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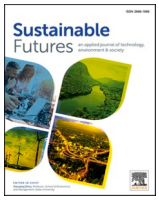

Classification and structural analysis of value chain contracts for biodiversity conservation in the European Union

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ABSTRACT

Enhancing biodiversity is crucial for ensuring food security and fostering sustainable agricultural practices. To this end, agri-environmental and climate schemes (AECS) and innovative contracts are implemented to promote biodiversity conservation and Ecosystem Services. Studying the implemented contracts and their characteristics can lead to improving their performance and efficiency. This paper examines the value chain contracts covered in three European projects and classifies them based on their contractual, financial, environmental and biodiversity characteristics. The design of the contracts was analyzed and seven categories were identified regarding the structure of the value chains and the interplay among stakeholders within these contracts. Our findings underscore the significant role of the private sector in preserving biodiversity and financing environmental practices, complemented by the public sector's contribution in motivating farmers and raising consumer awareness.

1. Introduction

Biodiversity is a basis of many Ecosystem Services (ES) and is critical to the health and functioning of ecosystems. It plays a key role in the provision of food, water, fuel and genetic resources, is essential for regulating services such as air quality and climate regulation, and for supporting services such as pollination and biological control [12]. Therefore, the loss of biodiversity is a significant and concerning threat to various species, ecosystems and ultimately to the stability and sustainability of the environment. Agriculture is the main cause of threats to biodiversity, e.g., through habitat loss and conversion of natural ecosystems, and it is also one of the main sources of greenhouse gases [14] Subsequently, due the impact of biodiversity on agriculture, such as pollination, pest and disease control and soil health [14,23], this leads to a reduction in agricultural sustainability, a decrease in the diversity of wild species and an acceleration of climate change. Specialization in agriculture has led to the abandonment of traditional varieties and breeds, some of which are neglected and endangered. At least 28 percent of local livestock breeds are threatened with extinction [14]. Food production relies predominantly on a limited number of species. Only nine crop species and eight animal species produce more than 60 percent of the world's food and 97 percent of meat production [14]. Although agriculture is the main driver of biodiversity loss, it holds the capacity for its preservation [15].

The contribution of food production and agricultural activities to biodiversity loss requires a trade-off between agricultural objectives and ESs by farmers [33]. Aligned with the Farm to Fork Strategy and the new Common Agricultural Policy (CAP), the EU Biodiversity Strategy for 2030 has a comprehensive program to preserve and restore biodiversity, reduce ecosystem use, and implement sustainable management in the EU [13,27]. Some of the identified goals and commitments for the agricultural sector include reducing the use of chemical pesticides and fertilizers by 50 % and 20 %, respectively, protecting and increasing pollinator populations, reducing soil pollution, implementing organic farming, and expanding agri-environmental practices [13]. Motivating farmers to adopt environmentally friendly practices is performed by Agri-Environmental Climate Schemes (AECS) [3,31,36].

Agri-environmental schemes were presented primarily as an optional approach for providing environmental services by the European Community in 1985 but later in 1992 alongside the CAP objectives, they became mandatory for all European Union Members [32,36]. AECS are widely used as they contribute to improving the sustainability of the agri-food system by incentivizing farmers and other stakeholders by providing compensation for the adoption of environmentally friendly practices [3,9,22,31]. However, their effectiveness for biodiversity conservation and ESs is questionable [2–4,7]. This ineffectiveness is

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mainly due to the inaccurate consideration and neglect of key stakeholders in the schemes, inflexibility of action-based measures for farmer adaptations, and lack of adequate spatial coordination [2,7,19]. Innovative contracts have been introduced as a solution to these limitations; they are defined as contracts, agreements, or contractual arrangements that motivate farmers to provide environmental services in addition to agricultural products [7].

Depending on the involved parties, innovative contracts can be categorized into three types: Payment for Ecosystem Services (PES) contracts, land tenure contracts, and value chain contracts [7]. PES contracts are concluded between the buyers of ESs, who are usually public authorities or Non-Governmental Organizations (NGOs) outside the value chain, and ES providers, farmers, or landowners to produce environmental public goods [7]. Land tenure contracts are made between landowners and land managers with conservation objectives. Finally, in the value chain contracts, parties from the demand side are private agents involved in the supply chain, such as processors, retailers, consumers, and other intermediaries. In this type of contract, the Ecosystem Service or public good is provided simultaneously with the production of the agricultural private good [7]. The main difference between PES contracts and value chain contracts is that PES contracts are usually applied to ESs without a specific functional market, whereas in value chain contracts the ES is sold together, with the product, in traditional market, and is often expressed by a label.

Given the importance of value chain contracts for biodiversity conservation [7] and the lack of a comprehensive and focused study on this topic, the objective of this paper is to provide an overview of 22 value chain contracts for biodiversity conservation that have been previously identified by three projects financed by the European Commission (i.e., Horizon projects): CONSOLE, Contracts2.0 and EFFECT. In this article, we undertake a comprehensive examination of value chain contracts used as a solution for biodiversity conservation in the European Union. The focus of this study is to analyze the characteristics of these value chain contracts in the context of biodiversity conservation and to establish a new categorization of these contracts based on their application inside the value chain structure.

The following section presents the background and literature on value chain contracts and biodiversity conservation. The methodology section illustrates the basis and measures for classification and the characteristics of the contracts. Then, the results of the classification of the contracts are presented and the different categories of implemented contracts are discussed. Finally, conclusions are drawn.

2. Background and literature review

FAO defines biodiversity or biological diversity as the number, variety, and variability of species, habitats, and ecosystems. It is the basis for most ESs including pollination, climate regulation, and soil conservation [14]. There is not any distinguished definition of biodiversity in the agricultural policies of the European Union. According to the EU Biodiversity Strategy for 2030, biodiversity is the variety of life in nature and source of human needs [13]. Biodiversity is recognized at three levels: genetic diversity, species diversity, and ecosystem diversity [15], which plays a critical role in food security, agroecosystem resilience, and agricultural sustainability [37]. Agrobiodiversity refers to all the elements of the biological diversity containing domesticated and wild species, related to agriculture and food production, that are implemented in the agroecosystem, including crop farming, animal husbandry, fisheries, and forestry [15,18,24].

Innovative contracts, as a derivative of AECS, are becoming to be used by private companies or food producers to achieve the goals of national and EU policies [9] and to respond to increasing consumer demand for environmentally friendly products [1].

The value chain contract is a type of innovative contract implemented to reduce the negative impacts of agricultural activities on biodiversity loss and other environmental externalities. Value chain approaches provide environmental services within the value chain and in conjunction with private goods. The cost of environmentally friendly practices is often included in the product price [35]. The producer or supplier of the environmental service must comply with certain practices and requirements. On the other hand, the demand side provides motivation and incentives, including price premiums, guaranteed purchases, and labels for environmentally friendly production [34].

Each supply chain consists of various actors, farmers, producers, distributors and retailers and is a combination of different stakeholders [20]. Therefore, inconsistent objectives, expectations, and lack of coordination lead to uncertainty and ambiguity. Contracts are used as an instrument to overcome inefficiencies in the value chain [28]. As a result, a contractual framework creates transparency, guarantee, and certainty for the parties [6]. For example, Watteyn et al.[37] showed that Costa Rican farmers prefer to contract with buyers to perform biodiversity conservation and adopt sustainable production practices for vanilla cultivation, which can increase transparency and effectiveness in the supply chain.

