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Dimensions of Sustainability in Origin Schemes: An Approach from Protected Appellation of Origin*

Dimensiones de la sustentabilidad en sellos de origen: una aproximación desde las Denominaciones de Origen Protegidas

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Abstract

Territorial resources sustainability, especially those with a great linkage to local agronomic, social or cultural conditions, could be globally recognized through Protected Designations of Origin (PDO) figures, which emphasizes food qualities based on its origin. Nonetheless, a coherent analytical framework around this PDO's sustainability, from a multidimensional perspective (economic, sociocultural and environmental), is needed. Therefore, the main objective of this paper is to propose an analytical framework based on coding principles of Grounded Theory, to operationalize sustainability's three dimensions; this by performing a systematic literature review methodology under Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) method. From this screening process 21 papers were selected, and 27 theoretical revised codes were proposed to operationalize sustainability. The results showed that economic dimension had the highest weight on the sustainability matter, being "consumer's behavior" code the most mentioned one; in second place "product's identity" (a sociocultural code that reflects product's territorial embeddedness) position itself, followed by "certifications to improve quality" (and environmental code).

Keywords: sustainability, Protected Appellation of Origin, economic dimension, sociocultural dimension, environmental dimension, European Union.

Resumen

La sostenibilidad de los recursos territoriales, especialmente aquellos con una gran vinculación a las condiciones agronómicas, sociales o culturales locales, pueden ser reconocidas globalmente a través de figuras como las Denominaciones de Origen Protegidas (DOP), que enfatizan las cualidades de productos alimentarios en función de su origen. No obstante, es necesario un marco analítico coherente en torno a la sostenibilidad de estas DOP, desde una perspectiva multidimensional (económica, sociocultural y ambiental). Por lo tanto, el objetivo principal de este trabajo es proponer un marco analítico basado en los principios de codificación de la Teoría Fundamentada, para operacionalizar las tres dimensiones de la sustentabilidad, esto a partir de realización de revisión sistemática de la literatura bajo la metodología Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). A partir de este proceso se seleccionaron 21 artículos y se propusieron 27 códigos teóricamente revisados para operacionalizar a la sostenibilidad. Los resultados mostraron que la dimensión económica tuvo el mayor peso en el tema de la sostenibilidad, siendo el código "comportamiento del consumidor" el más mencionado; en segundo lugar, la "identidad del producto" (un código sociocultural que refleja la inserción territorial del producto), seguida de las "certificaciones para mejorar la calidad" (perteneciente a la dimensión medioambiental).

Palabras clave: sustentabilidad, Denominaciones de Origen Protegidas, dimensión económica, dimensión sociocultural, dimensión ambiental, Unión Europea.

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Introduction

The sustainability discussion has special relevance when agri-food systems do not only involve agronomic, organoleptic, natural, or environmental characteristics, but also considering those goods that are embedded in the territory, and that is linked to cultural, historical, and traditional elements; in this kind of goods, its specific qualities respond largely to the conditions of origin and the production techniques that are used in it (Arancibia, 2016).

Therefore, and in the face of the vulnerability and loss of agrobiodiversity, and the possible social, economic and environmental effects of the destruction of agri-food ecosystems, these territorial embedded food goods could be saved from institutional protection figures (IP) such as Protected Designations of Origin (PDO), that allows a good to be evaluated considering not only its natural production conditions but also those human and social elements that incorporate specific or differentiating characteristics.

Hence, it is particularly interesting in this research to analyze only the PDO institutional protection, since this figure, unlike the Protected Geographical Indication (PGI), has a more extensive regulatory design and could be considered a "stronger"1 protection tool because they allow a good to be evaluated based on the characteristics obtained due to the geographical environment (as well as the PGIs), but also while including natural and human factors as well (WIPO, 2017).

Also, PDOs could have the potential to "act as an engine to boost either resilient localized agri-food systems or wider processes of rural development" (Vecchio et al., 2020: 1). Nonetheless, despite PDOs relevance, there is a lack of research that comprehensively considers the environmental, economic and social elements of sustainability that could genuinely support territorial development around these IP figures, which could be due to the absence of a proper analytical framework that enhances the operationalization of sustainably dimensions and its elements.

Hence, the main objective of this paper is to propose an analytical framework based on coding principles of Grounded Theory, to operationalize sustainability's three-dimension (economic, socio-cultural, and environmental), by performing a systematic literature review methodology under Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) method. This method was applied to the Scopus, WoS, and Science Direct database by including the concepts "protected designation of origin" and "sustainability". From this screening process, and after the exclusion of papers that do not met geographical criteria (only research located in the European Union was selected because this geographical space has a great tradition of use and exploitation of PDO quality schemes), and those that did not include the three sustainability dimension approach (through the explicit mention of at least one of the 27 codes proposed to operationalize sustainability) an empirically contrasted in a 21 papers sample (3D sample n=21 onwards).

1 The "stronger" label of PDOs implies that for PDOs to be obtained, all production process and phases should take place in the area or region protected by the PDO scheme; while PGIs are a more flexible instruments since it can be achieved by certify that at least one of the production stages are carried out on the geographical protected zone.

This study is structured in three sections: after a brief theoretical analysis of thematic convergence among sustainability in the protected designation of origin, the authors described the methodology used. This is followed by the qualitative (in-depth content analysis) and graphical analysis of the 3D sample n=21.

