

Review Paper

Insights into innovative contract design to improve the integration of biodiversity and ecosystem services in agricultural management

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ABSTRACT

Innovative contracts are needed that promote the provision of biodiversity and diverse ecosystem services from land under agricultural production, given that mainstream agri-environment-climate measures (AECM) funded by the public purse have shown limited effectiveness. Recently, various actors from the public, private and third sectors have experimented with and implemented innovative contracts that incentivise farmers for the increased provision of environmental public goods alongside private goods. Due to their evolving and experimental nature, detailed information on characteristics of contract design and governance context of these contracts is lacking, hence preventing them from being used more widely.

This paper addresses this gap and reports the findings of an analysis of 62 cases, based on information from a literature review and complemented by expert knowledge. Following an actor-based typology, we identified innovative payments for ecosystem services (PES) as the most common contract type, followed by value chain approaches and very few land tenure contracts. Alternative classifications are possible, with hybrid contracts showing promising combinations of different contract characteristics such as basis of payment (action-based, results-based) and contract parties (collective or bilateral arrangements). The most innovative approaches were value chain contracts. They exhibited more tailored contracts between (single) producers and processors instead of the generic publicly-funded AECM, a stronger bottom-up approach to define the (mostly action-based) measures, and the interest of processors to use these activities for marketing purposes. In contrast, publicly-funded PES contracts appeared to be more innovative with respect to results-based payments rewarding the environmental performance of farmers, and providing them more flexibility and autonomy. Future research should focus on the benefits of such innovative contracts, e.g. with regard to costs and environmental effectiveness.

1. Introduction

Society increasingly demands that large-scale land users such as agriculture promote biodiversity and diverse ecosystem services (ES). This demand is promoted by policies like the Green Deal (European Commission, 2019) and the current change in the orientation of the European Union's Common Agricultural Policy (CAP).

Nevertheless, a discrepancy exists between the provision of private goods such as food and the provision of public goods such as biodiversity

or soil fertility from agricultural landscapes. Voluntary agri-environment-climate measures (AECM) are a key policy instrument to promote environmentally sustainable farming and, thus, to provide public goods. In the period 2015 to 2019, an average of 12% of the utilised agricultural area of the EU-28 was supported under payments for AECM commitments. This refers to an expenditure of approximately €12.7 billion (own calculation based on European Commission, 2022). Despite this high expenditure, the available evidence shows that the impact of AECM contracts is limited (Batáry et al., 2015; Kleijn et al.,

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2006). They are only partially successful, which means they are commonly neither effective nor efficient enough in the provision of environmental public goods (Dupraz and Guyomard, 2019; Ekroos et al., 2014; Pe'er et al., 2017).

This is mainly due to the current design of mainstream AECM in terms of the involved actors, the implementation level, as well as their design and implementation rules: i) Typically mainstream AECM contracts are concluded with individual farmers or land managers, neglecting other important actors in rural areas. For example, tenure relations are often decisive for the implementation of AECM (e.g., Defrancesco et al., 2007; Wilson and Hart, 2000), so it is important to also consider landowners as another relevant actor (Sikor et al., 2017). In addition, in order to implement more sustainable food systems, the involvement of actors along the value chain as well as consumers seems crucial as well (cf. UNEP, 2015). ii) Mainstream contracts are mainly applied to the field or farm level and have limited (if any) coordination at the landscape level, although the provision of biodiversity and many ecosystem services occurs at multiple scales than the field or farm level (Plieninger et al., 2012; Westerink et al., 2017). iii) Finally, mainstream contracts mainly rely on action-based, prescriptive measures. Although these can have fundamentally positive effects, they do not unfold their full potential because they are not sufficiently targeted, do not allow the farmers any flexibility in adjusting measures to their farm conditions and, thus, do not honor the farmers' knowledge (Armstrong et al., 2012; Mack et al., 2020; Reed et al., 2014; Uthes and Matzdorf, 2013).

To overcome the limited effectiveness of the current mainstream AECM contracts, new concepts are being discussed that address the aforementioned critical points. AECM can be considered one type of Payments for Ecosystem Services (PES). PES offer a promising alternative approach to deal with environmental externalities, complementary to regulatory approaches (Engel et al., 2008; Wunder et al., 2008). In the narrowest understanding, PES are developed from direct negotiations between ES providers and ES beneficiaries leveraging private money (Sattler and Matzdorf, 2013; Wunder, 2015). In the case of AECM, the government uses public money to pay the ES provider (i.e., the farmer or land manager) on behalf of the direct ES beneficiaries (Engel, 2016; Sattler et al., 2013). However, the success of these direct payments depends on the specific design of the underlying contracts – “The devil is in the details” (Engel, 2016). PES can therefore go far beyond the possibilities of mainstream AECM because they can enable improved targeting of environmental outcomes through results-based design characteristics (i.e., remunerating the land manager based on measurable outcomes, e.g., Matzdorf et al., 2008; Russi et al., 2016) or through collective design characteristics (i.e., coordinated management at the landscape level, e.g., Prager, 2015; Westerink et al., 2017).

In addition to the direct payments applied in the PES approach, other options to incentivise the provision of biodiversity and ES have emerged. Value chain contracts can be used to incentivise the provision of environmental public goods by, for example, a processor or manufacturer concluding arrangements with the farmer or producer that reflect the consumers' desires (cf. Manyase and Dentoni, 2021; Opdam and Steingröver, 2018). Furthermore, adopting approaches that link land tenure conditions to environmental outcomes is an additional option to contractually stipulate incentives (cf. Tseng et al., 2021). For example, a landowner may contractually require the tenant to comply with certain management requirements like waiving of agrochemicals (e.g., Perrot-Maitre, 2013). In return, long-term and secure contracts often lead to land investments providing benefits for nature and human well-being (Robinson et al., 2018), e.g., through a more sustainable use of natural resources (cf. Katusiime and Schütt, 2020; Leonhardt et al., 2019).

In parallel to these strictly contract-related advances, so-called soft factors are becoming increasingly important, such as an enabling environment (cf. Piñeiro et al., 2020) that provides the necessary framework conditions. Such an enabling environment includes, for example, factors that increase the willingness of farmers to participate in the approach (e.g., Dessart et al., 2019), a well-established, trusted network of actors (e.

g., Molina et al., 2021), or a good reputation of the farmer in society (e.g., Braitto et al., 2020; Rex, 2021).

Thus, it is the interplay of many different factors that contributes to improved approaches in the provisioning of environmental public goods. However, such improved contracts that involve additional actors and promote co-learning and co-design processes, are rarely implemented. Thus, recent work has turned to the question of innovative contract design (cf. Olivieri et al., 2021; Opdam and Steingröver, 2018).

