



HAL
open science

Collective action as a tool for agri-environmental policy implementation. The case of diffuse pollution control in European rural areas

Laurence Amblard

► To cite this version:

Laurence Amblard. Collective action as a tool for agri-environmental policy implementation. The case of diffuse pollution control in European rural areas. *Journal of Environmental Management*, 2021, 280, pp.111845. <10.1016/j.jenvman.2020.111845>. <hal-03095373>

HAL Id: hal-03095373

<https://hal.inrae.fr/hal-03095373v1>

Submitted on 2 Jan 2023

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons CC BY-NC 4.0 - Attribution - Non-commercial use - International License

37 **Collective action as a tool for agri-environmental policy implementation. The case of**
38 **diffuse pollution control in European rural areas.**

39

40 **1. Introduction**

41 The European Union (EU) Water Framework Directive, adopted in 2000, set the objective of
42 achieving good water status for all bodies of surface waters and groundwater (EU, 2000). Despite a
43 significant reduction in levels of nutrients in European freshwaters over the past two decades, diffuse
44 pollution from agriculture still poses a major threat to the quality of surface and ground waters in
45 Europe. More particularly, nitrate and phosphorus pollution from agriculture accounts for the largest
46 proportion of diffuse run off (EEA, 2018).

47 The policy tools available to address diffuse pollution include regulatory instruments, economic
48 instruments (taxes/subsidies) and voluntary compliance approaches (Shortle and Abler, 2001).
49 Because of the diffuse nature of nitrate pollution, it is not feasible to define policy instruments based
50 on emissions by farmers such as emissions charges or standards (Shortle et al., 2012). The policies
51 implemented rather aim at modifying the agricultural practices known as influencing the extent of
52 nutrient leaching and runoff (McCann and Easter, 1999; Shortle and Abler, 2001). Reductions in
53 organic and mineral nitrogen fertilization, the introduction of nitrate catch crops into the cropping plan
54 and the establishment of riparian buffers along watercourses are examples of the different measures
55 that may be implemented.

56 In the EU context, regulatory instruments (the EU Nitrate Directive) and incentive schemes targeting
57 individual farms (agri-environmental schemes) remain the main policy instruments implemented to
58 control diffuse nitrate pollution from agriculture. Yet, collective approaches to policy implementation
59 have been recently developing (Polman et al., 2010; OECD, 2013; Westerink et al., 2017). Since 2014,
60 the EU rural development policy gives an opportunity to groups of farmers to commit jointly to
61 collective agri-environmental schemes (EU, 2013). There also exist some examples of voluntary
62 cooperation among farmers (and other stakeholders) for achieving water quality regulatory objectives,
63 e.g., in drinking water catchments (Brouwer et al., 2002; Grolleau and McCann, 2012; Amblard,
64 2019).

65 Previous studies have assessed the relevance of cooperation for the provision of ecosystem services by
66 farmers (Goldman et al., 2007; Stallman, 2011; Prager, 2015a; Westerink et al., 2017), including water
67 quality management (Sarker et al., 2008; Stallman, 2011). The literature also stresses the need to
68 compare individual and collective approaches as well as the range of policy instruments available for
69 environmental public goods provision (Polman et al., 2010; Stallman, 2011; OECD, 2013). More
70 particularly, there has been no systematic assessment of the costs and benefits of agri-environmental
71 cooperation as a complement to regulatory or incentive policy tools for the prevention of diffuse
72 pollution.

73 This article aims at assessing the potential of hybrid policy instruments relying on collective action
74 among farmers for addressing diffuse nitrate pollution from agriculture. Collective action is defined as
75 an “action taken by a group (either directly or on its behalf through an organization) in pursuit of
76 members’ perceived shared interests” (Marshall, 1998). The hybrid arrangements considered involve
77 public authorities using an external body (cooperative or association) as an intermediary to coordinate
78 the actions of individual actors (Van Huylenbroeck et al., 2009). In particular, this paper seeks to
79 identify: (i) the benefits and costs of collective policy approaches to diffuse pollution control and (ii)
80 the factors that influence the success of collective action.

81 A conceptual framework combining the Social-Ecological System (SES) framework with transaction
82 cost economics (Amblard, 2019) is used to identify the conditions under which hybrid policy
83 instruments are likely to be environmentally effective and cost-efficient tools for diffuse pollution
84 control. Transaction cost economics are used to assess the potential advantages of collective action as
85 a complement to other agri-environmental policy tools. For these advantages to be effective, the gains

86 of collective action have to be superior to the associated costs, including transaction costs, for
87 participating stakeholders. The conditions under which cooperation may be successful are identified
88 using the SES framework (Ostrom, 2009; McGinnis and Ostrom, 2014). While the SES framework
89 was originally designed for the study of common pool resource problems, its application to diffuse
90 water pollution as an externality problem contributes to recent developments aimed at broadening the
91 scope of application of the framework (Villamayor-Tomas et al., 2014; Bennet and Gosnell, 2015;
92 Hinkel et al., 2015; Partelow, 2018).

93 A review of empirical studies focused on cases of collective action for agricultural water pollution
94 prevention in the EU context serves as a basis for a first identification of the factors likely to affect the
95 success/failure of such cooperation. This literature review is structured by the conceptual framework
96 combining transaction cost economics with the SES framework. The analysis relies more particularly
97 on two cases: the Environmental Cooperatives in the Netherlands and the “Ferti-Mieux” operations in
98 France. While the Environmental Cooperatives in the Netherlands constitute an example of collective
99 action initiated by farmers themselves, the “Ferti-Mieux” operations in France were initiated by public
100 agencies. Furthermore, the comparison of two cases in different Member States allows for exploring
101 the role played by factors related to the social, economic and political contexts at the national level.
102 Previous comparative studies of collaborative arrangements in different Member States have focused
103 on the role of collectives as bridging organizations (Prager, 2015b) or on the diversity of governance
104 approaches to the spatial coordination of agri-environmental management (Westerink et al., 2017). To
105 the best of the authors’ knowledge, no comparative analysis has been conducted before with the
106 objective of assessing the potential of collective action for water quality management in agriculture.

107 The paper is organized as follows. The second section of the paper introduces the conceptual
108 framework used for the analysis. Section 3 describes the methodology applied. Potential advantages of
109 collective action as a complementary tool to achieve water quality objectives and factors identified as
110 crucial for the success of cooperation are presented in Section 4. In the final section of the paper, the
111 results are discussed from a conceptual and policy perspective.

112 **2. Conceptual framework**

113 A comparative perspective in terms of transaction costs is adopted with regard to the alternative policy
114 instruments targeting individual farmers versus collectives (Section 2.1). The factors affecting the
115 benefits and transaction costs of cooperation among farmers are identified on the basis of the SES
116 framework (Section 2.2).

117 **2.1 A transaction cost analysis of policy options**

118 Transaction costs are the resources used to define, establish, maintain, and transfer property rights
119 (Allen, 2000). Transaction costs arise because information is incomplete and asymmetrically held by
120 parties to exchange (North, 1990). Depending on the characteristics of the good or service considered,
121 the level of transaction costs linked to market coordination will be more or less important. Diffuse
122 pollution, as an output of agricultural production affecting the utility of the production activities of
123 other economic agents, is an externality. Externalities are present “whenever some individual A’s
124 utility or production relationships, include real (that is nonmonetary) variables, whose values are
125 chosen by others (persons, corporations, governments) without particular attention to the effects on
126 A’s welfare” (Baumol and Oates, 1988). Water pollution, similar to many externalities, presents some
127 characteristics of a public good (Holtermann, 1972; Baumol and Oates, 1988). Pure public goods are
128 goods that are non-exclusive and non-subtractive (Samuelson, 1954; Head, 1962). The restoration or
129 maintenance of water quality by farmers constitutes a public good, as (i) everyone can benefit from the
130 resulting improvement in water quality without diminishing others’ benefits (non-subtractability) and
131 (ii) it is difficult (impossible) to prevent anyone from enjoying the benefits of water pollution
132 reduction (non-excludability). In this case, the transaction costs associated with decentralized market
133 exchange are so high that the public good will be underprovided. For example, in the case of diffuse
134 water pollution, the costs of identifying the sources of pollution and the other affected individuals will

135 highly constrain market coordination (Falconer, 2002). Some form of organization is needed to
136 overcome the suboptimal provision of the public goods (Ostrom and Walker, 2000). However, the
137 alternative institutional arrangements (including the diverse types of government intervention) also
138 present transaction costs and the question is then which arrangement allows for the provision of the
139 public good at the lowest costs.

140 Coase (1960) suggested adopting a comparative perspective on the relative benefits and costs
141 (including transaction costs) of the different social arrangements. Such an approach has recently been
142 developed in the field of environmental policy. A growing body of research seeks to include
143 transaction costs in the analysis and evaluation of environmental policies (McCann et al., 2005;
144 Coggan et al., 2010; Garrick et al., 2013; McCann, 2013). In this context, transaction costs correspond
145 to search and information costs, bargaining and decision or contracting costs and monitoring,
146 enforcement and compliance costs (McCann et al., 2005). Several studies have empirically measured
147 the extent of transaction costs linked to the implementation of environmental policies, showing their
148 high significance (McCann and Easter, 1999; Falconer, 2000; Falconer et al., 2001; Mettepenningen et
149 al., 2009).

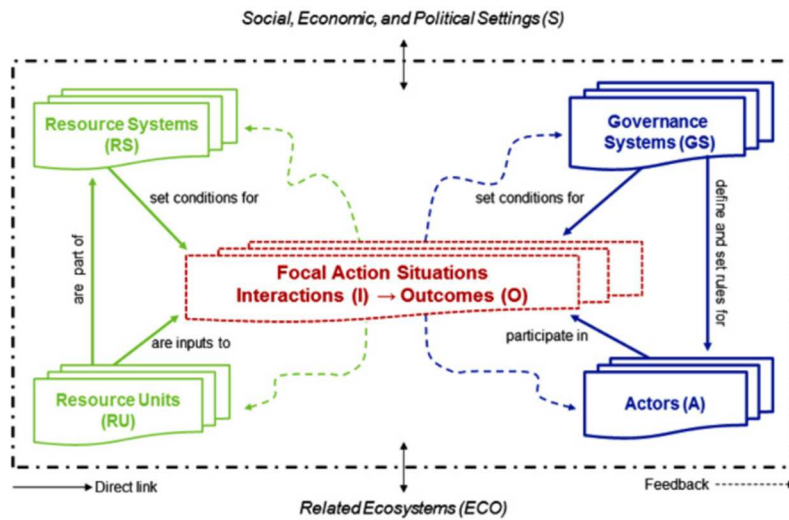
150 In the paper, hybrid policy instruments relying on collective action are compared to regulatory and
151 individual incentive instruments in terms of relative benefits and costs, including transaction costs.
152 The potential of collective action for diffuse pollution control further depends on the potential private
153 benefits and transaction costs borne by participants.

