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Can Geographical Indications promote sustainable shellfish farming? The example of Bay of Mont-Saint-Michel mussels

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Abstract :

This paper investigates the potential of Geographical Indications to enhance the environmental sustainability of bivalve aquaculture, with a focus on the Protected Designation of Origin (PDO) granted to the bouchot mussel of the bay of Mont Saint-Michel (BMSM). First, a retrospective analysis of the PDO application process was carried out to provide insight into specific environmental and regulatory issues facing mussel farming in the BMSM (e.g. common resource management). Second, further assessment relied on a comparative analysis with other public labelling strategies developed by mussel farmers, notably emerging organic certification. This involved setting up an ad-hoc analysis grid to evaluate different dimensions of sustainability, namely economic, environmental and governance. The discussion then addresses the potential of PDO to promote sustainable mussel farming with respect to the current trends in food/mussel labelling in the market and to the increasing demand for environmental preservation in marine and coastal areas. It also emphasises the overlap between different EU labelling schemes that questions their consistency and legibility, particularly for bivalve aquaculture. In conclusion, the system of quality linked to origin has provided an appropriate framework for supporting the implementation of sustainable bouchot mussel farming in the BMSM, thanks to the relevance and inclusiveness of the PDO labelling process and institutional support. Next, to strengthen the legitimacy of the PDO to guarantee the environmental sustainability of farming methods and increase protection on the market, more adaptive management of the PDO label is recommended.

Highlights

► The potential of GIs to promote sustainable bivalve aquaculture is investigated through the French PDO mussels. ► Beyond quality linked to origin, the PDO application process integrated the issue of common resource preservation. ► Factors of success: institutional support, inclusiveness, increased involvement of producers in the co-management system. ► Scope for progress: more adaptive management of the PDO to respond to further environmental and social concerns. ► Recommendation: improve consistency and legibility of EU agricultural products quality policy for bivalve aquaculture.

Keywords : Geographical Indication, PDO, Mussel farming, Bivalve aquaculture sustainability, Socioeconomics

1 Introduction

Geographical Indications (GIs) constitute a system of identification and protection of quality linked to origin. Initially inspired by French agricultural policies on appellations of origin set up decades ago, this system was adopted by the EU in the early 1990s, resulting in the first regulation (EEC) No 2081/92[i]. The EU regulation relies on two instruments, Protected Designation of Origin (PDO) and Protected Geographical Indication (PGI), distinguished by the intensity of the link between quality and origin. The first text was subsequently revised twice to result in the current Regulation (EU) N° 1151/2012 on quality schemes for agricultural products and foodstuff. Meanwhile GIs became a global phenomenon and their potential benefits relating to the protection of biological resources and collective knowledge were put forward to justify their protection under the IPR[ii] regime [1]. Discussions over GI protection led to the adoption of successive international agreements within the TRIPS[iii] Agreement and the Geneva Act of the Lisbon Agreement in 2015. GIs have also been advocated by the FAO as a tool for sustainable rural development [2] and as a "promising territorial approach towards achieving Sustainable Development Goals (SDGs)" [3]. This interest in GIs reflects the evolution of expectations regarding them, as they have broadened in scope to go beyond quality linked to origin and tradition (natural and human factors) to enhance sustainable food systems.

The different dimensions of GIs have been emphasized in literature reviews**.** The origin labelling of agricultural products was subject to numerous academic works in social sciences, which first explored the link between quality and "terroir"[1] by mobilizing different disciplines: economics, geography, sociology, ethnology, etc. In the fields of socioeconomics and politics, the main themes addressed ranged from production systems and value chain analyses to "actor systems", coordination modes and economic performances, governance and institutional analyses [4,5,6]. This was quickly followed by greater attention being paid to environmental issues and sustainable production systems under GI, although the mention of resource protection is a subsidiary factor in the EU regulation on quality schemes[iv]. Links between geographical indications (in particular

[1] A terroir is a delimited geographic area where a human community has developed a collective production method and knowhow over time. It is based on a system of interactions between physical and biological milieu and a set of human factor involved to convey specific attributes and engender a reputation for a product" [2].

PDO) and biodiversity, environmental services, the relationship between the protection of GIs and the environment, etc. are some of the subjects explored [7,8,9].

Compared to the agro-food sector as a whole, geographical indications in the fisheries and aquaculture sectors have been less subject to socioeconomic research. Indeed, fisheries and aquaculture products (FAPs) represents only a small share of all agricultural products and foodstuffs under GIs (3.7%[v]) and the link to "terroir" or to a specific geographical area could be a more challenging specification to achieve, especially for captured fish. However, interest in according GI protection to the seafood sector has been increasing over time and has followed successive revisions of the EU regulation. It is currently mainly focused on bivalve molluscs and freshwater fish for PDO while dominated by processed seafood for PGI. The growing involvement of FAPs in quality schemes may continue, especially as they are included in the market measures of the current Common Fishery Policy (CFP).

In this context**,** this paper will explore to what extent GIs may contribute to achieving one of the general CFP objectives regarding the development of EU sustainable aquaculture, and notably bivalve aquaculture. The more specific question asked is about the legitimacy and efficiency of the PDO in enhancing the environmental sustainability of the mussel farming sector. To address these issues, the selected case-study is based on the PDO labelling of the mussel cultivated in the Mont-Saint-Michel Bay (France). The paper starts with the presentation of the method and material used for conducting the research (section 2), followed by elements of context and labelling issues for mussel farming at the national and case-study scales (section 3). Section 4 reports the main findings according to a two-step presentation: the first is based on a retrospective analysis of the PDO application process and outcomes; the second carries out further assessment through a comparative analysis with other labelling strategies. The final sections are devoted to the discussion and conclusion.

2 Material and Methods

This paper presents a case-study developed within the framework of the H2020 project SUCCESS, with the purpose of analysing producers' initiatives for enhancing the competitiveness and sustainability of the fisheries and aquaculture sectors. It focuses on the labelling strategies of French mussel farmers, excluding private labels and regional trademarks. Its geographical perimeter was limited to the main production areas for bouchot mussels (i.e. the French Channel and Atlantic coastline) and particular attention was paid to the PDO "*moules de bouchot de la baie du mont Saint Michel*". Due to the different issues raised by quality schemes and organic labelling for the mussel farming sector, the method entails sector and value-chain analysis and institutional analysis. Previous outcomes from the description of production systems and the French value-chain provided the background required for analysing the main trends in mussel distribution and consumption and related issues at stake for mussel labelling.

