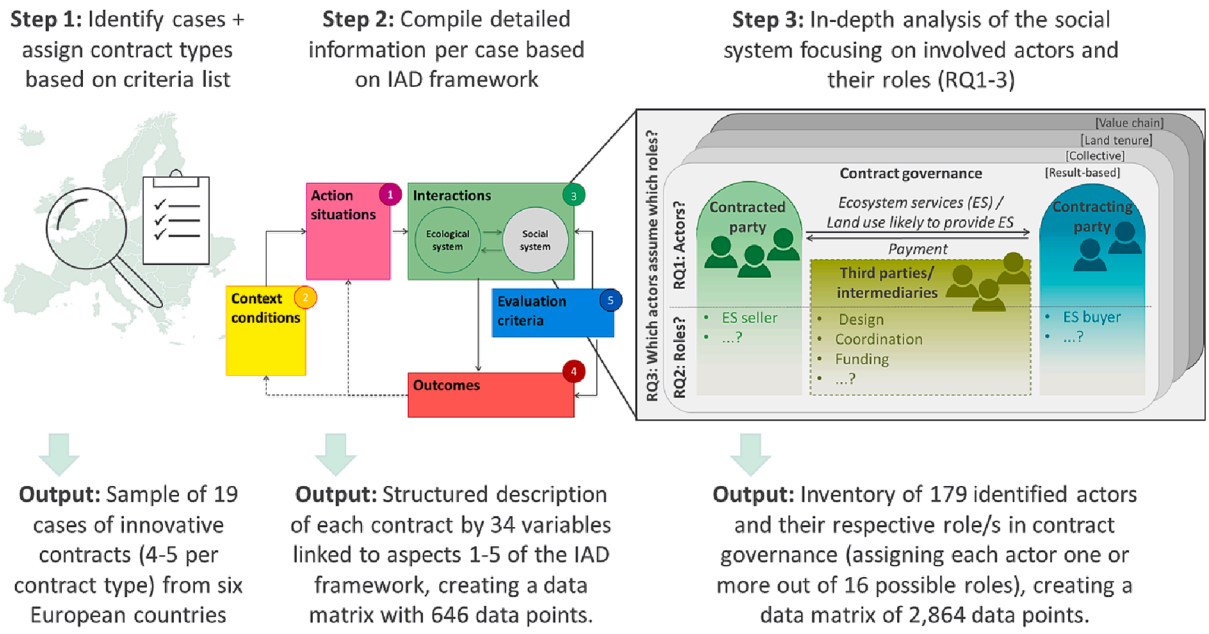

Fig. 1. Analytical framework applied for the institutional analysis in this study comprised of three steps. The placeholder '…?' in step 3 indicates potential additional roles this party might assume. Source: Own figure, elaborated based on Ostrom (2005:15), cf. also Roggero et al. (2018:425) for step 1, and Prager et al. (2020:8) for step 3.

their lease agreements which public-good-type ES should be supported by certain (action-based) land management measures on the contracted land.

Finally, we assign case examples to the value chain contract type, if additional actors along the food value chain (e.g. processors, retailers, or consumers) are involved as third parties from the demand side, who help to ensure that additional public-good-type ES are co-produced together with the contracted private-good-type ES. Thereby, the information which non-commodity ES are jointly produced together with the sold commodity, is often communicated via a product label.

In the second step, we compile detailed information on each case, using Ostrom's institutional development and analysis (IAD) framework to structure our data collection. This allows us to get a good understanding of each case. The IAD framework was developed to facilitate comparative analysis to understand the ways institutional settings operate focusing on five different aspects (cf. McGinnis, 2011):

- a certain type of 'action situation' (1),
- under a given set of 'context conditions' (2),
- considering the 'interactions' (3) within and between the concerned social and ecological systems (3),
- also taking into account the actual 'outcomes' (4) of the interaction, as well as
- the applied 'evaluation criteria' (5) to assess performance.

For the purpose of our study we define: (1) as a specific contract in a given country and region, (2) as the general bio-physical, socio-economic, and political context conditions under which the contract operates, (3) as the targeted interactions within and between the social and ecological system which represents the governance system under investigation, (4) the (measurable) outcomes of the governance system, both in the social and the ecological system, and (5) as the indicators or criteria used for evaluating the outcomes of the governance system, both in the social and the ecological system (cf. Supplement 1).

In regard to aspect (3) 'interactions', the IAD framework is closely linked to the concept of social-ecological systems, which is based on the notion that both systems are highly interconnected (Folke, 2007). While the ecological system represents a bio-physical system within the spatial or functional boundaries surrounding particular ecosystems, the social system is made up of the social actors and their associated institutions (cf. McGinnis, 2011). The IAD framework has been used in a wide range of studies, including those focused on the analysis of environmental governance and public good provision (e.g. Barton et al., 2017; Basurto et al., 2010; Bisaro et al., 2018). By differentiating between the five aspects, complex governance situations can be broken down into smaller units of analysis.

In the third step, we zoom in on the social system as part of aspect (3) 'interactions' of the IAD framework, to conduct an in-depth analysis of the involved actors and their roles addressing our three research questions (see Section 1). Informed by the institutional design of PES schemes in general (Prager et al., 2020:8; Dutilly and Prager, 2020:9; cf. also Matzdorf et al., 2014), we group actors into three categories: contracted, contracting and third parties (cf. Supplement 2). Contracted parties (e.g. farmers or other land managers) are involved in the role of ES sellers representing the supply side for ES. Contracting parties are engaged in the role of ES buyers, either paying as the direct beneficiary or on behalf of them, representing the demand side of ES. Third parties are any other party involved, including all actors functioning as intermediaries between two or more other actors. Further, we differentiate four different actor types (cf. Supplement 3): public (e.g. governmental entities, municipalities), private (e.g. farmers, other entrepreneurial actors), civil (e.g. not-for-profit organizations), as well as hybrid actors (e.g. public–private partnerships). This is based on the assumption that actors from all societal spheres can have a vital role in innovative contracts (Delmas and Young, 2009; Lemos and Agrawal, 2009). We also take into account at which governance level (local, regional, national, international) the actors are located (cf. Supplement 4). This is based on the assumption that the contracts may represent examples of multi-level governance (Newig and Fritsch, 2009). In order to identify actors' roles in contract governance we draw on the work of Westerink and others (Westerink et al., 2017:178), who identified 12 governance tasks for collective AECS. We consider these as a basis to start from. But since we are not only interested in collective contracts, we keep the list open for the addition of further roles which might emerge from the analysis of other contract types.

