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► To cite this version:

Alice Berthet, Audrey Vincent, Philippe Fleury. Water quality issues and agriculture: An international review of innovative policy schemes. Land Use Policy, 2021, 109, pp.105654. 10.1016/j.landusepol.2021.105654 . hal-03703689

HAL Id: hal-03703689

<https://isara.hal.science/hal-03703689v1>

Submitted on 2 Aug 2023

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Title

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

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Declarations of interest

None

Acknowledgements

The authors gratefully thank the Water Agency 'Rhône-Méditerranée-Corse' for its financial support.

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1 **Abstract**

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

16 **Keywords**

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

19 **1 Introduction**

20 Water resources are threatened by pollutants contamination throughout the world, making it
21 challenging to ensure safe drinking water for human health. At European level, the Drinking
22 Water Directive (1998)¹ has fixed the essential quality standards of water intended for human
23 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

24 Directive (WFD) ² that established a framework for the assessment, management, protection
25 and improvement of water quality. Member States had initially agreed to achieve good status
26 in all bodies of surface water and groundwater by 2015 (European Environment Agency,
27 2015). The deadline has been extended to 2021, or at the latest 2027, as many water bodies
28 remained subject to pressures. Diffuse sources pollution are responsible for 38% of pressures
29 affecting water bodies, mainly due to agricultural sources such as nitrates and pesticides
30 (European Environment Agency, 2018).

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

43 AECMs are expected to bring ecological benefits for biodiversity, soil, water, landscape, air
44 quality or climate (European Commission et al., 2017). However, their environmental
45 effectiveness is debated, including in their capacity to deliver water quality improvements
46 (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

47 depends on the structure and the management of the surrounding landscape whereas they are
48 mostly implemented at field or farm scale (Kleijn et al., 2011; Batáry et al., 2015). This means
49 that the spatial scale of agricultural management is not suited to that of the ecological process
50 being managed, resulting in a spatial scale mismatch (Cumming et al., 2006; Pelosi et al.,
51 2010). For instance, the implementation of AECMs at field scale does not reduce nitrate
52 leaching that occurs at a larger scale (Toderi et al., 2017). This mismatch, combined with the
53 low participation rate of farmers in AECMs, creates a threshold effect because the farming
54 area enrolled does not cover a sufficient portion of the watershed (Dupraz et al., 2009;
55 Kuhfuss et al., 2015). Thus, the individual and field or farm scale nature of most current agri-
56 environmental contracts, is one of the explanations for their lack of environmental
57 effectiveness.

58 AECMs are subject to numerous evaluations in regards to their cost-effectiveness. One of the
59 key sources of inefficiency identified by several scholars is an information asymmetry due to
60 the contractual relationship between public agencies and farmers (Blanford, 2007; Ferraro,
61 2008). This gives rise to hidden information concerning the true cost of opportunities farmers
62 have foregone, and hidden actions when farmers do not comply with the measures contracted
63 (Gómez-Limón et al., 2019). Both issues generate high transaction costs involved in gathering
64 information, negotiating contracts and monitoring their implementation (Mettepenningen et
65 al., 2009, 2011). These costs are usually not included in the AECM payments which are
66 constrained by the World Trade Organization's (WTO) non-trade distorting Agreement on
67 Agriculture (Hasund & Johansson, 2016). Compliance with the WTO's Greenbox, means that
68 the EU only grants compensation for 'additional costs and income foregone' (EU Regulation
69 No 1305/2013⁴). This follows the provider-gets principle, which means that these payments
70 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)

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

76 Policy makers are faced with the challenge of incentivising environmentally friendly farming
77 practices at the appropriate scale while complying with non-trade distorting regulations.
78 Given these constraints, scholars have suggested diverse improvements to the contractual
79 design of AECMs. Some papers provide theoretical insights on design features that could
80 improve their effectiveness by favouring spatial targeting (Früh-Müller et al., 2019)
81 increasing participation (Riley et al., 2018) or reducing transaction costs (Lundberg et al.,
82 2018). Another group of papers describes empirical case studies of innovative schemes
83 addressing water quality issues, in France (Amblard, 2019), Germany (Wezel et al., 2016) or
84 the United-Kingdom (Cook et al., 2017) among others. However, policy design analysis of
85 existing schemes is scarce, and often limited to a specific policy instrument such as
86 collaborative schemes (Kuhfuss et al., 2019), results-oriented schemes (Herzon et al., 2018) or
87 payments for environmental services (Matzdorf et al., 2019). This paper intends to fill this gap
88 by providing a comparative design analysis of existing agri-environmental schemes (AES) for
89 water quality protection. Looking at design features that go beyond the restricted provider-
90 gets principle and/or field or farm scale limitations, it aims to identify innovative policies to
91 address water quality issues in agriculture. From an implementation perspective, the paper
92 seeks to provide an overview of schemes available to policy implementers who have local
93 responsibility for water quality protection. For that reason, we do not consider regulatory and
94 informative instruments designed at national level by policy makers but focus on voluntary
95 instruments on which policy implementers have more flexibility. Specifically, it aims to