We define ‘innovative contracts’ as contracts or contractual arrangements that “incentivise farmers for the increased provision of environmental public goods alongside private goods” (Prager et al., 2020: 2), but that are experimental and deviate from mainstream AECM as described above, either in their characteristics, the (re)combination of their characteristics, or their implementation including contract governance.

However, due to their evolving and experimental nature, detailed information on innovative contracts is lacking, i.e., the configuration of their characteristics, which could make them a widely used instrument to promote environmentally sustainable farming, is largely unknown. To shed light on these contracts, we focus on the question:

What types of contracts and features are most widespread, what insights can we gain for their classification and which new combinations of features are promising?

Based on a literature review and expert knowledge, we identify a comprehensive set of innovative contract approaches from the fields of PES, value chain and land tenure. In particular, value chain and land tenure approaches have been less systematically considered in the context of environmental public goods provision. However, against the backdrop of more sustainable production and supply of agricultural products, value chain and land tenure approaches are going to play an important role in the new CAP period (cf. ENRD, 2022). Therefore, we provide an overview of the different innovative contracts that are currently being tested and piloted and classify them according to typical features. This allows us to make statements about i) which types of innovative contracts and respective features are most prevalent, and ii) which aspects should be considered when developing innovative contracts, especially from a policy and practice perspective.

2. Material and methods

We generally defined a contract as a formal, written agreement for a specified duration signed by (at least) two parties, one party seeking to purchase something that the other party can produce or offer. The beneficiary (public or private) represents the demand side, while the farmer or land manager as the provider of ES represents the supply side. We searched for formal contracts, but also included informal arrangements if they played a central role in the support of ES provision (e.g., additional support to the farmer from a processor by providing seed for flower strips).

2.1. Case and data collection

The basis for the case collection was a standardised literature search using Web of Science. Search terms included the key terms for the different contractual approaches and variations thereof. A list of used search terms can be found in Supplement 1.

The search was restricted according to the following criteria: i) records were limited to the period 1992 (MacSharry reform) to 2020, ii) only peer-reviewed articles were included, i.e. editorials, letters to the editor, short communications, meeting abstracts and congress communications were excluded, iii) articles were restricted to those published in English, iv) the geographical scope was limited to European countries.

The formal case and data collection process followed [Fink \(2010\)](#) and [Moher et al. \(2009\)](#). In a first step, more than 3,000 peer-reviewed studies were gathered through the screening based on the formal quality criteria ([Fig. 1](#)). In a second step, we then reviewed the titles, abstracts, and finally full texts for a further reduction of the retrieved materials, only including articles that satisfied the following criteria: i) The studies had to deal with topics related to enhancing biodiversity and ES in agricultural management, and ii) contain details on contractual design that stand out from mainstream contracts, i.e. specifically looking for innovative features such as collective, result-based, value chain or land tenure based elements. As a result of this content-based qualitative screening the majority of the initially identified records had to be excluded, because they did not conform to the specified criteria.

Due to their evolving and experimental nature, innovative contracts are still rarely described in-depth in academic publications. Associated research has a publication lag of several years. Therefore, we also reviewed other relevant sources, including grey literature, relevant websites, such as those of the Operational Groups of the European Innovation Partnership for Agricultural productivity and Sustainability (EIP-AGRI, [n.d.](#)), and expert knowledge from research partners of the project Contracts2.0 (<https://www.project-contracts20.eu>) and their networks.

Finally, the combined case search of peer-reviewed and grey literature, websites and expert knowledge identified 62 cases from 48 records that met all our search criteria ([Fig. 1](#)). Thirty-one cases originate from the literature (peer-reviewed and grey) and websites, 31 cases originate from expert knowledge. The complete list of cases can be found in [Supplement 2](#).

2.2. Selection of characteristics and criteria

Contract characteristics and criteria to classify the contract examples were taken from literature reviews. We focussed on two sets of characteristics: i) characteristics relating to the contract itself, i.e., contract design features and ii) characteristics relating to contract governance and the wider policy framework ([Table 1](#)). These criteria were mainly derived from studies of classifications of PES schemes (e.g., [Grima et al., 2016](#); [Mayrand and Paquin, 2004](#); [Sattler et al., 2013](#); [Wunder et al., 2008](#)).

Contract design characteristics are contract-specific features regarding the content of a contract. They mainly concern two criteria:

Table 1

Contract design and contract governance characteristics.

| Criteria | Specifications |
|--|--|
| 1. Contract design characteristics | |
| Contract type | PES/AECM; land tenure (LT); value chain (VC) |
| Main objective of the contract | Biodiversity enhancement; flood management; sustainable food production; water quality enhancement |
| Basis of payment | Results-based; action-based; hybrid |
| Involved contract parties | Individual; collective |
| Collective implementation | Farmer-to-farmer collaboration; coordination of individually implemented practices |
| Contract initiation | Bottom-up; top-down; hybrid |
| Spatial scale | Local; regional; national; international |
| Temporal scale | Short-term (≤ 5 years); mid-term (> 5 to ≤ 10 years); long-term (> 10 years) |
| Option for extension | Yes; no |
| Type of funding | Public; private; hybrid |
| Contractors | Public; private; hybrid |
| Type of land use agreement | Covenant; easement |
| Targeted environmental medium | Water; soil; biodiversity; other |
| Targeted ecosystem service type | Provisioning; regulating; cultural; supporting/biodiversity |
| Target achievement of contract | Indicators to measure target achievements |
| 2. Contract governance and wider policy framework | |
| Advice and type of advice | Administrative; technical; content |
| Actor type which provides advice | Governmental; non-governmental; entrepreneurial |
| Main governance type for institutional setting | Governmental; non-governmental; entrepreneurial |
| Environmental monitoring | Self-monitoring; third-party monitoring |
| Institutional setting in case of third-party monitoring | Public; private |
| Motivation | Economic; environmental; social; ethical |
| Tenure system | Private; communal; open access; state |

the basis of payment and the contract parties directly involved. For the first criterion, the question of result-based or action-based payments is of key interest. In action-based approaches, payments are bound to a predefined action or measure, i.e., farmers are paid for implementing specific land management practices such as the restricted use of fertiliser or the adherence to specific mowing dates ([Burton and Schwarz, 2013](#); [Derissen and Quaas, 2013](#)). Within the scope of results-based approaches land managers are paid for achieving concrete environmental outcomes, such as the presence of particular species ([Burton and](#)