4. Methods

For the first step, we use a mix of different methods to identify potential cases combining literature review, web search, and expert consultation (cf. Bredemeier et al., 2022). We choose a sample of 19 cases to represent the four contract types, focusing only on Europe. This was also done to keep the overall overwork load linked to data collection and data analysis manageable.

The final selection of contracts (Table 1) aimed to: a) compare several contracts for the same contract type and also different contract types for the same country under similar context conditions, and b) represent the diversity of the institutional design of existing contracts, e. g. in terms of bottom-up vs. top-down initiated, CAP-related or independent, small- vs. large-scale, still emerging vs. already mature, private vs. publicly funded, single ES vs. ES bundles addressed (cf. Table 1). Further, all selected cases represent existing and mostly still ongoing

Table 1
Basic characteristics of selected contracts.

Contract name, country (Abbreviation)	Initiated in year	Length of contract in years	Number of participants	Enrolled area in hectare	Targeted ecosystem/s	Targeted public-good-type ES	Type of contracting with farmers	Land ownership	Funding source
Results-based									
Beverhoutsveld Flanders, BE (**BEV-BE**)	2012	3	5 + 5	8.2 + 5.4	Grassland, arable land	Supporting, regulating	Individual	Common	Public
Collaborative pro-tection of meadow birds, Schleswig-Holstein, DE (**MB-DE**)	2007	<1 (a breeding season	85	326	Grassland, peatland	Supporting	Individual	Private	Public
Burren programme, IR (**BP-IR**)	2016	5	327	23,120	Grassland, grazed habitats	Supporting, cultural	Individual	Private	Public
Valuta vor veen, NL (**VVV-NL**)	2020	10	1	32	Grassland, peatland	Regulating, supporting	Individual	Private	Private + Public
Wensleydale payment-by-result pilot, UK (**WP-UK**)	2016	1–2	18	50 + 285	Grassland	Supporting	Individual	Private	Public
Collective									
Collective AECS pilot Saxony-Anhalt, DE (**CP-DE**)	2020	1	27	185	Arable land (highly productive)	Supporting	Individual	Private	Public
Collective mesures agro-environnemen-tales et climatiques, FR (**CMAEC-FR**)	2016	5	1,068	55,000	(Mountain) grassland	Supporting	Group	Common	Public
Agrarisch natuur- en landschapsbeheer Natuurrijk Limburg, NL (**NALI-NL**)	2016	6	1,300	2,618	Arable land, horticultural land	Supporting, regulating	Individual	Private	Public
Agrarisch natuur- en landschapsbeheer Oost-Groningen, NL (**OG-NL**)	2016	6	100	719	Arable land, grassland	Supporting, regulating	Individual	Private	Public
Countryside stewardship facilitationfund, UK (**CSFF-UK**)	2016	3–5	4,000 (180 groups)	453,000	All	Supporting, regulating	Individual	Private/ Common	Public
Land tenure									
BioBoden, DE (**BIOBO-DE**)	2015	perpetual	72	4,155	All	Regulating, supporting	Individual	Private	Private
Bail rural environ-mental, FR (**BRE-FR**)	2007	9 + 9	(no info)	(no info)	All	Regulating, cultural, supporting	Individual	Private/ Public	Private + Public
Aardpeer, NL (**AP-NL**)	2021	30	4	533	Arable land	Regulating, supporting	Individual	Private	Private
Sustainable catch-ment management program, UK (**SCaMP-UK**)	2005	10	53	57,000	Peatland, grassland	Regulating, supporting	Individual	Private	Private
Value chain									
Neumarkter Lammsbräu, DE (**NELA-DE**)	1977	'Long-term'	170 (+13)	1,100 (hop)	All	Regulating, supporting	Individual	Private	Private
Agriculture for biodiversity, DE (**AFB-DE**)	2012	>1	150	~40,000	All	Supporting, regulating	Individual	Private	Public + Private
C'est qui le patron, FR (**CQLP-FR**)	2016	3	>3,000	(no info)	All	Supporting, regulating, cultural	Individual	Private	Private
Boeren van Amstel, NL (**BVA-NL**)	2019	'Long-term'	18	180	Grassland	Cultural, supporting	Individual	Private	Private
Swaledale M&S lamb scheme, UK (**MS-UK**)	2011	1 year	45	2,428	Grassland	Cultural	Individual	Private	Private

contracts, i.e. we do not include contracts in the planning stage or hypothetical cases constructed for economic experiments.

The sample of cases encompasses several contracts each for Germany (DE), France (FR), the Netherlands (NL), and the United Kingdom (UK), complemented by two additional contracts from Belgium (BE) and Ireland (IR). From now on, to refer to single cases in the text, we use the abbreviations highlighted in bold in Table 1.

Table 2
Definition of the five aspects of the IAD framework for this study and considered variables for data collection per aspect.

