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A Multi-Criteria Approach to Evaluate Sustainability: A Case Study of the Navarrese Wine Sector

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Abstract: The present work introduces a multi-criteria approach focused on the evaluation of wine production, considering the three dimensions of sustainability: environmental, economic and social. In this sense, the most relevant key performance indicators were selected within each dimension and disaggregated into sub-indicators to address the different sustainability aspects within the wine value chain. Furthermore, the analytic hierarchy process was applied as the method to weight the relevance of the three dimensions and corresponding key performance indicators, in order to allow the producers to understand which aspects need to be covered to improve their production sustainability. Results demonstrate how the approach proposed is able to identify, for both the vineyard and winery, the strengths and weaknesses regarding the sustainability performance of their production. Additionally, this study also contributes by shedding light on the most suitable and recommended actions to increase the company's sustainability from a sustainable perspective. Additionally, it is important to highlight that, although the developed approach is specifically designed for the wine sector in the Navarrese region, it can be replicated by adjusting the key performance indicator selection to apply this methodology to the reality in other wine production regions.

Keywords: sustainability; wine sector; analytic hierarchy process methodology; key performance indicators

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1. Introduction

The agriculture and the wine industry, in particular in Europe, are currently experiencing a high level of expansion and competitiveness. Currently, wine production makes a significant contribution to the agricultural industry output in Europe. It represents more than 5% of the value of gross output produced by the EU's agricultural industry in Europe [1], with Italy, Spain and France as the top wine producers in the EU in 2019. Specifically, Spain represented 21% of the European production of wine in the same year [2]. This was caused by the diversification and dynamicity of the wine sector, in comparison with other agri-food sectors, which is in constant evolution to address the new consumption trends, legislation requirements and climate change adaptation, among others [3–8]. In terms of the latter, this industry is moving inexorably toward a new model, seeking a more sustainable production that necessarily implies better management of resources and a better fit with the environment by being aligned with what we call the triple bottom line [3,9]. However, this evolution of agriculture sustained through the next reform of the Community Agricultural Policy (CAP) (2023–2027) [10,11] and supported by European and national strategies of agroecological transition and digital transformation [12] forces this sector to have its due effect on the markets and the consumers' capacity to recognize this model as an attribute of value that guides them in their purchasing decisions, as it has happened in the past [13]. Otherwise, there is the risk of generating quality production principles that do not have general access to a market dominated by different criteria [14] where globalization allows competition not to be forged from sustainability but from price and sales marketing.

Wine industry activity is developed principally through family businesses and cooperatives that correspond to small and medium-sized enterprises (SMEs) [15]. In addition, since the principles of viticulture and wine production are the same throughout the world, natural, economic, social and technological conditions of individual producers can significantly differ from one country to another or even among regions within the same country [9]. This fact is closely linked to the fact that non-technical barriers are affecting the sustainability performance of some SME wineries which need to be improved or overcome such as the lack of transferring knowledge to the producers on sustainable agri-food approaches [4], though to date, vinicultural organizations themselves have made a certain effort to become more environmentally friendly [16], Schimmenti et al. [17] concluded that the main reasons for wineries to be involved in sustainable initiatives are mainly ethical and environmental, and less important are economic reasons. Although this action can be seen as a positive step, economic and social aspects are not being covered given the importance they have, and therefore sustainability is another marketing tool partially oriented to the environmental pillar [15]. Despite the significant trends and interest of the research community, market and consumers in sustainable production systems, regarding resource consumption, and environmental, economic and social performance optimization of the wine sector, there is a lack of shared approach regarding the identification of key performance indicators (KPIs) [18]. A well-defined KPI system is key to identify the process responsible for the higher impact in environmental and social but also economic terms in vineyard exploitation and wine marketing [19,20]. In this sense, and based on a sustainability point of view, KPIs defined should consider the three sustainability dimensions, i.e., economic, social and environmental [21,22]. Consequently, the right balance or harmony among the three dimensions should be attained to guarantee process sustainability. The sustainability concept may be defined, on a general basis, as using business practices that are environmentally friendly, socially equitable, in terms of treating employees and communities fairly, and economically feasible [23]. The concept of "sustainability" becomes less clear when applied to grape and wine products due to the absence of a common definition of sustainable viticulture and winemaking. It has been stated that sustainable viniculture is a "global strategy on the scale of the grape production and processing systems, incorporating at the same time the economic sustainability of structures and territories, producing quality products, considering requirements of precision in sustainable viticulture, risks to the environment, products safety and consumer health and valuing of heritage, historical, cultural, ecological, and landscape aspects" [18], having an important role in land use, society and regional development [24].