Based on the literature review, a few empirical studies have been conducted to investigate and analyze environmental service provision and biodiversity conservation through value chain contracts. For example, Aureo wheat is an innovative Italian supply chain project with a cultivation contract between farmers and Barilla company, implemented in dryland areas with environmental sustainability objectives which leads to a reduction in irrigation, as well as a reduction in chemical consumption and CO2 emissions [30]. In another study by Ciliberti et al.[9], sustainability goals and environmental services provided by Italian pasta and semolina producers are investigated and classified, encompassing a variety of objectives such as food security, sustainable production, biodiversity conservation, climate change, and economic growth. Dejouhanet et al.[10] examined the shortcomings and limitations of a biodiversity conservation contract for Piper marginatum in French Guiana. The program was an unsuccessful experience due to improper monitoring and control, insufficient incentives or motivation for farmers, and lack of coordination among the parties.

Given the importance of value chain contracts in agri-environmental and climate schemes (AECS), there is a lack of empirical studies analyzing the provision of environmental services and biodiversity conservation through value chain contracts, which limits the understanding and improvement of these approaches. Therefore, a detailed analysis of these contracts and their characteristics can be useful in developing new contractual solutions. Our research contributes to the evaluation of value chain contracts, with a focus on the inclusion of biodiversity characteristics.

3. Material and methods

Value chain contracts regarding biodiversity conservation are selected from three Horizon projects funded by the European Commission: CONSOLE, Contracts2.0 and EFFECT. For this purpose, all contract solutions and innovative contracts in the three projects were studied and value chain contracts aimed at biodiversity conservation were selected. Twenty-two contracts were identified, sixteen contracts were selected from CONSOLE, five contracts from Contracts2.0 and one contract from EFFECT project. Of these, nineteen contracts were examined and classified as case studies, and three contracts were distinguished as special cases, as they differ in the role of stakeholders and their involvement in the provision of environmental services. In the case studies, farmers provide various environmental services and practices, which are listed in Table 1.

The selected contracts are classified based on several characteristics, which are mainly derived from previous studies (e.g.,Bredemeier et al. [7], Ciliberti et al.[9] and Sattler et al.[25]). These characteristics are categorized into four groups: general, contractual, financial, and biodiversity characteristics (Table 2), which are described in detail in the following sections.

Table 1
Environmentally friendly practices provided by farmers.

Num	Contract name	Practices
1	ALMO	Compliance with certain husbandry conditions, including mandatory grazing periods for oxen in mountain areas and GMO-free feeding
2	Organic honey StaraPlanina	Placing hives in natural areas with special requirements and avoidance of consumption of synthetic drugs and sweeteners
3	The Wild Farm	Fulfilment of requirements for organic husbandry and organic meat certification
4	Organic farming for biodiversity	Implementation of selected conservation measures for species and habitats from more than 100 nature conservation measures
5	Cooperative rice production (Arrozua)	Using a minimum of agrochemicals in line with integrated production, creating a habitat for migratory birds by leaving water in the fields for an extra month
6	Organic wine in Rueda	Fulfilment of requirements for organic production and certifications
7	Terresde Sources-Public food in Brittany	Compliance with production conditions, such as restrictions on certain pesticides and animal health measures for GMO-free animal feed and limitations on the use of preventive antibiotics
8	Esprit Parc National	Commitment to several mandatory criteria such as location in a pollution-free environment within the national park, prohibition of the use of synthetic chemicals, and water conservation, as well as some optional criteria for fresh products.
9	"Carta del Mulino" –Barilla	Compliance with management requirements in accordance with the food safety, quality and environmental standards established by Barilla
10	Green Deal Dutch Soy	Utilizing non-GMO seeds and compliance with hygiene regulations.
11	Biodiversity monitor for dairy farming	Implement sustainable production and biodiversity conservation by improving biodiversity-enhancing Key Performance Indicators such as greenhouse gas emissions and permanent grassland in each farm
12	Biodiversity monitor for arable farming	Implementing sustainable production and biodiversity conservation through improvement in biodiversity-enhancing Key Performance Indicators
13	Bio-Babalscy	Performing organic production conditions and producing produce varieties of cereals as required by the processor
14	Top Farms Group	Protecting the environment and producing GMO-free soybeans by implementing solutions based on regenerative agriculture.
15	HiPP	Implementing organic farming requirements to fulfil the baby food regulations and HiPP organic quality standards
16	Őrség National Park	Fulfilment of certain conditions such as no use of pesticides, production of GMO-free products, environmentally friendly packaging
17	Unione Comuni Garfagnana	Producing seeds of endangered varieties with environmentally friendly techniques and preserving local breeds threatened with extinction.
18	German organic brewery- Neumarkter	Implementing organic farming requirements
19	Integrated production in the olive groves	Performing mandatory and recommended practices, such as reducing tillage and drip irrigation

3.1. General characteristics

The general characteristics include production types, farming systems and size criteria. Based on the area covered, contracts are categorized into four groups: 0–1000 hectares, 1000–10,000 hectares, 10,000–100,000 hectares and more than 100,000 hectares. Value chain contracts are concluded for different types of products, which can be divided into three categories: plant production, livestock production and hybrids. The farming systems can be divided into conventional, organic and hybrid. In some contracts, organic farming systems are mandatory, in other cases both farming systems can fulfil the requirements.

Table 2
Contract characteristics and criteria.

Characteristics	Criteria	Levels
1. General characteristics	Spatial scale	0–1000 ha, 1000–10,000 ha, 10,000–100,000 ha, > 100,000 ha
	Type of production	Plant production, animal production, hybrid
	Farming system	Conventional farming, organic farming, hybrid
2. Contractual characteristics	Involved parties	Private, public, hybrid
	Contractors	Individual, collective, hybrid
	Contract conclusion	Written agreement, verbal agreement, hybrid
	Monitoring	Private, public, hybrid
	Temporal scale	Short term, long term
3. Financial characteristics	Type of funding	Private, public, hybrid
	Payment mechanism	Product price, incentive payments, hybrid
	Basis of payment	Action-based, result-based
4. Environmental services and biodiversity characteristics	Type of Ecosystem Service	Biodiversity, landscape conservation, climate change, organic farming, carbon storage, water quality enhancement, soil protection, sustainable food production, animal health and welfare, rural viability and vitality and cultural heritage
	Biodiversity level	Genetic diversity, Species diversity, Ecosystem diversity
	Ecosystem type	Farmland, mountain, forest biodiversity
	Objective biodiversity conservation	Domesticated or wild biodiversity

3.2. Contractual characteristics

Partnership in contracts consists of two criteria: involved parties and contractors. Involved parties refer to the nature of actors participating in the contract; they can be public entities such as local or national governments or agencies, or private parties such as farmers, processors, companies and other private intermediaries [16]. Therefore, based on the involved parties there are three types of contracts: private-private, private-public, and hybrid. Hybrid contracts are cases with more than one contract within the value chain. The second criterion, the contractors, refers to the arrangement of the contract, which is individual or collective. In the individual form, a contract is usually between each farmer and a processor or intermediary, while in the collective form, a group of farmers, an association, or a collective initiative represents the producers [7].

Monitoring is an important factor in the contractual design, since appropriate control or monitoring enables better implementation of environmental practices and establishes the degree to which goals are being achieved [21]. Monitoring can be done as self-monitoring by farmers, monitoring carried out by the parties involved in the contract or third-party monitoring. In this study, we divided the monitoring criteria into public, private, and hybrid. Public monitoring is conducted by public involved party or third-party governmental organizations such as biodiversity monitoring foundations or national agencies, while private monitoring includes monitoring by farmers, processors, or an independent private agency [7].