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

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

106 **2 Innovative approaches in agri-environmental policy**

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

112 **2.1 Market-based approaches**

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

120 private negotiation (Gómez-Baggethun & Muradian, 2015). Both governmental subsidies and
121 market transactions are economic instruments as they are using the price signal to internalize
122 costs (Pirard, 2012). However, governmental subsidies cannot be strictly described as market-
123 based instruments because their payment does not result from market trade (Hahn et al.,
124 2015). Indeed, market-based approaches imply a switch from public subsidies to private
125 trading. As market transactions are not limited by the restricted provider-gets principle, they
126 may represent an efficient way of delivering environmental benefits.

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

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

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

154 2.2 Landscape-scale and food-chain approaches

155 Scholars suggest adopting a landscape scale approach to deal with the scale issue in agri-
156 environmental policy. The landscape scale is defined as ‘an area of coherent landscape
157 character or a sub-unit of a natural region, above the field and farm scales’ (Prager et al.,
158 2012). For water quality issues, the landscape refers to the watershed, in line with the river
159 basins management promoted by the WFD (European Commission, 2014). From an
160 ecological perspective, it is meaningful to consider this scale where ecological processes
161 occur to reduce the spatial scale mismatch (Leventon et al., 2019). This allows the
162 geographical dispersion of parcels within the landscape to be taken into account while also
163 considering ways to overcome fragmentation caused by farmers working in isolation
164 (Leventon et al., 2017) Indeed, in some approaches, scale is used as a bridging concept that
165 encompasses the ecological, economic and governance dimensions of land management
166 (Westerink et al., 2015). It is therefore not limited to the re-scaling of dimensions, but also
167 considers the re-connection of rural stakeholders and the re-spacing of the whole agri-food
168 chain from the farmers to the consumers including processors, distributors and retailers
169 (de Krom, 2017). It refers respectively to the ‘horizontal’ and ‘vertical’ networks of Murdoch

170 (2000) in which the farm is integrated. Thus, such scale considerations assume a systemic
171 vision of the farm within both its networks.

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

184 Finally, re-spacing is about integrating the whole food chain into agri-environmental
185 governance (de Krom, 2017). Indeed, environmental certifications are recognised as well as
186 AECMs to benefit the environment (EU Regulation 1307/2013⁵). However, agri-food policy
187 is usually considered separately from agri-environmental policy although both could
188 contribute to make our agri-food system more sustainable (Forney, 2016). For that reason,
189 some scholars call for a reconnection between agriculture and food on environmental issues
190 (Lamine & Dawson, 2018). This is in line with a growing consumer interest in sustainable
191 agri-food products (Cecchini et al., 2018) and the increasing engagement of the private sector
192 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

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

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

197 **3 Materials and methods**

198 3.1 Research method for the literature review

199 On the ISI Web of Knowledge database, we looked for studies published in English between
 200 2000 and 2019 with a topic associated to AES (keywords *agri* and environment* and*
 201 *scheme**). The two main innovative approaches presented above, market-based approaches
 202 (keywords *payment* or trading**) and landscape scale approaches (keywords *landscape* and*
 203 *scale**) were given specific focus. Additionally, a specific search has been performed on food-
 204 chain approaches with environmental expectations that are usually considered apart from
 205 other AES (keywords “*food and (chain* or product*)*”). As the term ‘scheme’ is not always
 206 used when referring to agri-food schemes, it was replaced with either the words ‘certification’
 207 or ‘standard’ (Table 1). We reduced our first pool of papers by limiting our search to
 208 environmental reviews (WOS categories ‘environmental science’ and ‘environmental
 209 studies’), so the pool of papers for analysis was composed of 763 references.