The latter leads to establishing and providing verifiable, rigorous and traceable indicators to the concrete concepts that determine the principles of sustainability. The present study works in this direction, addressing the current trend in which an important group of consumers is moving forward, asking for sustainable food processes, reliability and information regarding their origin [25]. Identifying and quantifying the KPIs that describe sustainable behavior regarding the three dimensions of sustainability is paramount for assessing the resilience of the selected sector. However, it is essential to perform it from the perspective of each element involved in the value chain, since offering sustainable products is not only a task of the producers but also answers to a commitment of the food chain's engaged actors with the consumer [26,27]. If, in addition to this approach, that allows a continuous evaluation of the degree of improvement of each indicator, a management model incorporating the use of information and communication tools is added, as a tool to increase its transfer and credibility, representing an opportunity to provide actions that determine what sustainability means for the wine sector and how it should be transferred to the consumer in a reliable way within the framework of the digital transformation.

Previous works have defined a KPI system from the perspective of the life cycle assessment [4,23,28]. In this work, a new approach is followed, based on different KPI systems developed within the wine sector, which include qualitative social and economic indicators [29]; in this case, the qualitative indicator definition is applied to all three dimensions of sustainability and not only the social and economic dimensions, which are transformed into quantitative indicators through a scoring system for each of the criteria included in the KPI system. This KPI system, apart from the previously mentioned, will permit giving the assessment result in a global indicator that will be provided to the vineyard exploitation and/or wineries, to help them to make their sustainable efforts more visible to the market. The latter is achieved by a multi-criteria decision-making method (MCDM) which facilitates the assessment of the three dimensions of sustainability in several industrial sectors [30,31]. This method is based on applying a multivariable complex decision process that results in the prioritization of alternatives from the point of view of sustainability issues. Particularly, the analytical hierarchy process (AHP) is an efficient decision-making approach tool that facilitates the comprehensive assessment of how different conditioning factors may influence the system's sustainability [32,33]. Furthermore, it also allows for quantifying the level of their expected influence.

In this framework, this research proposes a systematic method based on the AHP model to carry out an advanced evaluation of relevant aspects to be considered for the sustainable development of the Navarre winery sector. Accordingly, the first objective of this work is to perform a detailed assessment of the KPIs to be considered from a sustainability perspective. After achieving this step, the second objective of the study is focused on analyzing the relevance of each parameter and elucidating its hierarchy.

The region of Navarre is a good case study throughout the territory, including different agro-climatic conditions and soils, which have shaped over a long tradition of several cultivation methodologies [34], elaborations and peculiar varieties that have allowed a core of wineries and winegrowers of high quality to be developed, being part of the heritage of the region. In this sense, the KPI system is developed taking into account the local perspective of this region within Spain. Based on this study, an overview of the key influencing parameters that might constrain the level of sustainability development of the Navarre winery sector will be identified, and some guidelines to overcome identified needs will be explored.

2. Materials and Methods

Environmental, social and economic dimensions or criteria are an increasingly popular tool for companies from different sectors to evaluate their current performance regarding sustainability and therefore support the decision regarding the type of actions in which they might want to invest to improve it [33,35–37].

In the present work, the three dimensions are assessed through specific indicators and sub-indicators (KPIs) selected and developed within this work, based on the provision of the indicators included in other methodologies, such as Agroinnovarse [38], Eco-prowine project [39], VIVA [29], Haprowine [40] and PEFCR [41], apart from authors' experience. The boundaries of the analysis are the vineyard, wine production and the packaging of the wine.

In this sense, the three dimensions include a series of concepts and indicators that are explained below:

Environmental dimension includes a company's energy use, waste, pollution and natural resource conservation or depletion, among others, as well as any environmental risks that a company might face and how the company is managing these risks, for instance, developing a contingency plan in advance. Social dimension looks at the company's interaction with other companies and regards personnel, such as, safety of working conditions planned considering the employees' health convenience or the consideration of the employees' needs and interest in the governance and operational system, as well as the relationship with the local community where the wine production is located. Economic dimension evaluates aspects such as the selection of suppliers holding the same values as the company, implementation at organization level of managing systems, dependence regarding investment aids or existence of quality control system, among others.

All three dimensions are key to address all the aspects involved in the sustainability performance of the company [42]. In this sense, the dimensions are closely related, and many aspects apply to two or even all three dimensions but from different perspectives. Excellence achieved in one of the dimensions does not imply a successful sustainability performance, since all three dimensions must be appropriately approached in order to achieve sustainability excellence.