The temporal scale, which represents the duration of the contract, is divided into short-term (less than five years) and long-term (more than five years) contracts. Long-term contracts provide more security, which can lead to better performance, while short-term contracts are more flexible and modifiable [26].

The final criterion in the contractual characteristics is contract

conclusion: it provides information about the technical execution of the contract, since it can be a written contract, a verbal agreement or a hybrid form [11].

3.3. Financial characteristics

The three criteria for the financial characteristics of contracts are the type of funding, the payment mechanism, and the basis of payments. The source of payment may be private, public or hybrid, which may be provided by the contractors or another party since in several cases there are non-financial contracts between contractors. Private funders include processors, foundations, and NGOs, while public funding comes from the governmental budget [26]. The payment mechanism consists of the product price and other incentives, which may be monetary or non-monetary. When farmers adopt environmentally friendly practices, the contracted price in most cases includes a premium; on the other hand, incentives refer to annual bonus, subsidies, or discounts on loan interest rates [11]. The two ways of payments for ES providers are "result-based" and "action-based" payments. In the result-based or outcome-oriented approach, payments are based on the achievement of specific environmental goals or quantitative measures such as improvement in Key Performance Indicators (KPIs), which are measurable values for the pursuit of goal achievement [7,17,26]. Action-based or practice-based approaches consider the implementation of a specific activity or management practice, including organic farming or chemical use [7,26]. It can be argued that action-based approaches serve to avoid practices with negative environmental impacts, while result-oriented approaches serve to achieve positive environmental results [8]. In addition, result-based payments provide more opportunities for farmers' personal knowledge and innovation. On the other hand, action-based payments are less risky and guaranteed against uncontrollable factors such as climate change that can affect the outcomes of environmental practices [25].

3.4. Environmental services and biodiversity characteristics

In this research, the main focus is on the value chain contract allowing biodiversity enhancement, however each contract is providing ESs as well. These include landscape conservation, climate change, organic farming, carbon storage, water quality enhancement, soil protection, sustainable food production, animal health and welfare, rural viability and vitality and cultural heritage.

There are three levels of biodiversity: genetic, species and ecosystem diversity [15]. Genetic diversity relates to abundance and differences of genes within a species of animals, plants and microorganisms such as different breeds of cattle or different varieties of wheat. Species diversity corresponds to the number and variety of different species. Ecosystem diversity refers to the variety of habitats including forests, mountains, farmlands [15]. Biodiversity conservation contracts consider different targeted ecosystems, such as farmland biodiversity, marine and coastal biodiversity, forest biodiversity, dry and sub-humid lands biodiversity. Based on case studies, three types of targeted ecosystems were recognized: farmland, forest and mountain biodiversity [25]. Agricultural biodiversity includes all life forms associated with agriculture, including domesticated and wild biodiversity. Domesticated biodiversity refers to the cultivation or breeding of rare crops or animals for the purpose of biodiversity conservation. On the other hand, wild biodiversity refers to all varieties and species other than the main crop that may be affected by agricultural activities, such as wild flora and fauna in agricultural landscapes [5]. Domesticated species affect human life directly and proper management of these species can contribute to sustainability in agriculture and preservation of wild ecosystems [29].

4. Results

This study analyzed 22 value chain contracts from three European Union projects. Nineteen contracts were classified as case studies and three contracts as special cases. Contracts classification and their characteristics are shown in Table (3).

4.1. General characteristics

The contracts were implemented in nine European countries, including Austria, Bulgaria, France, Germany, Hungary, Italy, the Netherlands, Poland, and Spain. The case studies have different spatial scales and are divided into four categories (Fig. 1). The first category is for areas under 1000 hectares, with two contracts implemented at the local level: the Wild Farm contract in Bulgaria and the Organic Wine in Rueda, Spain. There are four contracts in the 1000 to 10,000-hectare category, such as The Top Farms with regional coverage in Poland. Nine contracts are from 10,000 to 100,000 hectares, mostly implemented in national parks or in a large sector of a country. Four contracts fall into the category of more than 100,000 hectares, including two contracts for biodiversity monitoring in dairy and arable farming performed at the national level in the Netherlands.

The type of production is the second criterion in the general contract characteristics. Eleven contracts fall into the plant production category and three contracts fall into the animal production. Five contracts are classified as hybrids. It is also possible to set a more detailed classification on the base of the product considered, which can be cereals, legumes, vegetables, fruits, honey, meat, dairy products, flowers, and other crops (Fig. 1). Cereals have the largest share of product types at 44 %. In some contracts, there is only one type of product. For example, the contract farmers of the Arrozua cooperative in Spain and of Bio-Babalscy in Poland produce one main product, rice and wheat, respectively, but in most other cases there is more than one type of product. Unione Comuni Garfagnana in Italy offers contractual solutions for the cultivation of various agricultural products, including 35 local herbaceous varieties, 190 varieties of fruit trees, 50 traditional wines, sheep and cows. In general, involving only one product may lead to a reduction in the protection of biodiversity, but it can be successful if the objective of the contract is consistent with the agricultural system and cropping patterns of the region. For example, Arrozua protects wild biodiversity in the Doñana National Park, where rice is one of the most suitable and predominant crops in the area.

As mentioned, conventional agriculture is the main cause of biodiversity loss. Therefore, organic farming is more sustainable and contributes to biodiversity conservation, which is the most common in the contracts and is implemented in nine case studies, as it is one of the main requirements of the contracts in many cases. Conventional farming is practiced in three case studies and hybrid farming in seven case studies (Fig. 1). In the Almo project, for example, the majority of farms practice conventional farming, as the main objective of this contract is to protect the genetic diversity of Alpine oxen and the landscape.

4.2. Contractual characteristics

The studied value chain contracts consist of three types of contract parties (see Fig. 2). Eleven cases are private-private contracts, and most are contracts between farmers and a food producer or processor. Six contracts are private-public, and two cases are hybrid. The public parties are local or national organizations and governments. Biodiversity monitoring contracts (both dairy and arable farming) in the Netherlands are an example of a hybrid contract where farmers can choose between a government party and a business party in terms of payment services and incentives offered. Contractors or contract farmers are individual in five cases, collective in ten cases, and hybrid in four contracts. For example, one of the hybrid case studies is the Biodiversity monitoring for arable farming in the Netherlands, where a contract can be arranged for each farmer individually or for a collective organization of farmers. Depending on the objective and scope of the contract, the type of contract and the parties involved may differ, which increases the flexibility

Table 3
List of the case studies and their characteristics. 1= CONSOLE project, 2= Contracts2.0 project.