Sustainability in Protected Designations of Origin. A proposed analytical framework

Protected Designations of Origin (PDOs) could be established as a public policy instrument that, considering the agri-food activity, might seek to improve agri-food value chains through the recognition of the original quality of food goods, and because of their tangible and intangible elements that added value to food creations. These stamps could upgrade the insertion of territorial embedded food goods into local, national, and international specialized food markets, increasing, therefore, the income of agricultural producers (Cei *et al*., 2018). In addition, these PDO figures could contribute to the dynamization of the different agri-food value chains links and contribute to adequate management of natural resources, boost cultural heritage protection as well as socio-economic spillovers (Arfini *et al*., 2019) thus enhancing territorial development

Nevertheless, to assess a real territorial development, a sustainability approach must be met, hence it is important to mention that literature has systematically addressed that "sustainability is shaped by three interrelated dimensions that are economic, social, and environmental dimensions" (Lozano, 2008), and in this paper sustainability approach is considered only if a three-dimensional perspective is attended. Likewise, it is interesting to note that even while there is a continuous analytical discussion, and even detractors, around the scope of these three dimensions, and the way they represent a sustainability state, these sustainability pillars have managed to achieve a strong position in the theoretical, public policies and stakeholders' agendas (Purvis *et al*., 2019).

Therefore, considering that PDO is an instrument designed for the conservation of food heritage, traditional methods, and natural conditions and to valorize the indivisible link between food and sociocultural conformed territories, the mainstream three-dimension perspective on sustainability might no longer be accurate. Hence, in this research the sustainability dimensions were the following: economic, socio-cultural, and environmental, being sociocultural a dimension proposed by the authors considering that "culture [might be] the fourth pillar of sustainability" (Palazzo and Aristone, 2017: 2). Each one of these dimensions implies a different multidisciplinary study approach, mainly because they are related to a different aspect of an agri-food system, the stakeholders involved in it, as well as to some characteristics of the territory. Hence, in this paper, we propose an analytical framework to operationalize the threes sustainability dimensions by exposing its elements and by creating a series of 27 codes to analyses sustainability in PDOs. The elements that integrate each dimension have been selected based on a literature review: first, an economic dimension consists of the analysis of the economic factors such as cost of productions, profitability, market position, value-added, exportations, farmer's income, and economic spill-over effects on agri-food supply chains (Krishnankutty *et al*., 2021).

On the other hand, when assessing a sociocultural aspect of sustainability, it could include elements such as institutional or political conditions as well as regulatory frameworks that could impact the management of a PDO (Molina, 2018); and the territorial governance process (Torre and Traversac, 2011), social network (García-Cornejo, 2020) and stakeholder collective action (Sánchez-Hernández, 2011) presented around the preservation of a product's identity (territorial embeddedness) and its cultural heritage (Palazzo and Aristone, 2017). Lastly, an environmental perspective on the sustainability approach relates to climate change phenomenon, agrobiodiversity systems, ecological conditions, agroecological systems, water management, traceability, and environmental protection techniques, certifications of product quality, and maintenance of landscapes (Blakeney, 2017).

Considering the mentioned theoretical premises, coding principles (or theoretical categories) of Grounded Theory (GT) were also selected based on the principle that GT is a systematic qualitative-quantitative process to gather knowledge and organized it through proposed categories, based on defined characteristics shared by the categories, to analyze the data. GT proposes that the researcher performs, in two phases, a process of information recollection and coding based on the research subjectivity, this grounded theory is useful especially if we are facing scarcely approached topics (Páramo, 2015), such as sustainability in PDOs. Those categories allow the researcher to unify information with similar characteristics and categorize them under defined codes. Therefore, in a pre-coding phase (phase 1), a coding guideline was designed based on the literature review on the sustainability three dimensions, which resulted in the 'coding categories' of the dimensions of sustainability, listed in Table 1.

Table 1. Coding categories of the dimensions of sustainability in PDOs (pre-coding phase)
Tabla 1. Codificación de categorías de las dimensiones de sustentabilidad in DOPs (fase de precodificación)

ECONOMIC DIMENSION	SOCIOCULTURAL DIMENSION	ENVIRONMENTAL DIMENSION
1. Cost of production 2. Consumer's behavior and marketing strategies 3. Farmer's income or profitability 4. Externalities or economic spillover on the territory 5. Effects on agri-food supply chains	1. Institutional and regulatory frameworks (public policies) 2. Product's identity (territorial embeddedness) 3. Cultural heritage 4. Territorial governance/ collective action (stakeholders) 5. Social networks	1. Climate change 2. Agrobiodiversity or native species conservation 3. Agroecological or organic systems 4. Traceability and food safety 5. Water management 6. Certifications, or tests, to improve product quality 7. Maintenance of landscapes 8. Improvement of agronomical supplies

Source: own elaboration. Note: the code "improvement of agronomical supplies" included improvement on seeds, biotechnology, and machinery. Fuente: elaboración propia. Nota: el código "mejora de insumos agronómicos" incluye mejoramiento de semillas, biotecnología y maquinaria.