These preliminary outcomes were completed with: a) a review of the literature and legislative texts on quality schemes in general and applied to French mussel farming; and b) the analysis of the regulation system in force for the management of the shellfish farming sector and the literature on the subject. It is worth mentioning that the socio-ecosystem of shellfish farming in the BMSM has long been a significant topic for researchers, and it has provided valuable inputs and historical insight. In addition, more specific quantitative and qualitative data related to labelling approaches were obtained during interviews with actors in the value-chain carried out in 2016-2017. The interviewees (n 20) belonged in majority to the production and first-hand sales sectors, including the PDO label committee, but also involved the wholesale and large retail sectors.

The method for assessing producer labelling initiatives was tailored to research needs in a context of scarce economic data, unsuitable for in-depth cost/benefit analysis. The first step of the assessment relied on the retrospective analysis of the PDO application process and on its main factors of success. The second step made use of inputs from desk and field work and relied on ad-hoc evaluation grids of the PDO mussel compared with other mussel public labels for different dimensions: economic, environmental and governance. The different criteria and related indicators used for such assessment were found in the literature review (see Reference), or adapted to address the specific issues of the case study.

3 Context and Case Study

Overview of labelling strategies implemented by French mussel producers

Public labelling initiatives have played a significant role in the economics of the French mussel farming sector and in the coordination of the value chain. French production mainly supplies the domestic fresh market (less than 5% of export). This market is also supplied by imports (Figure 1), but remains seasonal, in line with domestic production.

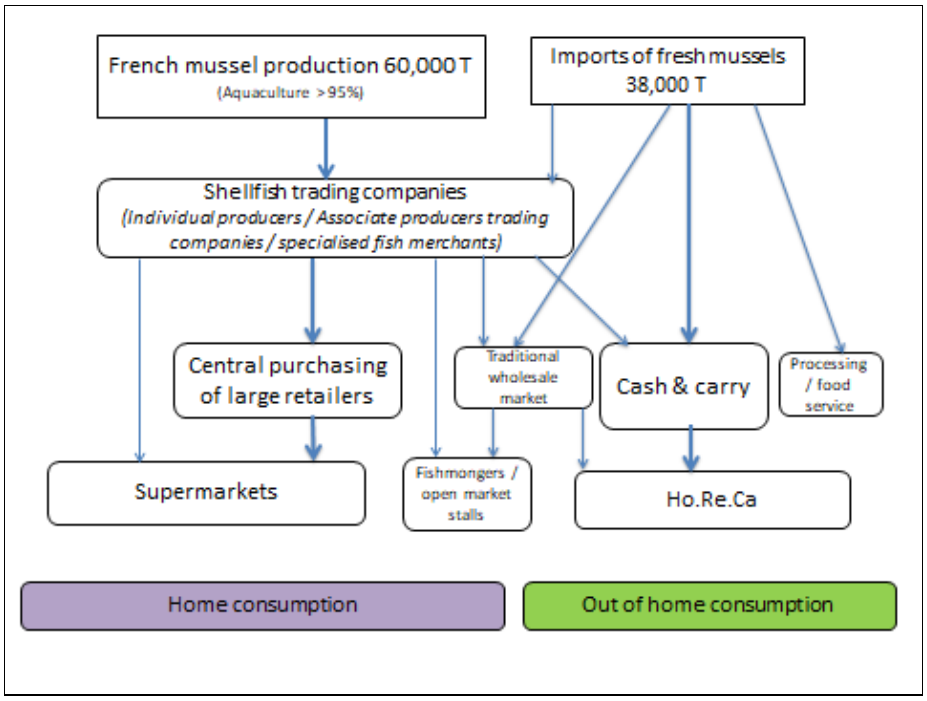

Figure 1. The French value chain for fresh mussels (2014 data, source: Agriculture and Food Ministry).

This figure provides a representation of the main distribution channels for French and imported mussels. Upstream, the French mussel farming sector comprises small to medium family-owned production enterprises, most of them equipped with approved purification/dispatching establishments (according to Regulation (EC) N°853/2004). Downstream, large retailers became dominant from the mid-1990s, up to 80% of retail sales from 2010[10]. The catering sector (Ho.Re.Ca) also constitutes a significant outlet for fresh mussels (about 40% of the whole consumption) [11] and is more dependent on imports, mainly from the Netherland, Spain and Italy.

From the beginning of the 1990s, the CNC[vi], the national inter-professional organisation for shellfish farmers, was involved in differentiation approaches according to production methods and bivalve farming basins. Several steps, covering a twenty-year period, led notably to increased protection of the typical cultivation technique on "bouchot" (fixed wooden stakes), used for 85-90% of blue mussel production in France. In 1994, the CNC

registered a national trademark, followed by a CCP (*Certification Conformité Produit*), a French certification granted in 2004. Then it applied for a Traditional Speciality Guaranteed (TSG), approved in 2013, in order to extend the protection of the name "bouchot" mussels to the EU market. The TSG, a quality label expressing the specific character of an agricultural product[vii], was included in the latest EU quality schemes regulation in 2012. The product specification of the TSG *moules de bouchot* states that "mussels must be cultivated exclusively on stakes on the foreshore from larvae caught in their natural habitat. It does not cover mussels that are fished or cultivated in other ways".

Other labelling approaches were launched at the same period to differentiate quality based on geographical origin. The most emblematic is that initiated for protecting the mussels cultivated in the bay of Mont Saint Michel (BMSM), in North Brittany, which started with the application for the AOC[viii]. After a long labelling process, the granting of the AOC in 2006 marked the first step towards recognition and protection on the French market. This was followed by the registration of the PDO in 2011, which broadened the protection to the EU market. More recently, some producers of blue mussels not eligible for TSG or PDO have been pushed into other labelling approaches. Two groups of producers obtained the Label Rouge, a French label vouching for extra-quality. The development of organic certification should also be mentioned, despite being initially driven mainly by the large retail sector for imported mussels. For instance, organic blue mussels from Irish long-line production have been commercialised in France since 2011 under both the EU organic label and the French label (AB). For French producers, organic certification is still in the early stage and is added to bouchot certification for blue mussels.