154 As farmers do not primarily bear the costs of water pollution or do not enjoy the benefits of water
155 quality improvements, they have generally little incentive to engage in collective action to reduce the
156 level of pollution (preventing the public bad) or contribute to the maintenance of water quality
157 (providing the public good). Still, they can draw indirect economic advantages as well as non-
158 monetary benefits from such cooperation. In some cases, farmers may reap some private economic
159 benefits from changing their agricultural practices towards less polluting practices. A better
160 management of fertilization may lead to some savings in fertilizer expenses without any decrease in
161 yields (Brouwer, 2003; Buckley and Carney, 2013). Another economic motivation for farmers to
162 participate in collective action may include the possibility to maintain or increase their profits through
163 the certification of their products (e.g., ecolabels) or through the development of activities based on
164 the improved quality of the environment (e.g., agritourism) (Ribaud et al., 2010; Grolleau and
165 McCann, 2012; OECD, 2013). Finally, besides economic benefits, nonmonetary incentives may play a
166 role in farmers' willingness to participate in collective action. Farmers with preferences for
167 environmental preservation will be more willing to participate in cooperation to reduce water pollution
168 (Lubell et al., 2002; Dupraz et al., 2009). Transaction costs associated with collective action include
169 the costs of defining actions to control diffuse water pollution (information and bargaining costs) and
170 the monitoring and enforcement costs of actions. Collective action for the provision of environmental
171 services with public goods characteristics such as the restoration/maintenance of water quality more
172 particularly entails a potential free-riding problem due to the difficulty in excluding beneficiaries for
173 failing to contribute to the maintenance of the public good (Ostrom, 2003). The extent of expected
174 benefits and transaction costs and thus the effectiveness of collective action are influenced by a
175 number of factors identified on the basis of the SES framework (Section 2.2).

176 2.2 Identifying the factors affecting collective action: the SES framework

177 The SES framework was developed as a tool for the analysis of complex Social-Ecological Systems
178 (SESs) (Ostrom, 2007; 2009; Poteete et al., 2010). This ontological framework lists and structures the
179 variables which have been found in previous research to influence the patterns of interactions and
180 outcomes in diverse SES. The SES framework constitutes an extension of the Institutional Analysis
181 and Development approach (Ostrom, 1998) with specific attention given to the characteristics of
182 biophysical systems and their impact on natural resource management (Ostrom, 2011; McGinnis and
183 Ostrom, 2014).

184 Focal action situations represent the diverse interactions occurring between actors within SESs (e.g.,
 185 harvesting the resource, information sharing or self-organizing for resource management) leading to
 186 social and ecological outcomes (Figure 1). The characteristics of the natural resource considered
 187 (resource system and resource unit), the characteristics of actors involved and the characteristics of the
 188 governance system are the first-tier variables considered as potentially important to analyze
 189 interactions and outcomes achieved in a given SES. The broader social, economic and political
 190 contexts and related ecosystems are also included as interacting with the other subsystems.



191
 192 Figure 1: The SES framework (Source: McGinnis and Ostrom, 2014)

193 First-tier variables are further characterized by second-tier variables identified in previous studies to
 194 influence interactions and outcomes in SESs (McGinnis and Ostrom, 2014) (Appendix 1). Among the
 195 second-tier variables identified as potentially relevant, a subset of ten factors likely to affect the
 196 benefits and costs of collective action is seen to be critical for the success of self-organization by users
 197 of common-pool resources (Ostrom, 2009) (Table 1).

198 Table 1: The factors identified as crucial for self-organization by users for CPR management

First-tier variables	Second-tier variables
Resource system (RS)	RS3 – Size of resource system RS5 – Productivity of system RS7 – Predictability of system dynamics
Resource unit (RU)	RU1 – Resource unit mobility
Governance system (GS)	GS6 – Collective-choice rules
Actors (A)	A1 – Number of relevant actors A5 – Leadership-entrepreneurship A6 – Norms (trust-reciprocity)/social capital A7 – Knowledge of the SES A8 – Importance of the resource

199 Source: Adapted from Ostrom, 2009

200 The characteristics of the resource systems identified as affecting the likelihood of self-organization
 201 by users include the size and productivity of the system (RS3, RS5) and the predictability of system
 202 dynamics (RS7). A resource system of moderate size is seen as conducive to self-organization, as a
 203 larger size means higher management costs while a smaller size may imply a less valuable flow of
 204 products from the system (Chhatre and Agrawal, 2008; Ostrom, 2009). A moderate level of resource
 205 scarcity (productivity of the system) is also likely to induce collective action by users, unlike situations
 206 in which the resource is either already exhausted or abundant (Meinzen-Dick, 2007). A low
 207 predictability of system dynamics will increase the management costs of the resource, thereby

208 reducing the likelihood of self-organization (Agrawal, 2001). Management costs also depend on the
209 resource unit mobility (RU1), stationary units (e.g., water in a lake) being less costly to manage than
210 mobile units (e.g., water in a stream) (Schlager et al., 1994; Agrawal, 2001). A larger number of users
211 (A1) means higher transaction costs, however a small group size may constrain the pooling of
212 resources needed to sustain collective action (Wade, 1987; Ostrom, 2010). The presence of well-
213 respected local leaders (A5) and the existence of norms of reciprocity and/or social capital within the
214 group (A6) are likely to decrease the transaction costs associated with collective action (Pretty and
215 Ward, 2001; Meinzen-Dick, 2007; Poteete et al., 2010). The sharing of a common knowledge of the
216 SES (A7) is seen as decreasing the perceived costs of organizing by users (Ostrom, 2009). The
217 importance of the resource to users in terms of economic or noneconomic value (A8) will affect the
218 expected benefits of collective action relative to its costs (Acheson, 2006). Finally, identified as
219 crucial for the success of self-organization is the autonomy users have to define and enforce the rules
220 governing resource management, i.e., their autonomy at the collective-choice level (GS6) (Ostrom,
221 2009; Poteete et al., 2010).

222 The SES framework is used to identify the factors influencing collective action for the control of
223 diffuse pollution from agriculture. More particularly, the subset of ten factors highlighted by Ostrom
224 (2009) (Table 1) constitutes an initial set of assumptions with regard to the variables affecting the
225 benefits and costs, including transaction costs, of cooperation.

226 **3. Methodology**

227 Section 3.1 introduces the case study approach adopted for the analysis. The next subsection briefly
228 describes the cases of Environmental Cooperatives and “Ferti-Mieux” operations. Table 2 presents the
229 main characteristics of the two cases.

230 3.1. A case study approach based on a literature review

231 The analysis of hybrid policy instruments relying on collective action for nitrate pollution control
232 relies on a review of empirical studies focused on cases of collective action for agricultural water
233 pollution prevention in the EU context. Two cases are more particularly analyzed: the Environmental
234 Cooperatives (ECs) in the Netherlands and the “Ferti-Mieux” operations in France. The two cases
235 were selected because of their historical depth; both initiatives have developed since the beginning of
236 the 1990s. Furthermore, while the ECs in the Netherlands constitute an example of collective action
237 initiated by farmers themselves, the “Ferti-Mieux” operations in France were initiated by public
238 agencies. Finally, the comparison of two cases in different Member States allows for exploring the
239 role played by factors related to the social, economic and political contexts at the national level.

240 The secondary sources used include scientific and technical journal articles, research and policy
241 reports, PhD and master theses as well as policy briefs. While the case of Environmental Cooperatives
242 has been the subject of multiple analyses published in the academic literature, the Ferti-Mieux
243 operations are mostly documented in technical outlets and policy reports.

244 The evidence from the diverse secondary sources was reviewed through the lens of the conceptual
245 framework combining transaction cost economics with the SES framework. More particularly, the
246 second-tier variables highlighted by Ostrom (2009) (Table 1) served as a frame for identifying the
247 factors affecting the benefits and costs, including transaction costs, borne by the participants to agri-
248 environmental collective action. Other second-tier variables were selected in the list updated by
249 McGinnis and Ostrom (2014) (Appendix 1) when identified as having an impact on cooperation in the
250 documents reviewed. Third- and fourth-tier variables characterizing the second-tier variables (Basurto
251 et al., 2013; Frey and Cox, 2015; Thiel et al., 2015) were also developed if the literature review
252 suggested that they play a role in the success/failure of collective action. The references supporting the
253 influence of each identified factor on cooperation are presented in Appendix 2.

254 3.2. Two cases of collective action in the EU context

255 *3.2.1. The Environmental Cooperatives in the Netherlands*

256 The ECs have developed as a new governance structure since the beginning of the 1990s (Glasbergen,
257 2000; Renting and van der Ploeg, 2001). They are regional groups of farmers, including in some cases
258 other rural stakeholders (e.g., environmental organizations and local authorities) (Wiskerke et al.,
259 2003). Most ECs are formal associations, some are foundations, and a few have legal cooperative
260 status (Polman et al., 2010).

261 By 2016, 160 associations involving 10% of the Dutch farming population (65% of which were dairy
262 farmers) managed 25% of the rural area of the Netherlands. Their activities covered land areas ranging
263 from 1,000 up to 130,000 hectares (Ministry of Economic Affairs, 2011; Terwan et al., 2016). The
264 ECs' environmental activities are not restricted to water quality management and one EC can be active
265 in several environmental "domains," including also biodiversity conservation or wildlife management
266 (Franks and Mc Gloin, 2007a). In addition to nature management and the reduction of environmental
267 pollution, some ECs have also developed activities in the fields of rural tourism and regional quality
268 production (Renting and van der Ploeg, 2001; Franks and McGloin, 2007a).

269 The ECs are generally managed by a board elected annually. Subcommittees are responsible for
270 managing individual projects and developing new activities. Regular meetings take place, as well as an
271 annual general meeting at which changes to the group's plan and constitution can be made (Franks and
272 McGloin, 2007a). Individual members decide for themselves whether to participate in any EC activity.
273 While they can suggest programs for the ECs to be involved in, only those initiatives supported by a
274 large share of members will be supported by the ECs (Franks, 2010).

275 The development of ECs led to innovations in the implementation of agri-environmental policy in the
276 Netherlands. In some cases, ECs have been allowed to develop themselves the measures and
277 instruments used to achieve the regulatory objectives defined by state agencies (Glasbergen, 2000;
278 Renting and van der Ploeg, 2001; Wiskerke et al., 2003; Stobbelaar et al., 2009; Termeer et al., 2013).
279 With regard to the implementation of agri-environmental schemes, priority has been given to
280 collective rather than individual applications since 2000 (Franks and Mc Gloin, 2007a; 2007b). While
281 some ECs had received and distributed payments to farmers, contracting with ECs as collectives
282 turned out to be incompatible with the EU regulations at the time. From 2003, ECs were compensated
283 by national funds for their role in coordinating their members' applications to agri-environmental
284 schemes while payments were directed to farmers (Franks and McGloin, 2007b; OECD, 2013).