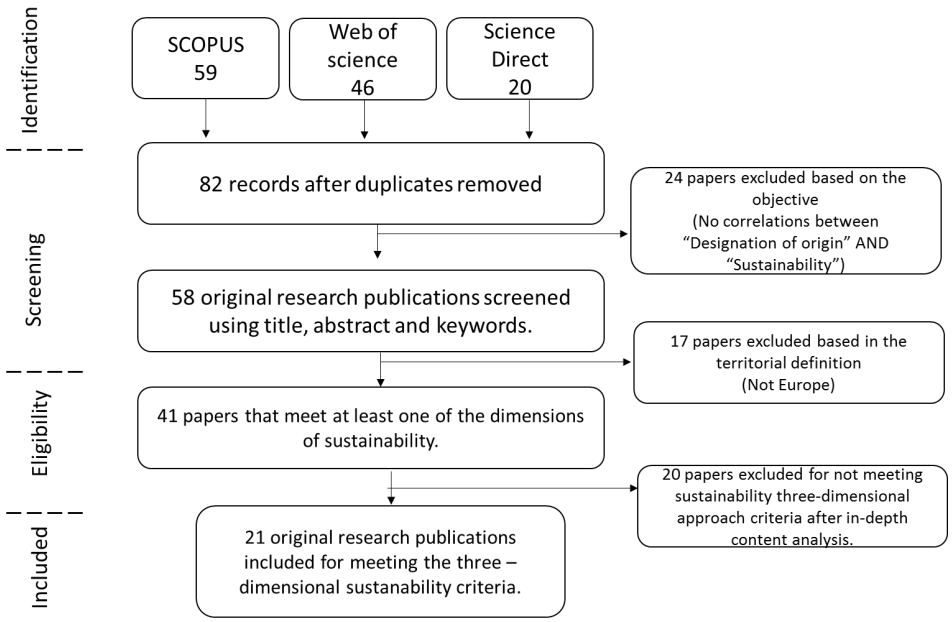
The first analysis was based on 5 codes proposed for the economic dimension: 5 codes for the sociocultural dimension, and 8 codes for the environmental dimension of sustainability (18 initial codes). Those categories helped to see the convergences and divergences that were found through the encodings in the 3D Sample (n=21). Nonetheless, during the in-depth review of the selected sample, an in vivo phase (phase 2) was performed and new coding categories were obtained.

Materials and methods

Before presenting the results of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) methodology, it is important to keep in consideration that the database obtained was aimed from the beginning to include only scientific literature that covered the three dimensions of Sustainability in PDO studies, which is relevant because not all studies on PDO considered them. Therefore, the final database only took into consideration studies that included the social, environmental, and economic dimensions of PDO. The result is a very specific sample, but its strength lies in emphasizing the main characteristic of Sustainability, which is to ensure that this and the following generations can meet their needs by balancing the three dimensions. In the case of PDOs, Sustainability must be the condition required to maintain the activity in the future, considering the balance between social, environmental, and economic aspects. Therefore, the studies that consider two or fewer dimensions of sustainability were discarded because they do not rescue the integral and integrating character of the concept of Sustainability.

To analyze, based on the codes proposed, the link between sustainability and PDOs, a systematic literature review was delivered by using PRISMA methodology, collecting research papers from Scopus, WoS, and Science Direct database from 2005 to march of 2021. The literature sampling and data collection using PRISMA delivered a large amount of information on the topic of Protected Designation of Origin. The process was divided into four steps: (1) identification of materials; (2) screening with specific objectives; (3) eligibility according to the type of research, and finally, (4) final selection of scientific articles to be included (Figure 1).

Figure 1. Flow diagram of the data collection process using Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)
Figura 1. Diagrama del flujo del proceso de recopilación utilizando elementos de informe preferidos para revisiones sistemáticas y meta análisis (PRISMA)



Source: own elaboration. Fuente: elaboración propia.

This PRISMA process layout 41 possible eligible papers that address at least one of the three dimensions of sustainability, which after an in-depth review, considering those that attend the three dimensions of sustainability became 21 papers (3D sample n=21); therefore, this 3D sample was analyzed by using the designed open coding categories proposed, based on the dimensions of sustainability mentioned before. Considering grounded theory, a second in vivo phase (phase 2) during the review process was performed to build up the coding categories of the dimensions of sustainability, of the 21 papers (3D Sample) some other codes were obtained, which are mark with a (*) sign as it can be seen in Table 2.

Table 2. Coding categories of the dimensions of sustainability in PDOs. (in vivo phase)
Tabla 2. Codificación de categorías de las dimensiones de sustentabilidad en DOs (fase in vivo)

ECONOMIC DIMENSION	SOCIOCULTURAL DIMENSION	ENVIRONMENTAL DIMENSION
1. Cost of production 2. Consumer's behavior and marketing strategies 3. Added value* 4. Exportations or global markets* 5. Farmer's income or profitability 6. Externalities or economic spillover on the territory 7. Effects on agri-food supply chains 8. Innovation* 9. Competitiveness and productivity* 10. Entrepreneurship*	1. Institutional and regulatory frameworks (public policies) 2. Product's identity (territorial embeddedness) 3. Cultural heritage 4. Territorial governance/ collective action (stakeholders) 5. Territorial multifunctionality: gastronomic traditions or agro tourism* 6. Social networks 7. Ancient farming tradition, local knowledge*	1. Climate change 2. Agrobiodiversity or native species conservation 3. Agro ecological or organic systems 4. Traceability and food safety 5. Good environmental practices* 6. Water management 7. Certifications, or tests, to improve product quality 8. Maintenance of landscapes 9.Soil restoration or desertification* 10. Improvement of agronomical supplies

Source: own elaboration. Note: "good environmental practices" included waste management, decreasing water pollution or CO2 emissions, and no pesticides used.
Fuente: elaboración propia. Nota: "buenas prácticas medioambientales" incluye manejo de desechos, disminución de contaminación de agua o emisiones de CO2 y no uso de pesticidas.

These codes add value and depth to the analysis mainly because if the study would only keep those codes proposed to form the pre-coding phase, much relevant information on the topic might be left out of the analysis, thus probably losing relevance by not considering all possible existing categories.