Key features of mussel farming development in the BMSM

French mussel production is dominated by *Mytilus edulis,* cultivated on the Channel and the Atlantic coastlines. The BMSM (*Ille et Vilaine)* is one of the main production areas for blue mussels (Figure 2).

	Number of enterprises with mussel production	Mussel production in volume (tons)
Manche	88	10 811
Ille-et-Vilaine	56	10 625
Côtes-d'Armor	37	6 472
Morbihan	47	3 699
Loire-Atlantique	20	2 080
Vendée	43	3 279
Charente-Maritime	92	11 944

Figure 2. Main production areas for blue mussels in France and key indicators by departement (Ifremer data processed from the National Census of shellfish farming, Agreste/CASD 2012 data). *Departements are French administrative sub-regions. The seven departements indicated on the map represent nearly 90% of the French blue mussel production.*

Mussel farming in the BMSM started to develop at the end of the 1950s with the arrival of mussel farmers from Charente-Maritime. They looked for new areas to establish themselves, as mussel production in their original basin (Pertuis Breton) was severely affected by the parasite "*mytilicola intestinalis*". The development of mussel farming in the BMSM thus benefited from the technical knowhow of these mussel farmers and the space conceded to mussel farming evolved rapidly afterwards. While in 1958 only 78 km of "bouchot" were conceded in the public maritime domain for mussel farming, 10 years later more than 200 km were conceded, corresponding to about 500,000 stakes [12]. It then stabilised to around 270 km from the beginning of the 1990s [13]. This fast expansion was followed by successive falls in growth performances due to *mytilicola* infestation events, a very likely indicator of the overexploitation of primary trophic resources [14]. The first production crisis, in 1970-1973, raised awareness among producers and led to the creation of a professional syndicate for mussel farmers which proposed, in agreement with scientific recommendations, to reduce densities and to forbid the creation of new concessions. Another drop in production in 1983 led to imposing a reduction of the number of stakes in 1985 within the BMSM [14]. In the meanwhile, these crises were also managed

by successive transfers of bouchot concessions from the west to the east of the bay, towards more conducive areas.

A major restructuring operation in the BMSM was then undertaken in 2002. It took several years to achieve as the targeted zone did not initially meet sanitary standards and was contested by oyster farmers and certain mussel farmers. While the sanitary obstacle was removed in 1997, mediation by the administration was still necessary to resolve the conflict. After numerous consultation meetings, the restructuring project was finally approved by the majority of mussel farmers, and elements of consensus found through the setting up of differentiated seeding rates for bouchot for the new East mussel farming zone and for existing zones [15]. It was officially submitted by the regional organisation for shellfish farming (CRC[ix]) in 2001 and a prefectural order in 2002 launched the restructuring operations. The latter were based on maintaining equivalent farming capacities: about 148,500 stakes were removed while 145,000 were planted in the new zone [15, 16].

4 Results

Retrospective analysis of the PDO process for "*Moules de bouchot de la BMSM*"

4.1.1 Issues at stake and milestones

The rationale for labelling the bouchot mussels cultivated in the BMSM came from the producers' will to take advantage of the reputation of BMSM mussels and of the effort made towards quality and resource management. The application for the AOC was initiated in 1992 by the syndicate of mussel farmers. The quality labelling process was interrupted in 1998, when the mussel farmers voted against the product specification project due to a lack of agreement on the AOC objectives. In particular, the minimum marketable size proposed initially was difficult to reach for some of the producers, who might not have been allowed to use the designation "*moules de bouchot de BMSM*" anymore if the specification was agreed to on this basis [17]. Moreover, this disagreement arose in the context of restructuring the bouchot area, which had been planned for improving the overall mussel growing performances, but at the same time pointed out natural productivity differentials within the BMSM[x] [18, 19]. Economic disparities between producers, in terms of investment capacity for acceding to new more remote farming zones, were also at stake [20,13]. Nevertheless, the AOC project was relaunched in 2003, at the end of the "bouchot" restructuring operations. The product specification

was drawn up at the time just after the revision of the stocking density rules for mussel farming within the structural schemes of mariculture (see 4.1.2). The French AOC "*moules de bouchot de la BMSM"* was finally approved in 2006 and represented the first seafood product qualified as AOC in France. European recognition was obtained in 2011 with the registration of the PDO.

The mussel farming area eligible for the PDO corresponds to the Breton part of the BMSM. It is limited, in the east, by the border between the two departements *Manche* (Normandy) and *Ille et Vilaine* (Brittany). Inshore, it comprises the mussel bouchot concessions resulting from successive transfers and restructuring operations, and onshore, the municipalities approved for the establishment of production enterprises and trading companies with their packaging facilities.

4.1.2 Governance of the PDO

The granting of the mussel AOC and then PDO was the result of a voluntary collective approach which was superimposed onto the regulation system for mussel farming. This relies on the "structural schemes for marine aquaculture" (SSECMs[xi]) that are spatial and management plans which regulate this activity in the part of the public maritime domain conceded to mariculture (Article D923-7 of the French Rural & Fishing Code). SSCEMs are drawn up at the scale of departement on the strength of proposals by the CRCs and in agreement with local administrations in charge of fisheries (DDTMs), so that they constitute co-management tools [21]. After validation by a specific commission called CCM ("*Commission des cultures marines"*), they must be approved by the prefectoral authorities[xii].

The SSCEMs integrate measures to comply with national and EU legislation in terms of concession cleaning and maintenance, habitat preservation, the control of pests and predators and the eradication of non-indigenous invasive species. They also include cultivation rules set up by type of bivalve farming and by "homogeneous farming zones", in order "to ensure the best growth of marine cultures, including in particular maximum farming densities and space occupation"[xiii]. Regarding *bouchot* mussels, they rely on a combination of parameters such as fixing the number of wooden stakes by row, the maximum rate of seeded stakes, etc. In the BMSM, these parameters were revised downwards with the bouchot restructuring and took into account the productivity gap between the three main zones: *Cherrueix*, North-West *Hermelles* and North-East

Hermelles. The stocking density norms agreed in 2002[xiv] were renewed in the latest revised SSECM (approved in June 2019).