210 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

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

228 3.2 Theoretical framework

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

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

238 Table 2 :Comparison of policy design framework suggested by Howlett (on left), Rogge (in the middle) and our
 239 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>

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

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

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

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

273 **4 Results**

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

281 4.1 Nine main types of instruments according to their innovative design features

282 Nine main types of agri-environmental instruments have been identified in the literature: PES,
283 results-oriented schemes, auctions, water quality trading (WQT) schemes, collective bonus,
284 farmers' groups, collective contracts, public labels and private standards (Table 3). Most of
285 them are subsidy payments according to a price-based mechanism but we also identified one
286 type of tradable permits (WQT) and two different certification instruments (public label and
287 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

292 4.1.1 *Payments for Environmental Services (PES)*

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

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

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

324 *4.1.2 Results-oriented schemes*

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

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

354 *4.1.3 Auctions*

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

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

372 *4.1.4 Water quality trading schemes*

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

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

395 *4.1.5 Collective bonus*

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

410 *4.1.6 Farmers' groups*

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

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

426 *4.1.7 Collective contracts*

427 Collective contracts are payments based on a contractual agreement with a collective of
428 farmers. They differ from current AECMs for which the government contracts independent
429 agreements with individual farmers, because the payments here are made to an intermediary
430 actor. This actor has a coordinating role at the local level, and is in charge of distributing
431 payments received from the government among farmers according to specific criteria. Two
432 European schemes implement collective payments: Environmental Collectives (EC) in the
433 Netherlands and the Common Land Element (CLE) option of the Glastir scheme in Wales.
434 Although in both schemes, collective payments are publicly funded by the national
435 government, the two schemes differ in scope. On the one hand, collective contracts have been
436 experimented in the Netherlands since 2012 and they were adopted as the national scheme in
437 2016. On the other hand, collective payments within Glastir are an option that has emerged in
438 2012 in Wales and are limited to common land that are recognized as HNV areas. Besides
439 these differences, both are organised around an intermediary that receives payments from the
440 government and distributes the funds among farmers: the Environmental Collectives in the
441 Netherlands and the Farmers' Association in Wales.

442 *4.1.8 Public labels*

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

458 *4.1.9 Private standards*

459 Private standards are voluntary initiatives that recognize the compliance of a product or a
460 process with the food safety and quality requirements of the standard through a third-party
461 certification. Although these schemes have existed for several decades, it is only recently that
462 food standards have included environmental requirements. Standards established within a
463 business-to-business (B2B) perspective can be distinguished from those that directly concern
464 consumers (B2C). The former is largely dominated within the agri-food sector by the Global
465 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

466 Alliance for Water Stewardship (AWS) has established a standard in 2014 for major water
 467 user companies to assess the sustainability of their practices within their watershed. The latter
 468 B2C standards group together a wide range of private initiatives (Nature plus, Earth friendly,
 469 Terra Vitis, among others) that have proliferated in the last years (Gruère, 2015). Most of
 470 these B2C standards belong to the ISO 14 020 family of environmental labelling that has
 471 established principles and procedures that such labels should respect. Three types of ISO
 472 14 020 labels can be distinguished: ISO 14 024 or type I on environmental labelling
 473 programs, ISO 14 021 or type II on self-declared claims, and ISO 14 025 or type III on
 474 quantified environmental declarations based on life cycle analysis (LCA). Additionally, some
 475 private initiatives at national scale such as Linking Environment and Farming (LEAF) in
 476 England or Milieukeur in the Netherlands are promoting the integrated management of
 477 agricultural production.