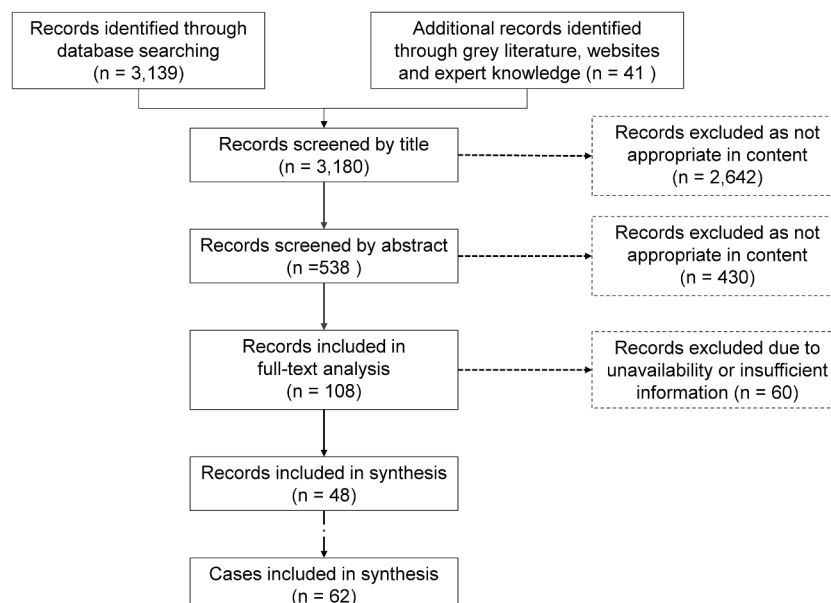


Fig. 1. Flow diagram for standardised case collection.

Schwarz 2013). In practice, there are also approaches that show variability in these characteristics, i.e., they combine specifications of certain features, for example, action-based schemes with result-based top-ups (Burton and Schwarz, 2013; Herzon et al., 2018).

The second criterion reports on the contract parties involved. Contracts can either be arranged individually, i.e., bilateral contracts between a farmer or land manager and the paying party, or collectively, i.e., between a group of farmers or land managers and the paying party or a group of payers. For example, a value chain contract may involve a group of farmers and a single retailer, as well as several contract partners along the value chain (processors, market distributors, consumers) (Prager et al., 2020).

Other criteria concern the contractor (i.e., the provider of a service, ES seller), the source of funding and the spatial and temporal scale of implementation since both may influence the outcome (Christensen et al., 2011; Grima et al., 2016; Sattler et al., 2013). We also analysed the individual or bundles of ecosystem services being targeted. According to the Millennium Ecosystem Assessment (2005), we distinguished ecosystem services as follows: provisioning (food, fibre), regulating (water, carbon), cultural (landscape aesthetics, recreation), and supporting (biodiversity, habitats).

As a final criterion, we analysed the indicators used to measure the target achievement of a contract. The target achievement reports on certain outcomes resulting from the contract. This criterion has an exploratory character, as the descriptive indicators can be highly variable. We included both socio-economic and environmental indicators. For example, indicators could be the demands of different social actors being met (cf. Mills et al., 2021), or the state of the environmental resource in question.

The **contract governance and the wider policy framework** are described by criteria concerning mainly the socio-economic and the environmental context of a contract. Contracts connect human action with natural production processes. Together they generate bundles of goods and services (Deal et al., 2012; Raudsepp-Hearne et al., 2010). Therefore, it is important not only to map design characteristics of the contract itself, but also characteristics that reflect the interaction within an enabling environment in which the contract is embedded, which is necessary to generate environmental public goods and ecosystem services. This interaction is important for land managers to decide whether to enter into a contract. Design characteristics that describe this interaction include, for example, the type of other actors involved in the implementation of a contract, logistics such as advice and environmental monitoring (Wilson, 1997), the actor's motivation such as interest in nature (Herzon and Mikk, 2007; Poppenborg and Koellner, 2013), or the tenure system that determines who can use what resources for how long, and under what conditions (FAO, 2002).

As contractual approaches to promote biodiversity and ES are complex, we do not deem the list of characteristics (Table 1) exhaustive, but aimed to capture the key characteristics of contract design and governance. For a definition of all the characteristics shown in Table 1, see the associated data set provided in Bredemeier et al. (2021).

The analytical criteria were applied to all 62 cases. The information needed to characterise the contract types according to the criteria was completed on the basis of expert knowledge, related websites, and available literature.

2.3. Description of contract types

The results of the analysis could be presented by any of the criteria derived in Section 2.2. We opted for distinguishing contract types by the actors involved, as this is a common approach in literature.

This resulted in three types of contracts: PES-type contracts, value chain-type contracts, and land tenure-type contracts (cf. Prager et al., 2020). For illustration, we provide an innovative example for each type in Boxes 1 to 3.

1. PES-type contracts exist between farmers/land managers as ES

providers/sellers (supply side) and ES beneficiaries as ES buyers (demand side). The contracting parties can be either directly involved in the contract, or indirectly (then another actor pays on behalf of the direct beneficiary). The underlying aim is to create a quasi-market for certain non-provisioning ecosystem services (regulating, supporting, or cultural) for which no functional market exists so far.

2. A Value chain (VC)-type contract involves additional actors from the demand side such as food processors, retailers, and consumers. This is due to the fact that here mostly the non-provisioning ES are jointly sold with a particular provisioning ES as a commodity (e.g., food, fiber, water) for which well-functioning markets already exist. The non-provisioning service itself is rarely marketed. Parts of the ES that are jointly produced with the sold commodity are often communicated via a product label.

3. A Land tenure (LT)-type contract incorporates additional actors from the supply side. Often this is the landowner, based on the ownership and related property rights regime that apply to the land on which the ES provision is realised. Contracts (land tenure agreements) then exist between landowners and land managers (where landowner and land manager are identical, the PES-type contract applies). The specification of which non-provisioning ES should be produced from the contracted land is then often an integral part of the land lease agreement.

In addition to the three pure contract types, hybrids can occur. Hybrid contracts refer to contracts that combine design and contract governance characteristics from across the three contract types. This means they do not clearly fall into one of the categories, but may exhibit mainly characteristics of one type while also featuring characteristics of another type. An example would be the combination of a value chain (VC)-type approach with a specific land lease agreement as typical feature of land tenure (LT)-type approaches.

3. Results

We analysed 62 cases from 14 countries. Thirty-two cases were classified as PES approaches, 16 as VC approaches, and two as LT approaches. In addition, hybrid forms of the defined contract types were identified. Seven of the cases examined were a hybrid of PES and VC, three a hybrid of LT and VC, and two a hybrid of PES and LT. The full list of analysed cases can be found in Supplement 2.

The following description gives a broad overview of selected characteristics of the different contract types. The mentioned percentages refer to the respective sample size. They do not always correspond to the total number of cases identified for a contract type, as it was not possible to determine corresponding information on all characteristics for each case.