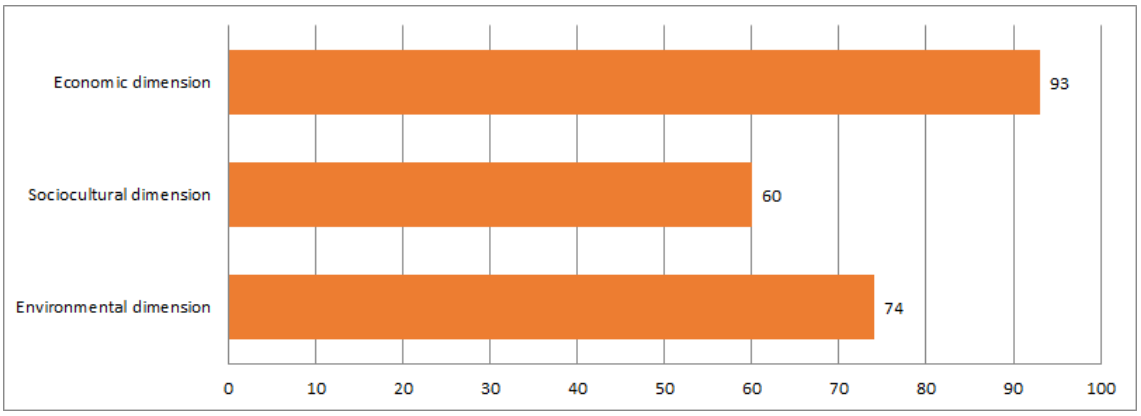
With this 3D sample, an initial statistical analysis was performed to establish the most mentioned codes for each sustainability dimension, with weights that provided the opportunity to visualize the most relevant codes presented within the sample, then convergences between codes within the same dimensions (intradimensional) were found and analyzed; as well as at an interdimensional level (between different dimensions). Also, the link between sustainability's three dimensions and food type products was analyzed; the results were gathered by food type and shown using a graphical network.

Results and discussion

Sustainability in PDOs from a three-dimensional sustainability approach

As mentioned in the methodological section, to analyze the link between sustainability in PDO research, a second in-depth reading of the literature was carried out which resulted in a new three-dimensional sample (3D Sample n=21); this new sample was analyzed based on the coding categories proposed (27 codes) of the three-dimensional of sustainability to identify the dimension most approached on research (Figure 2); all of the papers have at least one of the coding categories in each of the sustainability dimensions, which is logical given that all the papers are in this second classification (3D Sample n=21).

Figure 2. Number of mentions of the codes by dimensions of sustainability in PDOs
Figura 2. Cantidad de menciones de códigos según dimensiones de sustentabilidad en DOs

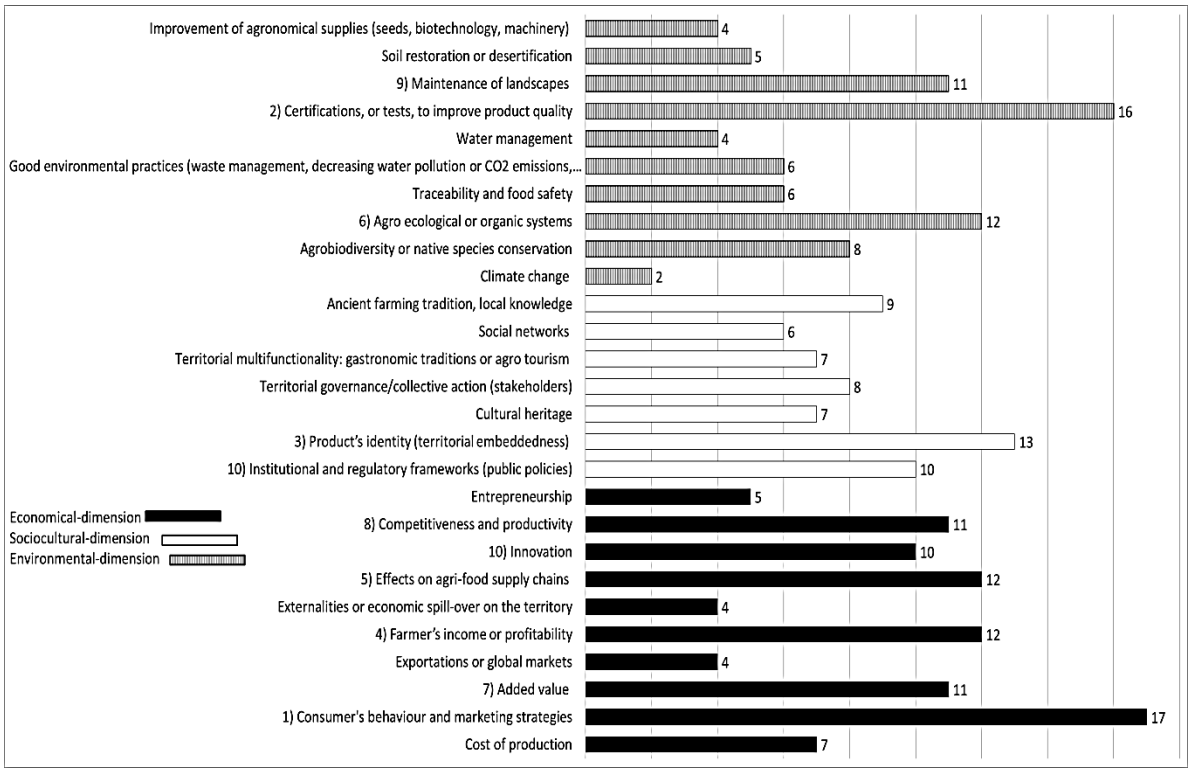


Source: own elaboration. Fuente: elaboración propia.