The followed approach is based on qualitative and consequently non-dimensional indicators aiming to produce a simplified tool for wineries and vineyard exploitations to evaluate their sustainability performance in terms of economic, social and environmental performance.

Economic dimension indicators and sub-indicators are depicted in Table 1.

Table 1. Economic dimension indicators and sub-indicators.

Economic Dimension	Indicator	Sub-Indicators
	Agri-food sustainability	Codes of good business practices, sustainable procurement protocol, food chain law
	Economic feasibility	User-driven business model, company investment plan, vineyard exploitation professionalism, CAP aid
	Resilience	Agricultural insurance system, financial advisory services procurement, climate change adaptation plan, contingency plan
	Productivity and efficiency	Productivity and efficiency monitoring, growth objectives and monitoring, improvement measures
	Food security and quality systems	Quality system, certification, food security, education for responsible consumption, communication on nutritional quality
	Digital transformation and R&D	Level of digitalization, reinforcement of R&D, digitalization-driven improvement, technology 4.0, collaboration with innovation institutes and AKIS [43,44] network, knowledge transfer networks
	Customer orientation and marketing	Responsible practices, customer satisfaction, marketing channels adapted, additional services, invasive advertising practices, inclusive communication strategy, information transfer about impact related to the activity

The agri-food indicator looks into the company's relation with other actors of the value chain, including raw material procurement, as an example, to clarify if sustainability criteria are considered in the selection of suppliers and to what extent, as well as the fulfillment of the requirements established by the regulations that imply the need to establish a contact including relevant information regarding the contracting terms (duration, payment, delivery, possible incidents, etc.) and, most importantly, if the price is regulated considering the production costs.

Economic feasibility mainly focuses on the dependence of the company on respecting different financial schemes, linking sustainability to the financial independence of the company. In this regard, CAP aid scheme [45] is a key tool on many occasions for vineyard exploitations but the dependency on this kind of subsidy needs to be balanced seeking to decrease the financial risks. Additionally, systems implemented seeking to adapt or update according to the needs considering new consumption trends are also considered. In any case, professionalism is also addressed in this indicator.

Considering that the agri-food sector must deal with a high degree of uncertainty due to, for instance, weather conditions, contingency plans play a key role to maintain the sustainability of the agri-food companies.

Productivity and efficiency are the basis of the economic sustainability of a company; therefore, using monitoring systems that will enable the entrepreneur to assess if the efficiency measures implemented are working, or activating improvement measures that can contribute to increasing productivity, is essential to confirm if growth or efficiency objectives have been fulfilled and take action accordingly on time.

Food security and quality system indicator covers two aspects. On the one hand, the existence of a quality system is indispensable in the agri-food sector, which is linked with the certification schemes that allow a company to show if the brand complies with the specifications of a concrete certification scheme. On the other hand, aspects related to the participation of the company in education campaigns, to promote responsible consumption or the inclusion of nutritional quality information on the product, which is quite relevant for people suffering from food intolerances, are also addressed.

The digital transformation and R&D indicator mainly focuses on two aspects. On one hand, the level of digitalization of the company, in this regard, the adaptation of the company to the new channels, new technologies and new trends, is essential to last over time. On the other hand, improvements brought by the digital age can significantly contribute to increasing the company's efficiency and productivity. In this sense, working jointly in collaboration with a technological or research center and innovation institutions or knowledge transfer networks can also result in increasing productivity and efficiency performance.

The last indicator of the economic dimension focuses on customer orientation and marketing which is a key aspect in the agri-food sector. In this case, there is a combination of regulated issues such as invasive advertising with aspects linked to the company's commitment such as the implementation of adapted marketing channels.

Social dimension indicators are sub-indicators, which are depicted in Table 2.

Business ethics is the study of appropriate business policies and practices regarding potentially controversial subjects including transparency, code of conduct, CAP eligibility criteria and legal risks.

Work environment indicator deals with the compliance of the company with the access of the working personnel to the key information of the company as well as the existence of an internal communication flow and workers' training programs.

Equity intends to evaluate if the company staff receives respectful and dignified treatment in their working space.

Contractual stability refers to good practices concerning the selection and insertion of personnel, clear criteria for remuneration of the different professional categories and jobs, social responsibility systems and good practices related to contractual conditions.

Training and personal development covers aspects related to the implementation of training programs or development of training plans, career plans and internal promotion.