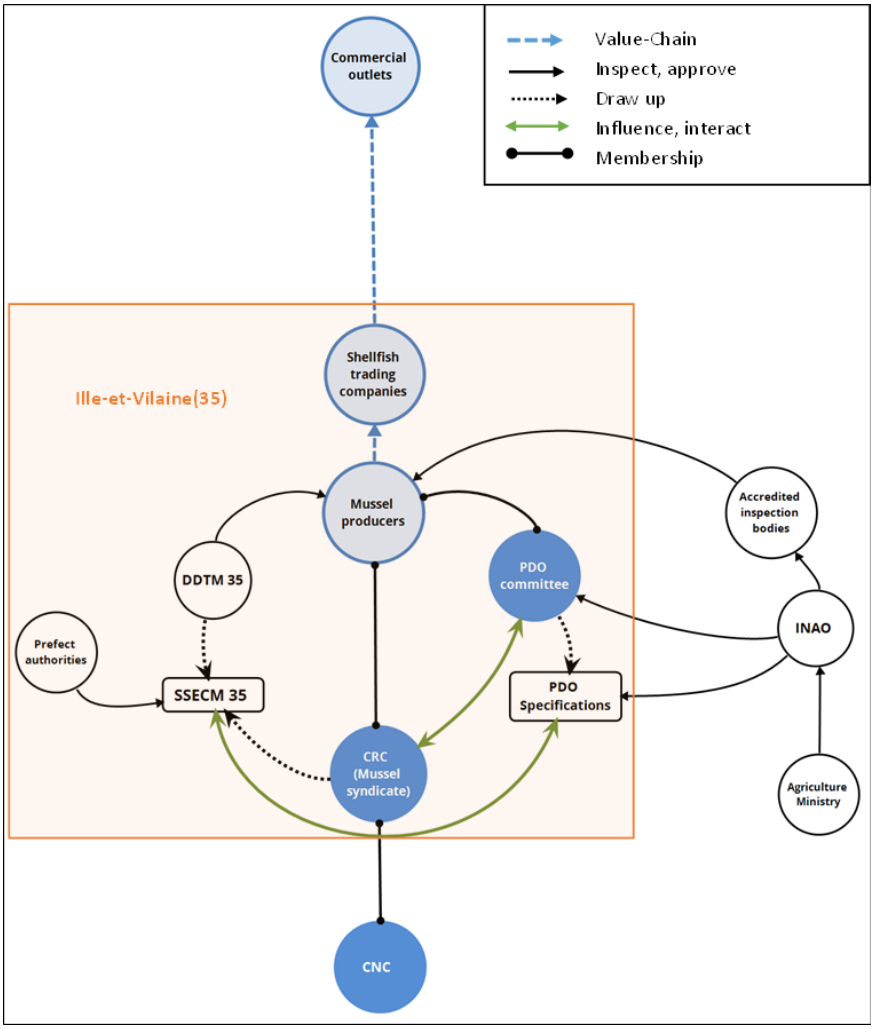

Figure 3. Institutional mapping of the PDO *"moules de bouchot BMSM" (Girard & Chenouf)*. *Legend: On the right, the PDO committee, emanating from the mussel farmers' syndicate, drew up the specification in relation to the INAO (National Institute for Quality and Origin). The PDO committee, as a label defence and management organisation, gathers all its members, PDO producers or/and mussel trading companies located in the PDO protected area. INAO is the French public agency, under the responsibility of the Ministry of Agriculture, in charge of the implementation and control procedures for official quality and origin signs with accredited inspection bodies. On the left, local administration and prefect authorities involved in the implementation of French regulation (SSECM) at the scale of Ille et Vilaine are represented.*

Figure 3 synthetises the governance of the PDO, at the crossroads of food quality policies and the shellfish farming regulation system. The bilateral linkage between PDO specification and the SSECM 35 (*Ille et Vilaine*) indicates, on the one hand, the

subordinate relationship towards sectorial regulation. On the other hand, it illustrates the role played by the PDO in strengthening the implementation of mussel farming density rules through additional inspections.

4.1.3 Preliminary outcomes

First of all, the competitive advantages of the PDO "bouchot mussels of the BMSM" should be considered in the light of its fundamental commitments: the protection of quality linked to a geographical origin and a guaranteed traceability and inspection system. i) The notion of "terroir" derived from agriculture proved to be suitable for bivalve farming. The BMSM provides a good illustration, with its natural environmental conditions giving specific quality attributes to the bouchot mussels: exceptional tidal range, thermal characteristics and turbidity of the bodies of water that favour an abundance of nutritional resources, and a high diversity in phytoplankton,[xv] etc. ii) The inspection system of labelled production that relies on both internal and external inspections is essential for the credibility of the appellation. Moreover, the PDO is, by its very nature, a good tool for enhancing the traceability of the live mussels produced in the BMSM, as individual producers can be identified.

Furthermore, the reasons for the success of the PDO process go back to the history of mussel farming development in the BMSM, collective organisation and institutional support (scientific, administrative). The awareness of the importance of resource protection acquired by professional representatives, through their previous experience in Charente-Maritime, facilitated the adoption of stricter farming rules in the SSECM and continued through to the end of the PDO process [15]. Despite initial dissensions about the ambition of the AOC and the length of the whole process, this labelling approach could finally succeed. Combined with the restructuring of the BMSM, it increased the involvement of producers in the existing co-management system. The adoption of the AOC specifications by all the mussel farmers after only 3 years was crucial for the achievement of the objectives defined in terms of quality upgrading and for the adoption of better cultivation practices.

Further assessment of the PDO and positioning towards other public labels

This section starts with a reminder of the quality attributes of the PDO and other public labels granted to French bouchot mussel production. The comparative assessment then

focuses on the PDO and organic labels, with TSG mentioned as a standard for bouchot mussels. It made use of an ad-hoc analysis grid to evaluate the different dimensions of the PDO (economic, environmental, governance), and comparison with other mussel labels.

4.1.4 Preliminary comparison of the PDO with other public labels

The comparison focuses on quality attributes likely to provide product differentiation and hence added value on the French market for live mussels (Table 1). It does not include specifications on seed sourcing, which depends on the use of endemic blue mussel spat for production located in Atlantic areas or the purchase of spat from these basins by the producers in the Channel waters that are too cold for spat collection. In all cases, the economics of "quality" in mussel farming appears to rely entirely on natural seed, obtained from collectors put in authorized and regulated areas.