Num	Contract	VC structure	Location	Products	Involved parties	Contractors	Funding	Payment mechanism	Basis of payment	Biodiversity level	Ecosystem Biodiversity	Biodiversity conservation
1	ALMO (1)	1	Austria	Oxen meat	Private/ private	Collective	Private	Product pr.	Hybrid	Genetic/ ecosystem	Farmland/ Mountain	Hybrid
2	Organic honey StaraPlanina (1)	2	Bulgaria	Honey	Private/ private	Collective	Private	Product pr.	Action-based	Genetic/ species	Farmland/ Mountain	Hybrid
3	The Wild Farm (1)	1	Bulgaria	Meat	Private/ private	Collective	Private	Product pr.	Action-based	Genetic/ species	Farmland	Hybrid
4	Organic farming for biodiversity (1)	3	Germany	Meat & apple	Private/ private	Hybrid	Private	Hybrid	Result-based	Species	Farmland	Wild
5	Cooperative rice production (Arrozua) (1)	1	Spain	Rice	Private/ private	Collective	Private	Product pr.	Action-based	Species/ ecosystem	Farmland	Wild
6	Organic wine in Rueda (1)	1	Spain	Grape & wine	Private/ private	Individual	Private	Product pr.	Hybrid	Species/ ecosystem	Farmland	Wild
7	Terresde Sources-Public food in Brittany (1)	1	France	Agricultural products	Private/ public	Collective	Public	Hybrid	Hybrid	Species	Farmland	Wild
8	Esprit Parc National (1)	6	France	Fruits, vegetables & edible flowers	Private/ public	Collective	Private	Product pr.	Action-based	Species/ ecosystem	Forest	Wild
9	"Carta del Mulino" –Barilla (1)	2	Italy & France	Soft wheat & flowers	Private/ private	Individual	Private	Product pr.	Action-based	Species	Farmland	Wild
10	Green Deal Dutch Soy (1)	7	The Netherlands	Soy	Private/ public	Hybrid	Private	Product pr.	Result-based	Species	Farmland	Wild
11	Biodiversity monitor for dairy farming (1)	1 & 5	The Netherlands	Dairy	Hybrid	Hybrid	Hybrid	Hybrid	Result-based	Species/ ecosystem	Farmland	Wild
12	Biodiversity monitor for arable farming (1)	1 & 5	The Netherlands	Crops	Hybrid	Hybrid	Hybrid	Hybrid	Result-based	Species/ ecosystem	Farmland	Wild
13	Bio-Babalscy (1)	1	Poland	Cereal, pasta & spelt coffee	Private/ private	Individual	Private	Product pr.	Action-based	Genetic/ species	Farmland	Hybrid
14	Top Farms Group (1)	1	Poland	Cereal & potato	Private/ private	Collective	Private	Product pr.	Action-based	Species	Farmland	Wild
15	HiPP (2)	1	Germany	Agricultural products	Private/ private	Individual	Private	Hybrid	Action-based	Species	Farmland	Wild
16	Őrség National Park (2)	5	Hungary	Fruit products, dairy, honey	Private/ public	Collective	Public	Incentive payment	Action-based	Genetic/ species	Farmland/ Forest	Hybrid
17	Unione Comuni Garfagnana (2)	5	Italy	Agricultural products	Private/ public	Collective	Hybrid	Hybrid	Result-based	Genetic/ species/ ecosystem	Farmland	Hybrid
18	German organic brewery-Neumarkter (2)	1	Germany	Beverage	Private/ private	Hybrid	Private	Product pr.	Hybrid	Species	Farmland	Wild
19	Integrated production in the olive groves (1)	4	Spain	Olive	Private/ public	Collective	Private	Product pr.	Action-based	Ecosystem	Farmland	Wild

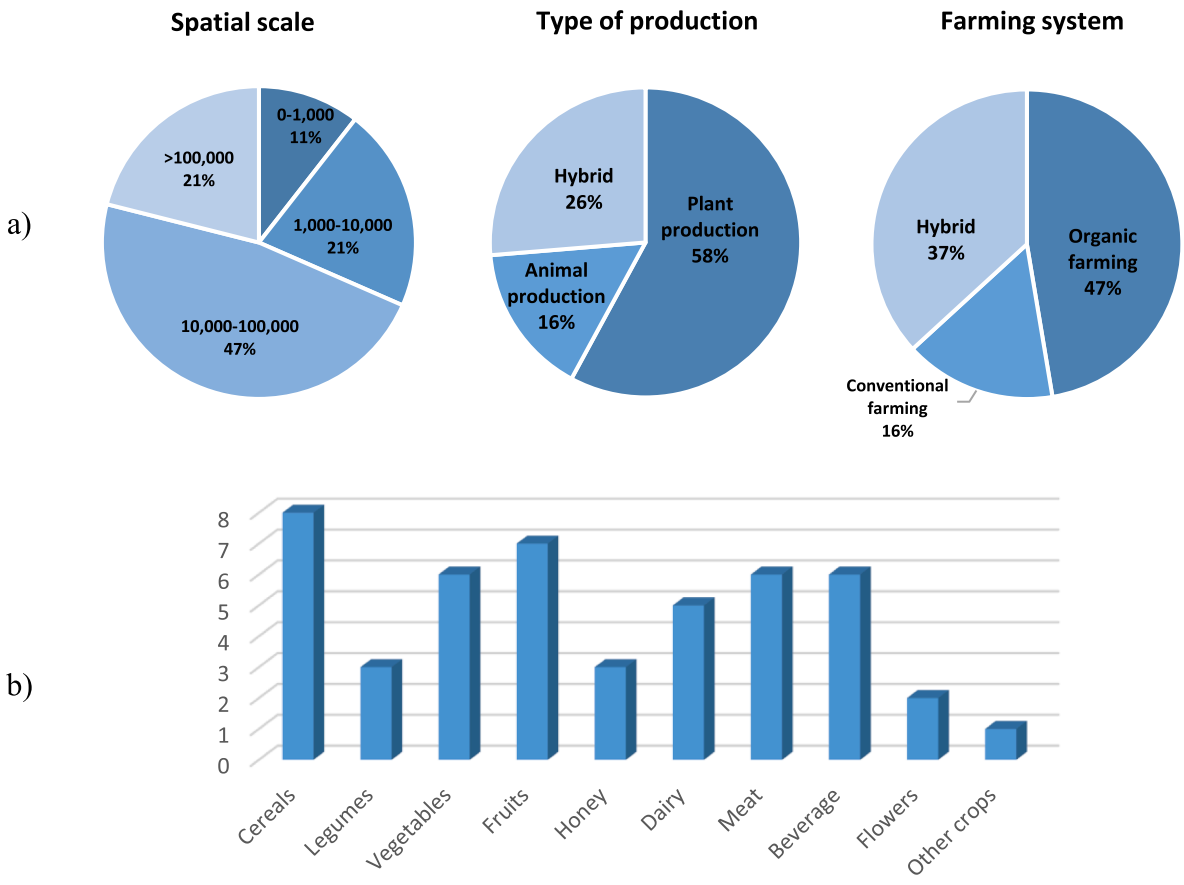

Fig. 1. a) General characteristics of the contracts, b) Type of products.

and adaptability of contracts. It makes it applicable and at the same time fulfils the existing needs.

Most of these contracts, fifteen, are as written agreements, two contracts are verbal agreements or handshake, and two contracts are hybrid. In hybrid cases, there are both written and verbal agreements between the contracting parties. Relying on verbal agreements can lead to potential legal and enforcement problems. One of the exceptions is the Bio-Babalscy company in Poland, a family business that produces organic pasta and contracts 90 farmers through a verbal agreement. This agreement is based on the trust and friendly relationships between farmers and producers that have been built up over the years. Therefore, trust between the parties is the most important factor for the success of verbal agreements; in this case, flexibility and adaptability of contractual agreements will increase.