For further details on contract design characteristics and elements of contract governance and the wider policy framework, see Supplement 3 and 4. For a detailed definition of the individual design characteristics and their specifications (e.g. landscape context features), see Bredemeier et al. (2021).

3.1. PES-type approaches

Considering the basis of payment, the PES contracts were mainly of the hybrid type, in which predefined measures are combined with payments for results (38%, Fig. 2a). Thirty-four percent of the approaches paid according to the specified results and prescribed non-management actions. In 28% of the cases, there were exclusively action-based payments.

The contracts were mostly concluded individually (53%). Forty-seven percent involved a group of farmers that worked collectively. Twenty-seven percent of these collectively implemented contracts were

BOX 1

PES-type example BoerenNatuur, the Netherlands.

In 2014, the Dutch government decided to only allow joint applications for AECM from 2016 onwards, i.e., a collective approach. 160 already existing environmental collectives merged into 40 collectives, all established as legal entities and certified as professional conservation organisations (Terwan et al., 2016).

The collectives are regional groups of farmers, and sometimes other land managers such as environmental organisations and local authorities that have voluntarily implemented agricultural nature and landscape management (Wiskerke et al., 2003). The Dutch national organisation BoerenNatuur represents all 40 collectives in the Netherlands (BoerenNatuur, n.d.). Each of the collectives works in a delimited area, ranging from a whole province with more than 1,000 farmers to smaller areas with around 150 farmers (BoerenNatuur, n.d.). The collectives are managed by a board, with members elected based on their knowledge and professional network.

The collective approach can be described as the “front door – back door principle”. The government signs a contract with the collective. In this front door contract, the agri-environmental targets and the AECM that the farmers can implement are described. The collective enters a contract with each farmer individually, the so-called back door, describing specific AECM and payment levels. The length of the contract is six years (Terwan et al., 2016).

The government sets national environmental targets and a broad range of AECM and payment levels is offered from which the collectives can select. The province allocates the budget to the collectives, based on conservation priorities and number of collectives within the province. The collective is responsible for most of the implementation work. It prepares management plans, aims for spatial coordination of AECM and provides guidance to the farmers. The collective assesses the implementation of the AECM by the farmer on a yearly basis and communicates with the national Payment Agency (RVO, n.d.; Terwan et al., 2016).

BOX 2

Value chain-type example Neumarkter Lammsbräu, Germany.

Neumarkter Lammsbräu is an organic beverage producer based in Neumarkt, Bavaria. Its main objectives are the careful use of resources and a strong promotion and exclusive use of organic raw materials to create a sustainable value chain (Neumarkter Lammsbräu, n.d.). This makes the protection of soil, water and biodiversity the main focus of their operational commitment. As early as 1977, the family-run, medium-sized company established its own environmental guidelines, which it continues to develop and implement on a daily basis.

The supply chains of Neumarkter Lammsbräu are characterised by long-standing and trusting cooperation at eye level, which enables a high degree of transparency and reliability. This partnership-based approach is fixed in the company's corporate and procurement policy. Lammsbräu tries to source the raw materials for its beer production exclusively from an organic producers' association of farmers whose land is located in the Neumarkt region.

The beverage producer concludes a framework agreement with the producers' association, which binds the individual farmers. In addition, an individual contract is signed with each farmer for the yearly quantity of hop to be delivered.

Each year, Neumarkter Lammsbräu finances a nature conservation plan for two members of its organic producers' association. The plan is tailored to the respective farm and designed for several years. The implementation of the plan is supported by Bioland consultants. In addition, Neumarkter Lammsbräu offers training and education to its farmers. Environmental monitoring and control take place through regular on-site audits carried out on the farms of the producers' association.

based on a farmer-to-farmer collaboration (see Supplement 3). The majority built on the coordination of individually implemented practices. Nearly all of the collective contracts were “quasi collective”. This means that areas were managed collectively to reach a defined target, but the underlying contracts were individual. For example, in the Dutch collective approach (Agrarische Natuurvereniging Oost-Groningen and Natuurrijk Limburg), the province concluded an agreement with a cooperative and, in turn, the cooperative entered into legally binding contracts with each farmer individually. This was also the case for the Söne Mad Grazing Association (Sweden) and the Blackstairs Farming Futures (Ireland). Only in the case of Hautes-Pyrénées (France) we found a farmer-to-farmer-collaboration with genuinely collective contracts where the group as a collective entity is the legally responsible contract partner.

The funding of the PES contracts was mainly public (81%). This is because our review included many AECM approaches. These AECM approaches also had a limited duration due to funding periods under the CAP. Therefore, the considered contracts were primarily short-term arrangements (69%) with a duration of less than five years. Long-term

contracts with a duration of more than ten years were scarce, with only one example, the AUBI project in Germany. However, also 50% of the contracts had an option for extension (see Supplement 3).

The PES contracts were either top-down (50%) or bottom-up (44%) initiated (see Supplement 3), so no obvious pattern could be derived here. Cases with a clear bottom-up structure were, for example, the BRIDE project (Ireland) or Agora Natura (Germany). The spatial implementation level of these contracts was mainly local to regional (see Supplement 3).

The main objective of the PES approaches was biodiversity enhancement, predominantly associated with the protection or support of specific species or habitats (63%, see Supplement 3). In addition, two-thirds of the approaches listed various ES bundles they aim to promote (Fig. 2a). These were regulating services (25%), but also cultural (18%), and provisioning services (13%).

Concerning the contract governance and wider policy framework (Fig. 2b), the institutional setting was mainly governmental (41%) or a hybrid form of governmental and non-governmental elements (41%). A purely non-governmental setting was rare in PES approaches (18%), and

BOX 3**Land tenure-type example BioBoden, Germany.**

The main objective of the BioBoden initiative is to secure additional land for organic farming in Germany (BioBoden Genossenschaft, n.d.). BioBoden was founded against the background that many farmers in Germany have to give up their farms because farming is becoming uneconomical for them, or because they cannot find a successor for their farms. At the same time, many young farmers lack both the land and the means to take over an existing organic farm or to start their own. So BioBoden acts as an intermediary, bringing both parties together. Land is secured either by buying single plots or whole farms. The land or farm is then either sold or leased on a long-term basis to farmers who have to commit to organic farming according to the guidelines of one of the German umbrella organisations. Farmers who lease or buy land become part of the nationwide network of partner farms, which currently involves 65 farms from all over Germany. Farmers can get advice on converting their farms from conventional to organic farming. BioBoden also invests in environmental education through various communication channels.

BioBoden was created in 2015 as a cooperative which is financed through open memberships. These can be acquired by individuals, as well as private and public organisations. The governance structure is made up of an elected management board and supervisory board, complemented by the general assembly of all members, so that the latter can participate in the decision-making processes.