478 4.2 Three main drivers for change

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

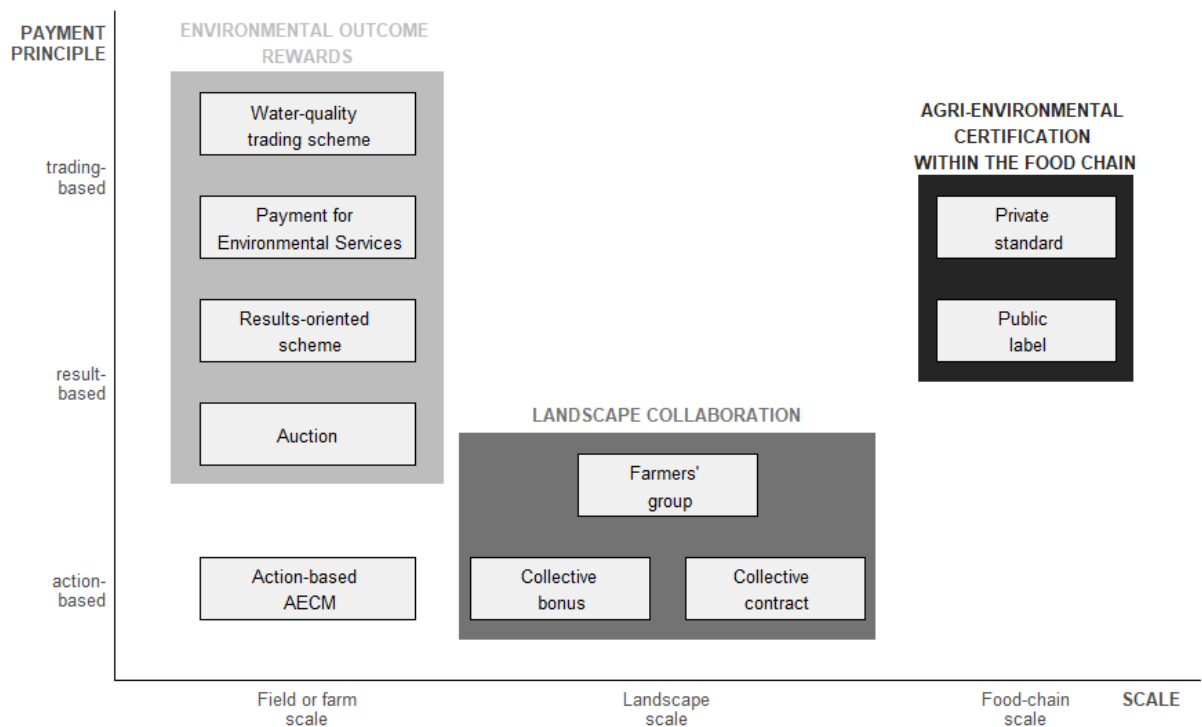


Figure 1 : Innovativeness of agri-environmental instruments according to three main drivers for changes (in the dark boxes): the nine types of AES instruments (in the light boxes) have innovative design features in respect to payment restrictions (y-axis) and/or scale constraints (x-axis)

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

489 4.2.1 Rewarding the environmental outcomes of agriculture

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

498 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.

519 Another range of schemes with innovative payments have an underlying economic purpose
520 which assumes that a scheme rewarding environmental outcomes could reduce costs. For
521 public actors, the use of competitive payment mechanisms like tenders is cost-effective
522 because it has the potential to reduce transaction costs (Schilizzi & Latacz-Lohmann, 2016).
523 For private actors that are facing environmental issues such as pollution, paying farmers
524 directly to protect nature will reduce the cost of cleaning up polluted water (Matzdorf et al.,
525 2014). It means solving problems at-source rather than developing costly end-of-pipe
526 solutions. In both cases, funding actors are looking for a cost-effective way to address the
527 environmental problem that they are already facing. For that reason, some schemes have been
528 used for a limited period of time, until a collective dynamic between farmers had been created
529 (CH in France or Northeim model in Germany) or the environmental target had been achieved
530 (SNRTPM in Canada).

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

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

546 *4.2.2 Encouraging environmental collaboration at landscape scale*

547 In order to extend beyond the field or farm scale, different types of instruments are available
 548 such as collective bonus, farmers' groups and collective contracts. These schemes encourage
 549 cooperation among farmers and between farmers and other rural stakeholders (Lefebvre et al.,
 550 2014). Cooperation here refers to differing degrees of collective actions: from coordination
 551 when 'farmers are working towards the same objective but in isolation' to collaboration when
 552 'farmers meet, work together and maintain a dialogue' (Boulton et al., 2013). For AES, these
 553 degrees are: connected parcels and collaborating between farmers and other rural stakeholders
 554 (Table 5).

555 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)

556 (Country code / Objective code)

557 Objective code: B: Biodiversity – E: environment

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

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

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

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

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

585 *4.2.3 Certifying environmentally friendly agri-food products*

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

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

592 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)

593 (Country code / Objective code)

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

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

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

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

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

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

620 **5 Discussion**

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

626 **5.1 Policy design framework for innovative AES**

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

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

662 5.2 Towards an integrated water governance

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

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

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

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

702 5.3 One best scheme or a mix of schemes?