The method of monitoring or controlling the terms of the contract is private in twelve contracts and can be done by the processor, a third party, or the farmer himself. In the case of Neumarkter Lammsbraeu, a German company that produces organic beverages, on-site audits are conducted by a farmers' association (EZOB) to monitor the implementation of organic farming guidelines. Public and hybrid monitoring are included in four and three contracts, respectively. In some contracts with private and public parties, such as Terres de Sources - Public Food Order in Brittany, France, monitoring can also be carried out by private individual third parties. In this case, the diagnosis is done by one of the specified public or private organizations (Chamber of Agriculture, Agro-Bio or Adage). Fewer contracts include public or hybrid monitoring, which may lead to less transparency and accountability. Private monitoring, on the other hand, can be more flexible, confidential and efficient and offers a higher level of expertise and technology. To increase transparency in private monitoring various approaches can be used, such as setting clear objectives, data minimization and anonymization, and compliance with legislation. In some cases, a hybrid approach that combines the strengths of private and public monitoring can be beneficial.

According to the temporal scope, ten cases are classified as short-term contracts, varying from one growing season to a maximum of five years, and nine other cases are long-term contacts. Short-term contracts are more flexible and adaptable but may not provide enough stability for long-term environmental and biodiversity goals. It should be noted that in some cases, such as Barilla, the duration of the contract or length of participation in the program is one growing season, but the program is implemented over several years, which may also offer some advantages of a long-term contract.

4.3. *Financial characteristics*

Contract funding is private in forteen case studies, while two and three contracts are public and hybrid, respectively (see Fig. 3). The Esprit Parc National contract is a public-private contract between farmers and a national park in France, financed by private funds coming from consumers and their payments for environmental services. Most contracts are privately funded, which can limit the scope and scale of initiatives requiring major investment, while the public sector can provide greater financial resources than the private sector.

A very important criterion for the financial characteristics of the contracts is the basis of payment. Nine contracts are from action-based approaches, six are result-based approaches, and the other four are a mix of both, classified as hybrid. The payment in the Organic honey from

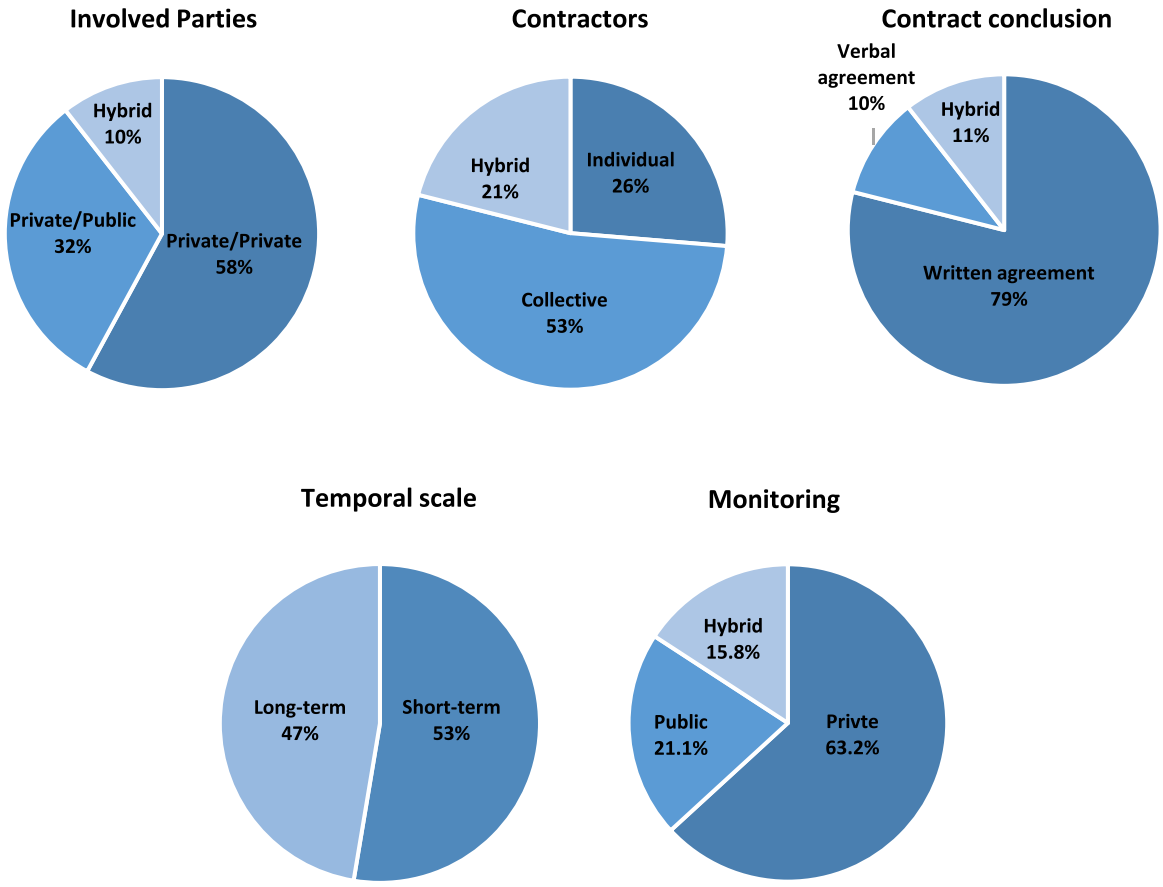

Fig. 2. Contractual characteristics of the contracts.

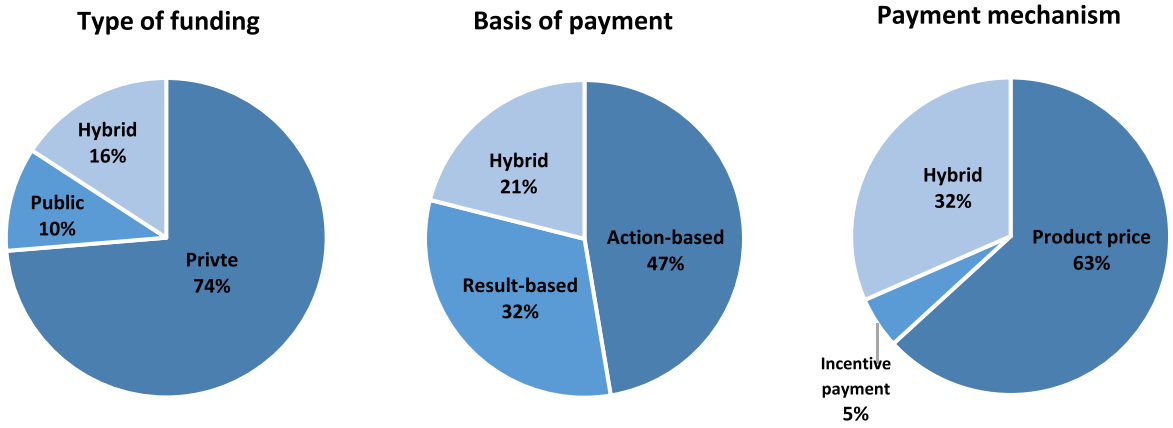

Fig. 3. Financial characteristics of the contracts.

Stara Planina (Bulgaria) mountain sites contracts is based on an action-based approach in terms of the implementation of organic farming and the requirements for the installation of hives. Within the framework of the Organic farming for biodiversity contract in Germany, result-based payments are made by monitoring the success of the implementation of the measures in question on the farms. Terres de Sources or public food order in Brittany, France, is an example of hybrid cases. In this contract, payment is based on agricultural practices such as GMO-free production and the prohibition on preventive antibiotics and some pesticides, in combination with result-based approaches such as improving IDEA measures. IDEA (Indicateurs de Durabilité des Exploitations Agricoles), or farm sustainability indicators, developed by the Research Supervision of the French Agricultural Ministry, cover various aspects of sustainability, including agroecology, sociology, and

economics [11].