Security and health condition compliance at work implies that the company has a health and safety policy, a health and safety system implemented and carried out an evaluation of these aspects such as a work accident ratio analysis.

Community participation and development refers to the following aspects: collaboration with the different agents of the local community and social inclusion (e.g., young and vulnerable people) as well as reduction in depopulation risk.

Table 2. Social dimension indicators and sub-indicators.

Social Dimension	Indicator	Sub-Indicators
	Business ethics	Transparency Code of conduct CAP eligibility criteria Legal risks
	Work environment	Information Internal communication and knowledge management Satisfaction with the company Work–life balance and quality of life of workers
	Equity	Equity
	Contractual stability	Good practices in hiring Remuneration Social responsibility Type of contract Employment stability
	Training and personal development	Entrepreneur training Worker training Advisory entities Career
	Security and health at work	Psychosocial evaluation Work accidents Accident or incidence in inspections Health and safety system Health and safety conditions
	Community participation and development	Accessibility to work Community collaboration Depopulation risk Social inclusion

2.1. Environmental Dimension

Environmental dimension indicators and sub-indicators are depicted in Table 3.

The environmental policy indicator intends to evaluate if the vineyard exploitation complies with the conditionality of the CAP and if the company has a production certificate/scheme. It is also relevant to evaluate if the vineyard exploitation has a defined environmental policy or similar: a certified environmental management system (ISO 14000 [46]; adherence to a commitment to a continuous improvement process, environmental certificate (carbon footprint—ISO 14064 [47], Environmental Product Declaration (EPD) [48], voluntary CO_2 reduction agreement or implementation of Sustainable Development Goals (SDGs), etc.).

The use of energy indicator considers the existence of internal control or energy audits and if they are regularly conducted, as well as emission control of electricity and fuel consumed (energy consumption in vineyard, winery, bottling; liters of fuel consumed in vineyards, in winery). CO_2 emissions are also relevant and associated with fuel consumption and electricity. The carbon footprint of the company's products should be calculated as a tool to evaluate the performance and evolution seeking to reach a carbon-neutral process. For instance, a company strategy can address the use of renewable sources for self-consumption (biomass, PV, etc.) or grid-connected photovoltaic systems [49] or the purchase of green energy. In addition, it analyzes if there is a reduction commitment regarding CO_2 emissions, the existence of a GHG Reduction Plan and investment in greenhouse gas reduction projects on renewable energy production, which are promoted and managed by the local administration.

Table 3. Environmental dimension indicators and sub-indicators.

Environmental Dimension	Indicator	Sub-Indicators
	Environmental policy	CAP, sustainable production certification, environmental policy
	Energy use	Energy consumption monitoring, actions to reduce energy consumption, increase energy efficiency, good practices and technologies for the efficient use of energy, renewable energies
	Greenhouse gas (GHG) emissions	GHG emission control, GHG emission reduction plan
	Resource use	Fertilizer consumption control, phytosanitary consumption control, actions for fertilizer consumption reduction, actions for herbicide consumption reduction, phytosanitary pressure, actions to reduce enological resources, actions to reduce bottling and packing resources
	Water use	Water consumption control, fertilizing and watering common management, actions for reducing water consumption, good practices for the efficient use of water, water footprint
	Social impact	Low-carbon farming
	Biodiversity maintenance	Local crop varieties, crop diversification, agroecology
	Circular economy	Vineyard and winemaking by-products, waste prevention, life cycle assessment (LCA), eco-design, noise level, sustainable mobility
	Sustainable mobility	Worker's transport, growing optimization practices, travel optimization, fleet control

The resource use indicator evaluates the consumption of inorganic fertilizer and organic fertilizer but also if phytosanitary product and antimicrobial use is controlled (through a field guide or other system). GHG emissions associated with the application of fertilizers are also relevant in this regard. Additionally, technologies and good practices for rational fertilization or integrated pest control can contribute to improving the environmental sustainability of the vineyard exploitation. Therefore, the phytosanitary pressure in the vineyard exploitation should be calculated. Good practices are carried out regarding the use of resources in the wine production value chain and during the bottling process (reduction in the weight of glass in bottles, plastic stoppers, cork stoppers, cardboard), etc., that can greatly affect the environmental balance.

The water use indicator is linked to the measures that are carried out for the control and optimization of water consumption, as well as the technologies and good management practices for the efficient use of water, and if there is a water footprint calculation. Environmental sustainability will increase when measures are implemented to improve water quality by minimizing nutrient leaks from agricultural activity through sustainable management plans and water use.

