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Title

Water quality issues and agriculture: an international review of innovative policy schemes

Authors' name

Alice Berthet ^{a, b}, Audrey Vincent ^{a, b}, Philippe Fleury ^{a, b}

Affiliations

^a Social Sciences Team, ISARA, 23 rue Jean Baldassini, 69364 Lyon, France

^b Laboratory of Rural Studies (LER), University Lumière Lyon 2, 86 Rue Pasteur, 69007
Lyon, France

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Address

Corresponding author: aberthet@isara.fr (A. Berthet)

Abstract

Current agri-environmental policies are facing challenges to protect the environment, including in delivering water quality improvements. These difficulties are mainly due to payment restrictions and field or farm scale limitations in existing policy schemes. Innovative approaches have emerged in the last decades to overcome these constraints, such as market-based, landscape-scale and food-chain approaches. In order to understand the potential of these approaches to deal with water quality issues, we have analysed the design features of 62 innovative agri-environmental schemes. We grouped them into nine types of instruments that could provide benefits on water quality and we identified three main drivers for change that are: rewarding environmental outcomes, encouraging collaboration between rural stakeholders and certifying agri-environmental practices within the agri-food chain. The diversity of the schemes reviewed emphasises the importance of the local context, which strongly conditions the effectiveness of instruments. Furthermore, mixing several schemes seems promising to encompass multiple governance levels involving both public and private actors.

Keywords

agri-environmental scheme – market-based – landscape-scale – food-chain – policy instrument

1 Introduction

Water resources are threatened by pollutants contamination throughout the world, making it challenging to ensure safe drinking water for human health. At European level, the Drinking Water Directive (1998) ¹ has fixed the essential quality standards of water intended for human consumption. Then, the European Union (EU) has adopted in 2000 the Water Framework

¹ Council Directive 98/83/EC of 3 November 1998 on the quality of water intended for human consumption

Directive (WFD) ² that established a framework for the assessment, management, protection and improvement of water quality. Member States had initially agreed to achieve good status in all bodies of surface water and groundwater by 2015 (European Environment Agency, 2015). The deadline has been extended to 2021, or at the latest 2027, as many water bodies remained subject to pressures. Diffuse sources pollution are responsible for 38% of pressures affecting water bodies, mainly due to agricultural sources such as nitrates and pesticides (European Environment Agency, 2018).

The EU Common Agricultural Policy (CAP) takes into account the protection of water quality through cross-compliance requirements with Environmental Directives, such as the Nitrates Directive (1991) ³, and voluntary measures, particularly Agri-Environmental-Climate Measures (AECM) (Matthews, 2013; Simoncini et al., 2019). Most current AECMs are action-based schemes applied at the field or farm scale that offer farmers financial incentives to adopt more environmentally friendly agricultural practices. They are usually co-funded by the European Agricultural Fund for Rural Development (EAFRD) for a period of five to seven years. It is currently the main scheme used for rural development in Europe in terms of public expenditures and areas enrolled. Indeed, AECMs were scheduled to cover 31,7 million ha and to cost over €25 billion, representing respectively 22,5% of the total utilised agricultural area in the EU-28 and 23% of EU expenditures for rural development over the period 2014-2020 (European Commission, 2019).

AECMs are expected to bring ecological benefits for biodiversity, soil, water, landscape, air quality or climate (European Commission et al., 2017). However, their environmental effectiveness is debated, including in their capacity to deliver water quality improvements (Jones et al., 2017). Several scholars argue that the ecological effectiveness of AECMs

² Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy

³ Council Directive 91/676/EEC concerning the protection of waters against pollution caused by nitrates from agricultural sources

depends on the structure and the management of the surrounding landscape whereas they are mostly implemented at field or farm scale (Kleijn et al., 2011; Batáry et al., 2015). This means that the spatial scale of agricultural management is not suited to that of the ecological process being managed, resulting in a spatial scale mismatch (Cumming et al., 2006; Pelosi et al., 2010). For instance, the implementation of AECMs at field scale does not reduce nitrate leaching that occurs at a larger scale (Toderi et al., 2017). This mismatch, combined with the low participation rate of farmers in AECMs, creates a threshold effect because the farming area enrolled does not cover a sufficient portion of the watershed (Dupraz et al., 2009; Kuhfuss et al., 2015). Thus, the individual and field or farm scale nature of most current agri-environmental contracts, is one of the explanations for their lack of environmental effectiveness.

AECMs are subject to numerous evaluations in regards to their cost-effectiveness. One of the key sources of inefficiency identified by several scholars is an information asymmetry due to the contractual relationship between public agencies and farmers (Blanford, 2007; Ferraro, 2008). This gives rise to hidden information concerning the true cost of opportunities farmers have foregone, and hidden actions when farmers do not comply with the measures contracted (Gómez-Limón et al., 2019). Both issues generate high transaction costs involved in gathering information, negotiating contracts and monitoring their implementation (Mettepenningen et al., 2009, 2011). These costs are usually not included in the AECM payments which are constrained by the World Trade Organization's (WTO) non-trade distorting Agreement on Agriculture (Hasund & Johansson, 2016). Compliance with the WTO's Greenbox, means that the EU only grants compensation for 'additional costs and income foregone' (EU Regulation No 1305/2013⁴). This follows the provider-gets principle, which means that these payments compensate the providers of public goods for their contribution to environmental protection

⁴ Regulation (EU) No 1305/2013 of the European Parliament and of the Council of 17 December 2013 on support for rural development by the European Agricultural Fund for Rural Development (EAFRD)

(Hanley et al., 1998; Hodge, 2000). This economic principle justifies the existence of AECMs in respect to the additional efforts made by farmers, but limits their financial compensation to agricultural opportunity costs (Uthes & Matzdorf, 2013). As it reduces the efficiency of the AECMs by restricting payments to compensation for lost revenue, it will be referred to as the restricted provider-gets principle in the rest of this paper.

Policy makers are faced with the challenge of incentivising environmentally friendly farming practices at the appropriate scale while complying with non-trade distorting regulations. Given these constraints, scholars have suggested diverse improvements to the contractual design of AECMs. Some papers provide theoretical insights on design features that could improve their effectiveness by favouring spatial targeting (Früh-Müller et al., 2019) increasing participation (Riley et al., 2018) or reducing transaction costs (Lundberg et al., 2018). Another group of papers describes empirical case studies of innovative schemes addressing water quality issues, in France (Amblard, 2019), Germany (Wezel et al., 2016) or the United-Kingdom (Cook et al., 2017) among others. However, policy design analysis of existing schemes is scarce, and often limited to a specific policy instrument such as collaborative schemes (Kuhfuss et al., 2019), results-oriented schemes (Herzon et al., 2018) or payments for environmental services (Matzdorf et al., 2019). This paper intends to fill this gap by providing a comparative design analysis of existing agri-environmental schemes (AES) for water quality protection. Looking at design features that go beyond the restricted provider-gets principle and/or field or farm scale limitations, it aims to identify innovative policies to address water quality issues in agriculture. From an implementation perspective, the paper seeks to provide an overview of schemes available to policy implementers who have local responsibility for water quality protection. For that reason, we do not consider regulatory and informative instruments designed at national level by policy makers but focus on voluntary instruments on which policy implementers have more flexibility. Specifically, it aims to

capture the way these schemes are addressing water governance defined ‘as the range of political, social, economic and administrative systems that are in place to develop and manage water resources, and the delivery of water services, at different levels of society’ (Rogers & Hall, 2003).

The article is structured as follows. Firstly, our Section 2 begins with an overview of innovative approaches in agri-environmental policies. Section 3 goes on to explain the methodology applied to identify and analyse the different schemes. Then, Section 4 presents a description of the innovative features and drivers for change that these schemes foster. Finally, Section 5 discusses the potential insights of this analysis for the design and implementation of more efficient and effective AES.

2 Innovative approaches in agri-environmental policy

Innovative approaches suggested by agri-environmental studies that go beyond the contractual design issues of current AES include market-based approaches that overcome the payment constraints through application of an extended provider-gets principle on the one hand, and on the other, scale approaches that extend beyond the limits of the field or farm scale, up to the landscape and food-chain scales.