285 In anticipation of the recognition of farmer groups as eligible beneficiaries of agri-environmental
286 payments in the 2014-2020 EU rural development program, the Ministry of Agriculture chose four
287 ECs as pilot projects to assess the feasibility and added value of the collective implementation of agri-
288 environmental measures (Ministry of Economic Affairs, 2011; OECD, 2013; Westerink et al., 2015).
289 In 2016, the Dutch government chose to implement agri-environmental schemes through collective
290 applications only. New farmer collectives were established as formal contract partners of the regional
291 governments in charge of the implementation of agri-environmental policy. While some of the
292 collectives were initiated by the original ECs, others were created by farmer unions (Terwan et al.,
293 2016; Jongeneel and Polman, 2018). There are currently 40 new collectives, involving more than
294 6,300 farmers and covering a land area of 68,000 hectares (Jongeneel and Polman, 2018).

295 There is no formal appraisal of the environmental impact of ECs, however, they are perceived as being
296 ecologically effective for their positive influence on the participation of farmers in agri-environmental
297 schemes and on the evolution of agricultural practices (Franks and Mc Gloin, 2007a; 2007b; Smits et
298 al., 2008; Slangen et al., 2008; Van Dijk et al., 2015). Data collected between 1995 and 2000 on trends
299 in the nitrogen surpluses of member farms of the two first ECs (VEL and VANLA¹) and a regional
300 reference group of farms show that member farms realized lower nitrogen surpluses and reduced these
301 losses at a higher rate than the regional average over the five years (Renting and van der Ploeg, 2001).
302 In 2000, 33% of VEL and VANLA dairy farmers reached nitrogen surpluses below the national policy

¹ These respectively are the acronyms for Vereniging Eastermar's Lânsdouwe and Vereniging Agrarish Natuur en Landschapsbeheer Achtkarspelen.

303 objectives of 2003 while only 10% of dairy farms at the national level achieved this result (Sonneveld
304 and Bouma, 2003).

305

306

307 3.2.2. *The “Ferti-Mieux” operations in France*

308 The “Ferti-Mieux” operations were launched in 1991 by the French Ministry of Agriculture. Managed
309 by the National Association for Agricultural Development (ANDA)², the goal was to promote and
310 label local collective actions of farmers for a better management of nitrogen use at a water catchment
311 level (Papy and Torre, 2002). Within this frame, farmers voluntarily committed to changing their
312 practices to limit water pollution with no financial compensation, along collectively defined
313 prescriptions. Participating farmers benefited from free technical support for modifying their practices,
314 on the basis of a diagnosis of the local context (water resource system, farming systems, sources and
315 risks of nitrate pollution). Participants also benefited from the label “Ferti-Mieux” as official
316 recognition that their farming practices limited the risk of water pollution.

317 At the national level, a national steering committee gathering representatives from the Ministries of
318 Agriculture and Environment, the Water Agencies and farmers’ organizations was in charge of
319 defining the overall orientations of the “Ferti-Mieux” program. A national scientific and technical
320 committee involving researchers and technical representatives of agricultural organizations was
321 responsible for the evaluation of local operations as a basis for the decision to award the “Ferti-Mieux”
322 label. At the local level, a steering committee and a technical committee involving farmers’
323 organizations, local public agencies and in some cases water suppliers and agro-industrial cooperatives
324 were in charge of the management of operations. A coordinator (usually working for a local
325 Agricultural Chamber³) was responsible for defining, together with the participating farmers, nitrogen
326 management plans (Sebillotte, 2003).

327 A pre-label was granted to local operations based on two criteria: (i) the area covered by the
328 involvement of farmers in the water catchment and (ii) the adaptation of the nitrogen management
329 plan to the local context. The official “Ferti-Mieux” label was granted and renewed if the agreed
330 changes in farmers’ practices were effective (Ramonet, 2003).

331 Between 1991 and 2001, 65 operations were granted the “Ferti-Mieux” label, involving approximately
332 35000 farmers and representing 4.6% of the agricultural area. The effects of the “Ferti-Mieux”
333 operations on water pollution were mixed with no evidence of a decrease in nitrate rates in
334 groundwater bodies; however, this could be attributable to the time lags in groundwater quality
335 response to changes in agricultural practices. In areas where surface waters were targeted, more than a
336 half of the operations led to a decrease or stabilization of nitrate rates, demonstrating the
337 environmental relevance of the operations (Papy and Torre, 2002).

338 Following the dissolution of ANDA in 2002, the “Ferti-Mieux” operations were officially stopped at
339 the national level. However, Agricultural Chambers and the Water Agency of the Rhin-Meuse water
340 basin decided to undertake similar operations under the name “Agri-Mieux.” Indeed, the ongoing
341 “Ferti-Mieux” operations in the area were evaluated as successful in terms of farmers’ involvement
342 and water quality improvement. The new “Agri-Mieux” operations have the additional objective of
343 reducing diffuse pesticide pollution (Bernard, 2004). In Lorraine, eleven “Agri-Mieux” operations
344 gather 22% of farmers, covering 25% of the agricultural area in the region, while in Alsace, 4500
345 farmers participate in eight operations in the plain area (Rettel and Revest, 2013; Burtin, 2014).

² This association, which was disbanded in 2002, had a mixed membership of representatives from agricultural interest groups and the State. Its role was to provide advice to the Ministry of Agriculture and to fund agricultural development programs.

³ Agricultural Chambers in France are public organizations led by representatives of agricultural and other rural stakeholders. Agricultural Chambers are active at the regional and the department level.

346

347 Table 2: Two cases of agri-environmental collective action in the EU context: the Environmental
 348 Cooperatives in the Netherlands and the "Fertimieux" operations in France.

	Environmental Cooperatives (The Netherlands)	“Fertimieux” operations (France)
Initiative	Farmers	Public agencies (Ministry of Agriculture)
Composition	Farmers or Farmers and non-farmers	Farmers and non-farmers
Structure	Formal organization	Ad hoc network
Funding	Member fees Public agencies (direct support, contracts)	Public agencies (Agricultural Chambers, Water Agencies, ANDA, local governments)
Environmental “domain”	Multiple (water quality, biodiversity, wildlife)	Water quality
Activities	<ul style="list-style-type: none"> ▪ Information sharing and advice provision ▪ Coordination of changes in agricultural practices ▪ Fundraising ▪ Interest representation/lobbying ▪ Research activities 	<ul style="list-style-type: none"> ▪ Information sharing and advice provision ▪ Coordination of changes in agricultural practices

349 Sources: Franks and McGloin, 2007a; Verron, 2007.

350 **4. Results**

351 The advantages of collective approaches to regulation and incentive schemes for diffuse pollution
 352 control are specified in Section 4.1. Factors affecting the potential of cooperation are presented in
 353 Section 4.2.

354 4.1 The advantages of hybrid policy instruments relying on collective action for diffuse
 355 pollution control

356 Reaching the objectives of water quality improvement requires action that extends beyond farm
 357 boundaries at the scale of the drinking water catchment or watershed. Coordination at the appropriate
 358 scale of management can be achieved by regulations through zoning. For example, the EU Nitrate
 359 Directive is implemented in areas designated as "vulnerable zones" for nitrate pollution. Agri-
 360 environmental incentive schemes are also frequently offered in specific areas chosen to match the
 361 environmentally relevant scales (Prager, 2015a; Westerink et al., 2017). However, the incentives
 362 provided, on an individual farm basis, are not linked to the implementation of measures at a larger
 363 scale (Goldman et al., 2007; Mettepenningen et al., 2013). Collective contracts with groups of farmers
 364 allow environmental actions to be taken across land management boundaries (Falconer, 2000; Franks
 365 and McGloin, 2007a; Mettepenningen et al., 2013).

366 The agricultural impact in terms of nitrate diffuse pollution shows high levels of spatial variation
 367 depending on hydroclimatic conditions, soil types and agricultural practices. The adaptation of
 368 measures to local conditions is thus of importance for an effective reduction of water pollution
 369 (Lacroix et al., 2010). However, designing precise measures may be very costly for public agencies in
 370 terms of information collection and processing. Relying on collective action permits taking advantage

371 of the knowledge held by farmers about their own farming system and local environment (Stuiver et
372 al., 2003; Wiskerke et al., 2003; Franks, 2010). In turn, collective action among farmers favors their
373 access to research and extension services (Slangen, 1994; Franks and McGloin, 2007b).

374 The level of information asymmetry between public agencies and farms is an important issue in
375 monitoring diffuse nitrate pollution (Shortle and Horan, 2001). Relying on a collective for controlling
376 and enforcing farmers' practices will lower public costs (Slangen, 1994; Renting and van der Ploeg,
377 2001). Compared to public agencies, farmers' collectives may be advantaged by easier access to
378 information and the possibility of using enforcement mechanisms such as trust or reputation (Falconer,
379 2002; Franks, 2011; Westerink et al., 2015). Still, public agencies will remain ultimately accountable
380 for the group's performance and thus will incur some monitoring and enforcement costs (OECD,
381 1998; Falconer, 2002).

382 Farmers may be more willing to comply with measures they contribute to design than with measures
383 externally imposed to them. There is growing empirical evidence on the effects of external
384 interventions (positive monetary rewards or regulations with sanctions) on the intrinsic motivation of
385 individuals (Frey and Jegen, 2001; Moller et al., 2006; Akers and Yasué, 2019). More particularly,
386 external interventions may crowd out motivation if individuals affected perceive them to be
387 controlling. As a result, individuals react by reducing their intrinsic motivation in the activity
388 controlled (Frey and Jegen, 2001). Self-organization for the definition of actions to address diffuse
389 pollution may thus improve the extent to which policy objectives are reached, by enabling farmers to
390 endorse the policy goals (Stobbelaar et al., 2009; OECD, 2013).

391 Several studies have shown that significant transaction costs have been associated with the
392 implementation of agri-environmental schemes in the EU context, both for implementation agencies
393 and for the participating farmers (Falconer, 2000; Falconer et al., 2001; Mettepenningen et al., 2009;
394 Mettepenningen et al., 2011). Transaction costs borne by farmers include the search and information
395 costs involved in their decision to participate in an agri-environmental program as well as the
396 contracting costs linked to the administrative tasks required with participation. Public agencies also
397 incur contracting costs with the management of farmers' applications and monitoring and enforcement
398 costs of farmers' compliance with the prescriptions. The transaction costs borne by farmers have been
399 shown to constrain their participation in the schemes and thus the achievement of environmental
400 objectives. In this regard, smaller farms may be relatively more affected due to the presence of high
401 fixed transaction costs (e.g., required farm audits for participation) (Falconer, 2000).