The soil impact indicator asks if soil management is applied with beneficial practices to prevent erosion and preserve fertility (permanent cover, vegetation cover, tillage, tractor use, etc.); it also includes the introduction of eco-schemes of the CAP reform.

Biodiversity maintenance indicator considers the inclusion of native varieties of crops in the vineyard. It also considers the management, good practices and environmental commitment, as well as non-productive investments that are made to contribute to the conservation or restoration of biodiversity. It also evaluates the introduction of eco-schemes of the CAP reform.

The circular economy indicator looks into the existence of any waste prevention plan in the vineyard and winery such as waste management, management of inorganic elements for production: plastics, packaging, etc. [50]. In addition, it considers if there is any adherence to toxic waste management systems, plastic packaging, tires, etc., and if the vineyard exploitation or the winery has performed or is performing an LCA [51,52]. Moreover, it assesses if the company incorporates eco-design criteria in its products, considering the whole life cycle [53]. Good practices carried out are also considered to ensure an adequate noise level.

Finally, the sustainable transport indicator takes into consideration the initiatives carried out to promote the use of sustainable means of transport, including public or shared transport but also initiatives to reduce the number of shipments, movements and deliveries (route optimization, tractors with front tank) or to reduce the number of trips to the workplace (mobility plan), since these initiatives will contribute to a decrease in CO_2 emissions and therefore improve the environmental sustainability performance of the company.

2.2. AHP Method

With the purpose of evaluating the KPI performance in terms of level of importance and influence, the analytical hierarchical process (AHP) was chosen. The AHP helps to define those features with objectivity and contributes to moving from a qualitative to, in this case, a quantitative KPI measurement, by a pairwise ranking of importance for a set of criteria, carried out by different participants [54]. The row geometric mean method (RGMM), as one of the most popular methods in AHP research, was used to calculate the importance weights [55]. Since there are several participants with different profiles and backgrounds, the coherence of the answers is handled with the consistency ratio (CR). According to Saaty [56], this ratio should be less than 10% which, in the present assessment, was verified for each one of the experts' participant weighting evaluations. As a final result, a unique score considering the three dimensions of sustainability considered is obtained [33]. It has been applied to other food sectors as explained by Mohammed et al. [36]. AHP uses a systematic practice to define priorities and make complex decisions [57]. In this work, the AHP model was applied based on four levels of hierarchy (Figure 1). The first level corresponded to the goal of the study problem, which is to identify the sustainable performance of the vineyard exploitation or winery through the unique score, which will be compared with an average which corresponds with the Navarrese wineries that will be participating in this initiative. The second level corresponds to criteria considered in this work, i.e., the three sustainability dimensions: economic, environmental and social. Furthermore, the third level of the hierarchy refers to the subcriteria level (i.e., indicators included in each dimension). Finally, level four is represented by sub-subcriteria, which represent one-to-many sub-indicators (please refer to Tables 1–3).

To achieve a consistent weighting ranking of the dimensions, indicators and sub-indicators specific to the wine sector, the AHP process involved the participation of a sectorial panel of experts invited by the Unión de Agricultores y Ganaderos de Navarra—Navarre Union of Farmers and Cattle breeders (UAGN) and el Consejo Regulador de la Denominación de Origen Protegida de Navarra—Protected appellation of origin Control Board of Navarre (CR D.O.P. Navarra) as initiative leaders, composed of 12 sectorial experts from different organizations involved in the wine value chain, seeking to include the different perspectives of the whole wine production value chain:

- Individual producers: 4 owners of Navarrese wineries;
- Vine and wine producer aggrupations or representatives: UAGN (1 R&D manager, 1 technician), Federación Española del Vino—Wine Spanish Federation (FEV) (1 technician), CR D.O.P. Navarra (CEO and President);
- Wine research demonstration and Innovation and knowledge transfer organizations: the Instituto Tecnológico del Vino—Wine Technological Institute (VITEC) (managing director) and la Plataforma Tecnológica del Vino—Wine Technological Platform in Spain (PTV) (President);
- International Federation of Wines and Spirits (FIVS) (Vice President).