2.1 Market-based approaches

Market-based approaches broadly speaking use taxes, subsidies and tradable permits to influence prices or set quantities in order to achieve environmental or other policy objectives (European Commission, 2007). An abundant literature agrees on the expansion of such approaches into agri-environmental policies. The increased confidence in markets to handle environmental problems is based on their expected economic efficiency (Vatn, 2014). From an economic perspective, environmental problems are considered as externalities resulting from market failures that should be internalized as costs by governmental intervention or

private negotiation (Gómez-Baggethun & Muradian, 2015). Both governmental subsidies and market transactions are economic instruments as they are using the price signal to internalize costs (Pirard, 2012). However, governmental subsidies cannot be strictly described as market-based instruments because their payment does not result from market trade (Hahn et al., 2015). Indeed, market-based approaches imply a switch from public subsidies to private trading. As market transactions are not limited by the restricted provider-gets principle, they may represent an efficient way of delivering environmental benefits.

The adoption of market-based approaches into agri-environmental policy has been favoured by the concomitant emergence of the ecosystem framework which has allowed market features to be applied to environmental goods. (Muradian & Gómez-Baggethun, 2013) Indeed, the economic valuation of ecosystem services makes it possible in theory to turn them into tradable commodities even if it remains challenging in practice due to their nature as public goods (Muradian & Rival, 2012). It leads to the promotion of market-based instruments into agri-environmental policy by setting up a market for ecosystem services, or more particularly Payments for Environmental Services (PES) (Gómez-Baggethun, 2010). The term PES is an umbrella term used to describe a variety of existing schemes, from an 'ideal-PES' to 'PES-like', that are positive environmental incentives (Wunder, 2015). For our purpose, we will use the narrow definition of Wunder (2005) that characterized a PES as a voluntary transaction where a well-defined ecosystem service is being bought by a buyer from a provider, and where the purchase is conditional upon the effective delivery of the agreed ecosystem service. A well-known case of such PES is the Vittel PES, where the water company Vittel made contracts with farmers to reduce nitrate inflow to water bodies (Perrot-Maître, 2006).

Although market-based approaches are promising, the creation of markets for the provision of environmental services remains challenging for two main reasons: the difficulty to

commodify ecosystem services and their common good character (Muradian & Gómez-Baggethun, 2013). First, it is necessary to use valuation techniques to set an appropriate price on the ecosystem services provided (Reed et al., 2014). Then, because the number of beneficiaries is high, individuals and firms have little motivation to pay for an environmental service that is spread over so many and does not provide much profit (Vatn, 2018). For both reasons, the involvement of governments in market-based approaches remains essential, either as a regulator or a buyer (Matzdorf et al., 2019). Therefore, market-based approaches as developed into agri-environmental policy are more likely to be hybrid approaches that bring market features into governmental instruments.

2.2 Landscape-scale and food-chain approaches

Scholars suggest adopting a landscape scale approach to deal with the scale issue in agri-environmental policy. The landscape scale is defined as ‘an area of coherent landscape character or a sub-unit of a natural region, above the field and farm scales’ (Prager et al., 2012). For water quality issues, the landscape refers to the watershed, in line with the river basins management promoted by the WFD (European Commission, 2014). From an ecological perspective, it is meaningful to consider this scale where ecological processes occur to reduce the spatial scale mismatch (Leventon et al., 2019). This allows the geographical dispersion of parcels within the landscape to be taken into account while also considering ways to overcome fragmentation caused by farmers working in isolation (Leventon et al., 2017). Indeed, in some approaches, scale is used as a bridging concept that encompasses the ecological, economic and governance dimensions of land management (Westerink et al., 2015). It is therefore not limited to the re-scaling of dimensions, but also considers the re-connection of rural stakeholders and the re-spacing of the whole agri-food chain from the farmers to the consumers including processors, distributors and retailers (de Krom, 2017). It refers respectively to the ‘horizontal’ and ‘vertical’ networks of Murdoch

(2000) in which the farm is integrated. Thus, such scale considerations assume a systemic vision of the farm within both its networks.

Such a re-connecting dimension requires collaborative agri-environmental management among farmers within a landscape (Westerink et al., 2017). Coherent land management at an appropriate scale to provide environmental benefits could be achieved through collective action (Mills et al., 2011). Various forms of collective action are distinguished according to the degree of collaboration (from coordination to collaboration), the initiator (top-down vs bottom-up) and the members involved (farmers and others local actors) (Prager, 2015). Since the 2013 reform of the CAP, agri-environmental payments are allowed to compensate transaction costs related to joint actions undertaken by a ‘group of farmers or groups of farmers and other land-managers’ (EU Regulation 1305/2013). According to some scholars, farming cooperation could nudge farmers to enrol in AES (Kuhfuss et al., 2015). Then, collaborative design features may favour the adoption of environmentally friendly farming practices at a larger horizontal scale.

Finally, re-spacing is about integrating the whole food chain into agri-environmental governance (de Krom, 2017). Indeed, environmental certifications are recognised as well as AECMs to benefit the environment (EU Regulation 1307/2013⁵). However, agri-food policy is usually considered separately from agri-environmental policy although both could contribute to make our agri-food system more sustainable (Forney, 2016). For that reason, some scholars call for a reconnection between agriculture and food on environmental issues (Lamine & Dawson, 2018). This is in line with a growing consumer interest in sustainable agri-food products (Cecchini et al., 2018) and the increasing engagement of the private sector with environmental sustainability within the agri-food chain (Thorlakson et al., 2018). Thus,

⁵ Regulation (EU) No 1307/2013 of the European Parliament and of the Council of 17 December 2013 establishing rules for direct payments to farmers under support schemes within the framework of the common agricultural policy

scale approaches are not limited to the consideration of farmers, but also include the wide range of actors involved in the agri-food chain.

Market-based, landscape-scale and food chain approaches deploy a wide array of market and policy instruments. The following inventory of AES aims to capture this diversity.

3 Materials and methods

3.1 Research method for the literature review

On the ISI Web of Knowledge database, we looked for studies published in English between 2000 and 2019 with a topic associated to AES (keywords *agri* and environment* and scheme**). The two main innovative approaches presented above, market-based approaches (keywords *payment* or trading**) and landscape scale approaches (keywords *landscape* and scale**) were given specific focus. Additionally, a specific search has been performed on food-chain approaches with environmental expectations that are usually considered apart from other AES (keywords “*food and (chain* or product*)*”). As the term ‘scheme’ is not always used when referring to agri-food schemes, it was replaced with either the words ‘certification’ or ‘standard’ (Table 1). We reduced our first pool of papers by limiting our search to environmental reviews (WOS categories ‘environmental science’ and ‘environmental studies’), so the pool of papers for analysis was composed of 763 references.

Table 1 : Research method for the literature review and resulting pool of papers

Backbone search equation ...	<i>agri* AND environment* AND ...</i>			TOTAL
... and specific keywords	<i>... scheme* AND ...</i>		<i>... (certificate* OR standard*) AND ...</i>	
	<i>... (payment* OR trading*)</i>	<i>... (landscape* AND scale*)</i>	<i>... (food AND chain* OR product*)</i>	
Number of papers found	251	229	283	763
Number of papers reviewed	58	24	17	99

Although it was not specified in the search equation, choices were made to limit the scope of the review. First, a particular attention has been given to schemes addressing water quality issues, but some schemes dealing with biodiversity were also included, especially in Europe because of the close relationship between water quality and biodiversity issues in the CAP. In such cases, although both issues are addressed within similar regulatory and legal frameworks, their specificities must be taken into account at the field level. From a geographical point a view, the research was extended to countries located in Europe, North America (United-States and Canada) and Oceania (Australia and New-Zealand) as these countries are all facing similar challenges due to agricultural intensification. Using these criteria, a first selection was performed on the pool of 763 papers based on title and abstract that excluded a range of papers because of their topic (24%) or due to their geographical scope (17%). Additionally, a significant number of papers were set aside as they adopted an ecological (21%) or economic (7%) approach, or focused on technical (14%) or social (7%) aspects. We only kept articles that provide sufficient details on schemes, either as a case study or a review. These selected papers were read and related papers added if they provided additional information on the scheme or mentioned another scheme. At the end, a pool of 99 papers was used to identify 62 innovative AES.