In this sense, it's important to consider that both the economic and environmental dimensions have 10 codifications, and the socio-cultural dimension has 7 only; nonetheless, the economic dimension outperforms the other two dimensions. In addition to this, the results displayed in Figure 3 show the most mentioned codes for each sustainability dimension, and depict the categorization made by using the open coding proposal in the 21 papers; the behavior is not homogeneous.

Figure 3. Number of mentions of the coding categories of the three-dimensional approach of sustainability in PDOs

Figura 3. Cantidad de menciones de las categorías de codificación del enfoque tridimensional de sustentabilidad en DOs



Source: own elaboration. Fuente: elaboración propia.

Therefore, if a ranking for the first 10 most mentioned codifications is considered, it was found that 50% correspond to the economic dimension of sustainability, 3 of them belong to the environmental dimension, and only 2 of them are part of the sociocultural one. This meant that this economic dimension had a higher weight in the analysis of sustainability related to PDOs, which could be explained partially because the PDO figure mainly focuses towards the protection of intellectual property, the added value for profitability, commercial activities and the integration of producers to specialized food markets. Therefore, not only do the studies regarding PDOs, but also seem to slant toward the economic elements.

Intra-dimensional convergence of coding categories of the dimensions of sustainability

During the review process, it was possible to find convergences between codes within the same dimensions (intra-dimensionally); the most common instance is the economic dimension, where the most mentioned codes were located (and where it was possible to find that the coding Consumer's behavior and marketing strategies were ranked as the most tackled element with 17 out of 21 mentions). Furthermore, it was found that the Cost of production and the Farmer's income or profitability appear several times in the same papers; the same happened with Innovation and Competitiveness, and productivity. This

could be explained given that the certifications that provide territorially differentiated products such as PDOs, favor quality processes, generating effects in local production chains, pay for competitiveness, profitability, and increase local agent's income (Palazzo and Aristone, 2017; Sanz and Macías, 2005).

In another convergence of codes within the dimensions, it was found that in the environmental dimension, mentions to Certifications, or tests, to improve product quality and Agroecological or organic systems appear in several papers; this might be explained given that some PDO products include organic elements, and for being considered as such and to be integrated into food markets with higher added value (premium price), it requires official certifications that guarantee compliance with norms and quality standards, e.g. producing free of agrochemicals or harmful substances, or the use of "organic fertilizers like compost" (Marescotti *et al*., 2020: 8). These certifications are materialized through market instruments such as organic labels or used in PDOs labels (De Boni *et al*., 2019). Also, on this environmental dimension, it is interesting to note that the Climate change code, which is commonly linked to environmental and sustainability issues, was the least of the mentioned codes regarding PDOs research, having only 2 appearances out of the 21 papers.

Regarding the socio-cultural dimension, it was possible to find convergence between the elements of Institutional and regulatory frameworks (public policies), and Territorial governance/collective action (stakeholders), as well as with Territorial multifunctionality because some strategies to diversify productive activities are based on the exaltation of PDOs products and local resource's value-added through agrotourism (García-Cornejo et al., 2020) through agro-tourism. In this sense, it is important to highlight the importance of governance in managing this territorial asset, by the collective action of multiple actors integrated into the decision-making processes "aimed at improving socio-economic phenomena (as of market evolution or the introduction of innovations) [to] generate a cross-cutting-effect on all the three sustainability dimensions" (Arfini *et al*., 2019: 5). Also, in the governance processes, which is derived from the collective interaction between actors in the territories, the local stakeholders show great interest, and power, to influence decisions and to design public policy strategies based on agri-food goods with territorial anchors, such as in the case of the Castanea Sativa Miller chestnut, and the Parmigiano cheese, both PDOs products.

It is interesting to mention that other analytical approaches such as Value chains are rescued on the selected sample (n=21) research by considering that this value chain approach "involves a complex array of actors who share an agreement about the qualities embodied in their particular foodstuff" (Sánchez-Hernández, 2011: 105), which has an added value that comes from the PDOs recognition. These elements (Value chain and Added value) correspond to a codification of the economic dimension. In the same way, the usage of the value chain perspective is worth mentioning, since not only do the local stakeholders are integrated from the food qualities agreements, but they are also institutionally established through regional public policies around PDOs, which determine the productive, agronomic, technical, commercial, and quality guidelines around the production of goods of this nature. Therefore, the analysis of public policies, or Institutional and regulatory frameworks (public policies), not only remains as part of proposal

recommendations for the implementation of development strategies around the management of territorial resources, but also around the effects on the value chains of products with PDOs might have regional agreements.

What is somewhat surprising about the research is that, despite considering that some Cultural heritage (as part of the sociocultural dimension) revaluation processes are broadly related to Territorial governance processes, within the analyzed articles, it was not possible to find a link between these two coding categories (although both of them belong to the same sociocultural dimension). It was found, however, that it seems to be a link among the recognition of Cultural Heritage and Territorial multifunctionality, because in territories with PDOs products, it is common to find active gastronomic activities, which might boost activities such as agro-tourism in local areas from the use of territorial resources. An example is the case of PDO Sjenica sheep cheese, which requires greater epistemic approaches from a sustainable perspective (Filipović, 2019) giving its potential to enhance tourism in the region based on the PDO recognition.