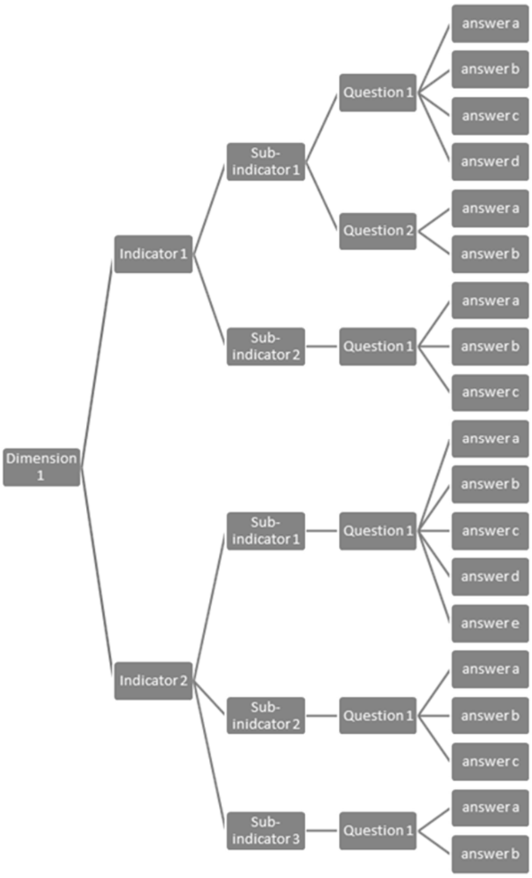

Figure 1. Evaluation system structure (source: authors).

On a practical level, companies assessing their sustainability performance must set priorities among the different criteria considered within each dimension to improve their performance. For this reason, rates were assigned to dimensions, indicators and sub-indicators. The first step comprised rating the three dimensions as well as the indicators. In this case, the panel of experts was asked to establish the corresponding rates by means of the AHP method. The second step addressed the sub-indicators following the same AHP method.

Considering the characteristics of the stakeholders from the wine sector, the best approach to evaluate the different aspects addressed by the sub-indicators was to design a questionnaire. The questionnaire includes one or several questions per sub-indicator enabling one to retrieve information concerning the way the vineyard exploitation or winery approaches this issue at that moment. It consists of 98 closed questions; they are multiple-choice or single-choice. An extract of the questionnaire can be seen in Figure 2. The language of the questionnaire is Spanish as it is addressed to the Navarrese wineries and producers, whose mother tongue is Spanish. It applies differently when the respondent is different. The different typologies of respondent are small vineyard (less than 5 working units), big vineyard (more than 5 working units), cooperative of farmers, or winery that can produce the wine and bottle it. In addition, it is available on an online platform where the respondents can include and edit their answers.

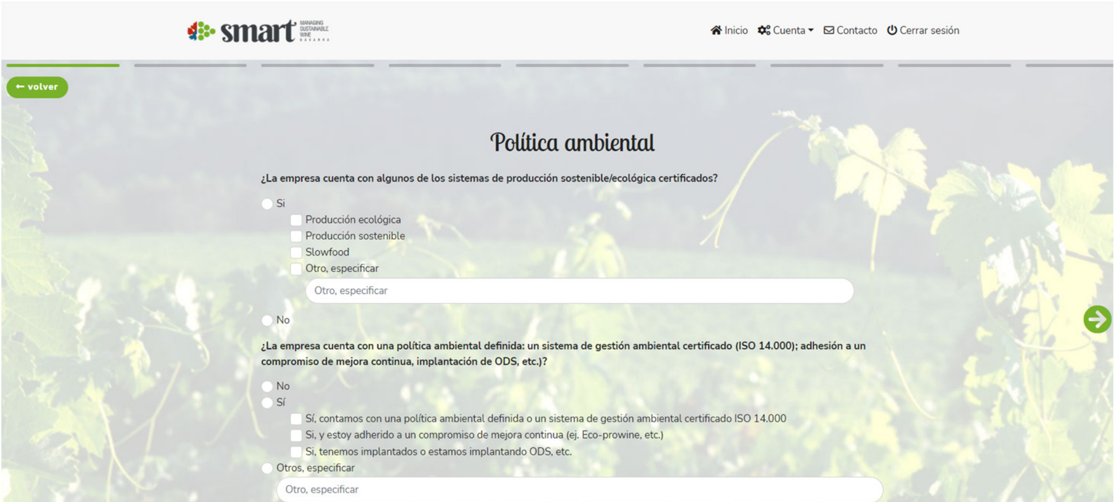

Figure 2. Extract of the Smartwine questionnaire addressed to Navarrese producers and wineries.

Accordingly, a set of answers reflecting the sector reality is provided, and the corresponding rating of these answers was established based on the combined criteria of UAGN and CIRCE.