3.2 Theoretical framework

The theoretical framework is inspired from the work of Howlett (Cashore & Howlett, 2007; Howlett & Cashore, 2009) with some insights from Rogge's policy mix concept (Rogge & Reichardt, 2016). Howlett has suggested a framework to assess the way policy tools may achieve policy ends (Howlett & Rayner, 2013) and applied it to the Conservation Reserve Program (CRP), an AES from the United-States (Howlett et al., 2014). The analytical framework proposed by Rogge includes many elements similar to the components suggested by Howlett but it goes further in explaining how these elements connect to each other to drive

change. We drew on both Howlett and Rogge to build our own framework designed to analyse AES (Table 2).

Table 2 :Comparison of policy design framework suggested by Howlett (on left), Rogge (in the middle) and our policy design framework (on right).

Components of policy according Howlett	Elements of policy according Rogge	Components of our framework
policy ends or aims	policy strategy <i>combination of policy objectives and principal plans to achieve them</i>	policy ends
policy goals <i>general ideas that govern policy development</i>	policy objectives	policy objective <i>environmental objective related to or including water quality issues</i>
program objectives <i>what does the policy formally aim to address</i>		
operational settings <i>specific on-the-ground requirements of policy</i>	principal plans	
policy means or tools	instrument <i>concrete tools to achieve overarching objectives</i>	policy means
instrument logic <i>general norms that guide implementation preferences</i>	instrument purpose	instrument purpose <i>cognitive model on which agri-environmental policy is based</i>
program mechanisms <i>specific types of instruments utilized</i>	instrument type	instrument type <i>main types of agri-environmental instruments</i>
calibrations <i>specific ways in which the instrument is used</i>	instrument design features	instrument design features <i>specific characteristics of the instruments detailing operating condition: payment mechanism, funding source, monitoring system, governing actor and targeted area</i>

Just as in Howlett's and Rogge's frameworks, ours contain two main blocks: policy ends and policy means. However, policy ends were restricted by our search methodology to environmental objectives, related to or including water quality issues, addressed by agricultural policy. For that reason, this block is described by a single element, the policy objective. On the other hand, we provide a deeper analysis of the elements related to policy means, which are described using three elements from abstract to more concrete levels: instrument purpose, instrument type and instrument design features.

First, the instrument purpose (or logic) encompasses the general norms underlying the choice of an instrument. It can be considered close to the cognitive notion of paradigm or *référentiel*

which are ideas or general representations of how a given problem influences the public action (Surel, 2000). These underlying ideas form the cognitive model on which the agri-environmental policy is based such as environmental performance or treatment cost reduction. Then, the instrument type (or mechanism) refers to the different typologies of instruments suggested in the literature. Rogge (2016) has proposed the commonly used ‘carrots, sticks and sermons’ typology that classify instruments into economic, regulatory and informative types. But alternative typologies have also been proposed to describe environmental policy instruments such as hard and soft instruments (Wurzel et al., 2013) or the continuum of policy instruments (Ring & Barton, 2015). As the scope of our review is limited to voluntary instruments, more precise types have been considered like PES, collective bonus, or private standards. Finally, the instrument design features (or calibrations) gather all the characteristics of the instruments such as: payments, guidelines, legal forms, targets, costs, or duration for instance. These characteristics provide details on the operating conditions in which the instrument is used. According to Rogge (2016), these design features are of greatest importance to the innovative character of the instrument. For that reason, we have accorded specific interest to the description, for each scheme, of five criteria to characterise its design features: payment mechanism, funding source, monitoring system, governing actor and targeted area. The choice of design features has been inspired by existing reviews of policy schemes (Burton & Schwarz, 2013; Herzon et al., 2018; Lundberg et al., 2018) and on our own knowledge of instruments.

For each scheme identified during the research process, its policy objective, instrument purpose, instrument type and design features were collected. These elements are used to characterize the types of agri-environmental instruments reviewed (Section 4.1) and the main drivers for change (Section 4.2). The detailed data are available in the Appendix.

4 Results

The literature review has identified 62 schemes, which are innovative in the way they address environmental objective related to or including water quality issues. These schemes are commonly distributed among different types of instruments according to their design features (payment mechanism, monitoring system, governing actor, funding source, targeted area). Section 4.1 will describe each of these instrument types with illustrations from various existing schemes. Then, Section 4.2 will identify instrument purposes and analyse the three main drivers for change that these schemes seek to activate.

4.1 Nine main types of instruments according to their innovative design features

Nine main types of agri-environmental instruments have been identified in the literature: PES, results-oriented schemes, auctions, water quality trading (WQT) schemes, collective bonus, farmers' groups, collective contracts, public labels and private standards (Table 3). Most of them are subsidy payments according to a price-based mechanism but we also identified one type of tradable permits (WQT) and two different certification instruments (public label and private standards).

Agri-environmental instruments	Country	Policy objective	Payment mechanism	Funding source	Monitoring system	Governing actor	Targeted area
PES (13)	De(4) En (3) US(2) Fr(2) Ca(1) Wa(1)	water quality (9) environment (3) biodiversity (1)	action-based (11) results-based (2)	private (5) municipal (4) mixed (4)	criteria (8) measure (3) others (2)	company (5) association (4) city (4)	watershed (10) no targeting (3)
Results-oriented schemes (15)	US(4) At(2) De(2) Be(1) Ch(1) Fi(1) Fr(1) Ie(1) NL(1) Se(1)	biodiversity (9) water quality (4) environment (2)	results-based (15)	public (14) mixed (1)	measure (7) score (5) model (2) other (1)	government (10) governmental agency (3) association (2)	HNV (6) no targeting (6) watershed (2) county (1)
Auctions (7)	Au (3) US(2) De(1) Fr(1)	environment (3) water quality (3) biodiversity (1)	bid (7)	public (7)	score (6) measure (1)	governmental agency (4) government (3)	watershed (4) county (1) HNV (1) no targeting (1)
WQT schemes (6)	US(4) Ca(1) NZ(1)	water quality (6)	credit exchange (6)	mixed (4) public (1) municipal (1)	model (5) measure (1)	governmental agency (4) government (1) association (1) city (1)	watershed (6)
Collective bonus (2)	Ch(1) En(1)	environment (1) biodiversity (1)	agglomeration bonus (2)	public (2)	criteria (2)	government (2)	HNV (1) no targeting (1)
Farmers' groups (6)	Au(1) At(1) Be(1) De(1) En(1) Fr(1)	environment (6)	project (6)	public (6)	group (6)	government (3) association (2) organization (1)	no targeting (5) HNV (1)
Collective contracts (2)	NL(1) Wa(1)	environment (2)	collective (2)	public (2)	criteria (2)	government (2)	HNV (1) no targeting (1)
Public labels (4)	Fr(1) It(1) EU(2)	food quality (2) environment (1) sustainability (1)	certification (4)	associated funding (3) no funding (1)	criteria (2) third-party (2)	government (4)	geographical (2) sectoral (1) no targeting (1)
Private standards (7)	En(1) NL(1) Ww(5)	environment (4) sustainability (2) food quality (1)	certification (7)	no funding (6) associated funding (1)	third-party (6) no monitoring (1)	organization (7)	no targeting (5) sectoral (2)

289 (*) Number of schemes concerned

290 Au: Australia – At: Austria – Be: Belgium – Ca: Canada – Ch: Switzerland – De: Germany – En: England – EU: Europe – Fi: Finland – Fr: France – Ie: Ireland – It: Italy –

291 NL: Netherlands – NZ: New-Zealand – Se: Sweden – US: United-States – Wa: Wales – Ww: Worldwide

4.1.1 *Payments for Environmental Services (PES)*

PES are schemes for which a buyer rewards farmers on condition that they provide an ecosystem service. Compared to current AES, two core elements are innovative: the payment by a buyer and the conditionality of the payments. However, few PES satisfy both of these criteria in practice and we will take into consideration PES that have at least one of these two innovative features. We distinguish PES with a buyer who is not the government but a beneficiary (user-financed PES) and PES that are conditional on the delivery of an ecosystem service (output-based PES) (Sattler et al., 2013). The first ones are innovative insofar as the source of funding is not public expenditures but are at the present time mainly action-based payments. The second ones boast an innovative payment mechanism that are results-based but are at the present time financed by public subsidies. These latter result-oriented schemes will be described in the next section.