402 Transactional economies of scale may be achieved by making collective management agreements
403 (Falconer, 2000). Information and knowledge sharing about agri-environmental schemes and
404 implications of participation within a group may reduce the costs of decision-making for individual
405 farmers (OECD, 1998; Franks, 2010; Mettepenningen et al., 2013). Collective applications for
406 participation in agri-environmental schemes may also reduce contracting costs, both for the farmers
407 and for the public agencies in charge (Mettepenningen et al., 2011). Several studies report effective
408 transaction cost savings achieved in the implementation of agri-environmental schemes in the
409 Netherlands with the development of collective contracts between the administration and the
410 Environmental Cooperatives (Franks and McGloin, 2007a; 2007b; Smits et al., 2008; Slangen et al.,
411 2008; Franks, 2011; Prager, 2015b). Van Dijk et al. (2015) found, on the basis of a quantitative
412 empirical study, that the facilitating role played by ECs in collective agri-environmental schemes was
413 positively related to farmers' intentions to participate in the schemes.

414 Collective approaches to regulatory and incentive instruments may thus present some advantages for
415 reaching water quality objectives in a cost-efficient way. The achievement of cooperation among
416 farmers will however depend on a number of conditions identified on the basis of the SES framework.

417

418

419 4.2 The factors affecting the potential of collective action

420 The potential of collective action depends on the expected benefits and transaction costs associated
421 with farmers' participation in cooperation. The first subsection presents the factors likely to affect the
422 extent of benefits that farmers can draw from collective action oriented towards the management of
423 water quality. In the second subsection, the variables that may influence the transaction costs of
424 cooperation are reviewed. The variables identified through the literature review are presented in Table
425 3. References for each variable are given in Appendix 2.

426 4.2.1. *The factors affecting the private benefits of farmers*

427 As discussed above, farmers have little direct economic incentive to engage in collective action for
428 diffuse pollution control. In some instances, they can benefit from cost savings by changing their
429 farming practices. However, the extent of these cost savings will vary according to the **type of**
430 **farming system (A2.1)**. In a context of intensive crop farming, reducing mineral fertilization may
431 induce high costs while cattle breeding farms have the potential to substitute organic for mineral
432 fertilization to a certain extent (AE RMC, 2007b; Lacroix et al., 2010). Prevailing inefficiencies in
433 production methods as well as personal characteristics of farmers (attitudes and skills) also affect the
434 potential for increased economic benefits (Brouwer, 2003; Groot et al., 2006).

435 The development of ecolabels or ecotourism as additional economic motivations will depend on the
436 existence of a demand for "green" products and activities (Ribaud et al., 2010; Grolleau and
437 McCann, 2012; OECD, 2013). Several ECs have pursued initiatives related to regional marketing and
438 agritourism to provide additional benefits to their members (Renting and van der Ploeg, 2001;
439 Termeer et al., 2013). Conversely, if **market incentives (S5)** are such that participation in collective
440 action leads to drastic income reductions, farmers will be less willing to engage into cooperation.
441 Busca (2004) found farmers' participation in Ferti-Mieux operations to be lower in areas in which the
442 economic weight of supply chains for high quality cereals was high. Restrictions on fertilization have
443 a direct impact on farmers' capacities to access such supply chains in terms of product quality (e.g.,
444 the high protein content of the produce) or quantity. Not surprisingly, the "Ferti-Mieux" operations
445 involving agro-industrial cooperatives or other trading partners were identified as attracting stronger
446 support from farmers (Busca, 2002; Verron, 2007).

447 Two further motivations can be identified in relation to the expected economic benefits associated
448 with collective action. The **threat of regulations or penalties (S4.1.1)** may encourage voluntary
449 collective action by reducing expected net farm profits (Ayer, 1997). This can be illustrated by the
450 emergence of the first environmental cooperatives in the Netherlands. The two cooperatives VEL and
451 VANLA were created in the Frisian Woodlands area as a reaction among farmers to a series of
452 national regulations aiming at limiting the environmental impacts of agriculture (including the
453 reduction of nitrogen losses by dairy farms) (Glasbergen, 2000; Stobbelaar et al., 2009). Farmers
454 considered these policies to threaten the viability of their local farming systems and to be ineffective
455 with regard to the environmental objectives targeted (Renting and van der Ploeg, 2001; Wiskerke et
456 al., 2003). The two cooperatives negotiated with the Dutch government for exceptions concerning the
457 application of state regulations and committed in exchange to undertake alternative actions to reduce
458 nitrogen losses (Wiskerke et al., 2003; Franks, 2010). The threat of regulation by public water utilities
459 was also identified as a factor favoring the participation of farmers in Ferti-Mieux operations in
460 drinking water catchments (Bernard, 2004; AE RMC, 2007b).

461 Another motivation for cooperation can be to gain political weight. Farmer-led collectives may be
462 seen by farmers as a political tool to influence policy decisions in favor of their economic interests.
463 The Environmental Cooperatives have become major actors in agri-environmental policy definition in
464 the Netherlands (Franks and McGloin, 2007a). Their emergence and success among farmers may be
465 explained by the initial dominance of ecological expertise in the definition of environmental policies
466 in the Dutch context, which led to a weak representation of farmers' interests (Daniel and Perraud,
467 2009; Franks and McGloin, 2007a; 2007b; Franks, 2008; 2010). The role of **political representation**
468 **(S4.1.2)** as a strong driver for environmental collective action was less important in France, where an

469 institutionalized co-management of agri-environmental policies between the State and farmers'
 470 organizations has for a long time permitted farmers to effectively represent their perspectives (Brives,
 471 1998; Daniel and Perraud, 2009). This may help explain the lack of support provided by agricultural
 472 professional organizations to the national Ferti-Mieux program, which was identified as an obstacle to
 473 its continuation after the dissolution of ANDA (Sebillotte, 2003).

474 Finally, a **stronger sensitivity to water protection (A8.1)** was identified as a factor influencing
 475 farmers' participation in Ferti-Mieux operations (Sebillotte, 2003). In contrast, Stobbelaar et al. (2009)
 476 and van Dijk et al. (2015) identified diverse attitudes towards environmental conservation among EC
 477 members. This could be explained by the difference in the general objectives of the two cases of
 478 collective action. While the Ferti-Mieux program promoted changes in farming practices without any
 479 financial compensation, the ECs have aimed at improving both the ecological and economic
 480 performance of agriculture.

481 Table 3: The factors identified as affecting the benefits and costs of collective action

First-tier variables	Second-, third- and fourth-tier variables
Social, economic and political settings (S)	S4 – Other governance systems <i>S4.1 – Larger scale governance systems</i> S4.1.1 – Regulatory threat S4.1.2 – Political representation of agricultural interests S4.1.3 – Support from public agencies
Resource system (S)	S5 – Markets RS3 – Size of resource system * <i>RS3.1 – Size of water catchment</i>
Governance system (GS)	RS7 – Predictability of system dynamics * GS6 – Collective-choice rules * <i>GS6.1 – Autonomy at the collective choice level</i>
Actors (A)	GS8 – Monitoring and sanctioning rules A1 – Number of relevant actors * A2 – Socioeconomic attributes <i>A2.1 – Type of farming system</i> <i>A2.2 – Heterogeneity of actors</i> A5 – Leadership-entrepreneurship * A6 – Norms (trust-reciprocity)/social capital * A7 – Knowledge of the SES * A8 – Importance of the resource * <i>A8.1 – Environmental preferences of farmers</i>

482 * Second-tier variables identified by Ostrom (2009) as crucial for self-organization by users for CPR
 483 management

484 4.2.2. The factors affecting the transaction costs of collective action

485 Among the factors affecting the transaction costs of collective action, the characteristics of actors
 486 involved were found to play a major role.

487 In the case of "Ferti-Mieux," the success of operations was clearly related to the **number of**
 488 **participants (A1)** involved. Operations initially involving a large number of farmers either failed or
 489 split up into smaller subgroups (Kockmann et al., 2003; Verron, 2007). The environmental
 490 cooperatives in the Netherlands show great variation in the number of their members, ranging from 15
 491 to 1700 members (Franks and McGloin, 2007a). Westerink et al. (2017) found that the larger size of a
 492 cooperative positively influenced its organizational capacity and institutional capital while putting at
 493 risk the social links between the association and its members. With regard to group composition,

494 **heterogeneity (A2.2)** in production systems and individual abatement costs of farmers may increase
495 the bargaining costs of defining the actions to implement for the prevention of water pollution
496 (Grolleau and McCann, 2012). Heterogeneity in preferences for environmental preservation of group
497 members is also likely to constrain the agreement process (Lubell et al., 2002). The participation of
498 farmers and non-farmers may also increase decision-making costs. In the case of the ECs, the different
499 goals and perspectives of farmers and other stakeholders (e.g., environmental associations or water
500 suppliers) could lead to conflicts (Franks and McGloin, 2007a). While heterogeneity in preferences
501 and interests among group members appears to be a barrier to collective action, heterogeneity in terms
502 of resources and skills may be a positive factor (OECD, 2013). In some ECs, the participation of non-
503 farmers was also recognized as bringing complementary resources, knowledge and skills (Franks,
504 2008; Uetake, 2014).

505 The **presence of a local leader/social entrepreneur (A5)** able to stimulate and animate collective
506 action also appears to be an important factor (Davies et al., 2004). The most successful "Ferti-Mieux"
507 operations were characterized by the involvement of a coordinator familiar with the local context and
508 considered to be knowledgeable and trustworthy by farmers (Kockmann et al., 2003; AE RMC, 2007a;
509 2007b; Verron, 2007). The role of respected leaders was identified as crucial in the emergence and
510 success of ECs as well (Franks, 2008; 2011). Political and inter-organizational leadership also proved
511 important for negotiating rules and policies favorable to the development of ECs with public
512 authorities at the local and national levels (Franks, 2010; Termeer et al., 2013).

513 The existence of **trust and shared norms of reciprocity (A6)** was found to play a crucial role in the
514 success of ECs and Ferti-Mieux operations (Polman and Slangen, 2002; Eshuis and van Woerkum,
515 2003; Kockmann et al., 2003). Local networks in small communities favor the development of trust
516 (Eshuis and van Woerkum, 2003). However, Lundqvist (2001) documents the case of a failed attempt
517 to induce collective action in a water catchment in Sweden where collective memories of trust and
518 reputation within the farming community seemed to rule out any possibility of cooperation. Further,
519 Davies et al. (2004) stress that the match between the optimal management scale and informal social
520 networks is context specific. The authors found in the Scottish context that, most often, strong social
521 relationships do not fall in contiguous spatial patterns, but may be scattered throughout a local area.