2.3. KPI Assessment Outcome

Questionnaires produced for the vineyard exploitations and wineries are slightly different considering distinctions among the business model and operational specificities or types of actors of the wine value chain. It is worth highlighting that the legal requirements are considered as red line due to their mandatory nature and are taken into account when rating the answers to the corresponding question. Therefore, the companies that do not comply with the legal conditions according to the answer provided by the company to the corresponding sub-indicator answer will not achieve a sustainable performance although they might perform well in other aspects until they comply with the mandatory regulation.

The output obtained by the stakeholders includes not only recommendations based on the answers provided but also a spider net figure in which the current performance of the company is depicted for the three dimensions identified. Additionally, specific spider nets considering the indicators addressed in each dimension are also available. These figures will allow the company to identify the most urgent issues, associated with the sub-indicator, indicator and dimension that need to be addressed to improve the sustainability performance of the company. Even more, companies can compare their performance in terms of sustainability from one year to another once mitigation measures have been implemented.

3. Results and Discussion

Based on the results obtained from the AHP, according to the expert panel weighting method, the environmental dimension accounts for 55% of the sustainability performance while the social and the economic dimensions account for 25% and 20%, respectively (Figure 3). Therefore, the environmental dimension is clearly the most relevant aspect winery and vineyard exploitations from the Navarrese DOP should consider, in order to increase their sustainability. On the other hand, social and economic dimensions have similar weight, and although social-related aspects are less explored in the wine sector context as mentioned by Martucci et al. [58], they have increasingly gained attention from the general public and from the companies. Consequently, there has been an improvement not only in the work conditions but also in the monitoring systems to verify that acceptable conditions are in place in this regard [59].

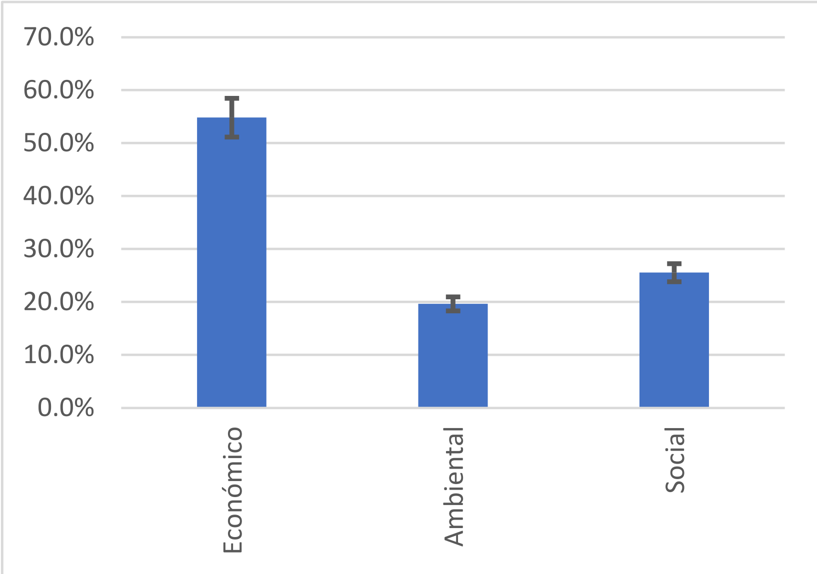

Figure 3. Relative weights of the three dimensions (source: authors).

Figure 4 depicts the environmental indicator ranking, based on the sectorial experts' weighting factors assigned and expressed as the relative weight of each indicator in the overall sustainability performance assessment. Figure 5 shows the significance (weight) of each indicator as the result of the AHP method. The most relevant aspect to achieve environmental sustainability is related to the optimization of the use of resources. The second aspect to take into account is closely related to the former energy consumption, addressing the energy use and GHG emissions which should also be optimized to avoid, among others, emissions associated with transportation; lower-weight packaging and locally produced electricity should also be used [60], and economic performance can be improved through local production or procuring energy produced by renewable resources [61]. These indicators' weights are directly connected to the most relevant impact categories included in the product environmental footprint category rules for wine from the EU of climate change and resource use of fossils, minerals and metals [41]. As mentioned in the previous section, the dimensions are closely related, and aspects addressed in one of the dimensions can significantly affect parameters included in the other dimensions. The biodiversity maintenance holds also a significant weight associated with the grape wine variety preservation importance, and soil impact and water use follow. These indicators have been considered traditionally when assessing the environmental impact of agricultural activities but also have a significant effect on the economic performance of the vineyard exploitation since degraded soils will decrease their yield or need an increasing amount of fertilizers, and wasting water will contribute to a reduction in this resource and the exploitation profitability. In this sense, in warm climates such as the Spanish one, the water resource is a critical issue that, if well managed together with the varieties chosen and the application of corrected soil treatment, can lead to a correct path to adapt to climate change [62]. But also, the newest indicators are addressed such as circular economy or environmental policy which have taken a very active role in Europe over the last decades [14,62–64].