This part only deals with user-financed PES for which funding comes directly from the beneficiary of the service provided and not the government. It can be either a company (the water supply company for Upstream Thinking (UST), Sustainable Catchment Management Plan (SCaMP) and Dorset in England or the bottled water companies Evian and Vittel in France), an association (Nature Conservation Foundations for the Cooperation Model (TKW) and Flowering Steinburg (BS) in Germany, Wildlife Trust in Pumlumon in Wales or an NGO for Alternative Land Use Services (ALUS) in Canada) or cities (Augsburg and Munich in Germany, New-York (WAP) and San Antonio (EAPP) in the United-States). In these schemes the funding source is at least partially private, except for the four PES financed by cities using local taxes. As mentioned above, for most of these schemes the payment is not conditional upon the delivery of an ecosystem service (results-based) but rather on the implementation of management practices (action-based). These actions are monitored according to criteria that are scored except for the Munich and EAPP schemes. In Munich, payments are made to

farmers if they are certified as practising organic farming, while the EAPP scheme requires that farmers subscribe to a land easement. Furthermore, two German schemes (Augsburg and BS) are really measuring the environmental outcomes provided, respectively the nitrate level and the number of species, and could be considered as results-oriented schemes as well. Finally, most of these PES schemes are applied in one specific administrative watershed (Augsburg, TKW, Munich, Dorset, SCaMP, UST, Evian, Vittel, EAPP and WAP) except the ALUS, BS and Pumlumum schemes that are not targeting specific area.

4.1.2 Results-oriented schemes

Results-oriented schemes condition payments to farmers on their delivery of environmental outcomes. As mentioned above, they differ from current AECMs because payment depends on the results achieved rather than actions undertaken. Different monitoring systems are used to determine the outcomes provided by farmers: measurable indicators, models, or scores. In European countries, most results-oriented schemes rely on measurable indicators, mostly the number of plant species (Flowering Meadows (FM) in France, MEKA-B4 in Germany, Ordinance of Ecological Quality - Quality Bonus (OQE-QB) in Switzerland) or animal species (Golden Eagle Compensation (GEC) in Finland, Community protection of Meadows Birds (GW) in Germany, Meadows Birds Agreement (MBA) in Netherlands and Conservation Performance Payments (CPP) in Sweden). Concerning water quality, only two results-oriented schemes that measure the nitrogen level through soil samples have been identified in Europe (Soil Nitrate Residue (APL) in Belgium and Augsburg in Germany, already mentioned in the previous section) due to the difficulty to measure pollution abatement on sites. An alternative monitoring system to overcome this difficulty is to estimate water quality improvements using a model as two US schemes have already done (Florida Ranchlands Environmental Services Project (FRESP) and Performance-based Environmental Policies for Agriculture (PEPA)). Other schemes have implemented a scoring system, either

based on common indicators (Eco-Points (OP) in Austria and Burren Farming in Ireland) or adapted to individual goals (Results-based Nature Conservation Plan (ENP) in Austria, and Conservation Stewardship Scheme (CSP) in the United-States). Finally, one scheme conditions payments on conservation easement (Conservation Reserve Enhancement Program (CREP) in the United-States). All the results-oriented schemes identified are funded through public expenditures, and governed by national or regional governments (OP, ENP, APL, GEC, MEKA-B4, Burren, MBA, CPP, OQE-QB, CSP), a governmental agency (FM, CREP, FRESP) or an association (GW, PEPA). Whereas some schemes are available to all farmers (OP, MEKA-B4, GW, MBA, CSP), others target specific areas from an administrative perspective (watershed for FRESP and PEPA, county for Burren, reindeer territory for GEC and CPP) or from an ecological point of view (HNV area for FM, OQE-QB, CREP or vulnerable area for APL).

4.1.3 Auctions

Auctions are schemes that use a tendering process to allocate contracts to farmers. It is an innovative feature compared to current AES that rely on fixed payments. All these schemes are based on a score aggregating the payments and the actions proposed by farmers. Then, bids are ranked and selected within the given budget constraints in such a way as to be able to pay the same amount to all successful bidders. The final payments are made on the basis of the true score achieved by farmers except for the Norheim scheme that measures the number of species. Most existing auction schemes are located in Australia (BushTender (BT), Catchment Care Auction (CCA), Reef Trust Tender (RTT)) or in the United-States (Conservation Reserve Program (CRP) and Environmental Quality Incentive Program (EQIP)). However, two European schemes have experimented with auctions over a few years in a limited area: the ‘grass cover’ call for proposals (CH) in France and the Norheim model in Germany. Such tender schemes are set up by governmental actors at the national level in

the United-States, at the regional level in Australia or by governmental agencies in France and Germany. All these actors are allowed to allocate public funding competitively. Most of these auction schemes target specific areas, either a watershed (BT, CCA, RTT, CH), a county (Northeim) or HNV area (CRP), except for the EQIP scheme which applies to the whole of the United-States.

4.1.4 Water quality trading schemes

WQT schemes are tradable permits in which participants can voluntarily exchange their water pollution credits. In most schemes, waste-water treatment plans earn credits by financing the implementation of best management practices by farmers located in the same administrative watershed. Thus, it offers polluters an alternative way to meet compliance requirements by purchasing an equivalent improvement in water quality. It is innovative in that it creates a specific market for water quality (Shortle, 2013). WQT schemes are mainly developed in the United-States (California Grasslands Areas (CGA), Greater Miami Trading (GMT), Medford Water Quality Trading (MWQT), Chesapeake Bay Nutrient Credit Trading (CBNCT), but successful examples also exist in Canada (South Nation River Total Phosphorus Management Plan (SNRTPMP)) or New-Zealand (Lake Taupo Nitrogen Trading (LTNT)). In agriculture, schemes usually address diffuse nutrients pollution (GMT and CBNCT), or specific loads in nitrogen (LTNT) or phosphorus (SNRTPM). Most schemes monitor trading in emission credits through models, except for the CGA scheme which measures agricultural emissions in order to reduce selenium in drainage water. All the other WQT schemes rely on trade between points, i.e. waste water discharge and nonpoint sources, i.e. agricultural emissions within a watershed. However, the LTNT scheme is the only one that exclusively regulates nonpoint sources of nitrogen pollution between farmers. Consequently, this scheme is financed solely by public funding whereas the other schemes also benefit from private funding from the waste-water treatment plants. Although credits are sold by farmers and purchased by credit

buyers, the administrative costs are financed by public funds. It is often regulated directly by the government but the other actors can be involved such as the city in Medford or a farmers' association in CGA.

4.1.5 Collective bonus

Collective bonus are schemes for which an additional payment is awarded over the standard one, conditioned on a participation threshold or spatial configuration patterns. These schemes are innovative because they are targeting connected areas rather than individual parcels. Although several bonus schemes have been experimented worldwide, collective bonus have been implemented in only two European schemes: the option HR8 'Supplement for group application' of the Environmental Stewardship Scheme (ESS-HR8) in England and the Network Bonus of the Ordinance of Ecological Quality (OQE-NB) in Switzerland. Both schemes propose an agglomeration bonus, i.e a bonus payment to neighbouring farmers for implementing the same practices in a spatially connected area (Wätzold & Drechsler, 2014). These payments are provided on top of the regular payments publicly funded by the national government. Whereas ESS-HR8 is implemented in a HNV area and does not specify any particular environmental management activity, OQE-NB is accessible to any farmer as long as they form part of a network project in line with established criteria on biodiversity conservation.