Table 1. Characteristics of public quality labels for French bouchot mussels and comparison of their product specification relating to the main quality criteria

	TSG bouchot mussel	PDO bouchot mussel BMSM	Label Rouge (+ TSG)	Organic label (+ AB + TSG)
Scope of the label	Traditional mode of production	+ Quality linked to the origin	+ Superior quality	+ Environmentally friendly production
Year of approval (entry in the French market)	2013	2011	2017	(2011)
Area of label protection	EU	EU	France	EU
Marketable size	≥ 4 cm	≥ 4 cm	≥ 4 cm	≥ 4 cm
Tolerance threshold*	*NA*	≤ 20%	≤ 15%	≤ 10%**
Minimum Meat rate % (Lauwrence & Scott score)	20% (100)	25% (120)	27% (151)	27% (151)**
Start of the commercial season	unspecified	Between 15 June and 31 July	June	unspecified
Organoleptic quality	linked to production mode	linked to production mode + specific origin	linked to production mode	linked to production mode
Resource management measures	none specified	Control of farming densities	none specificied	none specified
Other environmental protection measures	No additional measure compared to national regulation (e.g. in waste management)			+ Reuse & recycling of materials
Quality of the marine environnement	all areas suitable for bivalve shellfish farming (areas classified A or B according to Regulation (EC) N°854/2004)			+ Good environmental /High ecological status

** Tolerance threshold: proportion of sales allowed below the minimum size*
***Indicative value from GIE "moules de Penestin"*

The TSG, which certifies the traditional mode of blue mussel production in France, became the standard for bouchot farming, providing basic requirements in terms of minimum mussel size and meat content (20%) for the large retail sector (Interviews). Comparatively, the specifications of the PDO *"moules de bouchot de la BMSM*" include higher standards, especially for the meat rate (25%). Above all they include an accurate description of the organoleptic quality resulting from the natural environment of the BMSM and implement methods to measure quality through regular sensorial analyses. Another control variable linked to quality is the start of the commercial season which must be fixed yearly for the PDO mussels on the basis of the global growth performances of the bay. In turn, the extra-quality guaranteed by the French Label Rouge mainly relies on quantifiable attributes such as the minimum meat rate content and the tolerance threshold, but is not verified by organoleptic tests. A meat rate of 27% represents a selective criterion, harder to attain and limited to the most productive farming concessions only. For organic certification, the

minimum meat rate indicated in Table 1 refers to bouchot mussel production in South Brittany, but is not generalizable to other production areas.

Regarding "environmental quality", it should first be recalled that bivalve aquaculture has lower impacts than fish farming because neither supplementary feeding nor chemicals are needed. The main guarantee provided by organic certification for bivalve molluscs refers to the high ecological status of their growing areas, as required by Regulation (EU) 2018/848 on organic production[xvi]. Other environmental claims refer to the "sustainable management plan" mentioned in the preamble of the regulation on organic aquaculture, specifying measures such as waste reduction[xvii].

4.1.5 Economic dimension

The market relevance of labelling initiatives and their recognition are prerequisites for providing profitability for producers and constitute a first step towards environmental and social sustainability [3]. They were assessed through usual economic criteria and other qualitative indicators.

Table 2. Evaluation grid of the economic sustainability of the PDO (comparison with TSG and Organic)

Criteria	Indicator	TSG (national)	PDO (BMSM)	Organic (GIE Penestin)
Scope of the label	Size of the market	40,000 tons (potential)	≈10,000 tons	niche market
	Perimeter of the market	National	Regional, national…	Local, regional
Integration in the Value-Chain	Main retail outlets	Large retail + specialised	Large retail + specialised	Specialised
	Price premium (PP) at production stage	Yes (compared to EU imports/other PSs)	Yes (compared to other French production areas)	no clear evidence
	PP transmission at retail stage	Yes	no available data	no available data
Coordination of the VC	Main driver of labelling	Producers	Producers	Distributors at the outset
	Justification of the label (according to actor's perception)	High (certifying a traditional mode of production)	High (traditional mode of production AND quality linked to origin)	Weak (low environmental added-value)

Source: Official statistical data, FranceAgrimer/KantarWorld panel, interviews with stakeholders

Table 2 shows that the significant share of the PDO (about 20% of bouchot mussel production) could ensure the recognition of this label on the French market while conferring some market power to producers, notably through associate producers' trading companies located in the PDO area. On the other hand, this also involved adapting to

changing trends in the distribution of fresh mussels for meeting the logistic requirements of the large retail sector (e.g. increased sales of packed live mussels).

Next, the role of quality schemes in enhancing the value of blue mussels and consolidating market segmentation is assessed. Firstly, evidence of a price premium for the French bouchot production system (PS) against other origins/PSs was provided by price indicators calculated from the aquaculture data collection framework[xviii]. On the basis of average data 2014-2015-2016, mussel prices ranged from 0.5-0.7 €/kg for Mediterranean mussels (Spanish raft and Italian longline) to about €2.00/kg for French bouchot mussels, and €0.7-1.00/kg for other blue mussels (Irish longline, Dutch on bottom). Further analysis of DCF structural indicators showed that higher prices allowed compensation for the lower volume productivity related to this traditional mode of production while they also reflected the integration of purification and dispatching operations by French mussel producers [22]. Downstream, the transmission of price differentials at the retail stage was confirmed by KantarWorld panel data [23].

Secondly, evidence of a price premium for the PDO was mainly based on qualitative surveys for want of detailed official statistical data. Interviewed stakeholders agreed on a common production price scaling of blue mussels according to French mussel farming areas. At the bottom, they positioned the regions of Normandy and then Charente-Maritime, at the middle-range the Bay of Saint Brieuc (North-Brittany) and at the top the PDO BMSM with other small production basins supplying local markets through short-channels. This price scaling was consistent with the results of a previous study conducted in 2000 [24]. The extra-price offered to producers of the PDO bouchot mussels was estimated to reach 15-25% compared to the other main bouchot mussel areas. Comparatively, the premium for French organic bouchot mussels was estimated at only 5-10% by the GIE Penestin and considered hardly sufficient to cover the costs of certification (Interview). Although more exhaustive data are lacking, this preliminary result questions the additional benefit of organic certification for mussels under the bouchot label.