The product price is the most common payment mechanism in the studied value chain contracts. This type of payment is used as the only payment mechanism in twelve cases and as a hybrid or in combination with incentive payments such as bonuses or loan interest discount, in six cases. In the HiPP case study in Germany, for example, the payments consist of a higher price for the products and awards for complying with certain environmental and social measures. There is only one contract, the Őrség National Park in Hungary, that has incentive payments as the only payment mechanism for farmers. These payments take the form of market benefits and awarding. The type of payment mechanism depends on the parties involved in the contract and their role. For example, the price premium is often offered by a private buyer or processor, while public entities that are not the buyers of the products offer incentive payments. The diversity of contract types (private-private, private-public and hybrid) and monitoring methods can lead to inconsistencies and difficulties in standardizing best practices across regions and systems, while increasing the flexibility and adaptability of contracts.

4.4. Environmental services and biodiversity characteristics

Contarcutal solutions and innovative contracts provide various environmental services. In this study, value chain contracts related to biodiversity conservation were selected. However, each contract also provides environmental services (Fig. 4). Sustainable food production is one of the targeted environmental services in seventeen contracts. Because of the relationship between landscape conservation and biodiversity or ecosystem diversity, it is included in eight case studies. Organic farming, water quality inhancement and rural viability and vitality were each considered in eight contracts. Soil conservation is implemented in six cases such as Green Deal Dutch Soy in the Netherlands, which maintains soil quality by producing soy, sequestering nitrogen, and reducing fertilizer requirements. Topform Group in Poland provides various environmental services, including water and soil conservation and sustainable food production. One of the most important services in this contract is increasing soil biodiversity through soil reaction and conservation cultivation.

Species diversity is the most considered level of biodiversity in seventeen contracts. Genetic diversity and ecosystem diversity are considered in six and eight case studies, respectively. The value chain contract of the ALMO initiative, which is composed of 400 farmers and cooperates with a meat processor and an animal welfare organization (meat from alpine oxen from Austria), is one of the successful contract solutions that preserve the genetic biodiversity of alpine oxen and the ecosystem diversity of alpine mountain pastures in the Almenland region, Austria. While species diversity is the most considered, less attention is paid to the diversity of ecosystems, which is crucial for the holistic conservation of biodiversity.

Farmland biodiversity is the target ecosystem in eighteen case studies. Forest and mountain biodiversity conservation each are considered in two contracts. Mountain biodiversity is the target ecosystem in the contracts for the ALMO program in Austria and Organic Honey of Bulgaria. The organic honey is produced in the mountains of

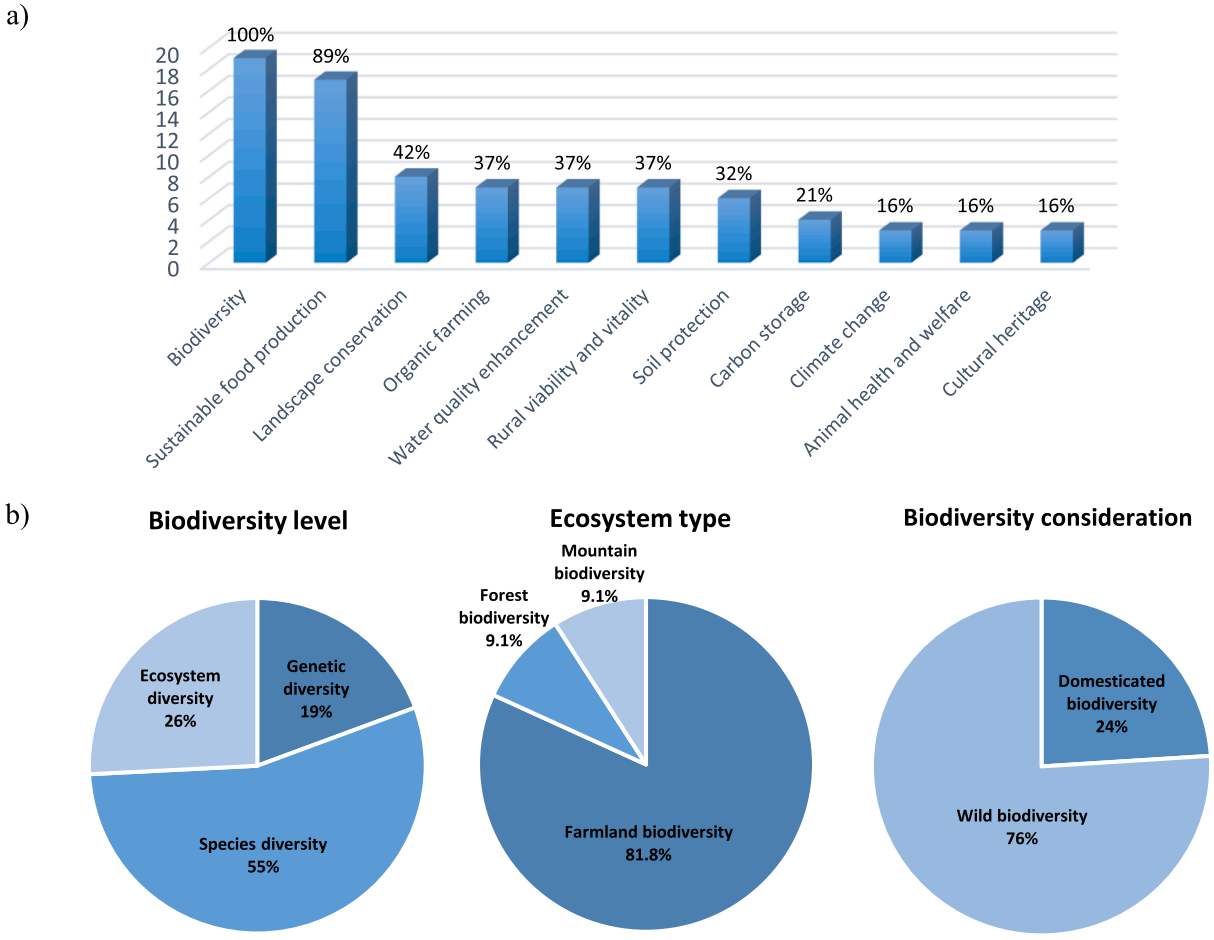

Fig. 4. a) Types of the targeting environmental services, b) Biodiversity characteristics of the contracts.

Stara Planina with environmentally friendly methods such as organic beekeeping.

The last criterion in this category is objective biodiversity conservation. In six contracts, domesticated biodiversity is the target of biodiversity conservation, while wild biodiversity is considered in all the nineteen case studies. In other words, wild biodiversity is covered and protected even if domesticated biodiversity is the main objective of the contract. For example, in the case of Wild Farm, one of the objectives is to popularize Bulgarian organic beef as a conservation of domesticated biodiversity through organic husbandry which at the same time preserves the biodiversity of rare breeds and ornithological species (wild biodiversity). Meanwhile, the Organic farming for biodiversity contract is implementing organic farming to preserve the biodiversity of wild flora and fauna in the northeast of Germany.