4.1.6 Farmers' groups

Farmers' groups are schemes that provide subsidies to a group of farmers working together towards common environmental objectives. It means that the payments do not finance the implementation of agri-environmental practices but the cost of coordinating the environmental project and carrying out collective facilitation processes. Several examples of farmers groups exist worldwide: National Landcare Program (ALP) in Australia, Cultural Landscape Project (KLP) in Austria, Agro-Management Group (ABG) in Belgium, Integrated

Local Delivery (ILD) in England, Environmental and Economic Interest Group (GIEE) in France, and Landcare Group (LPV) in Germany. All these groups are addressing environmental issues, with some specialised on water issues like Group 30 000 in France and Water ILD in England. All of these farmers' groups are financed with public funds and implemented at the national scale, except for the ABG scheme that has a regional scope. While the Australian, Austrian and French governments provide a framework for these groups in their country, the other schemes are managed by a national organization (ABG) or association (ILD and LPV). Some of these schemes (ALP, KLP and LPV) are community groups, which do not limit membership to farmers but also include other rural stakeholders.

4.1.7 Collective contracts

Collective contracts are payments based on a contractual agreement with a collective of farmers. They differ from current AECMs for which the government contracts independent agreements with individual farmers, because the payments here are made to an intermediary actor. This actor has a coordinating role at the local level, and is in charge of distributing payments received from the government among farmers according to specific criteria. Two European schemes implement collective payments: Environmental Collectives (EC) in the Netherlands and the Common Land Element (CLE) option of the Glastir scheme in Wales. Although in both schemes, collective payments are publicly funded by the national government, the two schemes differ in scope. On the one hand, collective contracts have been experimented in the Netherlands since 2012 and they were adopted as the national scheme in 2016. On the other hand, collective payments within Glastir are an option that has emerged in 2012 in Wales and are limited to common land that are recognized as HNV areas. Besides these differences, both are organised around an intermediary that receives payments from the government and distributes the funds among farmers: the Environmental Collectives in the Netherlands and the Farmers' Association in Wales.

4.1.8 *Public labels*

Public labels are governmental initiatives that protect the food quality of products, either based on geographical or characteristic criteria. The older food quality scheme is the well-known Organic Farming (OF) standard that originated back in 1924 and has been nowadays harmonized by the OF label at European level. In the 1990s, the EU created the Protected Designation of Origin (PDO) and the Protected Geographical Indication (PGI) (Council Regulation (EEC) No. 2081/92 ⁶). Although they are mainly focused on territorial criteria, some of these quality schemes can receive support from the EARFD if they guarantee ‘a quality of the final product that goes beyond the commercial commodity standards as regards (...) environmental protection’ (EU Regulation No 1305/2013). Finally, some national governments have designed quality schemes that have a specific added value for water quality protection. For instance, the French and Italian governments have set up respectively the High Environmental Value (HVE) certification and the VIVA Sustainability project. Both certifications are based on indicators related to various environmental issues that impact water quality, such as fertilization management, phytosanitary strategy or water footprint (Ravaglia et al., 2018).

4.1.9 *Private standards*

Private standards are voluntary initiatives that recognize the compliance of a product or a process with the food safety and quality requirements of the standard through a third-party certification. Although these schemes have existed for several decades, it is only recently that food standards have included environmental requirements. Standards established within a business-to-business (B2B) perspective can be distinguished from those that directly concern consumers (B2C). The former is largely dominated within the agri-food sector by the Global GAP standard that promotes ‘good agricultural practices’. Regarding water issues, the

⁶ Council Regulation (EEC) No 2081/92 of 14 July 1992 on the protection of geographical indications and designations of origin for agricultural products and foodstuffs

Alliance for Water Stewardship (AWS) has established a standard in 2014 for major water user companies to assess the sustainability of their practices within their watershed. The latter B2C standards group together a wide range of private initiatives (Nature plus, Earth friendly, Terra Vitis, among others) that have proliferated in the last years (Gruère, 2015). Most of these B2C standards belong to the ISO 14 020 family of environmental labelling that has established principles and procedures that such labels should respect. Three types of ISO 14 020 labels can be distinguished: ISO 14 024 or type I on environmental labelling programs, ISO 14 021 or type II on self-declared claims, and ISO 14 025 or type III on quantified environmental declarations based on life cycle analysis (LCA). Additionally, some private initiatives at national scale such as Linking Environment and Farming (LEAF) in England or Milieukeur in the Netherlands are promoting the integrated management of agricultural production.

4.2 Three main drivers for change

Several instrument purposes have been identified in this review of AES. These cognitive

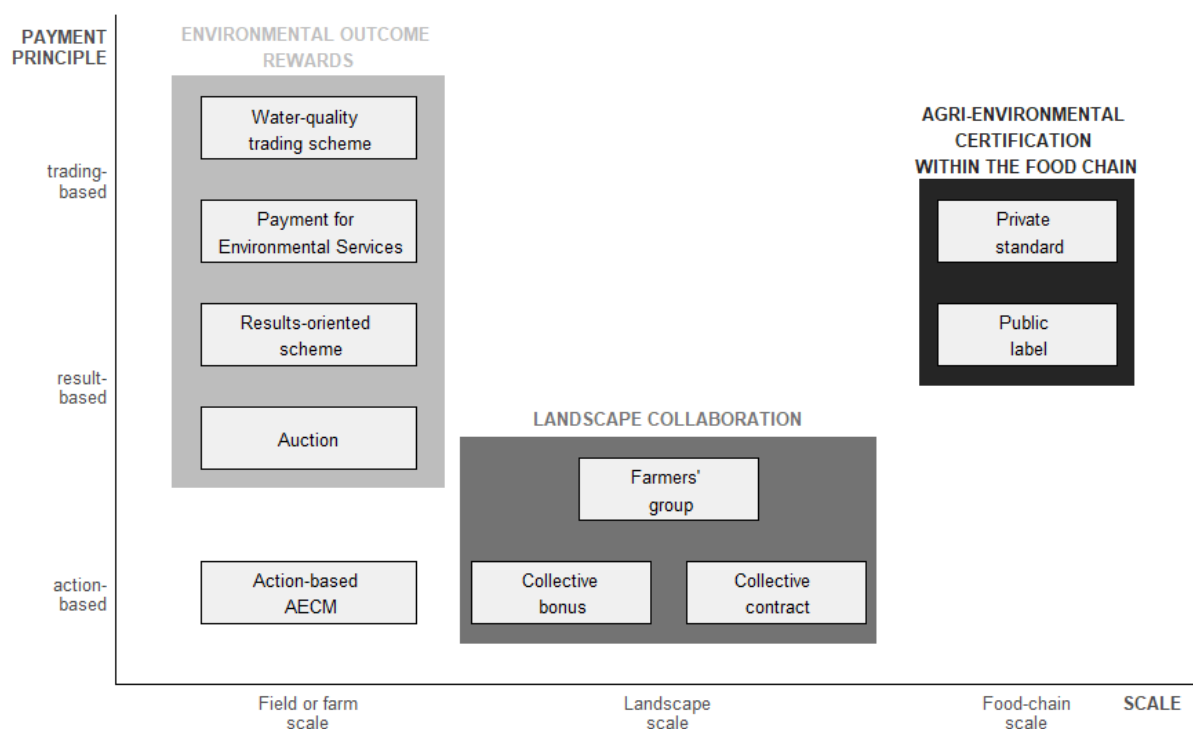


Figure 1 : Innovativeness of agri-environmental instruments according to three main drivers for changes (in the dark boxes): the nine types of AES instruments (in the light boxes) have innovative design features in respect to payment restrictions (y-axis) and/or scale constraints (x-axis)

models explain the emergence of innovative design features into agri-environmental policy. We can distinguish between schemes that are innovative as regards the restricted provider-gets principle (auctions, results-oriented schemes, PES and WQT schemes), as regards ways of overcoming the field or farm scale limitations (collective bonus, groups or contracts) or as regards both of these constraints (public labels and private standards) (Figure 1). Indeed, the various purposes behind the schemes could be gathered into three main drivers for change: to reward the environmental outcomes of agriculture, encourage the collaboration between farmers at the landscape scale, and finally to integrate agri-environmental certification within the food chain.