Finally, it emerged that the differentiation strategies implemented by the French producers for decades have continued to structure the fresh mussel market and to influence the coordination of the value chain (VC), despite the increasing weight of large retailers downstream. During interviews, the actors of the upstream VC confirmed the market relevance of STG and PDO labels, but expressed doubts about the justification of organic certification for bouchot mussels. They considered farmed mussels as “naturally

organic", dependent on external factors, i.e. the ecological status of marine coastal waters, resulting in only a small margin of manoeuvre for improving environmental performances. Organic was mainly perceived as a marketing strategy, driven at the outset by the large retail sector for mussel imports, and susceptible to limiting the potential for further quality initiatives from French producers. As for the distributors, the multiplication of producer labels and trademarks was, on the contrary, perceived as being confusing for the consumers and a source of increase in retail prices (Interviews).

4.1.6 Environmental dimension

The scope of the evaluation encompasses all the measures dedicated to the sustainable management of mussel farming, the majority of which are part of the national and local regulation system (SSECMs). Therefore, the key indicators used to assess the effectiveness of label environmental claims relate to the system of inspection established by product specifications to strengthen compliance with current rules (Table 3).

Table 3. Evaluation grid of the "environmental" dimension of the PDO (comparison with TSG and Organic)

Criteria	Indicator	TSG (national)	PDO (BMSM)	Organic (GIE Penestin)
Compliance with cultivation rules: farming densities	Additional inspections contained in the specification (Y/N)	N	Y, external inspection	N
Compliance with cultivation rules: waste management	Additional inspections contained in the specification (Y/N)	N	N	Y/N (internal audit)
Contribution to water quality enhancement	Preventive action towards watershed stakeholders	Depending on the CRC	Y	Y
Environmental impacts	Positive externalities	Mitigation effects on eutrophication		
	Level of impacts	Very low carbon foodprint		
Adverse effects of marine litter	Conflict with local associations	Depending on the region	Y	N

Sources: Structural schemes of shellfish farming, Product specifications, interviews, other

Regarding farming densities, only the PDO specification includes inspections based on in-situ monitoring of the number of stakes and rate of seeded stakes that are conducted at a higher frequency than inspections enforced by the administration. Moreover, these inspections are more incentivising: in the case of an infringement the offender must comply strictly with the regulation within a short period, in order to continue using the PDO label.

Regarding waste management, the PDO specifications do not contain any measure beyond the obligation of waste material removal included in the SSECM. On the other hand, organic certification went a step further in planning the reduction and progressive

elimination of non-recyclable material (e.g. plastics), but these environmental claims are not subject to increased monitoring from the accredited certification body (only internal audits).

Other criteria aim to assess interactions between producers and their environment. Positive impacts for the territories stem from their involvement in the defense of coastal water quality. Although this mission usually falls within the competence of the CRCs, it is decisive for the economics of the mussel farming sector. It is even more crucial for organic certification, whose eligibility depends on the ecological status of coastal marine waters. Other positive externalities relate to the mitigation effects on eutrophication and to the carbon sequestration associated with bouchot mussel farming. Evidence of a negligible carbon balance for mussel production in the BMSM (including packaging stages) was provided by an LCA[xix] study performed in this area. This result can be extrapolated to other production areas of bouchot mussels, with factors of variability according to the distance of farming sites to on-shore facilities and to mussel yields [25]. Moreover, any adverse effects of farming wastes (small mussel discards, shell fragments, plastics) were reported and assessed here through publicized conflicts with local associations, particularly in the BMSM.

4.1.7 The dimension of governance

Governance indicators also contribute towards assessing the legitimacy and credibility of labels (Table 4). For the PDO, it was shown in 4.1.1 that the labelling process relied on a collective approach, linked to a determined project for the sustainable management of mussel farming in the BMSM, and so had benefited from strong administrative and scientific support. The preservation of common resources was thus mentioned as an historical element in the AOC decree, in addition to the natural factors of linkage with terroir. Regarding organic cultivation, and beyond the case under review (GIE Penestin), French certification has relied on more individualistic strategies and benefited from less public input. Today, its development may be constrained by the sanitary zoning and ecological status of mussel farming areas. Conversely, inside the perimeter of the PDO area, the initial factor of exclusion (mussel minimum size) was removed and a collective arrangement was reached to make the final specifications more inclusive, without compromising on initial resource management objectives. Broad membership and commitment to label specifications is indeed essential to ensure that the adoption of better farming practices will yield results.

Table 4. Evaluation grid for the "governance" dimension of the PDO label (comparison with TSG and Organic)

Criteria	Indicator	TSG (national)	PDO (BMSM)	Organic (GIE Pénestin)
Labelling process	Type of producer initiative	Collective	Collective	Individual
	institutional support	High	High	Low
Scope of the label	Rate of membership	High	High (inside the BMSM)	Low
	Factor of exclusion (Y/N)	N	N (inside the BMSM)	Y (ecological status of farming area)
Promotion/ Defence of the labels	With respect to Origin (actor's perception)	Not applicable	Weak	Not applicable
Consumer information	Availability of product specifications	Public	Public	Not available
	Raising awareness on sustainable practices	Not applicable	No	Limited

In terms of promotion and defence of the quality schemes which fall under the national agency INAO, the PDO committee pointed out a lack of consistency in the protection of the designation of origin against geographical trademarks (Interviews). With respect to consumer information, required to reduce transaction costs and information asymmetry, the first step concerns the availability of product specifications. This indicates a lack of transparency concerning organic specifications. A further step refers to the capacity of label procedures and governance structures for raising consumer awareness about the respective environmental attributes of the PDO and organic mussels. No or limited communication was implemented in the two cases, beyond generic communication on quality labels.

5 Discussion

Bivalve mollusc farming is a specific field for the application of both EU quality schemes and organic certification due to the characteristics of the activity, which is highly dependent on the quality of the marine environment and on the collective management of common natural resources. The dependency of filter feeder production on a common pool of primary resources can lead to reciprocal negative externalities between shellfish farmers, not to mention trophic competition with other wild mollusc species, including non-indigenous species (NIS). These specific sustainability issues influenced the labelling strategies of the French mussel producers but should be broadened to other environmental protection issues to respond to the evolving regulatory framework.