4.5. Special cases

Based on the purpose of this study, value chain contracts were selected to provide biodiversity environmental service. Nevertheless, there were some special cases among these contracts. These cases differed according to the type of value chain and the role of the parties involved, in particular farmers. All these contracts indirectly influence the value chain of a specific product through environmentally friendly activities. In these cases, the farmers are not the providers of the specific product; on the other hand, with their behavior, they can affect (positively or negatively) the provision of the product and, at the same time, the biodiversity of the place. The first special case is PES by bottled water producer Vittel, introduced in France by Nestle Waters. Here we have contracts between Nestle (the majority shareholder of Vittel), farmers in the catchment area and public institutions. Participating farmers must change their farming system from intensive to extensive farming, which leads to a decrease in nitrates and water pollution.

Another special case is a contract to provide flower- fields for pollinators in Estonia. This program is a public-private contract between the Estonian Agricultural Registers and Information Board (ARIB) and farmers aimed at supporting honeybees and other pollinators through the expansion of flower fields. Each contracted farmer must plant at least three different flower crops near honeybee hives.

The last special case, Program Flowering Meadows, is a contract between a bottled water and soft drink producer in Poland, a private organization, and farmers. Contracted farmers must perform mowing activities during specific months, and the use of pesticides and fertilizers, the collection of surface water and drainage operations are not permitted.

5. Discussion

In the discussion section, firstly, a categorization of the contracts based on the structure of value chains is provided. Then, the role of biodiversity and its characteristics in the provisioning contracts are analyzed.

5.1. Value chains structures

Value chain contracts are categorized into seven groups based on the structure of the contract framework and the actors involved (Figs. 5). There is a separate category for special cases that illustrates their differences. Buyers can be either processors or final consumer, and intermediaries can be mills, farmer associations or other intermediaries within the product supply chain. A third party is any participant outside the product supply chain, e.g., a public or government agency or farming federation.

The first category, Group 1, which is the most common of all categories, refers to contracts between two parties, a farmer or an initiative of farmers and a buyer (see Fig. 5). The farmer is the supplier of the products and environmental services, and the buyer pays for both. Eleven contracts are assigned to this group (cases 1, 3, 5, 6, 7, 11, 12, 13, 14, 15, and 18). In this category, the buyer can be a processor, distributor, a farmers' association, agriculture enterprise, producer company or a local government. It should be noted that in cases 11 and 12, which relate to biodiversity monitoring in the Netherlands, there is more than one possible contract for each farmer, and they may enter different contracts with the parties involved. Depending on which contract or contracts are chosen, the case falls into group 1 or 5.

In the second group, an additional partner is added to the value chain. The intermediary has a bilateral contract or agreement with both the buyer and the seller (Fig. 5). In other words, there are two contracts, one between farmer and intermediate, and one between intermediate and buyer. The farmers provide the agricultural products and environmental services, and the buyers, the producers and processors, pay for them, but in this case the whole process goes through the intermediaries. Two case studies (2 and 9) fall into this category. In case study 2, Organic honey from Stara Planina Mountain sites in Bulgaria, the farmers' organization buys the honey from each farmer and sells it to the processor "Harmonica". The same process is used in case study 9, "Carta del Mulino" Barilla from Italy, where the mills have contracts with the farmers and Barilla buys the wheat from the mills.

The next categories, 3, 4, 5, and 6, are similarly structured, since they include a third party, but they differ in the presence of contracts and payments (Fig. 5). In group 3, there are two contracts between the involved parties, one between farmer and buyer and another between farmer and the third party. There is only one case study in this category, Case Study 4: Organic farming for biodiversity in Germany. In this case, the buyer is a retailer, EDEKA, who pays farmers a premium price for the product based on a written contract. The farmers do not receive any payments from third parties. The public parties, four organic farming associations, have a verbal agreement with the farmers and label the products with their logos. Group 4 has a similar structure, with the difference that there is no contract or agreement between farmer and buyer. Only case study number 19, Integrated production in the olive groves in Spain, belongs to this category, where the third party is the regional administration offering an environmentally friendly brand for olives produced by farmers, and the buyer is the final consumer. Group 5 refers to case studies in which there is no contract between the farmer and the buyer, while a third party pays the farmer for providing environmental services. This category includes four contracts: 11, 12, 16, and 17. The third parties involved are local government, banks, and public organizations. Farmers receive a higher price for the product from the buyers, who may be final consumers or companies, and additional payments from the third party as annual bonus and loan interest discounts, and other incentives.

Group 6, comprising case study 8, has a similar value chain structure, but is the only case where farmers pay third parties. In case number 8, Esprit Parc National, Food and services in the National Park of Guadeloupe in France, the buyer is the end consumer who pays a premium price for the environmentally friendly products, and the third party, the national parks, provide the collective brand. Farmers pay an annual fee to the national park for the use of the collective brand.

Group 7 has a different structure, where in addition to a contract between farmer and buyer, there is another contract between buyer and a third party (Fig 5). Case study number 10, Green Deal Dutch Soy in the Netherlands, belongs to this category. There is a contract between the farmers and the soy processor, and there is a non-financial agreement between the government parties and the processor. In this case, the third-party deals with legislative and regulatory issues, and the buyer provides knowledge sharing and practical support to the farmers in addition to payments.

The last category refers to special cases (Fig. 5). Three contracts were classified as special cases because farmers are not involved in the supply chain of the final product. In other words, unlike the previously studied cases, the farmers in these cases are not the providers of the "main" product and are only paid for implementing environmentally friendly