No.	Aspects of the IAD framework	Definition	Considered variables for data collection (step 2)
(1)	**Action situation**	A specific contract in a given country/region	Contract name, contract type, implementation stage, initiation (top-down vs. bottom-up), name of umbrella scheme, runtime of umbrella scheme, runtime of contracts, contracting (individual vs. group)
(2)	**Context conditions**	The general, bio-physical/ environmental, socio-economic, or political/ legal context conditions under which the contract operates	General: Country name, state/province name Biophysical/ environmental: Existing environmental restrictions/challenges Socio-economic: Existing socio-economic restrictions/challenges Political/legal: Existing political/legal restrictions, land tenure system
(3)	**Interactions**	The targeted interactions within and between the social (actors) and ecological (ecosystems) system which encompass the governance system under investigation	Social system: Targeted actors for participation, existing eligibility criteria for participation, benefits for participants and other involved actors Ecological system: Targeted ecosystems and ES, foreseen land management measures to maintain ecosystems/ secure one/several specific ES, existing eligibility criteria for land to be enrolled into the contract
(4)	**Outcomes**	The (measurable) results/ outcomes of the governance system, both in the social and the ecological system	Social system: Number and type of participants actually involved, their assumed roles, realized benefits Ecological system: Amount of land contracted, implemented land management measures, realized funding for these measures, provided single/ bundles of ES, if environmental monitoring system is installed
(5)	**Evaluation criteria**	The indicators/criteria used for evaluating the outcomes of the governance system, both in the social and the ecological system	Social system: E.g. number of participants/farms enrolled, acceptance/ uptake of single measures among farmers, administered funding, or other possible indicators/ criteria Ecological system: E.g. land area enrolled, frequency of controls, or other possible indicators/ criteria

In Table 2, we assigned all cases to one distinct contract type based on their main features according to the criteria described in Section 3. However, some of the contracts combine elements of several contract types (Supplement 5). We also acknowledge that other options to group innovative contracts are possible (cf. Bredemeier et al., 2022; Olivieri et al., 2021), but opt for these four contract types to explore how far each type calls for additional actors who then assume critical roles.

For the second step, the structured data collection based on the five aspects of the IAD framework, we used a survey with 34 questions to collect information on the same number of variables (Supplement 6). The information for each variable was collated from different sources into a data matrix created in Excel. Data sources included available peer-reviewed literature, gray literature, different contract-related websites, materials retrievable from websites (e.g. project reports, flyers, videos, links to Facebook pages), complemented by project internal documents from our project Contracts2.0 (e.g. project deliverables, milestones, or factsheets). Materials were mostly available in English. For materials in the local languages neither of us was familiar with (e.g. Dutch, Flemish) we first used DeepL or Google translate and then asked native speakers involved in our project to check if we understood the information correctly. In several cases, the data matrix was also filled in by an expert knowledgeable about the contract. In other cases, we conducted online interviews to fill in the data matrix together with the interviewed expert. Whenever possible the completed data matrix was again reviewed by an expert involved in the contract to verify entered data and close data gaps. Nevertheless, some data gaps remained.

In Table 2 we list the variables which we included per aspect in the IAD framework (cf. Supplement 7 and 8). Supplement 9 visualizes how the contracts in our sample differ in regard to selected key variables. We give an overview of which data sources we used in Supplement 10.

For the third step, we zoomed further in on the variables collected for the 'interactions' aspect of the IAD framework, focusing solemnly on the social system for the analysis on the involved actors and their roles in contract governance. Therefore, based on the information already compiled in the data matrix created in step two, we first listed all relevant governance actors for each case in a new data matrix. We then also added their attribute data, i.e. to which societal sphere (public, private, civil, or hybrid) and to which governance level (local, regional, national, international) they can be assigned. In a further step, we entered the information which role/s each actor performs in the governance of the contracts. In many cases, multiple roles were assigned to one actor. We started with the list of roles identified by Westerink and others (Westerink et al., 2017) for collective AECS, but whenever the description of an actor suggested a new role, we created a new column and reviewed cases already analyzed once again, if this new role also applied to some of the involved actors there. Alongside the analysis we created role descriptions which we refined further with each additional case analyzed. Where possible, we consulted again an expert directly involved in the contracts to verify information and to make additions or corrections, if they felt something was not yet accurate. For the visual presentation of the results we used Excel (Microsoft), Tableau Public (Salesforce) and Chordial (Gumroad).

5. Results

5.1. Key actors involved in contracting

We identified a total number of 179 actors for all analyzed cases. We only listed organizational actors, like government agencies or NGOs and groups of individuals, such as farmers or volunteers, but not single individuals. Per case between four (WE-UK) and 15 (CP-DE) actors are involved. By comparison, the number of involved actors is highest in the collective contracts, followed by land tenure, result-based, and value chain contracts. A complete list of all identified actors per contract can be found in Supplement 11.

When differentiated by actor category (contracted vs. contracting vs. third parties, Table 3), in the vast majority of cases, farmers as private actors are the contracted actors. Exceptions are CSFF-UK and CMAEC-FR as collective contracts with more diverse contracted parties. For CSFF-UK they also include other private actors, such as foresters. For CMAEC-FR, besides private actors (e.g. a group of farmers), also public (e.g. municipalities) as well as hybrid actors (e.g. pastoral and land tenure associations) are involved. In the latter case, this is due to the common land ownership, which requires cooperation among the collective users. Contracting for most cases typically rests with one specific actor. The exception is BRE-FR, where any actor owning land can serve as the contracting party. The most diverse category is third parties/intermediaries.

Fig. 2 shows the number of involved actors per contract type broken down per actor types (different societal spheres) and governance levels. When comparing across contract types, the figure highlights that all types of actors are involved, from all societal spheres and across all governance levels.

5.2. Roles of actors in the governance of contracts

The key role of ES seller is always assumed by the contracted party (supply side), and the role of ES buyer is always associated with the contracting party (demand side). However, we identified 14 further roles as listed in Table 4. Through the analysis, we found that most identified roles correspond well to the governance tasks already listed by (cf. Westerink et al., 2017:178). The additional roles which emerged through the analysis of our cases are highlighted in bold in Table 4.

We include '**ES seller**' as a new role to highlight the fact that the farmers involved in the innovative contracts, next to their traditional role of being a 'food seller' (focusing primarily on provisioning ES) diversify their ES spectrum to include other categories of ES. Due to this new role, they enlarge their original business model toward producing and selling also public-good-type ES. This provides them with another source of income and helps raise their profile and standing in society which is in high demand for such ES.