522 Finally, the costs associated with the definition and assessment of actions depend on the **knowledge of**
523 **the hydrogeological system (A7)**. In both EC and Ferti-Mieux cases, the definition of measures
524 targeting nitrate diffuse pollution benefited from partnerships with research and technical institutes
525 (Kockmann et al., 2003; Bernard, 2004; Stuver et al., 2003; Eshuis and Stuver, 2005; Van Der Ploeg
526 et al., 2006; AE RMC, 2007a; 2007b). The monitoring of water quality may also serve as a tool for
527 enhancing farmers' involvement in collective action to the extent that the response time of the water
528 system allows for short-term and visible results of changes in farming practices (Bernard, 2004; AE
529 RMC, 2007b; Verron, 2007).

530 Further, two variables characterizing the resource system were identified as influencing the level of
531 transaction costs. In relation to the size and heterogeneity of the group of participants, the **size of the**
532 **water catchment or watershed (RS3.1)** will affect the likelihood of successful collective action. A
533 larger water basin means a larger number of farmers and potentially more heterogeneity in their
534 farming systems (Brouwer, 2003). Ferti-Mieux operations located in large water basins usually split
535 up into groups working at a sub-basin scale (Kockmann et al., 2003). The **predictability of water**
536 **system dynamics (RS7)** is likely to affect the costs of defining the actions to implement and the costs
537 of assessing their impact on water quality (Nimmo Smith et al., 2007; Grolleau and McCann, 2012).
538 The short time lag between changes in agricultural practices and the evolution of nitrate concentrations
539 in hydrosystems targeted by Ferti-Mieux operations in the Lorraine region facilitated an evaluation of
540 the effectiveness of actions (Bernard, 2004; AE RMC, 2007b).

541 Transaction costs of collective action will also strongly depend on the rules defined for the decision-
542 making process and the enforcement of decisions within the group.

543 The two cases of ECs and Ferti-Mieux operations highlight the positive effect of an **autonomous**
544 **design of the rules by participants (GS6.1)**. In the Netherlands, all Environmental Cooperatives have

545 developed their own rules (Franks and McGloin, 2007a; Franks, 2008; 2011; Termeer et al., 2013). In
546 France, farmers created independent structures (e.g., associations), through which they could define
547 and enforce their own rules while remaining within the general "Ferti-Mieux" frame. This greater
548 autonomy among farmers was identified as having a positive effect on the durability of operations
549 (Kockmann et al., 2003; AE RMC 2007b).

550 Most cooperatives have developed **monitoring and sanctioning systems (GS8)**, involving members
551 or external professionals. Sanctions used by ECs include warnings, exclusion from activities and/or
552 financial penalties (Polman and Slangen, 2002; Eshuis and van Woerkum, 2003). The board of
553 cooperatives may also exclude individual members who do not respect the agreed rules (Wiskerke et
554 al., 2003). Evidence suggests that the use of a graduated system of sanctions, observed in some ECs, is
555 effective in preventing free-riding from members (Polman and Slangen, 2002; Eshuis and van
556 Woerkum, 2003; Termeer et al., 2013; Westerink et al., 2017). In the Ferti-Mieux case, the evaluation
557 of farmers' practices was realized by the local technical committee and then validated at the national
558 level. Evaluation was based on direct visits and checks of a representative sample of individual farms
559 (Verron, 2007). The risk of non-renewability of the Ferti-Mieux label was real: 12% of the operations
560 lost their label between 1991 and 2001 (Ramonet, 2003).

561 Finally, government policies can help lower the transaction costs associated with collective action
562 (Lubell et al., 2002; OECD, 2013; Villamayor-Tomas et al., 2019). The Dutch Ministry of Agriculture
563 supported the development of Environmental Cooperatives through grants to cover start-up costs
564 (Glasbergen, 2000; Franks, 2008; 2010), by approving exemptions from general regulations and
565 adjusting the national agri-environmental program to include an option of joint applications from EC
566 members (Wiskerke et al., 2003; Franks and Mc Gloin, 2007a; 2007b; Franks, 2010; Westerink et al.,
567 2015). **External support from public agencies (S4.1.3)** also included the provision of expert
568 knowledge and administrative support as well as research funding (Glasbergen, 2000; Franks, 2010;
569 Termeer et al., 2013). Termeer et al. (2013) note that the fragmentation of public organizations in the
570 Netherlands could have acted as a constraint for collectives seeking access to various resources. In the
571 French context, public funding compensated the extra-costs of coordination and follow up of the
572 "Ferti-Mieux" operations (Verron, 2007). Public support also took the form of providing rules for
573 framing collective action among farmers and the labeling of operations (Kockmann et al., 2003). It
574 seems that such support was crucial to the emergence and durability of local collective actions. After
575 the official stop of the policy at the national level, most operations collapsed, except in the Rhin-
576 Meuse water basin area where the Water Agency decided to maintain a similar program at the water
577 basin level (Bernard, 2004).

578 **5. Discussion and conclusions**

579 The analysis shows that collective action is a relevant tool to consider for improving the effectiveness
580 and cost-effectiveness of regulatory and incentive policies targeting diffuse pollution from agriculture.
581 Self-organization by farmers for reaching regulatory objectives will be associated with lower design
582 and enforcement costs for public agencies. A greater participation of farmers in the definition of
583 measures that they must implement is also likely to increase their compliance and thus foster the
584 realization of water quality objectives. Collective action for joint applications to agri-environmental
585 schemes allows for transaction cost savings both for farmers and for public agencies compared to
586 individual schemes. Cooperation will also improve environmental outcomes, as water quality
587 improvements require action at a larger scale than at the individual farm level.

588 However, as stressed by scholars in the field of institutional economics (Ostrom and Cox, 2010;
589 Ménard, 2011), no single policy approach or instrument is likely to solve complex environmental
590 problems in all settings. The results suggest that the success of collective action involving farmers
591 depends on a number of conditions related to the characteristics of the resource, the actors involved,
592 the governance of cooperation and the broader economic and political contexts (Table 3).

593 The size of the water system targeted, in conjunction with the number of potential participants and
594 their degree of heterogeneity, was found to affect the likelihood of successful collective action, with a

595 collective management of larger basins or catchments involving greater transaction costs. The less
596 predictable are the hydrogeological system dynamics, the higher are the management costs.

597 The level of management costs also depends on the knowledge available to participants regarding the
598 impact of farming practices on water quality. Among the characteristics of actors involved, the type of
599 farming system and the preferences of farmers were found to potentially influence the private benefits
600 drawn from collective action. Farmers incurring fewer costs in changing their practices and/or having
601 strong preferences for environmental preservation will be more likely to participate in collective
602 action. The results suggest that a larger number of farmers together with a greater diversity in
603 preferences and farming systems increase the costs of collective action. However, the participation of
604 non-farmers in collective action was identified as a positive factor for pooling the resources needed for
605 cooperation. The presence of a leader or the existence of trust and social capital within the group of
606 participants were shown to decrease transaction costs.

607 Characteristics of the governance system are identified as a crucial factor for the success of collective
608 action within the SES framework. Especially, the presence of a control and sanction system was found
609 to be important in limiting free-riding from participants in the two cases (Environmental Cooperatives
610 and “Ferti-Mieux” operations). The analysis also highlights the positive effect of an autonomous
611 design of rules by the participants.

612 Most factors highlighted by Ostrom (2009) as crucial for self-organization by users of a common-pool
613 resource were also identified in the case of collective action for water pollution control (Table 3). Two
614 variables were not found relevant for the analysis of collective action for diffuse pollution control: the
615 productivity of the resource system and the resource unit mobility, in relation to the non-subtractive
616 character of water quality (Hinkel et al., 2015). Further, the nature of market incentives, the political
617 context and the existence of government support were identified as strongly determining the
618 emergence and sustainability of agri-environmental cooperation. The importance of these conditions
619 can be related to the public good nature of diffuse pollution control by farmers. In the presence of few
620 direct economic incentives, the success of collective action will substantially depend on external
621 economic and political incentives.

622 From a policy perspective, the findings of this paper may serve as a basis for assessing whether
623 conditions are gathered for collective action to be an effective and cost-effective tool for diffuse
624 pollution control. When applied to a specific setting, such a diagnostic may inform policy choices
625 regarding the adoption of a collective approach and/or the design of measures addressing the
626 constraints identified as bearing on collective action.

627 Combining transaction cost economics with the SES framework proved useful to assess the potential
628 of hybrid policy instruments relying on collective action for water quality management in agriculture.
629 The results presented here were drawn from existing case studies mostly using different conceptual
630 approaches to address this issue. Further investigation is needed, including direct empirical data
631 collection to test the assumptions made on the factors identified as affecting cooperation for water
632 pollution control.