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

707 review has shown that a diversity of policy and market instruments coexist worldwide,
708 including in the same country or region. Thus, the question of which instrument is the ‘best’
709 no longer appears the most appropriate when seeking to optimize the effectiveness of policy
710 instruments on the environment. For that reason, some policy researchers are now looking at
711 how to balance the strengths and weaknesses of different schemes (Schmidt & Sewerin,
712 2019), in order to implement a policy that forges the best spatio-temporal mix out of the
713 different options. This combination of interacting instruments is called a policy mix (Rogge
714 & Reichardt, 2016).

715 Such a policy mix has already been tried out as for instance in AECMs that are layered over
716 time: from action-based to results-based, or from individual to collective contracts.
717 Furthermore, farmers will still have access to AECMs in the future period of the CAP,
718 despite the introduction of new eco-schemes (Lampkin et al., 2020). Thus, a policy is in
719 reality composed of a package of policy schemes that have evolved over time. The policy
720 schemes do not only interact over time, but also across and within geographical spaces. There
721 are already some examples of the resulting synergies as in the Munich case, where there are
722 financial synergies between organic certification and the public PES (Grolleau & McCann,
723 2012), or in the Pumlumom project where the PES schemes cover the costs of investments
724 required while the public AES is remunerating farmers for the practices implemented
725 (Matzdorf et al., 2014). All these combinations involve a variety of actors and governance
726 levels that create a complex mix of schemes in which multi-actor and multi-level interactions
727 occur (Flanagan et al., 2011).

728 Water governance could be characterized in a simplified way by the design features discussed
729 above, i.e. governing actors (public - private) and targeted area (administrative - ecological).
730 Although some diversity does exist in the design features within a similar type of instrument,
731 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

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

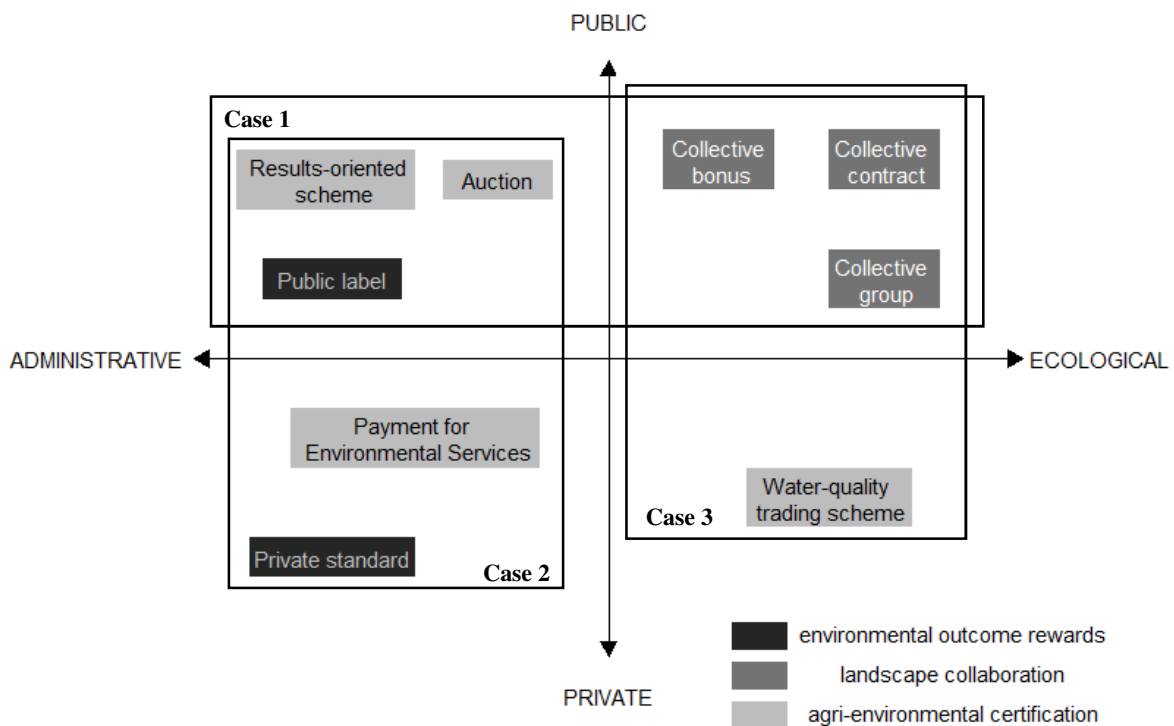


Figure 2: Types of agri-environmental instruments that could be mixed depending on the water governance described by its governing actors (public – private) and targeted area (administrative – ecological).

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

752 6 Conclusion

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

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

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

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