We also add the role of '**funder**', since innovative contracts increase the potential to tap into unconventional sources of funding, especially private money. Including this role allows seeing where additional (private) money for conservation finance could come from, or how innovative funding models could look like.

We further include '**reporting**' to complement the role of 'evaluation'. Reporting has a different quality than evaluation, as it happens more regularly and thus offers more options to collect regular feedback from core actors, including farmers and their contracting actors. This allows for more timely adjustments supporting professionalization of involved actors in their specific roles. By contrast, evaluation is often only done after a whole funding period to decide if the contract is to be continued.

'**Advocacy**' seems important when pilots of innovative contracts should be rolled out at a higher level or there are plans to transform them into an actual government-financed AECS. To achieve this, convincing additional supporters, getting media coverage, raising more funds, or winning over policy support is crucial.

Finally, we add '**certification**' as a new role, particularly relevant for value chain contracts, as here the additional provision of public-good-type ES along with the private goods needs to be verified and communicated. This can be done by certifying actors and by attaching a label to the marketed product (e.g. relevant for QELP-FR, AFB-DE).

A full overview of all actors and their assumed roles is provided in Supplement 12.

5.3. Patterns of actors and their assumed roles in contract governance

As a general pattern (cf. Supplement 13) we can observe that one actor often performs several roles (1:n-relation) and that several actors share the responsibility for one role (n:1-relation). Among the actors who perform several roles, some are 'multi-involved' with sometimes more than 10 roles. Nevertheless, also 1:1-relations exist where one actor performs only one role. A 1:1-relation may boost cost-efficiency when the role rests with an actor highly professionalized in conducting this role (e.g. payment administration or evaluation). A 1:n-relation allows the 'multi-involved' actors to keep several governance tasks in view and react quickly to possible hiccups in the governance process (e.g. coordinator role). A n:1-relation then can support knowledge sharing, co-creation of new knowledge, mutual learning, capacity-building for inexperienced actors, and it makes the contract more resilient to staff turn-over and actor drop-out. For instance, sharing of the monitoring role allows farmers to learn from involved experts (e.g. WP-UK, CMAEC-FR).

Table 3
Comparison of involved actors per actor category across different contract types.

	'Mainstream' AECS	Result-based	Collective	Land tenure	Value chain
Contracted	Private: Farmers	Private: Farmers	Private: Farmers, other land managers Public: Municipalities Civil: Farmer collectives/groups Hybrid: Land tenure associations	Private: Farmers	Private: Farmers
Contracting	Public: Government entities	Public: Government entities Civil: Associations	Public: Government entities Civil: Environmental collectives, foundations	Public: Government entities, protection area administration, municipalities Private: Landowners, companies Civil: Associations, foundations	Private: Companies
Third parties/ intermediaries	Public/Private: Extension services	Public: Government entities, water boards, protection area authorities, universities Private: Advisors, sub-contractors Civil: Trusts, associations, foundations, volunteers Hybrid: Steering groups, management boards, panel groups	Public: Government entities Private: Sub-contractors Civil: Environmental NGOs, associations, foundations, Hybrid: Facilitators, steering groups, science projects	Public: Government entities, municipalities Private: Investors, members, banks Civil: Associations, foundations, trusts Hybrid: Public-private partnerships, investors/donors	Public: Government entities, universities Private: Companies, retailers/supermarkets, professional industry networks, consumers Civil: Associations, environmental NGOs, environmental collectives