References

- Acheson, J.M., 2006. Institutional Failure in Resource Management. *Annual Review of Anthropology* 35, 117-134. <https://doi.org/10.1146/annurev.anthro.35.081705.123238>.
- Agence de l'Eau (AE) Rhône Méditerranée Corse (RMC), 2007a. Etude de cas : Les Sources de Gorze, in : Evaluation des politiques d'intervention de l'Agence de l'Eau Rhône Méditerranée et Corse. Actions de lutte contre les pollutions diffuses dans les bassins d'alimentation des captages d'eau potable. Annexes Volume 1, 34-43.
- Agence de l'Eau (AE) Rhône Méditerranée Corse (RMC), 2007b. Etude de cas : Les Plateaux du Haut Saintois, in : Evaluation des politiques d'intervention de l'Agence de l'Eau Rhône Méditerranée et Corse. Actions de lutte contre les pollutions diffuses dans les bassins d'alimentation des captages d'eau potable. Annexes Volume 1, 44-55.
- Agrawal, A., 2001. Common Property Institutions and Sustainable Governance of Resources. *World Development* 29 (10), 1649-1672. [https://doi.org/10.1016/S0305-750X\(01\)00063-8](https://doi.org/10.1016/S0305-750X(01)00063-8).
- Akers J.F., Yasué M., 2019. Motivational Crowding in Payments for Ecosystem Service Schemes: a Global Systematic Review. *Conservation and Society* 17, 377-89. https://doi.org/10.4103/cs.cs_18_90.
- Allen, D.W., 2000. Transaction costs, in: Bouckaert, B. and De Geest, G. (Eds.), *Encyclopedia of Law and Economics*. Edward Elgar, Cheltenham, 893-926.
- Amblard, L., 2019, Collective action for water quality management in agriculture: The case of drinking water source protection in France, *Global Environmental Change*, 58: 101970, <https://doi.org/10.1016/j.gloenvcha.2019.101970>.
- Ayer, H.W., 1997. Grass Roots Collective Action: Agricultural Opportunities. *Journal of Agricultural and Resource Economics*. 22(1), 1-11. <https://www.jstor.org/stable/40986928>.
- Basurto, X., Gelcich, S., Ostrom, E., 2013. The social-ecological system framework as a knowledge classificatory system for benthic small-scale fisheries. *Global Environmental Change* 23, 1366-1380. <https://doi.org/10.1016/j.gloenvcha.2013.08.001>.
- Baumol, W.J., Oates, W.E., 1988. *The Theory of Environmental Policy*. New York: Cambridge University Press.
- Bennett, D.E., Gosnell, H., 2015. Integrating Multiple Perspectives on Payments for Ecosystem Services through a Social-Ecological Systems Framework. *Ecological Economics* 116, 172-81. <https://doi.org/10.1016/j.ecolecon.2015.04.019>.
- Bernard, P.-Y., 2004. Gestion concertée de l'eau en Lorraine. Quels enseignements tirer d'une opération locale Ferti-Mieux ? *Travaux et Innovations* 11, 1-4.
- Brives, H., 1998. L'environnement, Nouveau Pré Carré Des Chambres D'agriculture ? *Ruralia*, 2, 9 pages. <http://journals.openedition.org/ruralia/30>.
- Brouwer, F., 2003. Occurrence of Co-operative Agreements, in: Brouwer, F., Heinz, I., Zabel, T. (Eds.), *Governance of water-related conflicts in agriculture. New directions in agri-environmental and water policies in the EU*. Kluwer Academic Publishers, Dordrecht, 23-43.
- Brouwer, F., Heinz, I., Zabel, T., 2002. The role of co-operative agreements in agriculture to achieve EU Water Policy targets, in: Hagedorn, K. (Ed.), *Environmental Co-operation and Institutional Change, Theories and Policies for European Agriculture*. Edward Elgar, Cheltenham, 260-279.
- Buckley, C., Carney, P., 2013. The potential to reduce the risk of diffuse pollution from agriculture while improving economic performance at farm level. *Environmental Science and Policy* 25, 118-126. <https://doi.org/10.1016/j.envsci.2012.10.002>.
- Burtin, M.L., 2014. Bilan technique des opérations Agri-Mieux alsaciennes et lorraines. Rencontre des présidents Agri-Mieux du bassin Rhin-Meuse -12 novembre 2014.

- Busca, D., 2004. La mise en œuvre négociée des dispositifs publics agri-environnementaux : appropriation stratégique, effets d'organisation et enjeux de territoire. *Annuaire Des Collectivités Locales*, 865-873.
- Busca, D., 2002. La mise en œuvre négociée des dispositifs agri-environnementaux. Effets d'organisation, enjeux de territoire et dynamique d'appropriation stratégique. PhD thesis. Toulouse, Université Toulouse-Le Mirail, 409 pages.
- Chhatre, A., Agrawal, A., 2008. Forest commons and local enforcement. *Proceedings of the National Academy of Sciences of the United States of America* 105 (36), 13286-13291. <https://doi.org/10.1073/pnas.0803399105>.
- Coase, R., 1960. The Problem of Social Cost. *Journal of Law and Economics* 3, 1-44. https://doi.org/10.1057/9780230523210_6.
- Coggan, A., Whitten, S.M., Bennett, J., 2010. Influences of transaction costs in environmental policy. *Ecological Economics* 69 (9), 1777-1784. <https://doi.org/10.1016/j.ecolecon.2010.04.015>.
- Daniel, F.-J., Perraud, D., 2009. The multifunctionality of agriculture and contractual policies. A comparative analysis of France and the Netherlands. *Journal of Environmental Management* 90, S132-S138. <https://doi.org/10.1016/j.jenvman.2008.11.015>.
- Davies, B., Blackstock, K., Brown K., Shannon, P., 2004. Challenges in creating local agri-environmental cooperation action amongst farmers and other stakeholders. Final Report, Scottish Executive Environment and Rural Affairs Department.
- Dupraz, P., Latouche, K., Turpin, N., 2009. Threshold effect and co-ordination of agri-environmental efforts. *Journal of Environmental Planning and Management* 52(5), 613-630. <https://doi.org/10.1080/09640560902958164>.
- Eshuis, J., Stuver, M., 2005. Learning in Context through Conflict and Alignment: Farmers and Scientists in Search of Sustainable Agriculture. *Agriculture and Human Values* 22, 137-148. <https://doi.org/10.1007/s10460-004-8274-0>.
- Eshuis, J., Van Woerkum, C., 2003. Trust and monitoring in governance processes: lessons from landscape management by farmers in a Dutch municipality. *Journal of Environmental Policy and Planning* 5(4), 379-396. <https://doi.org/10.1080/1523908032000171620>.
- European Environment Agency (EEA), 2018. European waters – Assessment of status and pressures 2018. EEA Report. <https://www.eea.europa.eu/publications/state-of-water>. Accessed on November 29, 2020.
- European Union (EU), 2013. Regulation (EU) n°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) and repealing Council Regulation (EC) n° 1698/2005, Official Journal of the European Union.
- European Union (EU), 2000. 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. Official Journal L 327, 22/12/2000, 0001 - 0073.
- Falconer, K., 2000. Farm-level constraints on agri-environmental scheme participation: a transactional perspective. *Journal of Rural Studies* 16, 379-394. [https://doi.org/10.1016/S0743-0167\(99\)00066-2](https://doi.org/10.1016/S0743-0167(99)00066-2).
- Falconer, K., 2002. Developing Co-operative Approaches to Agri-environmental Policy: a Transaction Cost Perspective on Farmer Participation in Voluntary Schemes, in: Hagedorn, K. (Ed.), *Environmental Co-operation and Institutional Change. Theories and Policies for European Agriculture*. Edward Elgar: Cheltenham, 239-259.
- Falconer, K., Dupraz, P., Whitby, M., 2001. An Investigation of Policy Administrative Costs Using Panel Data for the English Environmentally Sensitive Areas. *Journal of Agricultural Economics* 52(1), 83-103. <https://doi.org/10.1111/j.1477-9552.2001.tb00911.x>.

- Franks, J., 2011. The collective provision of environmental goods: a discussion of contractual issues. *Journal of Environmental Planning and Management* 54 (5), 637-660. <https://doi.org/10.1080/09640568.2010.526380>.
- Franks, J., 2010. Boundary organizations for sustainable land management: The example of Dutch Environmental Co-operatives. *Ecological Economics* 70(2), 282-295. <https://doi.org/10.1016/j.ecolecon.2010.08.011>.
- Franks, J., 2008, A blueprint for green co-operatives: organisations for co-ordinating environmental management across farm holdings, *Journal of International Farm Management* 4(3), 1-24.
- Franks, J.R., McGloin, A., 2007a. Environmental co-operatives as instruments for delivering across-farm environmental and rural policy objectives: Lessons for the UK. *Journal of Rural Studies* 23, 472-489. <https://doi.org/10.1016/j.jrurstud.2007.03.002>.
- Franks, J. R., McGloin, A., 2007b. Joint Submissions, Output Related Payments and Environmental Co-Operatives: Can the Dutch Experience Innovate UK Agri-Environment Policy? *Journal of Environmental Planning and Management* 50, 233-256. <https://doi.org/10.1080/09640560601156482>.
- Frey, B.S., Jegen, R., 2001. Motivation crowding theory. *Journal of Economic Surveys* 15 (5), 589-611. <https://doi.org/10.1111/1467-6419.00150>.
- Frey, U., Cox, M., 2015. Building a Diagnostic Ontology of Social-Ecological Systems. *International Journal of the Commons* 9 (2), 595–618. <http://doi.org/10.18352/ijc.505>.
- Garrick, D., McCann, L., Pannell, D.J., 2013. Transaction costs and environmental policy: Taking stock, looking forward 88, 182-184. <http://dx.doi.org/10.1016%2Fj.ecolecon.2012.12.022>.
- Glasbergen, P., 2000. The Environmental Cooperative: Self-Governance in Sustainable Rural Development. *The Journal of Environment and Development* 9, 240-259. <https://doi.org/10.1177/107049650000900303>.
- Goldman, R.L., Thompson, B.H., Daily, G.C., 2007. Institutional incentives for managing the landscape: Inducing cooperation for the production of ecosystem services. *Ecological Economics* 64, 333-343. <https://doi.org/10.1016/j.ecolecon.2007.01.012>.
- Grolleau, G., McCann, L., 2012. Designing watershed programs to pay farmers for water quality services: case studies of Munich and New York City. *Ecological Economics* 76, 87-94. <https://doi.org/10.1016/j.ecolecon.2012.02.006>.
- Groot, J.C.J., Rossing, W.A.H., Lantinga, E.A., 2006. Evolution of farm management, nitrogen efficiency and economic performance on Dutch dairy farms reducing external inputs. *Livestock Science* 100, 99-110. <https://doi.org/10.1016/j.livprodsci.2005.08.008>.
- Head, J.G., 1962. Public goods and public policy. *Public Finance XVII* (3), 197-219.
- Hinkel, J., Cox, E., Schlüter, M., Binder, C., Falk, T., 2015. A diagnostic procedure for applying the social-ecological systems framework in diverse cases. *Ecology and Society* 20 (1): 32. <http://dx.doi.org/10.5751/ES-07023-200132>.
- Holtermann, S.E., 1972. Externalities and Public Goods. *Economica* 39(153), 78-87. <https://doi.org/10.2307/2552058>.
- Jongeneel, R., Polman, N., 2018. Farmer groups as a device to ensure the provision of agri-environmental services in the Netherlands: a procurement perspective. *Agricultural Economics Society Annual Conference, University of Warwick, 16th -18th April 2018*. <https://library.wur.nl/WebQuery/wurpubs/543615>. Accessed on November 29, 2020.
- Kockmann, F., Kung-Benoit, A., Moretty, P., Guichard, L., 2003. La dynamique des opérations Ferti-Mieux : une réponse durable aux questions d'environnement. *Journée de l'Académie d'Agriculture de France sur Ferti-Mieux-12 novembre 2003*.