In accordance with the objectives of organic farming, targeted public goods include biodiversity and habitat conservation, as well as water- and soil-related ecosystem services, including climate regulation.

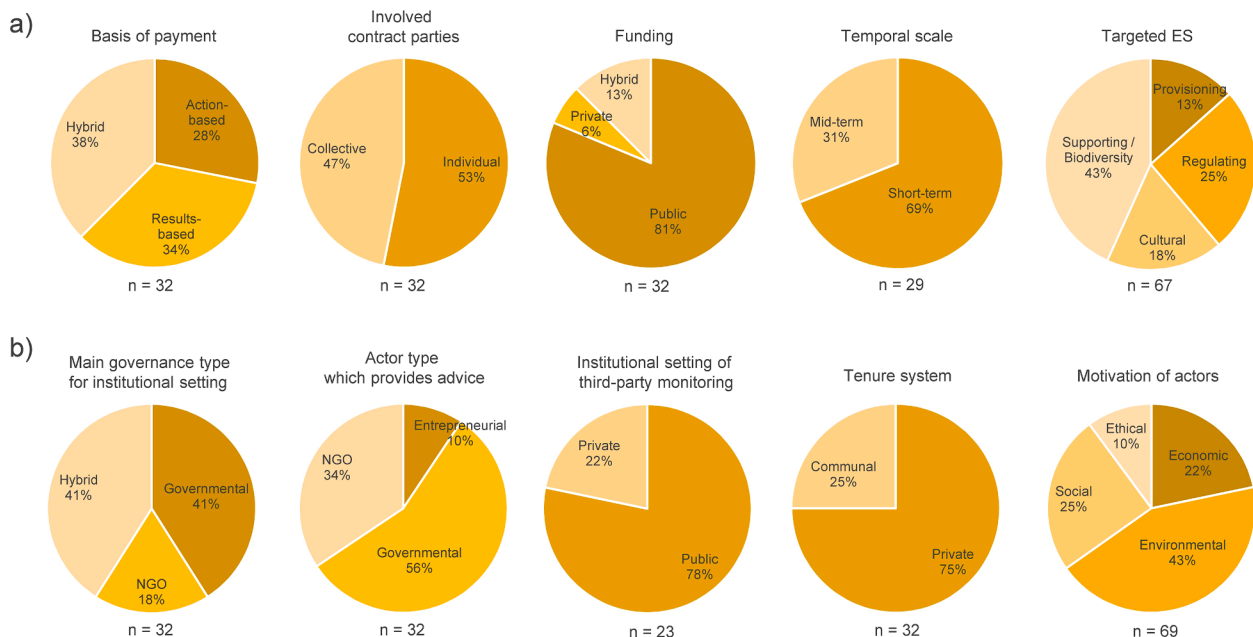


Fig. 2. a) Main design characteristics of PES contracts, b) Main characteristics of PES contract governance and wider policy framework. (The total sample size of the respective characteristic is set to 100%. NGO = non-governmental organisation).

the connection with entrepreneurial activities occurred only in very few cases (9%, see [Supplement 4](#)). Advice was offered to the contractor in 97% of cases [Supplement 4](#). This advice could be both administrative, technical and content-related. However, content-related advice was most common (75%, see [Supplement 4](#)). The advice was mainly provided by governmental institutions (56%, [Fig. 2b](#)). Monitoring was mainly a mixture of self-monitoring and third-party monitoring. In the case of third-party monitoring, this was mainly offered by public bodies (78%). The underlying tenure system in the PES approaches reviewed was mainly private (75%), i.e., the contract and thus the assignment of certain rights was concluded with a private party ([FAO, 2002](#)). Considering the motivation across all actors involved, it was predominantly environmentally (43%), but social (25%) and economic factors (22%) also played an important role.

3.2. Value chain-type approaches and related hybrids

The value chain (VC) contracts were mainly characterised by action-based and hybrid financing: 44% were rewarded on the basis of prescribed management actions, 38% represented hybrid forms of action- and results-based payments ([Fig. 3a](#)). Pure results-based remuneration plays only a minor role (19%). As in the case of PES, the contracts are mainly individually arranged (56%). However, 44% of the contracts are collectively designed. This is particularly true when small-scale farming structures and direct marketing play a role, as in the case of Nature et Progrès (France). Both farmer-to-farmer-collaboration and coordination of individually implemented practices occurred in the collectively designed cases (see [Supplement 3](#)). However, as for PES approaches, these collective arrangements are “quasi collective” because the underlying contracts were bilaterally agreed with farmers.

The funding was exclusively private (100%, [Fig. 3a](#)), as food processors were the ES buyers. The contractors were predominantly private

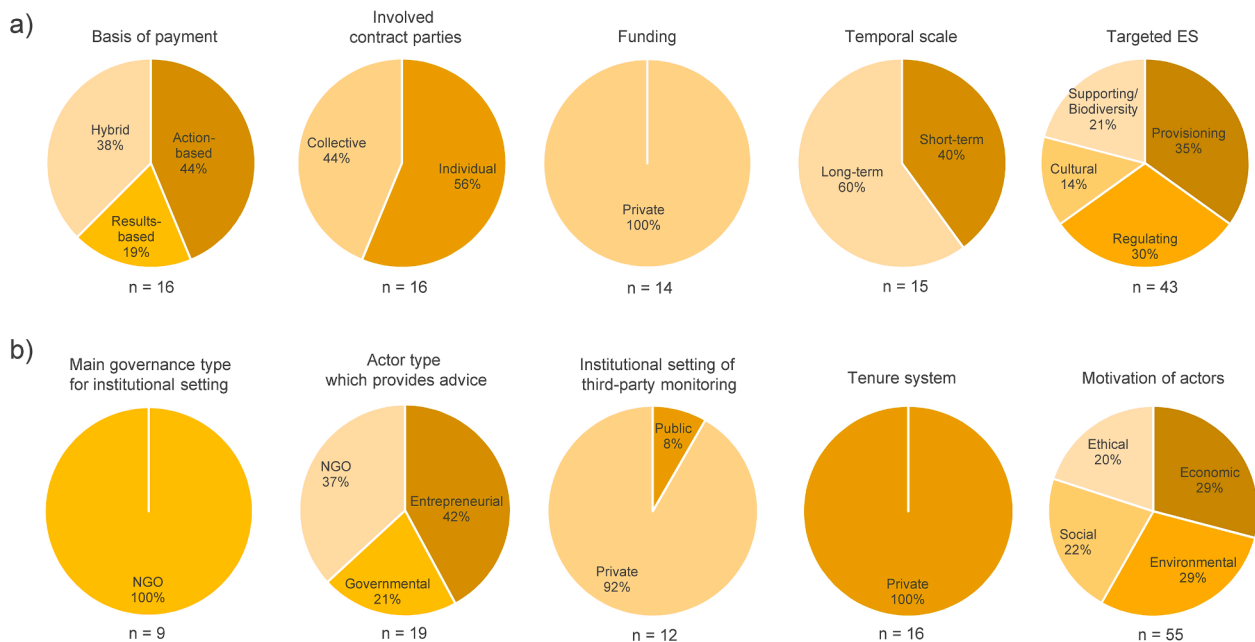


Fig. 3. a) Main design characteristics of value chain contracts, b) Main characteristics of value chain contract governance and wider policy framework. (The total sample size of the respective characteristic is set to 100%. NGO = non-governmental organisation).