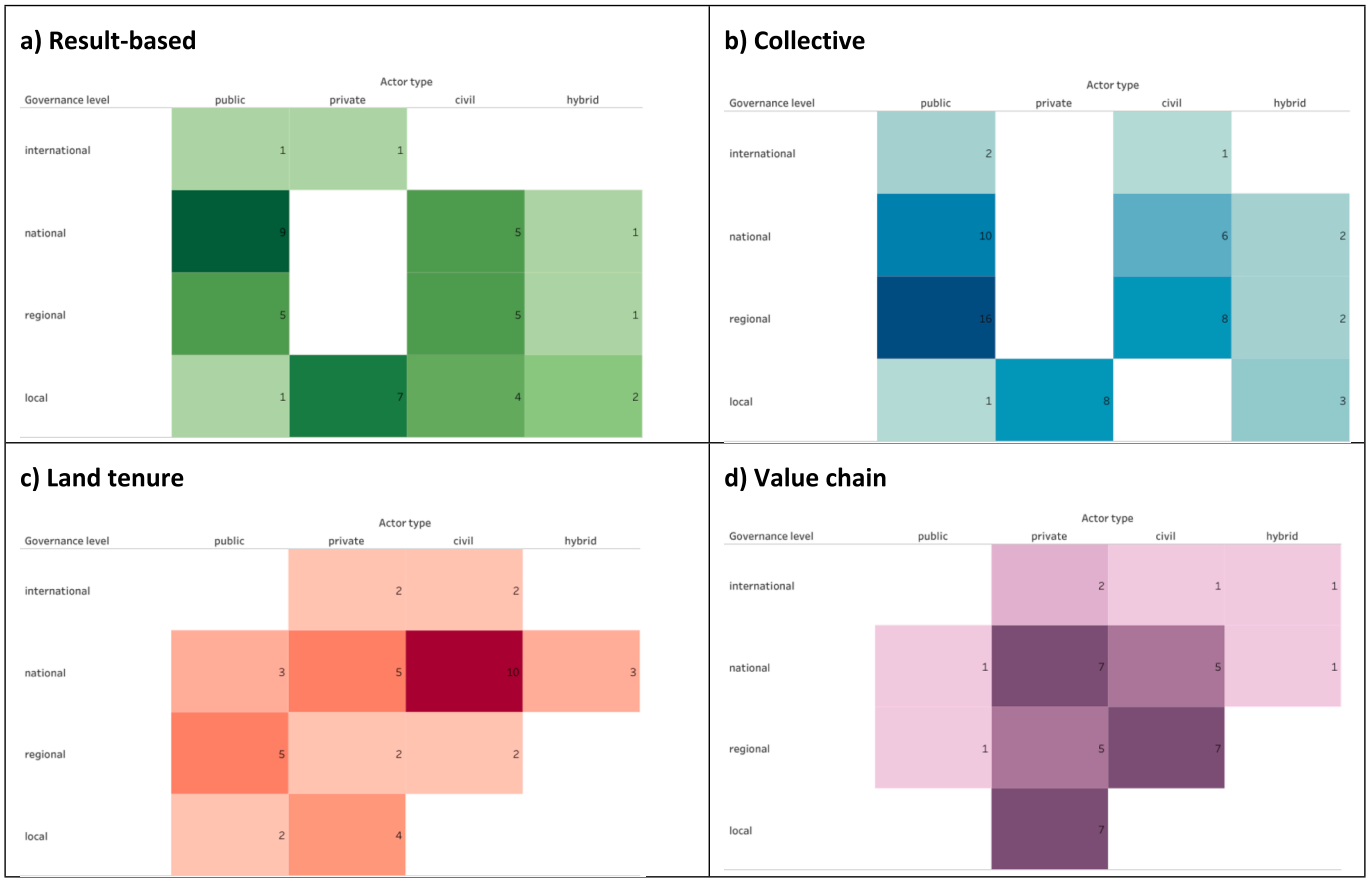

Fig. 2. Comparison of involved actors per societal sphere and governance levels across contract types.

For the single roles the following observations can be made:

ES seller: Across all contract types this role is primarily assumed by farmers as private actors at the local level (with the exceptions of CSFF-UK and CMAEC-FR as described in Section 5.1). In some cases, specific sub-groups of farmers are addressed (e.g. 'young' farmers in BEV-BE).

ES buyer: The role of ES buyer in collective and result-based contracts is either performed by a civil or public actor. In land tenure contracts all three actor types can play this role, depending on the respective land ownership arrangements. As expected, in value chain contracts only private actors act as ES buyers. The role of ES buyer is correlated to the role of controlling/sanctioning (Supplement 14).

Design: The design role is always shared among several actors (n:1 relation). Farmers as contracted actors are involved in the design in six cases, while the contracting party is involved in 13 cases. Multiple other actors share this role.

Coordination: Coordinating actors are mostly positioned at the local and regional level. The role is particularly relevant for collective contracts. However, also national actors are involved in this role, e.g. to ensure policy coherence with other running programs (e.g. NALI-NL, OG-NL). Actors in this role can be associated to all societal spheres, with civil actors being most prominent. As mentioned above, actors in this role are often 'multi-involved' (1:n-relation). The coordination role is highly correlated to the recruitment role (Supplement 14).

Recruitment: The recruiting role is assumed by the contracting actor or a third party. The vast majority of actors in this role are involved at the local or regional governance level. The recruiter role is often co-performed by the actor in the coordinator role (1:n-relation). The recruitment role is also correlated with the role advice/extension (Supplement 14).

Funding: The funder role is often (11 cases) fulfilled by the contracting party (e.g. BEV-BE, BP-IR, NELA-DE). However, in 10 cases a third party provides (co-)funding (e.g. the provinces provide co-funding for NALI-NL, OG-NL). Actors in the funding role can be linked to all actor types and governance levels. For the land-tenure contract they often involve a bank to secure capital for land acquisition (e.g. BIOBO-DE, AP-NL).

Monitoring: The role of monitor is regularly shared between two or more actors (n:1 relation). Farmers are only involved as self-monitors in three cases (NELA-DE, WP-UK, CMAEC-FR). In five cases the contracting actors are involved (CP-DE, NALI-NL, OG-NL, NELA-DE, MS-UK). For 16 cases this role involves third parties.

Controlling/Sanctioning: Controls, and, in case of contract violations, sanctioning, are either done by the contracting actor (e.g. BP-IR) or by third parties (e.g. CMAEC-FR) or by both (e.g. NALI-NL, OG-NL). Primarily national or regional actors, either public or civil, assume this role, except for value chain contracts, where also private actors are involved (e.g. NELA-DE, QELP-FR). This role is correlated with evaluation and payment administration (Supplement 14).

Reporting: This role is performed either by the contracting party, a third party or shared between the two. Reporting is correlated to evaluation, extension, and payment administration (Supplement 14).

Evaluation: This role is typically shared by two or more actors (n:1-relation), almost entirely by actors at regional or national level. Sometimes an external evaluator is invited for this role (e.g. IR-BP). The role is correlated to controlling and reporting.

Advice/Extension: Actors who assume the advisor role can be linked to all societal spheres (public, private, civil, including hybrids). In five cases local actors are involved who support the consideration of local circumstances (e.g. BEV-BE, MB-DE, BP-IR, CSFF-UK).

Payment administration: This role is sometimes performed by one specific actor (1:1-relation), but never for collective contracts, where government funds are channeled through an intermediating actor who

Table 4
Overview and description of identified actors' roles in contract governance.