Trends in food labelling and market opportunities for mussel farming

In France, the boom in organic food made them almost as popular as products under GI from 2001 to 2017 (Table 5) and they overtook French Label Rouge products. This growing demand for organic food was motivated by health concerns (66%), followed by environmental protection (58%) and quality/taste (56%) according to the barometer of the French Organic Agency (2017 data). It was also associated with particular attention paid to origin and advantage given to local production. However, the shift to organic labelling has been lower for animal products: for meat and fish the turnover of quality schemes still exceeded by 64% that of organic food in 2017 (INAO data). As for the French blue mussel sector, the economics of labelling is still dominated by quality schemes, with a turnover depending on the PDO at 15-20%[xx].

Table 5. Turnover of the French agricultural products and foodstuffs under public quality labels (**except wine and alcoholic beverages**), in billions of € (source: estimations *Sylvander et al* for 2001 [1] and INAO for 2017)

	2001	2017	Evolution	Main products under public label
Organic	0.53	3.7	594%	Fruit&Vegetables, Dairy, Poultry and eggs
AOC/PDO	2.04	2.2	8%	Dairy products (50%)
PGI/TSG	-	1.5	-	-
Label Rouge	3.5	1.2	-66%	Poultry and eggs, meat

At the EU level, the labelling strategies set up by mussel farmers can also be examined in the light of consumer expectations. On the one hand, the possible perception of organic mussels as being cultivated in high quality waters may provide market opportunities to producers located in such areas. On the other hand, consumer awareness about the objectives of organic certification for mussel farming and the specific environmental issues facing this sector is low. In France and Spain, the main EU mussel markets, the production of PDO mussels reached 10 thousand tons and 54 thousand tons, respectively, in 2018[xxi], representing 13-14% of total EU mussel production. Comparatively, the production of organic mussels was estimated at about 18 thousand tons (4%) and was mainly concentrated in Ireland, followed far behind by Italy[xxii]. The factors which could limit competition from organic mussel productions in the main EU mussel markets are the ecological and sanitary status of mussel production areas and the established reputation of PDO mussels, based on the preference for traditional modes of production and regional products. Besides, the big competitor for organic aquaculture may be more broadly "sustainable aquaculture" [26], encompassing a diversity of approaches from BAP (Best Aquaculture Practice) to ecolabels.

Although the economic benefit of GIs appears variable in the literature [3,4,27], evidence of a price premium was given empirically for French mussel producers under the PDO. Comparatively, no clear evidence of a price premium could be found for the French organic bouchot mussel, at this stage. The advantage provided to PDO producers could however evolve in the future if their lead position is challenged by the upgrading of other French production areas, or by the development of other quality labelling approaches. But, beyond expected private profits, the economic assessment should also take into account the significant non-monetary benefits that can be attributed to labelling and certification, such as support for co-management systems [28].

Room for improving the environmental sustainability of mussel farming

The two main orientations which emerged in the case-study to appraise the environmental dimension of mussel producer labelling initiatives were the sustainable exploitation of primary trophic resources and the management of farming wastes. The first one gave rise to significant research on the carrying capacity concept which is central for preventing primary resource depletion while limiting disease propagation [29,30,31]. In parallel, further knowledge about the complex interactions between bivalve farming and the ecosystem has been acquired. Potential impacts identified in the literature include food web effects, organic enrichment and the physical disturbance of the seafloor, alteration of the hydrodynamic regime, risks of spreading non-native species or diseases, farming wastes, etc. [31,32]. The main positive effect of mussel farming reported was the mitigation of coastal eutrophication due to nutrient removal which was documented through mass balance approaches [33,25].

Since the registration of the mussel AOC in 2006, the French regulatory framework of bivalve farming has been undergoing a process of consolidation to comply with EU environmental directives. The revision process of the SSECMs started in 2012 when they became subject to Natura 2000 and environmental impact assessments[xxiii]. It was also subordinated to the implementation of the Marine Strategy Framework Directive (MSFD) and the adoption of the first programme of measures (PoM) in 2015. For the French Channel coastline, the measures dedicated to bivalve aquaculture mainly rely on the implementation of the existing SSECM measures, e.g. the mandatory cleaning and maintenance of concessions, including the eradication of NIS and trophic competitors, like slipper limpets (C. *fornicata)*. They also include an extension of measures to address the MFSD descriptors D10 (marine litter), and D6 (seafloor integrity), with the aim of avoiding/reducing impacts on specific habitats of the foreshore [34].

The attention that must be paid to reducing marine litter indeed points towards some scope for progress with respect to mussel farming. Adverse effects on the environment and landscapes may be damaging for the reputation of the PDO, particularly in remarkable sites like the bay of Mont Saint Michel, listed as Unesco World heritage. A stumbling block for environmental and resident associations of the BMSM is linked to the management of organic wastes, especially small mussels under marketable size. They cause localised smell nuisance on the foreshore during the touristic summer period. The removal of these mussel discards is particularly challenging and various technical projects are being studied to collect and process this raw material for non-food or food uses.

Another controversy is related to the supposed "industrial" model which would have been developed by the mussel farmers in the BMSM according to some detractors. This opinion was publicized by environmental associations [35] and most of the arguments were taken up during the public consultation prior to the adoption of the revised SSECM. However, they must be placed in the context of this particular bay, in which a wide variety of human activities are practiced, thereby exacerbating conflicts of use. Nonetheless, the BMSM currently represents the French mussel farming basin with the highest regulated stocking densities, and the first to use a limitation method based on a lower number of seeded stakes by row [12]. The IPRAC[xxiv] research project (2007-2010) investigated different modelling scenarios to address important issues for stakeholders, such as the ecosystem carrying capacity of the bay and trophic interactions between cultivated and wild filter feeders, with C. *fornicata* representing the highest biomass in the BMSM [36,37,38]. The main findings showed that scenarios considering further proliferation of this non-indigenous species had the greatest potential impacts on trophic resource availability and bivalve growth performances. This notwithstanding, a scenario simulating a slight reduction of mussel density rules also had a significant impact on growth (Ibid).

Issues causing conflicts between mussel producers and other stakeholders of the BMSM highlight the management trade-offs necessary to meet the growing demand for environmental preservation and for sustainable seafood. In this respect, reducing the amount of small mussel discards is a priority issue for the sector that can be addressed indirectly through food processing, or directly by seeking new compromises on stocking densities and farming practices with mussel farmer syndicates. As for marine litter in general, including plastic materials, the main challenge will be to move from mitigation measures (collecting, recycling etc.) to prevention, in order to reduce wastes at source. To support dialogue with stakeholders, operational tools should also be developed to

implement regular monitoring of the bay's carrying capacity. Also, from the food system perspective, LCA findings must be used or refined to take into account the sustainability of bouchot mussels throughout their entire life cycle [25].