4.2.1 Rewarding the environmental outcomes of agriculture

The current AES are based on a restricted provider-gets principle that limits payment to compensation for income foregone or costs incurred by the adoption of specific management practices. In order to go beyond these action-based schemes while complying with the WTO's rules, some payment mechanisms have been tried out: payment upon results, bid and pollution credit trading as well as private funding. All these design features aim to strengthen the link between agri-environmental payments and the provision of environmental services. Several purposes, either social, economic or environmental in nature, have been put forward to promote the adoption of these schemes (Table 4).

Table 4: Main purpose of innovative schemes regarding the restricted provider-gets principle

	PES	Results-oriented	Auction	WQT
<i>Environmental outcome rewards</i>				
flexibility		Burren (Ie / B) ENP (At / B) FM (Fr / B) MEKA (De / B) OP (At / B) OQE-QB (Ch / B) PEPA (US / WQ)		
cost reduction <i>efficiency</i>		CREP (US / E) CSP (US / E)	BT (Au / E) CCA (Au / WQ) CH (Fr / WQ)	GM (US / WQ) SNR (Ca / WQ)

<i>at-source</i>	Dorset (En/ WQ) SCaMP (En /WQ) TKW (De /WQ) UST (En/ WQ) WAP (US /WQ)		CRP (US /E) EQIP (US /E)RTT (Au /WQ)	
environmental service <i>provide service (biodiversity)</i> <i>avoid disservice (water pollution)</i>	ALUS (Ca /E) Pumlumum (Wa /E) BS (De /B) Augsburg (De/WQ) Evian (Fr /WQ) EAPP (US /WQ) Munich (De /WQ) Vittel (Fr /WQ)	CPP (Se /B) GEC (Fi /B) GW (De /B) MBA (NL /B) APL (Be /WQ) FRESP (US /WQ)	Northeim (De/B)	CGA (US /WQ) LTNTP (NZ /WQ) MWQTP (US /WQ) PANCTP (US /WQ)

499 (Country code / Objective code)

500 Objective code: B: Biodiversity – E: environment – WQ: water quality

501 Country code: Au: Australia – At: Austria – Be: Belgium – Ca: Canada – Ch: Switzerland – De: Germany – En:

502 England – Fi: Finland – Fr: France –Ie: Ireland – NL: Netherlands – NZ: New-Zealand – Se: Sweden – US:

503 United-States – Wa: Wales

504 One main argument in favour of results-based payments is the flexibility given to farmers
505 regarding the agricultural practices they choose to implement. It makes it possible to adapt
506 management practices to local conditions and facilitate innovation (Matzdorf & Lorenz,
507 2010). However, this greater flexibility is associated with a risk of not achieving the proposed
508 environmental outcomes as they are influenced by external factors such as weather conditions
509 or farmers' insufficient knowledge (Russi et al., 2016). These risks could be mitigated by
510 associating ambitious results-based payments with easy baseline targets, action-based
511 requirements and appropriate advisory services (Herzon et al., 2018; Birge & Herzon, 2019)
512 For instance, results-based AECMs are combined with traditional action-based AECMs in
513 some countries like in FM in France (Fleury et al., 2015) or MEKA-B4 in Germany (Russi et
514 al., 2016). Such public payments are permitted by the WTO under the amber box of trade-
515 distorting support but expenditure is limited to a ceiling that prevents them from being
516 expanded to a larger scale (Hasund & Johansson, 2016). The switch to results-based payments
517 would require either revising the WTO rules or estimating the social value of these
518 environmental outcomes.

Another range of schemes with innovative payments have an underlying economic purpose which assumes that a scheme rewarding environmental outcomes could reduce costs. For public actors, the use of competitive payment mechanisms like tenders is cost-effective because it has the potential to reduce transaction costs (Schilizzi & Latacz-Lohmann, 2016). For private actors that are facing environmental issues such as pollution, paying farmers directly to protect nature will reduce the cost of cleaning up polluted water (Matzdorf et al., 2014). It means solving problems at-source rather than developing costly end-of-pipe solutions. In both cases, funding actors are looking for a cost-effective way to address the environmental problem that they are already facing. For that reason, some schemes have been used for a limited period of time, until a collective dynamic between farmers had been created (CH in France or Northeim model in Germany) or the environmental target had been achieved (SNRTPM in Canada).

Another purpose behind the design of such schemes is the effective achievement of environmental objectives, either by delivering an environmental service or avoiding an environmental disservice in the case of water pollution. It means that the payment to farmers rewards the environmental outcome, whatever measures are implemented. The effective design of such schemes relies on the definition of clear objectives and suitably associated indicators (Herzon et al., 2018). However, the link between agricultural changes and water quality improvement is quite difficult to measure due to the spatial and temporal factors involved (Sidemo-Holm et al., 2018). Some schemes are still based on measured data for water quality such as Augsburg or APL, while others are trying to bypass measurement difficulties by estimating pollution abatement through modelling as in some PES schemes (FRESP and PEPA) and most WQT schemes (SNRTPM, LTNT, CBNCT, GMT, MWQT). However, rewards for environmental service provision suffer from a lack of funding: on the one hand public funds for such rewards does not comply with WTO rules; on the other, the

involvement of private actors remains limited. An alternative way is to combine both public and private funding as it has been experimented in several PES and WQT schemes.

4.2.2 Encouraging environmental collaboration at landscape scale

In order to extend beyond the field or farm scale, different types of instruments are available such as collective bonus, farmers' groups and collective contracts. These schemes encourage cooperation among farmers and between farmers and other rural stakeholders (Lefebvre et al., 2014). Cooperation here refers to differing degrees of collective actions: from coordination when 'farmers are working towards the same objective but in isolation' to collaboration when 'farmers meet, work together and maintain a dialogue' (Boulton et al., 2013). For AES, these degrees are: connected parcels and collaborating between farmers and other rural stakeholders (Table 5).

Table 5 : Main purpose of innovative schemes regarding scale limitations

	Collective bonus	Farmers' group	Collective contract
Landscape collaboration			
connection of parcels	ESS - HR8 (En / E) OQE – NB (Ch / B)		
collaboration <i>between farmers</i> <i>between farmers and other rural stakeholders</i>		ABG (Be / E) GIEE (Fr / E) ILD (En / B) ALP (Au / E) KLP (At / E) LPV (De / E)	Glastir (Wa / E) EC (NL / E)

(Country code / Objective code)

Objective code: B: Biodiversity – E: environment

Country code: Au: Australia – At: Austria – Be: Belgium – Ch: Switzerland – De: Germany – En: England – Fr: France – NL: Netherlands – Wa: Wales

As a first step, agri-environmental payments can include an eligibility criterion based either on a targeted area (HNV or watershed area for instance) or a payment mechanism (agglomeration bonus). The purpose of these design features is to connect land areas by promoting the same agri-environmental practices in adjacent parcels. Although the benefits of such cooperative schemes have been demonstrated by several experimentations in France

(Kuhfuss et al., 2015) or in Spain (Villanueva et al., 2015), they are hardly ever implemented in practice. One explanation is that these schemes depend on the commitment of individual farmers on a voluntary basis (Lefebvre et al., 2014) which could be incentivised by setting an environmental threshold or a nudge (Kuhfuss et al., 2015).

Another step is to formalize groups of farmers to implement an agri-environmental project. The purpose of such collaborative schemes is to coordinate the environmental actions of farmers. These farmers' groups can benefit from public funding and sometimes agri-environmental payments since the 2014 reform of the CAP (Regulation EU No 1305/2013). However, these collective payments are mainly implemented in the Netherlands, which have a long track record of environmental cooperatives. Indeed, such formal farmers' groups need time for learning and adaptation (Westerink et al., 2017) and to build trust between members (Riley et al., 2018).