Role name* [Role ID]	Role description	Relation to governance tasks analyzed by Westerink et al. (2017)
ES seller [ESS]	Actors who are contracted (by ES buyers) to provide and sell specific ecosystem services (ES) targeted by the contract, typically farmers or other land managers	–
ES buyer [ESB]	Actors who are contracting other actors (ES sellers) and who act as buyers of the ES targeted by the contract (either as direct or indirect beneficiaries or on behalf of the actual beneficiaries, such as the government which acts as a buyer to secure specific ES for all citizens/society at large/the general public)	Contracting
Design [DES]	Actors who were/still are involved in the negotiation and the design of the contract, including the definition of environmental goals (targeted ES) and the possible measures to achieve them	Goal setting, scheme design, design of on-farm measures
Coordination [COO]	Actors who coordinate the efforts of other actors involved in the provision of the targeted ES, e.g. by supporting communication among farmers to choose measures which fit to their farm, but also complement measures chosen by other farmers	(Spatial) coordination
Recruitment [REC]	Actors who are involved in the recruitment of the targeted participants of the contract	Recruiting participants
Funding [FUN]	Actors who provide (public or private) funding for the contract	–
Monitoring	Actors who perform monitoring tasks at site, field or landscape scale	Monitoring results
Controlling/ Sanctioning [CON]	Actors who conduct random/ scheduled controls at site, field or landscape scale to verify that the contracted actors perform all agreed measures, and - in case of contract violations - are involved in the sanctioning of respective parties	Control
Reporting [REP]	Actors who are involved in the documentation and reporting of the environmental and other (economic, social) results/ outcomes of the contract	–
Evaluation [EVA]	Actors who are involved in the evaluation of the contract, where the outcomes of this evaluation have consequences for the continuation (or discontinuation) and the further design of the contract, e.g. for the next funding period	Evaluation
Advice/ Extension [EXT]	Actors who give advice/provide extension services to the contracted actor and/or other actors involved in the contract	Extension
Payment administration [PAY]	Actors who handle the administration of the payments	Payment
Spatial targeting [TAR]	Actors who are involved in the designating of priority areas in the landscape, where measures should be primarily allocated to maximize environmental effects	Spatial coordination
Knowledge [KNO]	Actors who are involved in knowledge provision, pooling, exchange and distribution	Organizing exchange/ learning
Advocacy [ADV]	Actors who speak in favor of, argue for, defend, or plead on behalf of other actors	–
Certification [CER]	Actors who are involved for developing product labels or for the certification of other involved actors	–

*Additional roles identified for this study are highlighted in bold.

then further distributes the payment to the farmers. This is called a 'front-door-back-door' approach in the Dutch cases (Terwan et al., 2016). For several cases an IT-system is used to assist the respective actor in performing this role efficiently (e.g. VVV-NL, NALI-NL, OG-NL, CP-DE).

Spatial targeting: For this role, actors from all governance levels can be important. At the national level, designation of priority areas to allocate certain measures is done mostly by public actors (e.g. NALI-NL, OG-NL). For regions with protected areas, the respective authorities are typically involved at the regional level (e.g. CMAEC-FR). And at local level farmers have a say in the choice and allocation of measures on their farmland (e.g. BEV-BE, MB-DE, BP-IR, CSFF-UK). Spatial targeting is correlated to the coordination role (Supplement 14).

Knowledge: By comparison, by far the most actors (92 out of the 179), from all societal spheres and governance levels, are involved in this role, helping in the provision, pooling, exchange and distribution of knowledge (n:1-relation). This holds true for all contract types.

Advocacy: The role of an advocate is mostly assumed by actors positioned at higher governance levels, either at regional, national, or even international level. A large number of civil, not-for-profit actors, like environmental NGOs (e.g. WWF for AFB-DE) perform this role, but also a number of lobby groups (e.g. farmers associations for BP-IR and MS-UK), or professional networks (e.g. Biodiversity in good company for NELA-DE).

Certification: This role is mainly relevant for the value chain contracts in regard to actor certification (e.g. MS-UK) and product labeling (e.g. AFB-DE, CQLP-FR) to be recognized among consumers. In our sample, actors assuming this role are mostly national actors.

'Multi-involved' actors (1:n-relations) taking on more than 10 roles include mostly civil actors (e.g. the contracting actors in collective contracts BEV-BE, CP-DE, NALI-NL, and OG-NL). Some actors are 'multi-involved' in several contracts, e.g. BoerenNatuur, involved in NALI-NL and OG-NL, also advises CP-DE, which copied the Dutch approach for a federal state in Germany.

Supplement 15 and 16 show which individual actors are engaged in which roles for each case.

6. Discussion

6.1. Discussion of results

6.1.1. Actors and their roles in contract governance

Our results show that innovative contracts tend to include a higher number and more diverse actors from different societal spheres and multiple governance levels (Fig. 2). This differs from 'mainstream' AECS contracts, where in most cases only farmers as private actors and governmental entities as public actors are involved. These findings are in line with other studies in environmental governance which also emphasize the growing role of non-state actors and the relevance of multi-level governance arrangements (Nasiritousi et al., 2016; Prip, 2020; Sattler et al., 2016). Advantages of this new mix of actors

discussed in the literature encompass, e.g. complementary skills, knowledge pluralism, access to additional resources, better leadership, increased accountability, creation of shared goals, trust-building, mutual learning, and higher acceptance of governance results (Armitage, 2007; Bodin et al., 2016; Ernstson et al., 2010; Folke et al., 2005; Newig and Fritsch, 2009). This can be confirmed for our study. For instance, in regard to knowledge pluralism when different actors contribute scientific, practical, or 'bureaucratic' knowledge (Edelenbos et al., 2011; Prager and McKee, 2015), or in view of improved access to funding when additional actors join for co-funding (Sattler et al., 2016). Challenges as discussed in the literature result from higher coordination efforts needed, especially if the number of actors is high (Westerink et al., 2017), or if there are several decision points that need to be passed before something can be agreed on (Newig and Fritsch, 2009). For our study, the former point mainly applies to collective contracts which showed the highest number of involved actors on average. The latter refers to situations where several actors share the responsibility for one role and who first need to deliberate with their affiliated organizations or groups before committing to something.

Our results regarding the different roles in contract governance complement the findings of other studies. Taking the 12 governance tasks listed by Westerink et al. (2017) as a point of departure, we identified five additional roles (Table 4), enlarging the initial set and also applying it beyond collective contracts. We also deviate from Westerink et al. (2017) by bundling 'goal setting', 'scheme design', and 'design of on-farm measures' together for the design role in the understanding that these tasks are too closely entwined to clearly differentiate based on the data we had available. We acknowledge that the roles that we distinguish for this study are just one possible way to define them (cf. de Haan and Rotmans, 2018; Hauck et al., 2020). For instance, de Haan and Rotmans (2018) analyzed actors' roles in regard to transformative change and identified 'frontrunners', 'supporters', 'connectors', and 'topplers'. In our study frontrunners could best be related to designers, connectors to coordinators, and supporters to most of the other roles such as recruiters, funders, or advisors. Topplers have no equivalent in our study and could possibly be related to actors who question AECS contracts per se as a suitable instrument to provide environmental public goods and instead rather promote command and control instruments. Westerink et al. (2017) arrange governance tasks into a sequence as part of a governance cycle. For our study this would make sense, if the process of contract design had also been part of the analysis.