- Lacroix, A., Bel, F., Mollard, A., Sauboua, E., 2010. La territorialisation des politiques environnementales. Le cas de la pollution nitrique de l'eau par l'agriculture. *Développement durable et territoires* 6: Les territoires de l'eau. <https://doi.org/10.4000/developpementdurable.1838>.
- Lubell, M., 2004. Collaborative Watershed Management: A View from the Grassroots. *The Policy Studies Journal* 32 (3), 341-361. <https://doi.org/10.1111/j.1541-0072.2004.00069.x>.
- Lubell, M., Schneider, M., Scholz, J.-T., Mete, M., 2002. Watershed partnerships and the Emergence of Collective Action Institutions. *American Journal of Political Science* 46 (1), 148-163. <https://doi.org/10.2307/3088419>.
- Lundqvist, L.J., 2001. Games Real Farmers Play: knowledge, memory and the fate of collective action to prevent eutrophication of water catchments. *Local Environment* 6 (4), 407-419. <https://doi.org/10.1080/13549830120091707>.
- Marshall, G., 1998. *A dictionary of sociology*. New York: Oxford University Press.
- McCann, L., 2013. Transaction costs and environmental policy design. *Ecological Economics* 88, 253-262. <https://doi.org/10.1016/j.ecolecon.2012.12.012>.
- McCann, L., Colby, B., Easter, K.W., Kasterine, A., Kuperan, K.V., 2005. Transaction cost measurement for evaluating environmental policies. *Ecological Economics* 52, 527-542. <https://doi.org/10.1016/j.ecolecon.2004.08.002>.
- McCann, L., Easter, K.W., 1999. Transaction Costs of Policies to Reduce Agricultural Phosphorous Pollution in the Minnesota River. *Land Economics* 75 (3), 402-414. <http://dx.doi.org/10.2307/3147186>.
- McGinnis, M.D. and Ostrom, E., 2014. Social-Ecological system framework: initial changes and continuing challenges. *Ecology and Society* 19 (2): 30. <http://dx.doi.org/10.5751/ES-06387-190230>.
- Meinzen-Dick, R., 2007. Beyond panaceas in water institutions. *Proceedings of the National Academy of Sciences of the United States of America* 104 (39), 15200-15205. <https://doi.org/10.1073/pnas.0702296104>.
- Ménard, C., 2011. A new institutional economics perspective on environmental issues. *Environmental Innovation and Societal Transitions* 1, 115-120. <https://doi.org/10.1016/j.eist.2011.04.002>.
- Mettepenningen, E., Vandermeulen, V., Delaet, K., Van Huylenbroeck, G., Wailes E.J., 2013. Investigating the influence of the institutional organisation of agri-environmental schemes on scheme adoption. *Land Use Policy* 33, 20-30. <https://doi.org/10.1016/j.landusepol.2012.12.004>.
- Mettepenningen, E., Beckmann, V., Eggers, J., 2011. Public transaction costs of agri-environmental schemes and their determinants – Analyzing stakeholders' involvement and perceptions. *Ecological Economics* 70, 641-650. <https://doi.org/10.1016/j.ecolecon.2010.10.007>.
- Mettepenningen, E., Verspecht A., and Van Huylenbroeck, G., 2009. Measuring private transaction costs of European agri-environmental schemes. *Journal of Environmental Planning and Management* 52(5), 649-667. <https://doi.org/10.1080/09640560902958206>.
- Moller, A., Ryan, M., Deci, E., 2006. Self-determination theory and public policy: improving the quality of consumer decisions without using coercion. *Journal of Public Policy & Marketing* 25, 104-116. <https://doi.org/10.1509/jppm.25.1.104>.
- Ministry of Economic Affairs, Agriculture and Innovation, 2011, Farmers' groups and the Common Agricultural Policy, Newsletter, 4 pages.
- Nimmo Smith, R.J., Glegg, G.A., Parkinson, R., and Richards, J.P., 2007. Evaluating the Implementation of the Nitrates Directive in Denmark and England using an Actor-Oriented Approach. *European Environment* 17, 124-144. <https://doi.org/10.1002/eet.440>.

- North, D.C., 1990. *Institutions, Institutional Change and Economic Performance*. Cambridge University Press, Cambridge.
- OECD, 2013. *Providing Agri-environmental Public Goods through Collective Action*. OECD Publishing, Paris. <http://dx.doi.org/10.1787/9789264197213-en>
- OECD, 1998. *Cooperative Approaches of Sustainable Agriculture*. OECD Publications, Paris.
- Ostrom, E., 2011. Background on the Institutional Analysis and Development Framework. *The Policy Studies Journal* 39 (1), 7-27. <https://doi.org/10.1111/j.1541-0072.2010.00394.x>.
- Ostrom, E., 2010. Analyzing collective action. *Agricultural Economics* 41(S1), 155-156. <https://doi.org/10.1111/j.1574-0862.2010.00497.x>.
- Ostrom, E., 2009. A General Framework for Analyzing Sustainability of Social-Ecological Systems. *Science* 325, 419-422. <https://doi.org/10.1126/science.1172133>.
- Ostrom, E., 2007. A diagnostic approach for going beyond panaceas. *Science* 104(39), 15181-15187. <https://doi.org/10.1073/pnas.0702288104>.
- Ostrom, E., 2003. How types of goods and property rights jointly affect collective action. *Journal of Theoretical Politics* 15(3), 239-270. <https://doi.org/10.1177/0951692803015003002>.
- Ostrom, E., 1998. The Institutional Analysis and Development Approach in: Loehman, E.T. and Kilgour, D.M. (Eds.), *Designing institutions for environmental and resource management*. Edward Elgar, Cheltenham, 68-90.
- Ostrom, E., Cox, M., 2010. Moving beyond panaceas: a multi-tiered diagnostic approach for social-ecological analysis. *Environmental conservation* 37(4), 451-463. <https://doi.org/10.1017/S0376892910000834>.
- Ostrom, E., Walker, J., 2000. Neither Markets nor States: Linking Transformation Processes in Collective Action Arenas, in: McGinnis, M.D. (Ed.), *Polycentric Games and Institutions: Readings from the Workshop in Political Theory and Policy Analysis*. The University of Michigan Press, 91-115.
- Papy, F., Torre, A., 2002. Quelles organisations territoriales pour concilier production agricole et gestion des ressources naturelles? *Etudes et Recherches sur les Systèmes agraires et le Développement* 33, 151-169. <https://hal.archives-ouvertes.fr/hal-01231540/>.
- Partelow, S., 2018. A review of the social-ecological systems framework: applications, methods, modifications, and challenges. *Ecology and Society* 23(4), 36. <https://doi.org/10.5751/ES-10594-230436>.
- Polman, N., Slangen, L., 2002. Self-organising and self-governing of environmental cooperatives: design principles, in: Hagedorn, K. (Ed.), *Environmental Co-operation and Institutional Change. Theories and Policies for European Agriculture*. Edward Elgar, Cheltenham, 91-111.
- Polman, N., Slangen, L., Van Huylenbroeck, G., 2010. Collective Approaches to Agri- Environmental Management, in: Oskam, A., Meester, G., and H. Silvis (Eds), *EU Policy for Agriculture, Food and Rural Areas*. Wageningen Academic Publishers, Wageningen, 363-368.
- Poteete, A.R., Janssen, M.A., Ostrom, E. (Eds.), 2010. *Working together. Collective Action, the Commons and Multiple Methods in Practice*. Princeton University Press, Princeton and Oxford.
- Prager, K., 2015a. Agri-environmental collaboratives for landscape management in Europe. *Current Opinion in Environmental Sustainability* 12, 59-66. <http://dx.doi.org/10.1016/j.cosust.2014.10.009>.
- Prager, K., 2015b. Agri-environmental collaboratives as bridging organisations in landscape management. *Journal of Environmental Management* 161, 375-384. <http://dx.doi.org/10.1016/j.jenvman.2015.07.027>.

- Pretty, J., Ward, H., 2001. Social Capital and the Environment. *World Development* 29(2), 209-227. [https://doi.org/10.1016/S0305-750X\(00\)00098-X](https://doi.org/10.1016/S0305-750X(00)00098-X).
- Ramonet, M., 2003. Le développement durable, réponse aux enjeux agricoles et environnementaux. Rapport d'information à l'Assemblée Nationale 1237. Paris, France, Assemblée Nationale.
- Renting, H., Van der Ploeg, J.D., 2001. Reconnecting Nature, Farming and Society: Environmental Cooperatives in the Netherlands as Institutional Arrangements for Creating Coherence. *Journal of Environmental Policy and Planning* 3, 85-101. <https://doi.org/10.1002/jepp.75>.
- Rettel, C., Revest, C., 2013. Les opérations Agri-Mieux. *Rencontre Agriculture & Eau. Concilier Production et Protection* - 18 décembre 2013.
- Ribaudo, M., Greene, C., Hansen, L., Hellerstein, D., 2010. Ecosystem services from agriculture: Steps for expanding markets. *Ecological Economics* 69, 2085-2092. <https://doi.org/10.1016/j.ecolecon.2010.02.004>.
- Samuelson, P.A., 1954. The Pure Theory of Public Expenditure. *The Review of Economics and Statistics* 36(4), 387-89. <https://doi.org/10.2307/1925895>.
- Sarker, A., Ross, H., Shrestha, K.K., 2008. A common-pool resource approach for water quality management: An Australian case study. *Ecological Economics* 68, 461-471. <https://doi.org/10.1016/j.ecolecon.2008.05.001>.
- Schlager, E., Blomquist, W., Tang, S.Y., 1994. Mobile Flows, Storage, and Self-organized Institutions for Governing Common-Pool Resources. *Land Economics* 70 (3), 294-317. <https://doi.org/10.2307/3146531>.
- Sebillotte, M., 2003. Ferti-Mieux. Une opération de lutte contre les pollutions par les nitrates. *Journée de l'Académie d'Agriculture de France sur Ferti-Mieux-12 novembre 2003*, 19 pages.
- Shortle, J.S., Abler, D. (Eds), 2001. *Environmental Policies for Agricultural Pollution Control*, CABI Publishing, New York.
- Shortle, J.S., Horan, R.D., 2001. The economics of nonpoint pollution control. *Journal of Economic Surveys* 15(3), 255-289. <https://doi.org/10.1111/1467-6419.00140>.
- Shortle, J. S., Ribaudo, M., Horan, R.D., Blandford, D., 2012. Reforming Agricultural Nonpoint Pollution Policy in an Increasingly Budget-Constrained Environment. *Environmental Science and Technology* 46, 1316–1325. <https://doi.org/10.1021/es2020499>.
- Slangen, L.H.G., 1994. The Economic Aspects of Environmental Co-operatives for Farmers. *International Journal of Social Economics* 21 (9), 42-59. <https://doi.org/10.1108/03068299410070407>.
- Slangen, L.H.G., Jongeneel, R., Polman, N., Guldmond, J., Hees, E., van Well, E., 2008. Economic and ecological effectiveness of collective nature and wildlife conservation contracts. Wageningen, Statutory Research Tasks Unit for Nature and the Environment. WOt-rapport 84, English summary.
- Smits, M-J., Driessen, P., Glasbergen, P., 2008. Governing agri-environmental schemes: lessons to be learned from the new institutional economics approach, *Environment and Planning C: Government and Policy* 26, 627-643. <https://doi.org/10.1068/c06106s>.
- Sonneveld, M. P. W., Bouma, J., 2003. Methodological Considerations for Nitrogen Policies in the Netherlands Including a New Role for Research. *Environmental Science and Policy* 6, 501-511. <https://doi.org/10.1016/j.envsci.2003.08.005>.
- Stallman, H.R., 2011. Ecosystem services in agriculture: Determining suitability for provision by collective management. *Ecological Economics* 71, 131-139. <https://doi.org/10.1016/j.ecolecon.2011.08.016>.
- Stobbelaar, D.J., Groot, J.C.J., Bishop, C., Hall, J., Pretty, J., 2009. Internalization of agri-environmental policies and the role of institutions. *Journal of Environmental Management* 90, S175-S184. <https://doi.org/10.1016/j.jenvman.2008.11.019>.