The last step of collaboration is the inclusion of other members such as local authorities or a water supply company. These mixed membership groups have the advantage of being able to consider both the whole landscape area and the conflicting interests of the local stakeholders (Prager, 2015). Sometimes, this collaboration can lead to partnerships between public and private actors around environmental objectives, thus requiring appropriate institutional arrangements that can enhance stakeholder participation (Taylor & Van Grieken, 2015). A typical example is the involvement of private water companies in making agri-environmental payments to decrease their investment in water treatment infrastructures.

4.2.3 Certifying environmentally friendly agri-food products

Certification was originally designed to ensure food safety and quality along the agri-food chain. As time goes by, the growing demand for a more sustainable agriculture lead to the proliferation of environmental labelling on food products (Udo de Haes & de Snoo, 2010). These schemes have a more or less positive impact on the environment depending on the

degree of commitment required: promoting best management practices, communicating product origin, or quantifying environmental performances (Table 6).

Table 6 : Main purpose of innovative schemes regarding both provider-gets principle and scale limitation

	Private standard	Public label
Agri-environmental certification		
promote best management practices <i>in environment</i> <i>in agriculture</i> <i>throughout water cycle</i>	ISO I et II (Ww : E) GG (Ww / S) AWS (Ww / WQ)	
communicate the product origin <i>link to territory</i> <i>link to tradition</i>		PGI – PDO (Eu / FQ) TSG (Eu / FQ)
quantify the environmental performance <i>in environment</i> <i>in agriculture</i>	ISO III (Ww /E)	HVE3 (Fr / E) VIVA (It /S)

(Country code / Objective code)

Objective code: E: environment – FQ: Food quality – S: Sustainability – WQ: water quality

Country code: Eu: Europe – Fr: France – It: Italy –Ww: Worldwide

Private standards and public labels which ensure food quality can integrate some environmental requirements, which consists most of the time in promoting good agricultural practices or an integrated farm management. Although their potential to increase the adoption of best agri-environmental practices has been demonstrated (Thorlakson et al., 2018), most schemes stick close to industrial legislation and are therefore not very demanding concerning environmental requirements (Lockie et al., 2015). There is still little evidence that such certifications benefit the environment (Waldman & Kerr, 2014), and their effectiveness on water issues in particular has not received much attention (Vos & Boelens, 2014).

Another purpose of these certification schemes is to link the quality of products to a geographical origin. Such Geographical Indications (GI) are based on the assumption of a virtuous system which provides fair gain for producers and clear information for consumers (Ravaglia et al., 2018). For most consumers, the local values of these schemes are associated with environmental sustainability (Albuquerque et al., 2018). However, the integration of environmental criterion within GI specifications remains scarce (Gallien et al., 2017).

However, even in the absence of such criteria, GIs can still benefit the environment because traditional know-how is associated with more extensive agricultural practices (Lamarque & Lambin, 2015).

Finally, another purpose has emerged in the last years: certification schemes that recognize environmental performances through quantified data. Beside LCA schemes which are time and money consuming, some countries like Italy and France have established more accessible schemes based on specific environmental indicators. There is often one indicator related to water issues, based on water used or water footprinting. Although these certification schemes are still recent and have not been widely adopted, these have the potential to drive change towards more environmentally friendly farming practices.

5 Discussion

The comparative analysis of AES including both policy and market instruments has identified several innovative design features that go beyond the limitations that hamper current schemes. It provides interesting insights for policy implementers to choose the schemes that are best suited to address local challenges. Specifically, it raises perspectives on the way to take water governance into consideration and the possibility of combining several of these schemes.

5.1 Policy design framework for innovative AES

The analysis of AES through a policy design framework provides an overview of the diversity of schemes that are addressing water quality issues in agriculture worldwide. By using a uniform terminology, it becomes possible to compare schemes designed by policy makers in different disciplines (Rogge & Reichardt, 2016). Furthermore, it provides useful insights into the innovativeness of the 62 schemes by identifying their design features. Specifically, it gives examples of how innovative payment mechanisms (results-based, bid, credit trading, agglomeration bonus, collective payment or certification), funding sources (mixed, private or

634 municipal) and monitoring systems (criteria, measurable indicators, models) have the
635 potential to overcome the current limitations of AES. In doing so, it helps policy
636 implementers to choose ex-ante a scheme adapted to the challenges encountered.

637 Although these schemes are characterised by their innovative design compared to current
638 AES, there are still limitations in how they are implemented. First, the innovative payment
639 mechanism that aims to reward environmental services is still paying the cost of providing
640 such environmental benefits, rather than evaluating the value of the service provided by
641 farmers. Then, the collaboration between actors usually remains limited to farmers, and does
642 not involve many of other rural stakeholders. Finally, the certification of agri-environmental
643 products is limited to rewards for holders of existing certification, rather than creating
644 certification that really benefits water quality. Thus, a deeper analysis of the whole policy
645 process that is not limited to policy making but also considers policy implementation is
646 required to make further advances (Rogge & Reichardt, 2016).

647 The analysis of policy implementation is crucial in determining the effectiveness and the
648 efficiency of policy schemes, both of which are criteria used in most evaluation frameworks
649 alongside relevance and coherence (European Environment Agency, 2016; OECD, 2018).
650 Although some papers supply data on the impact of the scheme studied, either in terms of
651 outputs (number of farmers involved or area enrolled) or outcomes (water quality
652 improvement), it was not possible to evaluate them due to the variety of contexts in which
653 they were implemented. However, evaluation is a critical process to measure, understand and
654 learn about public policies (Berriet-Sollicet et al., 2014). For instance, the switch to collective
655 payments in the Netherlands is the fruit of a long history with EC beginning back in the early
656 1990s (Franks, 2011) which may not be feasible elsewhere. Furthermore, some schemes are
657 appropriate in one area due to specific issues or contextual factors such as the pastoral
658 landscape in Burren (Dunford, 2016) but could not be successfully replicated in other

geographical areas. Thus, policy schemes need to be aligned with the local context in which they are implemented to be effective, specifically regarding their governance structure (Howlett et al., 2014).

5.2 Towards an integrated water governance

Water governance is a complex multi-actor and multi-level process that encompasses political, social, economic and administrative elements (Pahl-Wostl, 2019). It has been dominated by two major trends during the last decades, namely privatisation and decentralization. Firstly, the shift from government to governance has been associated with the increasing involvement of private actors in water policy, which traditionally was steered by governments (Wurzel et al., 2019). Secondly, water policies have been applied at a regional scale as a result of decentralisation and deconcentrating processes (Girard & Rivière-Honegger, 2014). However, both trends are mainly dependent on contextual factors such as the institutional settings, the socio-economic and environmental context and the geographical location (Pahl-Wostl et al., 2012). Thus, water governance provides a much more nuanced picture of public-private actors and global-local integration. Looking at the governing actors and targeted area design features gives information as to how this complexity is addressed by the schemes identified.

Public bodies are the main actors responsible for the implementation of the schemes, sometimes alone, more often in coordination with other local actors. Among the schemes identified in the review, some PES and most food standards are governed by companies. Although private actors are increasingly involved in water governance, public bodies remain the central actor (Vatn, 2018). In some cases, governance is shared as it has been for instance underlined in WQT schemes (Tabaichount et al., 2019), PES schemes (Matzdorf et al., 2019) or food standards (Casey, 2017). For a long time, private market and government have been

seen as two opposing governance options, in spite of examples showing they can coexist effectively. It means that each kind of actor can participate in water governance by implementing one or another scheme, alone or most likely in partnership with other actors. According to Pahl-Wostl (2019), such hybrid governance is essential for dealing with the complexity of water management challenges. Indeed, it allows several drivers for change to be mobilized and adaptability as regards local stakeholders.