Inter-dimensional convergence of coding categories of the dimensions of sustainability

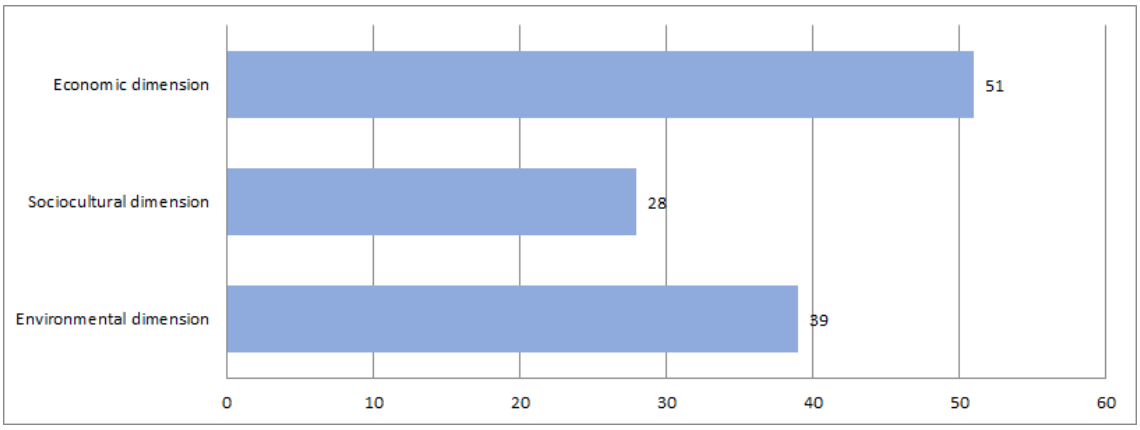
On the other hand, considering the existence of inter-dimensional, convergence among codes of different dimensions, it was found that the most common dimension convergence within the 3D sample (n=21) is the connection between Consumer's behavior (economic dimension) and the two most mentioned codes in the other dimensions, being Product's identity (territorial embeddedness) from the sociocultural dimension and Certifications, or tests to improve product quality for the environmental dimension, the latter also ranked as the second most mentioned code in all the 3D Sample (12 out of 16 mentions).

This link between the three dimensions, especially on the previously mentioned codes, is explained by the fact that the institutional recognition of origin (PDOs recognition) is obtained from a verification and certification process of a product's quality and its territorial embeddedness to protect and guarantee the presence of certain qualities in food products. Those qualities, both tangible and intangible, associate with PDO´s goods, rescue identity and socio-cultural elements of food, which together with mentioned certified food quality, turn food-goods into value-added items that might have the potential of enhancing "differentiation of production, providing consumers with reliable information on [the origin] and other quality attributes of typical products [and] promotion of local development" (Bryła, 2017: 350). Also, these elements might influence the consumer's perception around the intrinsic qualities of food products, which undeniably changes consumer trends and even consumer's willingness to pay (Tempesta and Vecchiato, 2019) for food. At the same time, commercial public policies in the Union European countries, arising from interregional treaties, require the mutual guaranteeing quality standards and process-certifications to create a sustainable image that favors sales for exports of products with PDO. That is what happens in the case of "Grana Padano cheese, one of the most consumed and exported Italian PDO products" (León-Bravo et al., 2021: 2), which has PDO labels.

Sustainability's three dimensions and its link to food type product

To deepen the intra and inter-dimensional analysis performed in the previous section, a link between sustainability's three dimensions and food type products was inspected. On this matter, 7 types of food were included: dairy, oils, grown food wine, bakery wine & seafood, and nuts. Also, it is worth mentioning that the 27 codes have another element to analyze, which is the number of times each code is mentioned in the research according to food type (Figure 4). The mentions of all economic, socio-cultural, and environmental codes were summed to contrast them.

Figure 4. Number of links between dimensions of sustainability in PDOs and food type products
Figura 4. Cantidad de vínculos entre las dimensiones de sustentabilidad en DOs y productos de tipo alimentario