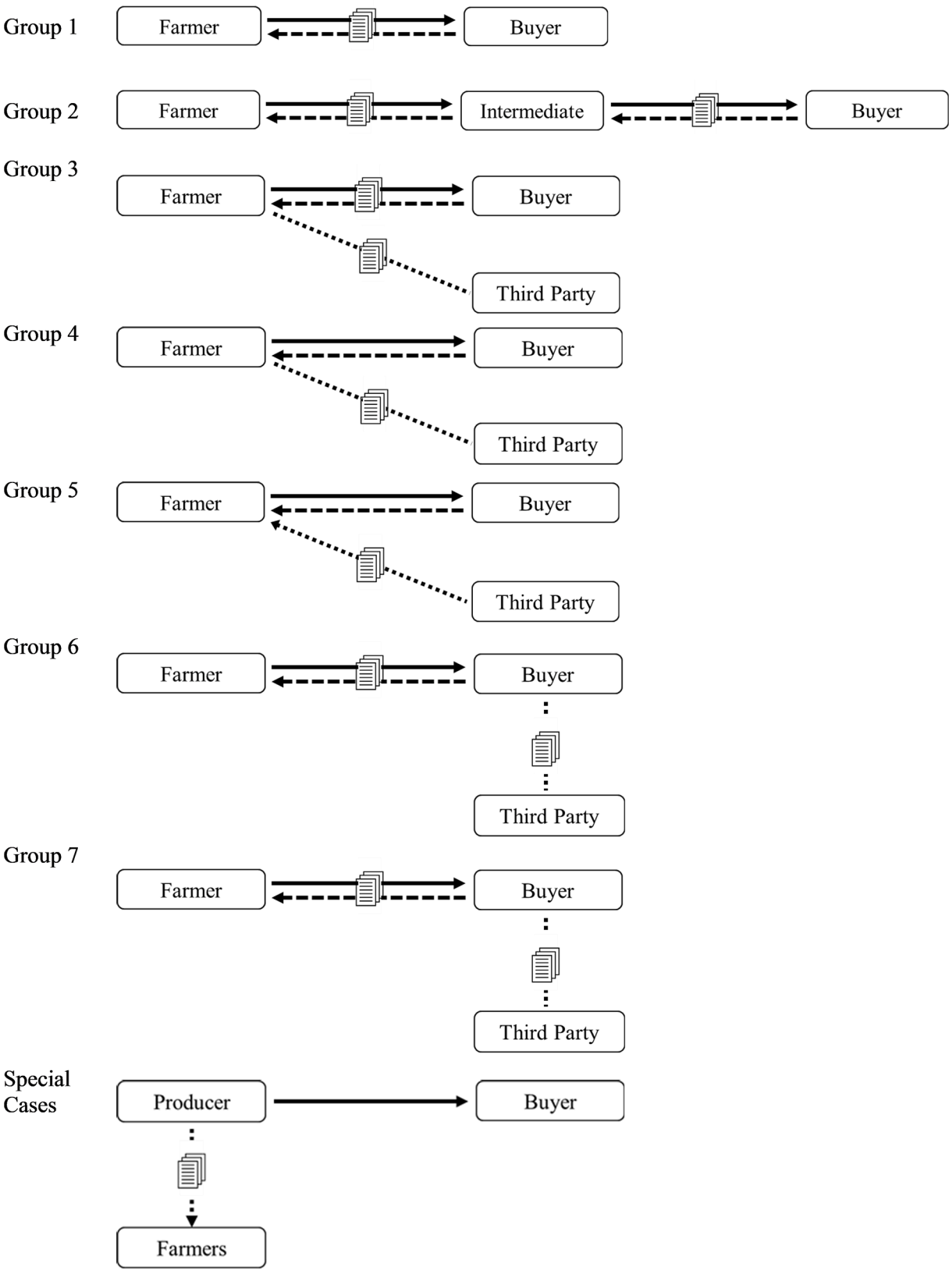

Fig. 5. Value chain structures. The solid arrow shows the flow of products, and the dashed arrow shows the payment or transfer of funds. The "document symbol" indicates existence of an agreement or contract between the parties.

practices. For example, two cases involve two beverage companies that pay farmers to implement certain agricultural activities to protect biodiversity and water resources used by the companies.

The categorization shows the flexibility of the contractual framework and the possible structure of the value chains. The nature of participation and collaboration in contracts may vary, and each party may have different roles depending on the agreement. For example, the public party may participate in the contracts as a buyer or as a third party, based on the requirements.

5.2. Biodiversity characteristics

In this section, the characteristics of the contracts and their properties related to biodiversity are discussed. Previous studies (e.g., Bredemeier et al.[7] & Sattler et al.[25,26] have examined various criteria and characteristics of different innovative contracts, including value chain contracts. Common characteristics found in most of these studies, as well as in the current study, are temporal and spatial scales, type of funding, payment basis, monitoring, contractors, parties involved and environmental services. For these characteristics, the results of the current study are consistent with those of Bredemeier et al.[7] and Sattler et al.[25]. However, what distinguishes our study from previous studies is the examination of biodiversity characteristics. Three biodiversity characteristics, biodiversity levels, targeted ecosystem diversity and objective biodiversity consideration were considered in this study.

The levels of biodiversity show that the conservation of genetic diversity is carried out to protect certain species such as Alphine oxen, the Bulgarian honeybee, and Bulgarian cattle, as well as old and neglected varieties of fruit and wheat. For example, in the Bio-Babalscy contract in Poland, about 70 varieties of ancient cereals are grown. Apart from the importance of genetic diversity for resilience to environmental problems, conservation of endangered and neglected varieties can simultaneously protect species and ecosystem diversity. Under “The Wild Farm" organic farmers contract, local biodiversity, rare breeds, and ornithological species are protected in addition to the conservation of Bulgarian cattle. In some cases, species diversity is the main objective level of biodiversity protection, such as in the Organic farming for biodiversity, but in most cases, although biodiversity is not the main objective, it is taken into account because organic farming and other environmentally friendly activities lead to the protection of insects and other species on agricultural land. The other level of biodiversity, ecosystem diversity, is considered in several cases, but it was the main objective level of biodiversity in the case of Integrated production in olive groves in Andalusia, Spain, with emphasis on the conservation of soil and its biodiversity.

Domesticated and wild biodiversity is another aspect of biodiversity conservation in the value chain contracts. Domesticated biodiversity is considered in several case studies, and largely coincides with the genetic diversity objective previously illustrated (i.e., Alphine oxen, the Bulgarian honeybee, and Bulgarian cattle, as well as old and neglected varieties of fruit and wheat). On the other hand, wild biodiversity conservation is one of the main objectives of all the contracts. Conservation of a domestic variety can lead to support the biodiversity of wild species as well.

Farmland, mountain and forest were the provisioned ecosystems. In most of the cases, farmland was the targeted ecosystem for protection of biodiversity. The mountain ecosystem was aimed at some contracts, for supporting the biodiversity of mountain pastures and grasslands. There is one contract Esprit Parc National - Food and services in the national park of Guadeloupe, with a focus on forest ecosystem biodiversity through agroforestry productions. In case study number 2, Organic honey from Stara Planina Mountain sites, due to the typology of the covered area and the role of pollinators and honeybees in the biodiversity conservation, all the farmland, mountain and forest ecosystems are considered.

6. Conclusions

This study provides an overview of value chain contracts implemented in three Horizon Europe projects: CONSOLE, Contracts2.0 and EFFECT, regarding biodiversity conservation in the agricultural sector. Various characteristics of the contracts were studied and classified, focusing on biodiversity features. In addition to the classification, another categorization of the contracts based on the value chain structure is presented. A limitation of our study was the accessibility to adequate information on some other projects conducted in the European Union. Comprehensive and detailed information on other EU projects is needed for future research. Similar studies in other geographical areas, with different ecosystems and institutional settings, would allow to have a larger vision of existing contractual patterns. This analysis did not consider quantitative data and indicators, which in the future will be essential to be identified in order to understand the long-term sustainability and effectiveness of different contractual choices. Other aspects that will need to be better considered are transparency (due to the privateness of the agreements) and comparison with other environmental conservation strategies, such as Payment for Ecosystem Services (PES) contracts.

In spite of these limits, the results of this study on the classification of contracts and their characteristics may have implications for biodiversity conservation, in particular in European Union. Our analysis has shown that the private sector can be a major provider of fundings to agrobiodiversity conservation, while the public sector and local government can be significantly involved in the process through different methods reflected in the structural categorization of contracts. Environmental results can be provided through a combination of value chain contracts and more classical tools such as PES contracts from governmental and non-governmental institutions, including EU Agri-Environmental Climate schemes. Consumers play a central role, as their behavior and preferences influence the decisions of processors and intermediaries, which can lead to the promotion of new contracts, labels and initiatives. Public authorities can accelerate this procedure by providing information to consumers.

There are several factors that could affect the success and better implementation of value chain contracts. Sufficient farmer motivation and appropriate payment mechanisms, such as premiums and other incentives, as well as adequate coordination between parties, can increase adoption of these contracts by farmers and other stakeholders. In addition to these factors, the selection of an appropriate basis of payment using a combination of action-based and result-based approaches, along with adequate monitoring and control can lead to better implementation of these contracts.

CRediT authorship contribution statement

Marzieh Aminravan: Writing – original draft, Methodology, Investigation, Conceptualization. **Luca Mulazzani:** Writing – review & editing, Supervision, Methodology, Conceptualization. **Abdallah Djella:** Investigation, Data curation. **Giulio Malorgio:** Writing – review & editing, Funding acquisition.

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.

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Contracts2.0 and EFFECT.

Data availability

Data will be made available on request.

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