About one third of the schemes identified in the review are implemented in an area determined by administrative boundaries. Another third target the watershed, considered as the reference area for water issues. However, this scale is not meaningful for the development of agricultural projects which require that the organisation of agricultural activities (both at farm and at food chains level) is taken into account (Petit et al., 2016). A large number of schemes are then not targeting a specific area making it possible to implement them in areas which cross different administrative, ecological and economic territories. Indeed, at one location there may be a mix of overlapping areas: a conservation area, private properties or administrative area for instance (Ring & Barton, 2015). Thus, there is a need for better integration both horizontally between public and private stakeholders and vertically between ecological and administrative scales (Kristensen & Primdahl, 2019). It also requires an opening up of water policy to other sectoral policies, in line with the recent call by scholars to promote a water-food-energy nexus (Pahl-Wostl, 2017; Venghaus & Hake, 2018).

5.3 One best scheme or a mix of schemes?

The inventory provides an overview of how each scheme addresses the water governance complexity. Guided by the Tinbergen rule which stipulates that ‘efficient policy requires at least as many policy instruments as there are targets’, policy makers tend to favour one instrument over another to deal with a specific issue (Schader et al., 2014). However, our

review has shown that a diversity of policy and market instruments coexist worldwide, including in the same country or region. Thus, the question of which instrument is the ‘best’ no longer appears the most appropriate when seeking to optimize the effectiveness of policy instruments on the environment. For that reason, some policy researchers are now looking at how to balance the strengths and weaknesses of different schemes (Schmidt & Sewerin, 2019), in order to implement a policy that forges the best spatio-temporal mix out of the different options. This combination of interacting instruments is called a policy mix (Rogge & Reichardt, 2016).

Such a policy mix has already been tried out as for instance in AECMs that are layered over time: from action-based to results-based, or from individual to collective contracts. Furthermore, farmers will still have access to AECMs in the future period of the CAP, despite the introduction of new eco-schemes (Lampkin et al., 2020). Thus, a policy is in reality composed of a package of policy schemes that have evolved over time. The policy schemes do not only interact over time, but also across and within geographical spaces. There are already some examples of the resulting synergies as in the Munich case, where there are financial synergies between organic certification and the public PES (Grolleau & McCann, 2012), or in the Pumlumom project where the PES schemes cover the costs of investments required while the public AES is remunerating farmers for the practices implemented (Matzdorf et al., 2014). All these combinations involve a variety of actors and governance levels that create a complex mix of schemes in which multi-actor and multi-level interactions occur (Flanagan et al., 2011).

Water governance could be characterized in a simplified way by the design features discussed above, i.e. governing actors (public - private) and targeted area (administrative - ecological). Although some diversity does exist in the design features within a similar type of instrument, each instrument type could be determined by the governing actors and targeted area typically

732 associated with it (Figure 2). Then policy implementers could choose instruments that are the
733 best suited to their local water governance context. For instance, if the area is dominated by
734 public actors (case 1 at the top), policy implementers should experiment with a few of the
735 public AES that target ecological area (collective bonus, collective contract, collective group)
736 or administrative one (results-oriented schemes, auction or public label). However, if the main
737 dynamic comes from an administrative level (case 2 on the left), it would be more beneficial
738 to combine payments based on environmental rewards (results-oriented schemes, auction,
739 PES) with agri-environmental standard on agri-food products (public label, private standard).
740 Otherwise, if there is a local dynamic at an ecological scale (case 3 on the right), schemes
741 based on landscape collaboration (collective bonus, farmers' group, collective contract) could
742 be associated with WQT schemes governed by private actors. These cases provide a few
743 theoretical examples of how schemes could be combined by policy implementers to attain

their water quality objective. Specifically, food chain initiatives seem promising to make the requirements of economic stakeholders and the environmental expectations of citizens consistent. Indeed, environmental requirements for farming practices designed at the food chain level seem to be able to motivate more farmers and enable more sustainable commitments from them. But such approaches cannot be sufficient on their own and may have a greater impact when combined with landscape approaches that specifically target the

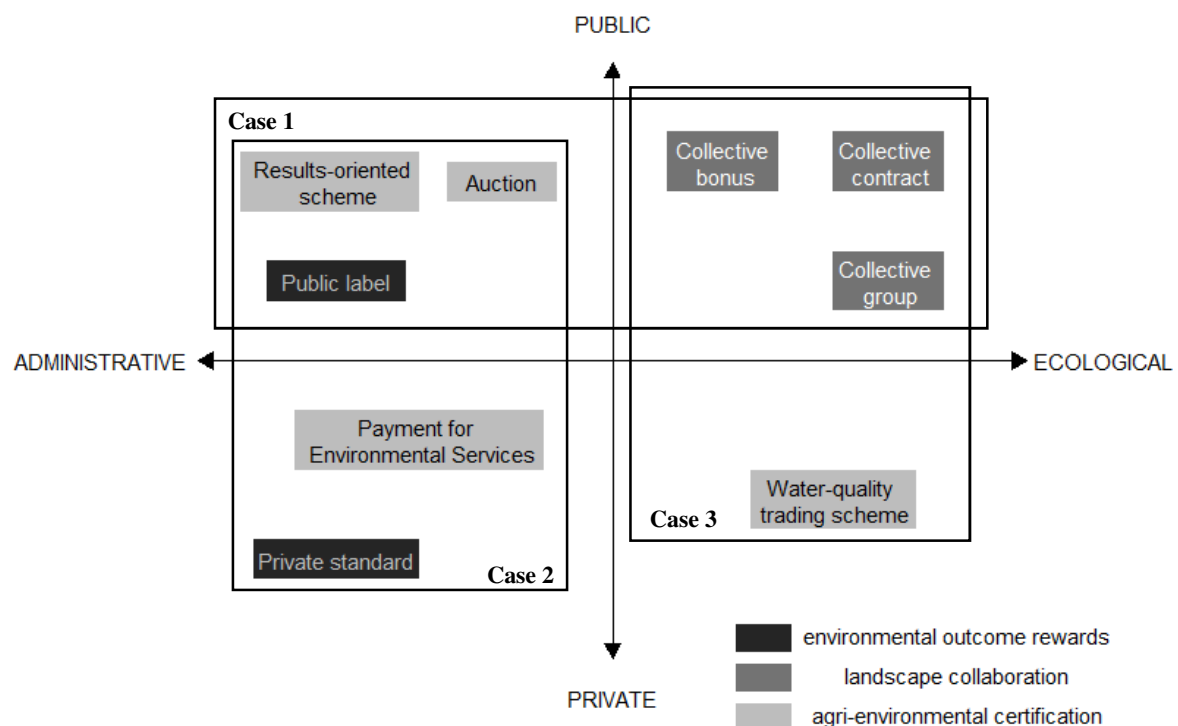


Figure 2: Types of agri-environmental instruments that could be mixed depending on the water governance described by its governing actors (public – private) and targeted area (administrative – ecological).

areas with high water quality stakes. Thus, it seems that it is often appropriate to combine several of the main drivers for change depending on the local water governance context.

6 Conclusion

Numerous policy schemes have been designed to tackle water pollution due to agricultural practices. Faced with the lack of effectiveness of current AES, innovative design features regarding payment mechanisms monitoring systems and funding sources have been suggested

in the literature. Based on our analysis of these design features, we have distinguished nine main types of agri-environmental instruments that are used to address water quality issues. The rationale behind these instruments is either to reward the environmental outcomes provided, to encourage the collaboration between rural stakeholders or to certify agri-environmental practices within the agri-food chain. In so doing, they are going beyond the restricted-provider-gets principle and/ or the field or farm scale issue that limits current AES.

The diversity of schemes identified reflects the variety of contexts in which they are implemented. Depending on geographical characteristics and historical background, some schemes are more suitable than others. However, a combination of the three drivers has greater potential for integrating the various actors and multiple levels that water governance implies. Indeed, the different instruments have been designed for different governing actors, either public or private, and for different targeted area, either administrative or ecological. Such complexity necessitates the mix of several schemes in order to involve the actors concerned and target the appropriate scale regarding both water quality and agricultural issues. Thus, the policy mix concept seems promising as a way of operationalising a combination of instruments to reduce water pollution from agriculture.

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