(92%), i.e., farmers. The VC contracts were either long-term with a duration of more than ten years (60%), or short-term (<5 years) and adapted to supplier contracts and purchasing conditions (40%). Mid-term contracts did not occur in the cases examined. All contracts had an option for extension.

The VC approaches were almost always bottom-up initiated (94%). Their implementation level varied considerably and ranged from local and regional approaches, as in the case of the „Dobrze” Food Cooperative (Poland), to global approaches, as in the case of HiPP (Germany) (see [Supplement 4](#)).

The main objective of the VC approaches was sustainable food production and was not related to the protection or support of specific species or habitats. Here, the ecological objective referred almost exclusively to bundles of ES being traded together with the raw materials. The targeted ES were, therefore, mainly provisioning (35%) and regulating services (30%) ([Fig. 3a](#)).

Where information was available, the institutional setting was exclusively non-governmental ([Fig. 3b](#)) and associated with entrepreneurial activities (see [Supplement 4](#)). Entrepreneurial activities played only a minor role in PES approaches. For all cases providing information on this, advice was offered to the contractor. This advice was mainly technical and content-related (92%) and mainly provided by entrepreneurial organisations (42%). As in PES, monitoring was mainly a mixture of third-party monitoring by private bodies (92%) and self-monitoring.

Unlike PES contracts, the motivation of the involved actors to participate or set up a scheme was mostly guided by economic and environmental considerations (both 29%, [Fig. 3b](#)). Overall, the different aspects of motivation are more evenly balanced in the VC cases considered than in the PES contracts, where, for example, ethical motivation plays a rather minor role.

We also found hybrid approaches that linked characteristics of VC approaches with those of PES. Examples were the Augsburg Catchment Model (Germany) and Upstream Thinking (United Kingdom). Typical characteristics of VC contracts that we found in the hybrid examples were action-based payments, individual contracts, bottom-up initiation and a predominantly non-governmental institutional setting (see [Supplement 4](#)). The funding was a mixture of private and public financing, indicating the influence of PES approaches.

In all VC/PES hybrid approaches, the contractor was offered advice, mostly by NGOs. However, advice was also provided by entrepreneurial organisations. These were an essential element of the VC contracts, but played a minor role in the pure PES contracts. For further details on VC/PES hybrid approaches, see [Supplement 4](#).

3.3. Land tenure-type approaches and related hybrids

We identified two pure land tenure (LT) approaches, BioBoden (see [Box 3](#)) and Fairpachten (both Germany). It is, therefore, difficult to derive common criteria for this contract type. Nevertheless, some tendencies can be mentioned.

The selected LT approaches were both bottom-up initiated. The land use agreement was a covenant, defined as contractual obligations that relate to the ownership and/or use of the land (cf. [Youngman, 2001](#)). Funding was exclusively private, as well as the underlying tenure system. The ecological objectives of these approaches were very broad and mostly linked to different bundles of ES and environmental media such as soil or water (see [Supplement 3](#)). The main institutional setting for this contract type was non-governmental.

We also found hybrid approaches that linked characteristics of LT approaches with those of VC or PES. When linked to VC, action-based characteristics became more important and individual contract design was spotlighted. However, the decisive factor was the added land use agreement that pure VC approaches did not provide. These agreements were exclusively based on covenants. In all LT/VC hybrid cases, administrative, technical and content-related advice was offered. As in the pure VC approaches, the advisory services were mainly provided by entrepreneurial organisations, third parties carried out monitoring. The institutional setting remained mainly non-governmental, but included entrepreneurial aspects, e.g., the case of Vittel that involved market interests and marketing strategies ([Perrot-Maître, 2013](#)).

When linking LT and PES approaches, the collective characteristic became more important and the initiation was rather bottom-up. As in the case of LT/VC hybrids, a land use agreement in the form of covenants was added. While the contractor remained private, the funding became predominantly public.

4. Discussion

The discussion will link to the research question and look at the distribution and abundance of types, the usefulness of the classification and the findings on innovative combinations of contract features. In addition, brief assessments of the policy implications will be given.

4.1. To what extent does the review provide an overview of current contract types?

The starting point for this study was the need to collate an overview of existing innovative contractual approaches that regulate the provision of ES in agricultural systems. Such an overview was missing, but can inspire different ways to overcome the limited effectiveness of the current mainstream AECMs as described in the introduction.

Overall, we found that it is predominantly the long-standing, mainstream approaches that have been documented and discussed in the literature. The dominance of these approaches is also illustrated by the extent to which these mainstream approaches are supported by the CAP (approx. €12.7 billion for the period 2015 – 19; [European Commission, 2022](#)). In contrast, innovative and more experimental approaches could hardly be found. Nevertheless, it was possible to describe basic characteristics of the three selected contract types and highlight overlaps between them. To find information on innovative approaches, it was necessary to draw on expert knowledge in the form of grey literature, websites and written information. This may have led to a selection bias, i.e. a slight over-representation of cases from certain countries where the project researchers have good contacts. However, this allowed us to identify exceptional contracts that show innovative characteristics but have not necessarily proven themselves in practice over a longer period. In this respect, the combination of information gathered from literature and experts was well suited for the goal to identify innovative contract approaches and provide an overview of their characteristics.

4.2. Insights on the classification of contracts

The three contract types referred to in this study had been derived theoretically and are described in [Prager et al. \(2020\)](#). We had chosen to distinguish contract types based on the actors involved. Even though the resulting types PES, VC, and LT proved helpful in structuring the analysis of identified contracts, we acknowledge that there are many more possible ways of classifying contracts. A key insight was that many contracts are hybrids across the pure types, i.e., they combine different design and contract governance characteristics in various ways. This reflects the respective context of the situation on the ground (especially concerning action- and results-based contracts), as well as the needs and capacities of actors involved. Hybrids would have been frequent even if a different typology had been adopted. The strong occurrence of the hybrid variants indicates that, in practice, different combinations are flexibly chosen depending on the local situation to address the existing problems in a way that is supposed to be as appropriate as possible to the situation. Despite hybrids and overlapping tendencies, the three contract types give a first orientation and make the discussion about contracts easier. For example, the distinction of collective and bilateral design of contracts can be found among all three contract types. A large number of the collective contracts are “quasi collective”, i.e., areas are managed collectively to reach a defined target, but the underlying contracts are individual ones (e.g., as shown for the Dutch collective AECM, see Box 1 and [Section 3.1](#)). We found only one case with genuinely collective contracts that provide for close farmer-to-farmer-collaboration, where the group as a collective entity is the legally responsible contract partner (Hautes-Pyrénées, France).