Our results regarding which actors take up which roles expand on recent research looking at this aspect in detail. Westerink et al. (2017) differentiate public and private actors (the latter including civil actors as defined in this study), providing a detailed analysis only on their role in spatial targeting. So our results complement this analysis by looking into the additional roles. Mossberg et al. (2018) studied actors' roles for promoting development of new technologies in the energy sector, looking at science actors and consultants. For our cases, we can confirm involvement of science actors (e.g. VVV-NL, AFB-DE, NELA-DE). However, also involved NGOs or public agencies have in-house scientific experts who provide scientific knowledge (e.g. for MB-DE, CP-DE, SCaMP-UK). Prager and McKee (2015) then investigated the level of interaction for knowledge co-creation between farmers, policy and science actors, pointing out where communication could be intensified. For our study we can confirm that multiple public, private, and civil actors participate in knowledge pooling, sharing and distribution (Supplement 15). Our observation that multiple actors may play similar roles (n:1-relation), while one actor may play multiple roles (1:n-relation) is also stated by other authors (cf. Hauck et al., 2020; Mossberg et al., 2018). On the one hand, this may have negative effects as multiple roles of actors may increase transaction costs (cf. Leifeld and Schneider, 2012). This in turn could limit the participation of resource-poor actors in such contracts (Gallemore, 2017). On the other hand, it contributes to the resilience of the contract if several actors share a role (in-built redundancy) and can compensate for the loss of one actor. According to Neumann (2020) successful operations need to mitigate the risk of losing key trusted individuals. This might be particularly relevant for actors who perform several roles as such actors will be hard to replace with a similarly competent actor.

6.1.2. Possible impact on environmental public good provision

In this section we discuss how the roles we identified can potentially affect environmental public good provision. Firstly, spatial targeting is highly relevant, to make sure measures are allocated to most suitable areas in the landscape (Guo et al., 2020; Uthes et al., 2010). Secondly, monitoring is essential for adaptive management in order to learn what works and adapt measures or their spatial targeting accordingly (Boonstra et al., 2021). To boost learning and buy-in, farmers should be part of the monitoring activities (Prager, 2022). Further, evaluation is important to allow for an assessment whether the contract design needs adjustment. For instance, Boonstra et al. (2021) point out that some former key actors are not yet adequately involved in the new national Dutch AECS. Preferably, the evaluation involves an independent actor (e.g. BP-IR) as insiders may overemphasize successful aspects. Reporting, as a complement to evaluation, should invite all actor groups to contribute their perspective to detect challenges possibly only faced by some parties. Sharing monitoring and evaluation outcomes publicly can inform actors interested in replicating innovative contracts for their own context. Coordination seems vital to select measures that fit individual farms and make optimal use of farmers' knowledge. Coordination appears also important to make sure farmers' measures are synergistic at landscape scale, e.g. to cover enough area to make a difference for a specific ES or to have the necessary mix of measures to address all targeted ES. If the recruitment role is conducted well this can boost the number of participating farmers. If already involved farmers become recruiters (not the case in our sample) this might increase uptake even more, as farmers might trust judgment of their peers most (Barghusen et al., 2021; Sutherland et al., 2013). The knowledge role becomes more important when different knowledge types (e.g. practical, scientific, bureaucratic or administrative knowledge, cf. Edelenbos et al., 2011) need to inform decisions. Co-funding can add to the permanence of a contract: even when one funder decides to stop the funding, the contract can carry on, although maybe not with the entire area contracted before. Finally, advocacy can provide a direct link to policy possibly increasing chances that a contract could be rolled out more widely.

6.1.3. Possible social co-benefits

Although the ambition behind the four contract types is often primarily the aim of enhancing environmental benefits, contracts can certainly bring about social benefits as well. According to Mills et al. (2021), including social farm-level indicators into the monitoring for AECS is still rare. They suggest a number of indicators which serve as a proxy to measure farmers' relations and their willingness and capacity to engage. In our study, we show that farmers are involved in several governance roles (e.g. design, coordination, cf. Supplement 15), which may influence all three aspects positively. For instance, offering involvement in contract design likely increases farmer willingness to participate later on, while access to advice and training may increase their capacity to identify with the contract objectives. Furthermore, working together through role sharing supports trust building and strengthens social capital (Berner, 2021). The social benefits of farmers might be further increased by actors engaged in other roles, such as advocacy, helping farmers to make their voices heard in policy making (Yoder and Chowdhury, 2018). Contract involvement may also affect farmers' 'self-image', changing it from being primarily a 'food producer' to an 'ES producer', also improving their standing in society. Through the collaboration between different actors also traditional lines of conflict (e.g. between farmers and conservationist, cf. Meierová, 2020) can be replaced by new partnerships.

6.1.4. Importance of context conditions

Existing context conditions played a major role in the initiation of contracts. A total of 13 cases were initiated bottom-up by non-governmental actors, who saw a necessity for change. For instance, BP-IR was initiated by concerned locals to prevent the loss of traditional farming practices essential to support local biodiversity (cf. Dunford and Parr, 2020), QELP-FR was initiated by consumers who wanted to design their own products (cf. Renault, 2019), and BIOBO-DE was initiated to allow farmers continued access to land under the condition of ever increasing land prices (https://bioboden.de/). Also change in policy played a role, such as the introduction of the 'group option' (based on Regulation (EU) No. 1305/2013, Article 28) in the 2013–2020 CAP, allowing group applications for farmers and other stakeholders, which encouraged the Dutch national AECS as the umbrella program for NALI-NL and OG-NL (Terwan et al., 2016). Another example relates to protected areas (relevant for eight cases), as contacts need to fit with the land use restrictions already in place. Some contracts are specifically aligned to certain land tenure systems, such as common land ownership calling for a collective contract type (e.g. CMAEC-FR, cf. Hayes et al., 2019). This case also illustrates the challenge of aligning formal contracting with informal customary practices (Dodsworth et al., 2020). Also, current environmental challenges continue to shape existing contracts (e.g. one round of CSFF-UK funding specifically targeted flood management after a massive flooding event). Since all contracts have evolved in a unique setting of context conditions this naturally has also affected which actors took on which roles.