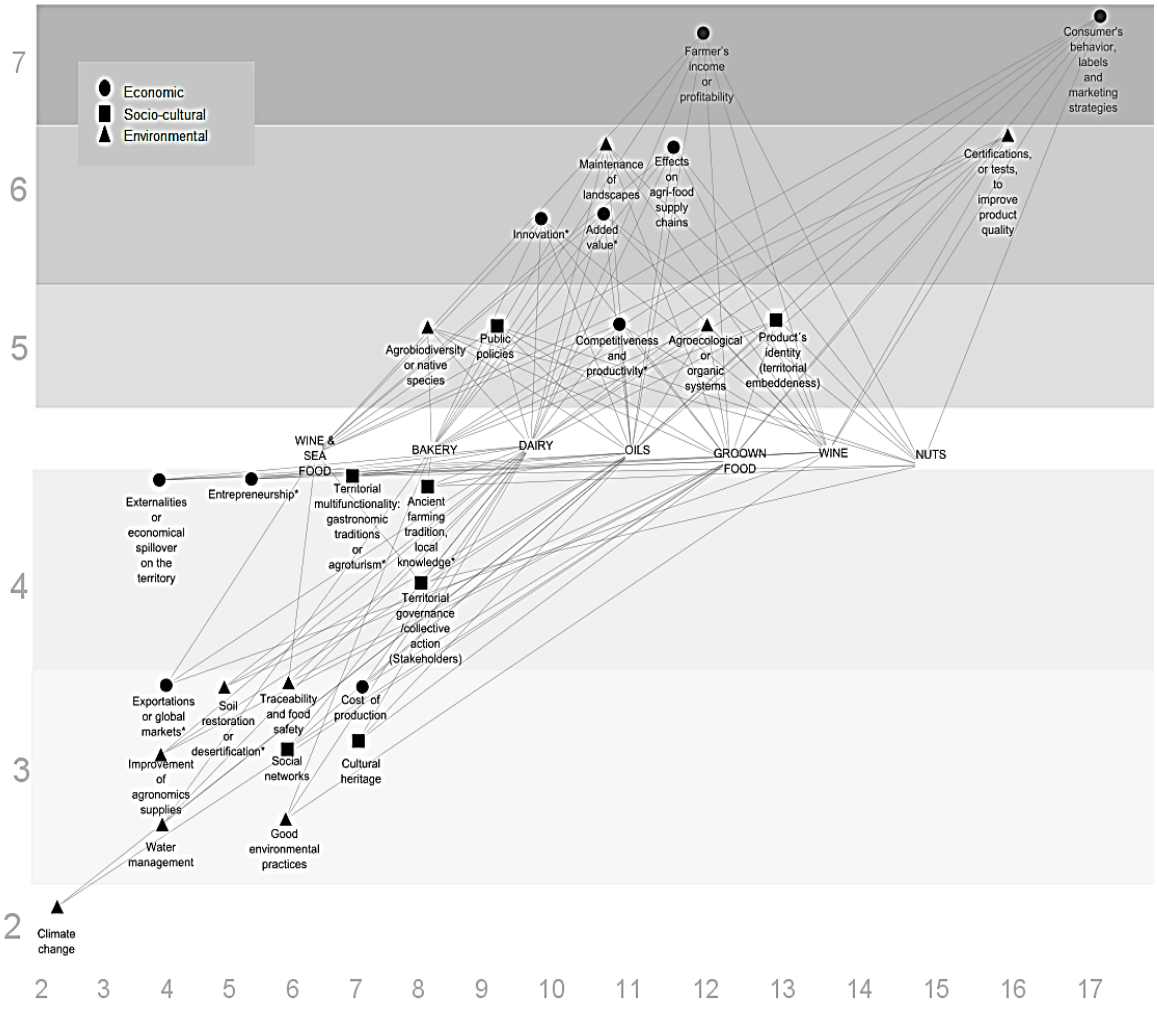
Source: own elaboration. Fuente: elaboración propia.

This figure also confirms that the economic dimension continues to surpass the other two dimensions because it has more links within the seven types of PDO's food (Eg: 51 is the number of times that the economic codes were connected to the 7 types of food). And in the case of socio-cultural codes, these had a total of 28 links, which makes them less significant than the others for the food types.

To discuss sustainability's three dimensions and its link to food type product, Figure 5 shows that the type of food that has more links with economic, socio-cultural, and environmental codes is Dairy (24/27), followed by Oils (19/27), Grown food (19/27), Wine[2] (15/27), Bakery (13/27), Wine and seafood (11/27) and Nuts (10/27).

2 These two products, wines and oils, due to their gastronomic nature, show great potential for these tourist activities, so it is not surprising that the elements of sustainability that involve economic, social and environmental impacts are addressed in this product's research.

Figure 5. Sustainability's three dimensions and its link to food type product
Figura 5. Tres dimenciones de sustentabilidad y su vínculo con productos de tipo alimentario



Source: own elaboration. Fuente: elaboración propia.

While it should be considered that these links might also have been influenced by the amount of research that was found and the food type to which each one belongs, it couldn't be denied that it shows the research tendencies on the sustainability matter regarding the type of product, and at first glance, it may appear that the elements that stand out most in the PDO's studies would be the environmental ones, but it is possible to observe that the economic dimension is the most relevant among the three, since it has 51 edges of connection with the nine categories of the PDO.

The graphical network is organized to show, from bottom to top, the codes that have the least to the most links to food types of products; thus, Consumer's behavior and marketing strategies are linked to all of the food types, while Climate change is the least connected code, with two links only with grown food and oils.

Also, considering the type of product and its relation to sustainability's dimension, the largest number of papers comes from dairy's studies. For this reason, it can be considered that

a greater number of codes of the three dimensions are covered. However, it stands out that the most relevant topics for dairy relate to the economic and environmental dimensions. This might be because dairy farms include livestock activities and that could be considered a wider agri-food value, therefore, a greater range of codes are included in the research.

Dairy is the most homogeneous category, not only because of the large number of studies that are included in this research, but also because it covers more elements of the value chain and involves other productive activities in addition to livestock farming, such as the transformation of dairy products into milk, cheese, or butter. For this reason, it is noteworthy that the most relevant topics are in the economic and environmental dimensions.

From the economic dimension rather than the Cost of production or Farmer's income or profitability, that could be expected, there is a greater emphasis on Consumer's behavior and marketing strategies as well as Effects on agri-food supply chains; this might mean a greater concern for maintaining a quality product by taking care of t inputs for the final product. Both Consumer's behavior and the Effects on agri-food chains are linked to the concern exemplified from the work of Bassanino *et al.* (2011), where the aim is to measure the number of nutrients in summer pastures so that the nutrients acquired in winter are comparable and the result is a dairy product of the same quality. This last point also has a reflection in the environmental part since it highlights that Certifications, or tests, to improve product quality have the highest representativeness for the dimension.

Continuing with the theme of the environmental dimension, it must be said that, for the set of studies on oil, environmental issues are the least significant; however, for the 3D sample n=21 as a whole, the environmental dimension of oils is the most interesting because it is one of the two products that address climate change; this is relevant because changes in climatology might have repercussions on the productivity of centuries-old species such as olive trees. Although olive trees are adapted to semi-arid climates such as those of Spain (Navarro-Navajas, 2012), climate change could affect production cycles due to increased temperatures or extended droughts. On the same oil matters, another finding on the environmental dimension of the oil studies was having greatest interest focused on soil restoration and landscape maintenance, especially due to the importance currently given to gastro tourism activities and tours where all the production stages for obtaining certified products are shown.