Improving the consistency and governance of public labels for shellfish farming

Bivalve aquaculture is included in the scope of the EU's quality schemes and organic regulations, which together form parts of the EU agricultural products quality policy, although this sector was not originally targeted and hence was involved later. Regardless of the purpose of each regulation, this French case-study showed that the PDO labelling process of bouchot mussels referred more explicitly to the collective management of common resources than organic certification. It benefited from significant institutional support and succeeded in being inclusive, a key to increasing the environmental sustainability at the scale of a production basin. On the other hand, organic certification reveals a lack of collective planning and has so far been perceived as providing low environmental added value.

A step forwards, a public eco-label scheme would provide the legitimate and relevant framework for mussel farming. In as much as it would consider both resource management and ecosystem protection issues, it would offer higher standards and reduce consumer confusion about the content of environmental claims. The feasibility of such a comprehensive scheme was questioned during the debate on a Community approach towards eco-labelling schemes for fisheries products launched in the early 2000's[xxv], but in the end the option for a Union-wide eco-label for FAPs was not retained (COM(2016)263 final). The principal arguments put forward were the risks of increasing the complexity of label schemes and undermining the organic logo without stopping the proliferation of private eco-labels. The risk of competition and overlap between EU labelling schemes already exists and calls into question their consistency and legibility, particularly for bivalve aquaculture (low trophic aquaculture).

As things stands, a specific policy recommendation would be to strengthen the legitimacy of quality schemes to promote sustainable food systems [3]. The green paper on agricultural product quality[xxvi] already emphasized in 2008 that for many GI products quality and reputation do not depend exclusively on factors linked to origin, but can also rely on other criteria, such as the contribution to local economy and the environmental sustainability of farming methods. The integration of specific sustainability criteria was therefore debated during the impact assessment on GIs prior to the adoption of the latest EU regulation [39]. The discussion was not conclusive at that time, although some actors

argued that this issue had become a major concern for consumers, compared to the period when the PDO/PGI system was first established. The issue is still topical however, as evidenced by the recent French CESE[xxvii] report on official quality signs which recommended involving enterprises under GIs in environmental certification and CSR[xxviii] to better meet new societal expectations [40].

Besides, the credibility of the PGI/PDO system should be strengthened through better governance of the procedures and institutions [1, 40]. Turning to the subject at hand, ways of improving the governance of public quality labelling initiatives in shellfish farming emerged. They include strengthening the position and means of the INAO with respect to the promotion and defense of the French PDO mussel against inappropriate use of the appellation or unfair competition with regional trademarks. They could also provide the PDO committee of the BMSM with the resources necessary to implement more adaptive label management. Identified needs range from scientific support to the simplification of administrative procedures, for instance to reduce the time required for amending product specifications. Consolidating the role of the PDO committee within the label governance system would also help to reassert the commitments of mussel farmers to common resource management and be more proactive towards emerging environmental and social issues (e.g. landscape protection).

6 Conclusion

The socio-economic analysis of PDO mussel labelling in the BMSM illustrated issues underlying quality schemes at the crossroads of food quality policies and bivalve aquaculture management systems. Different factors have contributed to the success of the PDO process, like the history of mussel farming development in the bay of Mont Saint Michel, institutional support and the inclusiveness of the approach. The EU regulation on quality schemes provided a relevant framework for promoting sustainable bouchot mussel farming in the BMSM, although there is still scope for progress, in relation to the current national regulation and overarching EU environmental directives like MSFD.

As for other labelling strategies, the mussel PDO can continue to act as an economic incentive and promote sustainable production systems only if it benefits from consumer recognition on the market, allows strengthening the implementation of the co-management system, and evolves to respond to further environmental and social concerns. For the EU quality schemes, this would imply harmonising PDO and PGI registrations upwards and improving consistency with other certification systems to increase the

protection of GIs on the markets. This could also entail strengthening the role of the PDO committee to give it the means to implement more adaptive management of label specification, in close cooperation with the different actors of the PDO governance system.

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

[ii] Intellectual property rights

[iii] Trade-Related Intellectual Property

[iv] Among all the "considerations" introducing the EU regulation of 2012, only one refers to "protecting the natural resources or landscape of the production area" (whereas 23).

[v] The door database consultation on 02/09/2019 showed that out of a total of 1,358 European GIs registered (except beverages), only 50 concerned seafood (36 PGI, 14 PDO).

[vi] For "*Comité National de la Conchyliculture"* in French. CNC membership is mandatory (Article 912-6 of the French Rural and Fishing Code)

[vii] Former Regulation (EC) N° 509/2006 on agricultural products and foodstuff as traditional specialities guaranteed.

[viii] *Appellation d'origine contrôlée*

[ix] For « *Comité Régional de la Conchyliculture»* in French

[x] According to professional data, average productivity ranged from 40 kg to 70 kg/stake in 2000 (Davaine 2002).

[xi] For "*schéma des structures des exploitations de cultures marines"* in French.

[xii] Prefects are government representatives in French departments.

[xiii] Article D923-7 of the French Rural & Fishing Code.

[xiv] Order n°45/2002 of the 1th December 2002 amending the SSECM of Ille et Vilaine

[xv] Product specification appended to decree n° 2011-640 concerning the AOC "Moules de bouchot de la baie du Mont-Saint-Michel".

[xvi] Paragraph 3.1.3.2: "the growing areas shall be suitable from a health point of view and shall either be of high ecological status as defined by Directive 2000/60/EC or of good environmental status as defined by Directive 2008/56/EC or of equivalent quality".

[xvii] (EC) n°710/2009 on organic aquaculture, cf. "whereas 4".

[xviii] Database downloaded on https://stecf.jrc.ec.europa.eu/dd/aqua

[xix] Life Cycle Assessment

[xx] Against 2.2% for all agri-food products according to INAO (Key figures 2017)

[xxi] https://www.mexillondegalicia.org/

[xxii] Latest available data published by EUMOFA in 2017 [26]

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[xxv] COM(2005)275 final

[xxvi] COM(2008) 641 final

[xxvii] Economic, Social and Environmental Council

[xxviii] Corporate Social Responsibility