- Stuiver, M., Van der Ploeg, J.D., Leeuwis, C., 2003. The Vel and Vanla Environmental Co-Operatives as Field Laboratories. *NJAS- Wageningen Journal of Life Sciences* 51, 27-39. [https://doi.org/10.1016/S1573-5214\(03\)80025-8](https://doi.org/10.1016/S1573-5214(03)80025-8).
- Termeer, C.J.A.M., Stuiver, M., Gerritsen, A., Huntjens, P., 2013. Integrating self-governance in heavily regulated policy fields: insights from a Dutch farmers' cooperative. *Journal of Environmental Policy and Planning* 15 (2), 285-302. <https://doi.org/10.1080/1523908X.2013.778670>.
- Terwan, P., Deelen, J.G. Mulders, A., Peeters, E., 2016. The cooperative approach under the new Dutch agri-environment-climate scheme. Background, procedures and legal and institutional implications. Ministry of Economic Affairs, The Netherlands, 14 pages.
- Thiel, A., Adamseged, M., Baake, C., 2015. Evaluating an instrument for institutional crafting: How Ostrom's social-ecological systems framework is applied. *Environmental Science and Policy* 53, 152-164. <https://doi.org/10.1016/j.envsci.2015.04.020>.
- Uetake, T., 2014. Agri-environmental Management Through Collective Action. *EuroChoices* 13, 29-34. <https://doi.org/10.1111/1746-692X.12072>.
- Van Der Ploeg, J., Verschuren, P., Verhoeven, F., 2006. Dealing with Novelties: A Grassland Experiment Reconsidered. *Journal of Environmental Policy and Planning* 8, 199-218. <https://doi.org/10.1080/15239080600915568>.
- Van Dijk, W.F.A., Lokhorst A.M., Berendse, F., de Snoo, G.R., 2015. Collective agri-environment schemes: How can regional environmental cooperatives enhance farmers' intentions for agri-environmental schemes? *Land Use Policy* 42, 759-766. <https://doi.org/10.1016/j.landusepol.2014.10.005>.
- Van Huylbroeck, G., Vuylsteke, A., Verbeke, W., 2009. Public good markets: the possible role of hybrid governance structures in institutions for sustainability in: Beckmann, V. and M. Padmanabhan (Eds.), *Institutions and Sustainability*. Springer Science, 175-191.
- Verron, J.P., 2007. Synthèse des opérations Ferti-Mieux: opérations de conseils ou proto-observatoires? « Methods and Tools for Land Use Planning » Master Thesis, INRA SAD, 80 pages.
- Villamayor-Tomas, S., Fleischman, F.D., Perez Ibarra, I., Thiel, A., van Laerhoven, F., 2014. From Sandoz to Salmon: Conceptualizing resource and institutional dynamics in the Rhine watershed through the SES framework, *International Journal of the Commons* 8(2), 361-395. <http://doi.org/10.18352/ijc.411>.
- Villamayor-Tomas, S., Thiel, A., Amblard, L., Zikos, D., Blanco, E., 2019. Diagnosing the role of the state for local collective action: Types of action situations and policy instruments. *Environmental Science and Policy* 97, 44-57. <https://doi.org/10.1016/j.envsci.2019.03.009>.
- Wade, R., 1987. The management of common property resources: collective action as an alternative to privatisation or state regulation. *Cambridge Journal of Economics* 11, 95-106. <http://www.jstor.org/stable/23597063>.
- Westerink, J., Jongeneel, R., Polman, N., Prager, K., Franks, J., Dupraz, P., Mettepenningen, E., 2017. Collaborative governance arrangements to deliver spatially coordinated agri-environmental management. *Land Use Policy* 69, 176-192. <https://doi.org/10.1016/j.landusepol.2017.09.002>.
- Westerink, J., Melman, D. C. P., Schrijver, R. A. M., 2015. Scale and Self-Governance in Agri-Environment Schemes: Experiences with Two Alternative Approaches in the Netherlands. *Journal of Environmental Planning and Management* 58, 1490-1508. <https://doi.org/10.1080/09640568.2014.932762>.
- Wiskerke, J.S.C., Bock, B.B., Stuiver, M., Renting, H., 2003. Environmental co-operatives as a new mode of rural governance. *NJAS- Wageningen Journal of Life Sciences* 51 (1-2), 9-25. [https://doi.org/10.1016/S1573-5214\(03\)80024-6](https://doi.org/10.1016/S1573-5214(03)80024-6).

Appendix 1: Second-tier variables of a social-ecological system (McGinnis and Ostrom, 2014)

First-tier variables	Second-tier variables
Social, economic and political settings (S)	S1 – Economic development S2 – Demographic trends S3 – Political stability S4 – Other governance systems S5 – Markets S6 – Media organizations S7 – Technology
Resource systems (S)	RS1 – Sector (e.g., water, forests, pasture, fish) RS2 – Clarity of system boundaries RS3 – Size of resource system RS4 – Human-constructed facilities RS5 – Productivity of system RS6 – Equilibrium properties RS7 – Predictability of system dynamics RS8 – Storage characteristics RS9 – Location
Governance systems (GS)	GS1 – Government organizations GS2 – Nongovernment organizations GS3 – Network structure GS4 – Property-rights systems GS5 – Operational-choice rules GS6 – Collective-choice rules GS7 – Constitutional-choice rules GS8 – Monitoring and sanctioning rules
Resource units (RU)	RU1 – Resource unit mobility RU2 – Growth or replacement rate RU3 – Interaction among resource units RU4 – Economic value RU5 – Number of units RU6 – Distinctive characteristics RU7 – Spatial and temporal distribution
Actors (A)	A1 – Number of relevant actors A2 – Socioeconomic attributes A3 – History or past experiences A4 – Location A5 – Leadership-entrepreneurship A6 – Norms (trust-reciprocity)/social capital A7 – Knowledge of SES A8 – Importance of the resource (dependence) A9 – Technologies available
Action situation: Interactions (I) - Outcomes (O)	I1 – Harvesting I2 – Information sharing I3 – Deliberation processes I4 – Conflicts I5 – Investment activities I6 – Lobbying activities I7 – Self-organizing activities I8 – Networking activities I9 – Monitoring activities I10 – Evaluative activities O1 – Social performance measures (e.g., efficiency, equity, accountability, sustainability) O2 – Ecological performance measures (e.g., overharvested, resilience, biodiversity, sustainability) O3 – Externalities to other SESs
Related ecosystems (ECO)	ECO1 – Climate patterns ECO2 – Pollution patterns ECO3 – Flows into and out of focal SES

Appendix 2. The factors identified as affecting the costs and benefits of hybrid policy instruments

Table 2.1: The characteristics of the social, economic and political settings

First-tier variable	Second-tier variables	References	
		Environmental cooperatives	Ferti-Mieux operations
Social, economic and political settings (S)	S4 – Other governance systems		
	<i>S4.1 – Larger scale governance systems</i>		
	S4.1.1 – Regulatory threat	Glasbergen, 2000; Renting and van der Ploeg, 2001; Wiskerke et al., 2003; Stobbelaar et al., 2009; Franks, 2010	Bernard, 2004; AE RMC, 2007b
	S4.1.2 – Political representation of agricultural interests	Franks and McGloin, 2007a; 2007b; Daniel and Perraud, 2009; Franks, 2008; 2010	Sebillotte, 2003
	S4.1.3 – Support from public agencies	Glasbergen, 2000; Wiskerke et al., 2003; Franks and McGloin, 2007a; 2007b; Franks, 2008; Franks, 2010; Termeer et al., 2013; Westerink et al., 2015	Kockmann et al., 2003; Bernard, 2004; Verron, 2007
S5 – Markets	Renting and van der Ploeg, 2001; Termeer et al., 2013	Busca, 2002; 2004; Verron, 2007	

Table 2.2: The characteristics of the resource

First-tier variable	Second-tier variables	References	
		Environmental cooperatives	Ferti-Mieux operations
Resource system (RS)	RS3 – Size of resource system		
	<i>RS3.1 – Size of the water catchment</i>		Kockmann et al., 2003
	RS7 – Predictability of system dynamics		Bernard, 2004; AE RMC, 2007b

Table 2.3: The characteristics of actors

First-tier variable	Second-tier variables	References	
		Environmental cooperatives	Ferti-Mieux operations
Actors (A)	A1 – Number of relevant actors	Westerink et al., 2017	Kockmann et al., 2003; Verron, 2007
	A2 – Socioeconomic attributes		
	<i>A2.1 – Type of farming systems</i>	Groot et al., 2006	AE RMC, 2007b
	<i>A2.2 – Heterogeneity of participants</i>	Franks and McGloin, 2007a; Franks, 2008; Uetake, 2014	
	A5 – Leadership-entrepreneurship	Franks, 2008; 2010; 2011; Termeer et al., 2013	Kockmann et al., 2003; AE RMC, 2007a; 2007b; Verron, 2007
	A6 – Norms (trust-reciprocity)/social capital	Polman and Slangen, 2002; Eshuis and van Woerkum, 2003	Kockmann et al., 2003
	A7 – Knowledge of SES	Stuiver et al., 2003; Eshuis and Stuiver, 2005; Van Der Ploeg et al., 2006	Kockmann et al., 2003; Bernard, 2004; AE RMC, 2007a; 2007b ; Verron, 2007
	A8 – Importance of the resource		
	<i>A8.1 – Environmental preferences of farmers</i>	Stobbelaar et al., 2009; van Dijk et al., 2015	Sebillotte, 2003

Table 2.4: The characteristics of the governance system

First-tier variable	Second-tier variables	Environmental cooperatives	Ferti-Mieux operations
Governance system (GS)	GS6 – Collective-choice rules		
	<i>GS6.1 – Autonomy at the collective-choice level</i>	Franks and McGloin, 2007a; Franks, 2008; 2011; Termeer et al., 2013	Kockmann et al., 2003; AE RMC, 2007b
	GS8 – Monitoring and sanctioning rules	Polman and Slangen, 2002; Eshuis and Van Woerkum, 2003; Wiskerke et al., 2003; Termeer et al., 2013; Westerink et al., 2017	Ramonet, 2003; Verron, 2007