6.2. Discussion of the analytical approach

We acknowledge the following limitations to our analytical approach and choice of methods:

Grouping of contracts: For our analytical framework, we divide contracts into four contract types (result-based, collective, land tenure, value chain) based on key features in their institutional design. However, the assignment to the four types is not always straightforward, since contracts sometimes combine different contract features (Supplement 5, cf. Bredemeier et al., 2022). For such hybrid contracts, a separate investigation might be warranted.

Case selection: Since scientific literature usually lags behind several years in reporting on innovative contracts, our case identification is informed to a large extent by other sources, i.e. web search and expert consultation. However, gray literature and information cannot be systematically searched and data elicited from these sources are often less organized and publishing dates and entities are not always identifiable (Adams et al., 2016). Further, selected contracts in our sample do not cover the possible diversity across Europe. However, with our sample we took a first step in identifying common patterns in innovative contracts which further studies can build on. Given that currently several projects (e.g. EFFECT, CONSOLE, Contracts2.0, see footnote 2) explore innovative AECS contracts across Europe, the availability of literature on the topic will likely increase soon (e.g. Bredemeier et al., 2022; Nguyen et al., 2022; Olivieri et al., 2021).

Data collection: For data collection, we relied on help from experts who volunteered for interviews or agreed to fill in the data matrix for a specific case. Therefore, information for these cases was very detailed and up-to-date. However, we could not always find sufficient information on all variables or get to the most recent information. Nevertheless, considering several sources helped to validate collected data. It also helped that we worked with several data collectors per contract (Supplement 17), as this allowed us to discuss how to handle ambiguous data.

Data analysis: The chosen analytical approach was very time-consuming, e.g. researching and looking through the different collected materials (websites, reports, videos, etc.), addressing language issues, collating and analyzing the data. Also, the analysis mirrors the status-quo of the contracts at the point in time when data were collected and curated so some of the obtained insights might be already outdated.

7. Conclusions

The results of our in-depth analysis of 19 innovative contracts highlight that all contract types involve a greater number of actors from different societal spheres and governance levels than is the case with mainstream AECS. These actors perform a number of essential roles for contract governance either assumed by a single, experienced, actor in this role or several actors sharing the responsibility, making the contract more resilient when one actor drops out. Oftentimes one actor performs several roles making this actor very well-informed with a high capacity to address problems. The provision of environmental public goods can potentially be affected through all roles, but most relevant seem spatial targeting, coordination, monitoring and evaluation. The caveat applies that actors need to have a clear understanding of their role and are able to carry it out effectively without conflicts hampering the collaboration, especially when roles are shared. A number of social co-benefits are likely to emerge from the close interaction of actors through the contract. Exploring those co-benefits is still in its infancy. Context conditions have a strong influence on the emergence of innovative contracts and their respective objectives. In addition, they influence which actor steps up for which role/s based on existing working relations and networks.

Therefore, the added value of our research is twofold. For existing contracts, the analysis can help to point out possible leverage points for improvement, for instance when a critical role is still vacant (e.g. monitoring). It also may inspire the adoption or adaptation of certain features present in one contract for another one. For new contracts, the analysis provided insights into the mechanisms of the selected contracts, which can inform their design and encourage the participation of certain actors right from the start.

A remaining critical issue is linked to the question if innovative contracts, such as the ones analyzed in this study, can really help to turn things around and contribute to halting biodiversity loss or mitigating climate change, since many of the contracts are still on 'probation', have still a limited number of participants, and cover only small areas (Table 1). Monitoring and evaluation thus seems critical to confidently assess what makes a difference. Monitoring should also include contract-type specific aspects such as increase or decrease of bureaucracy and transaction costs for collective contracts (cf. Westerink et al., 2020), or the challenge around devising suitable indicators for results-based contracts (Birge et al., 2017; Burton and Schwarz, 2013; Chaplin et al., 2021; Herzon et al., 2018). In addition, since these innovative contracts are rolled out alongside other policy instruments, making sure they work in coherence with other CAP instruments is also a challenge (cf. Börner et al., 2017; Nilsson et al., 2012).

Nevertheless, such contracts currently receive much attention, and expectations are high that new schemes representing one of the innovative contract types live up to the promise of being more effective and efficient than mainstream approaches. This is evident, for example, in the first evaluation report of the Dutch national collective scheme (Boonstra et al., 2021), the evaluation report of the CSFF-UK (Breyer et al., 2021), or the Result-based payment network (https://www.rbpnetwork.eu), which brings together experience with result-based contracts.

We conclude that there is still a need for further research on actors and their performed roles in contract governance. In particular, we suggest exploring two avenues: Firstly, complementary to our snapshot analysis conducted for a concrete point in time, a process-based analysis would help to better understand how innovative contracts emerge and mature over time and how this affects actor composition and their assumed roles (Fischer and Newig, 2016), as would a comparative analysis to study how actors and their roles are affected after a major governance intervention (Westerink et al., 2017). Secondly, a transaction costs analysis (Schomers et al., 2015), differing between costs for

private and public actors, would be helpful to understand the relative distribution of costs across actors (e.g. for intermediaries assuming the coordination role, or higher costs through close-meshed monitoring) and to what extent this could be balanced (e.g. by involving volunteers such as birders to assist in monitoring activities).

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

We plan to publish the whole data set via the Zenodo 'research shared' platform (https://zenodo.org). Part of the data is now already included in the supplementary data file.

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Appendix A. Supplementary data

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