We found that the most frequent types – the innovative PES and the VC approach – show clear differentiation. While the VC approaches focus on sustainable food production and the predominantly private funding is action-based, the innovative PES approaches have mainly a

results-based or hybrid remuneration, are based on public funding and focussed on biodiversity. Another difference is that VC contracts are more often bottom-up oriented, and advice is more widely used as a supporting mechanism. In the literature, PES are described as being directly negotiated between ES providers and beneficiaries with private money ([Sattler et al., 2013](#); [Wunder, 2015](#)). In practice, however, government-funded PES are more common ([Opdam and Steingröver, 2018](#); [Schomers and Matzdorf, 2013](#)). To resolve the contradictions between the (economic) literature and the examples found, further analysis would have to pay even greater attention to expert-based information on recent approaches outside the mainstream.

The combinations of the different characteristics of the contract types can also be fuzzier and thus, **hybrid** contracts arise, with combinations across the three types (see description of hybrids in [Section 2.3](#)). Thus, they can partly overlap or even merge into each other. This phenomenon could be due to the fact that the examples were analysed in aggregated statistical form and therefore, specific details did not emerge. To follow up on these individual characteristics, it would be necessary to look at the examples in more detail and, if necessary, to ask the authors of the cited studies directly, as many descriptions for some characteristics remained vague.

Within one contract type, there can also be a wide range of expressions of the characteristics examined. For example, the VC contract of HiPP refers to many different agricultural raw materials sourced nationally or from abroad, whereas in the ALB-GOLD example, only one raw material - durum wheat - is the subject of the contract. In the latter case, it is much easier to agree on appropriate measures to promote ES and to monitor the results. Another point is that, especially in the VC contract type, the additional provision of ES by the producers is often not regulated in the contract itself but is promoted by voluntary services that the processors provide (e.g., free provision of fruit trees or hedge material). Here, the question arises, whether the producer receives an additional compensation of lost income or an additional reward for top-up activities, which consist of measures going beyond the implementation of regulations, for example, those of organic farming. A crucial question is, therefore, which role the additional consideration of ES plays in the contracts. In addition, the support measures provided to the farmers by the enterprises in the VC examples are mostly site specific or offered as a bundle from which farmers can choose.

4.3. Insights for developing innovative contracts

On the one hand, the review confirms previous findings by other authors from recent years (e.g., [Boonstra et al., 2021](#); [Guerrero, 2021](#)), but on the other hand it has also brought new insights regarding the features that are the critical ones for innovative contracts. Firstly) a **trusted network of actors** is essential. This has been evident in contracts relating to landscape-based measures or collective forms of measures that require a larger number of farmers to work closely together, or in the case of private contracts (VC or LT), where farmers are given great freedom in the execution of the measures or even co-design the measures. Secondly) the **implementation level** should include the **landscape**. This is especially important for PES and LT to achieve the most efficient output for the support of ES, because for the provision of many ES it is insufficient to implement measures on a single field. Thirdly) regarding the design characteristics of programmes and measures, results-based payment and/or collective contracts are the most prominent to ensure a **good societal reputation**. Both can demonstrate the willingness of farmers to reach the best possible result and collaboration is assumed to provide efficient results for ES.

To illustrate these findings some examples of contracts will be presented in the following section that already have very innovative components and can therefore also provide good indications for the design of innovative contracts of the future.

When considering the **PES approach**, there are examples that clearly stand out from the mainstream, for example, through the use of

results-based payments. Only through a targeted approach, or at least a combination of action-based and results-based approaches, the promotion of ES steps into the spotlight and plays an important role, especially in the concrete protection of certain species and habitats due to the agreement of clear and measurable outcomes. Results-based payments reward the environmental performances of farmers and provide them more flexibility and autonomy. A well-known example with hybrid payments, also described in the literature, is the Burren programme (Ireland) (O'Rourke and Finn, 2020). Here, eligible areas are assessed on a habitat-specific basis using a scoring system: a basic number of points must be achieved for payment. If the field scores higher than the basic number, the payment will also be higher. A purely results-based approach, which rewards the "production" of biodiversity, is adopted, for example, by a project in the Tarnava Mare and Pogány Havas Regions (RO) (Oppermann and Sutcliffe, 2018). Here, too, a habitat-specific indicator plant species approach is used as the basis for the results-based payment. Thus, key to the success of results-based schemes is a clear definition of the environmental objectives and results indicators used in the scoring system (Schwarz et al., 2008). They must be locally adapted and allow to capture the variation in environmental conditions. Indicators work best if developed jointly with farmers and advisors, incorporate local knowledge, and are practical (e.g., Keenleyside et al., 2014; SRU, 2017). It has also been shown that guidance, training and support from advisors are essential (Cullen et al., 2018), even if some assessments are undertaken solely by specifically trained advisors and agency staff.

The approaches examined in this paper use various concepts and indicators to measure their target achievement. These are, for example, flagship species approaches to record valuable plant populations or habitats, or indicators that are easy to quantify, such as stocking densities, the number of participating farmers or the size of land under contract. However, "soft" factors, i.e. social capital, often also play an important role for the target achievement (cf. Calvet et al., 2019). Mentioned in this context are a common vision of all actors, mutual trust and acceptance at all levels, as well as shared responsibilities that favour an enabling environment.

Further on, *collective approaches* can be an additional step to ensure ES provision at the landscape scale. This is particularly important given that many ES are provided at the landscape scale rather than the farm scale (e.g., Plieninger et al., 2012; Sutherland et al., 2012). Collective approaches could also promote a closer farmer-producer-consumer cooperation and allow for a more direct control of the results. One of the examples is the collective management in upland landscapes of the Hautes-Pyrénées, Southern France (Dodsworth et al., 2020). In France, the funds provided by agri-environmental schemes (AES) are directly invested to support collective management, such as the pastoral infrastructure, and not distributed to single farmers for working together. One of the key criteria for a successful implementation of collective approaches is trust amongst the farmers of the collective (Emery and Franks, 2012; cf. Koutsou et al., 2014). However, as recent research highlights, many farmers also have pessimistic expectations about the possibility of collective action (Villamayor-Tomas et al., 2021). Therefore, more attention needs to be paid to these factors to make better use of the collectives' potential for biodiversity and ES.