The other category that mentions climate change is grown food, but in this food type the environmental dimension is the most important one, this could be because it is considered that in the years to come there will have to be sustainable management of resources that contemplates the ways to give continuity to food production under the impacts of climate change (Mili and Martínez-Vega, 2019); also, as Marescotti *et al.* (2020) mentioned, the environmental issue opens a new dimension for PDO's certification.

For the wine sector, it was observed that the economic dimension is the most addressed, one which could be explained by the dynamism of wine (alcoholic or distillates beverages) exports at the global level, and because a large part of the food tradition of PDO's countries is recognized through their distillates (eg. Mexico's most famous PDO's product is a distillate product which is Tequila); therefore, because of wine palliative and tasting characteristics, it has a great presence in the international market, which in this study is perceived through a significant relevance of the economic dimension of sustainability.

For the category of Bakery, it can be said that although bread is considered a staple of the Mediterranean diet, a decline in consumption has been observed, and the study by De Boni *et al.* (2019) was to note consumers' perception of bread consumption under these conditions. The study seeks to analyze the three dimensions of sustainability and consumer behavior concerning three types of bread but leaves out elements such as Institutional and regulatory frameworks (public policies), Cultural heritage, Territorial governance/collective action (stakeholders) as well as Social networks; however, it evaluates other indicators such as supply chain relations, rural development, and human health.

On the subject of nuts, there is only one research that addresses the category, its approach is based on Public policies and has a visible burden on Territorial governance processes that seek to achieve socio-cultural and economic benefits for the community while preserving the variety of nuts in the territory. For this reason, the economic and social issues are considered with equal importance; however, the environmental issue is addressed with Agrobiodiversity or native species conservation and Maintenance of landscapes. This is because nut trees, like olive trees, are long-lived species; however, for this study soil restoration is not as relevant as for olive trees, and the focus is on agrobiodiversity and maintenance of landscapes, which could also be used to lead this sector to the trend of gastro-tourism tours.

The only study that addresses wine and seafood confirms that if a product lacks a socio-cultural and environmental certification, there might be repercussions on consumer behavior. This category includes the consumers' perception of products that do not include environmental care in their marketing. In the case of cod, it was observed that consumers stopped consuming Norwegian cod because it was not certified as a product that included this dimension. The sustainability element is addressed because, according to (Sánchez-Hernández, 2011) the cod food value chain has not effectively communicated the major environmental benefits from artisanal cod production, which is of concern to Spanish consumers, and as a result, they stop consuming Norwegian cod.

Conclusion

Sustainability has become a widely attended topic through different academic disciplines, productive sectors, or public agendas. The incorporation of sustainability and its three dimensions has been gaining ground especially due to the urgency to find processes, products, and ways of living that will meet the needs of those who inhabit this planet in the present and the following generations. Hence, in PDOs, empirical evolution is growing as an integrative research topic and is also becoming of great relevance, especially for the European Union region. There, the agri-food activity is strongly defined by a series of normative and institutional frameworks (e.g., the PACC), which implies the establishment of a series of challenges around sustainable agriculture, and therefore, the value chains that derive from it. These guidelines might influence both the productive activity around goods with territorial anchorages such as PDOs and the research around them.

Even though sustainability can be considered a global impact issue, it has origins in local actions. Therefore, the territory becomes a space where a series of productive activities take place, but also an actor in the process of building sustainable development. Nonetheless, it should be considered that food and beverage producers (PDOs main producers) face a latent threat with the environmental crises, and for this reason, studying the possibilities of incorporating sustainability into production processes might contribute to increase consumer's acceptance of a product certified as sustainable', and to find ways to adapt production process on this sense. Therefore, considering a three-dimensional perspective of dimensions of sustainability might be beneficial for both consumers and producers as well.

PDO's scheme itself still has a long way to prove that its implementation might have real positive socio-cultural and environmental effects on territories under PDO's recognition. On the other hand, it is possible to perceive that in the research on this matter there is still a deficiency to end research by proposing strategies to enhance the usefulness of these PDOs from a three-dimensional perspective, and based on a multidisciplinary approach, which is always a challenge in research.

This research proved that there are still a lot of topics to explore while discussing sustainability in PDOs, and that sustainability still needs a useful analytical framework that allows researchers to integrate systemic elements, such as economic, sociocultural, or environmental dimensions in research, this creates, therefore, a holistic vision, of an integrative phenomenon.

This systematic literature review called attention to the fact that one of the greatest challenges that research on sustainability in PDOs still has lies in the operationalization of sustainability to abstract elements as complex as those in the sociocultural dimension. There is still a long way to go on this matter, therefore we considered that the proposed analytical framework, based on the 27 coding categories proposed, could be of use to materialize and abstract sustainability dimensions. Also, systematic literature reviews, such as the one carried out in this work, highlighted the need to distinguish areas of opportunity for in-depth research in other regions, and to generate knowledge from different latitudes around the globe. Furthermore, even though this paper tried to include the sociocultural dimension into the sustainability approach, more profound research on this matter is needed, especially since this dimension needs to fortify its value in academic agendas. In addition, as a window of opportunity, future research could focus on using a much representative sample to perform systematic literature review experiment, including PGIs quality scheme and by considering other geographical regions, which could amplify the knowledge on the issue of sustainability.

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