In addition, when we look at these innovative approaches, it becomes clear that the question of funding is a central one. So far, funding is provided by the state when it is a societal problem (e.g., pollution). In contrast, funding is provided privately when solving concrete individual problems, which may vary from farmer to farmer, for example. The latter is currently more likely to be undertaken by companies in the VC approach.

For the *value chain approach*, the case of Neumarkter Lammsbräu (see 2.3, Box 2) provides a good overview of what an innovative approach might look like. This company offers its contracted producers different *additional measures* (partly as a catalogue of measures from which the producer can choose), through which the company stimulates

an expansion of the ecological knowledge base or incentives for additional activities to improve biodiversity on the farm. A central success of this approach is the '*territorial embedding*' (Wiskerke and Roep, 2006) of the food chain including the use of local resources and the involvement of local actors (farmers as well as stakeholders). In addition, the food product represents the values and rules shared by the food network including consumers and society in general. By this, it influences the regional development in a sustainable direction.

In order to create incentives for such activities of private funders more *public advocacy and political legitimisation* as well as regulatory flexibility to ease the performance of innovative ideas would be necessary (Knickel et al., 2006). One important step in this direction might be the new anti-trust derogation of the CAP regulations 2021–2027 allowing for sustainability agreements concluded between different actors in the food value chain aimed at achieving higher sustainability standards than those required by law (EP/EUCO, 2021, §62).

Another approach would be the greater *involvement of the consumers*. The food network "*C'est qui le patron*" (<https://lamarqueduconsommateur.com/comment-ca-marche/>) is strongly oriented towards the involvement of the consumers regarding the price structure as well as the quality criteria of the food. Consumers negotiate with farmers and/or processors about *fair prices* for a specific food quality. This consumer initiative was founded in France in 2016. The innovative idea is to increase the direct interaction between consumers and producers. Consumers influence how products are made, but also exchange with producers about their needs (events with consumers and partners, visits to partners with a look behind the scenes). The initiative also exists in Germany, Spain, Morocco, Greece, Belgium and Italy.

A third innovative example of a short value chain is the „Dobrze" Food Cooperative (<https://dobrze.waw.pl/english/>). It is a growing grassroots food initiative in Poland. It runs two shops in Warsaw with organic and seasonal food. Shops are *members-based*, however *remain open to public*. Again the *direct cooperation between consumers and producers* is promoted to strengthen *active citizenship* and create a *fair economy*, beneficial for all involved parties. Their main focus is on short supply chains with small-scale farmers. The "Dobrze" Food Initiative also offers courses to their members and farmers. They support in particular young farmers and small non-certified, but trusted organic farms.

Even though only a few examples of LT approaches were available, some desirable design features for innovative approaches can be derived. Innovative **land tenure approaches** are characterised by *long-term contracts* as well as the negotiation of *fair land rents* and a *commitment to ecological management*.

The Aardpeer initiative (<https://www.aardpeer.nl/>) strives to give as many farmers and food initiatives as possible the opportunity to cultivate the soil in a natural way and to promote biodiversity. Starting 2021, anyone could buy bonds from Aardpeer. With the money of these bonds, land is purchased. This land is made available through *long-term contracts* based on a *fair lease* for the next seven generations (!) to nature-driven and socially connected farmers and food initiatives. All activities are oriented towards the support of a natural development and *ecological management*.

The project of the Alnatura Bio-Bauern-Initiative (ABBI, Germany) (<https://www.alnatura.de>) is organised in the form of a competition. It supports farmers who wish to convert their farm to organic farming or to expand their existing organic farm. Each year, 7 to 10 farmers can win the funding. The central objective is in particular to achieve a *long-term conversion* from conventional to organic farming. Prerequisites for the participation of farmers are that they *convert* their entire farm to *organic management*, join an organic farming association and produce organically for at least five years. Applications are also open to organic farms that want to establish a new branch that accounts for at least a 30 percent increase in area. The competition format is innovative in the sense that the farmers have to be proactive and present good and

convincing proposals for the conversion of their farms. By the *long-lasting contracts*, the farmers have a *security for their economic stability*, and the initiative can be sure of getting a longer lasting conversion.

5. Conclusions

The present overview of contract types helps to characterise and structure the information about the diversity of existing contracts for the inclusion of public good ES in agricultural production. It gives the inspiration to overcome the limited effectiveness of current mainstream AECM contracts.

The characterisation and description of existing approaches may in some respect be relevant for policy and/or practice implementation. Our analysis showed that the involvement of actors at all levels of programme and measure development might help to overcome the missing acceptance of the current programmes. “Soft” factors, i.e., social capital, often played an important role in implementation. A shared vision of all actors, mutual trust and acceptance on all levels, and shared responsibilities that favour an enabling environment were regularly mentioned in the studied cases. The pro-active role of farmers and the joint design of measures, together with the funding body and/or their advisory agencies, was also emphasised (cf. Beckmann et al., 2009; Bredemeier et al., 2021).

A closer exchange about the objectives and efficiency of results between provider and beneficiaries of ES (especially for private funding) can lead to a more site-specific, problem-oriented development of measures to support sustainable food chains. Already in 2006, first examples of such “food networks” (Roep and Wiskerke, 2006) were documented. These approaches go in the same direction as the new rules of the CAP, which aim at enabling agreements between different actors in the food value chain for higher sustainability standards.

Unfortunately, there is little experience to date with the success factors, pitfalls and outcomes of such new contracts.

Follow-up research could fill this gap by combining literature reviews with qualitative research (e.g., via surveys and interviews, cf. Rex, 2021) and help to produce empirical evidence regarding

- the concrete formal contract design (this is an important point especially for the actors in the value chain approach)
- the context conditions and their influence on the acceptance of innovative contracts (e.g. differences in land use or regional management conditions)
- a detailed analysis of the hybrids of contract types and the resulting implications.

Another central set of questions refers to a better implementation and higher acceptance of innovative contracts. We found some hints that the easily understandable description of the benefits (level of compensation, lower production costs, higher product prices, greater societal reputation, etc.) as well as the strengthening of soft skills on the part of providers and beneficiaries could play a central role. The literature review on its own gave a more anecdotal view on these questions. In addition, the success of innovative approaches must be evaluated to determine whether the expected added value is actually present.

In summary, this review of a wide range of contractual approaches from literature and expert knowledge provides an overview of existing innovative approaches. However, further development of innovative approaches that would enable the strengthening of ES provision at a larger scale, requires that individual preferences need to be considered more thoroughly. This applies both to the providers of ecosystem services and to the beneficiaries - be they public or private.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence

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Appendix A. Supplementary data

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