Figure 6 depicts the social indicator ranking based on the sectorial experts' weighting factors assigned (Figure 7) and expressed as the relative weight of each indicator in the overall sustainability performance assessment. The social dimension shows a clear significance of the security and health at work indicator compared with the rest of the indicators. Therefore, vineyard exploitations and wineries should first and foremost concentrate on adequately addressing this topic. Secondly, efforts should be allocated to contractual stability, business ethics and training programs and, on a secondary level, equity, work environment and community participation and development. When analyzing other sustainable wine initiatives, VIVA certification [29] is in line with the social indicators included in this work.

Other initiatives give more importance to human resource management, which is more in line with the main indicators identified with this methodology [4,65]. As previously mentioned for the environmental dimension, several indicators are closely related and will contribute one to another. However, social indicators are more weakly connected to other dimensions' indicators.

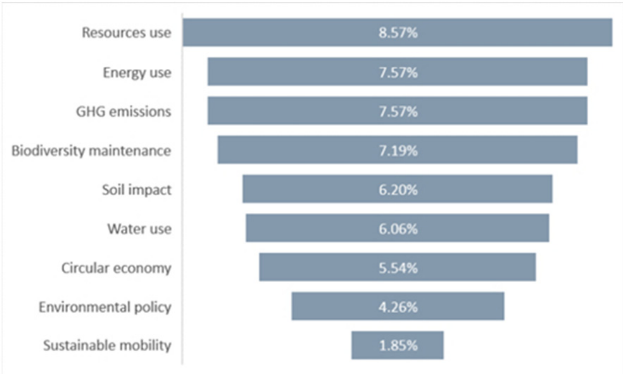

Figure 4. Ranking of environmental indicators (relative weight).

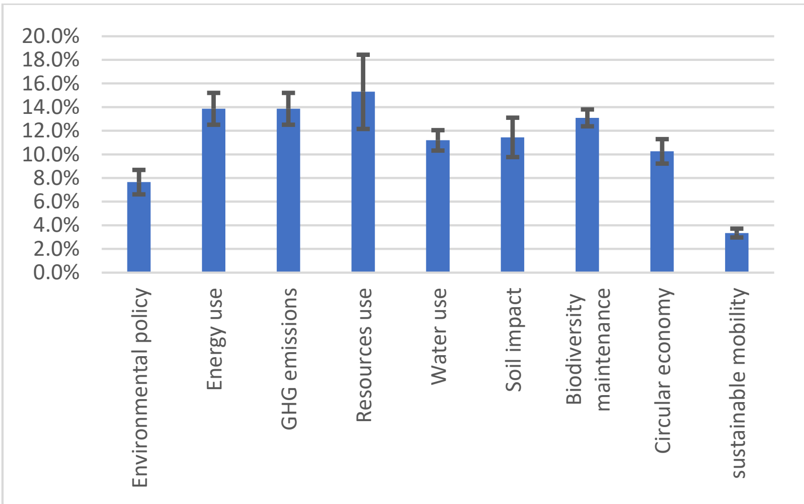

Figure 5. Weighting factors for the environmental indicators (significance).

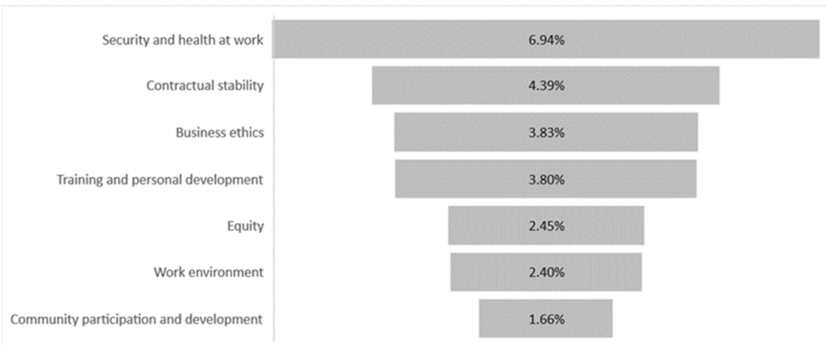

Figure 6. Ranking of social indicators (relative weight).

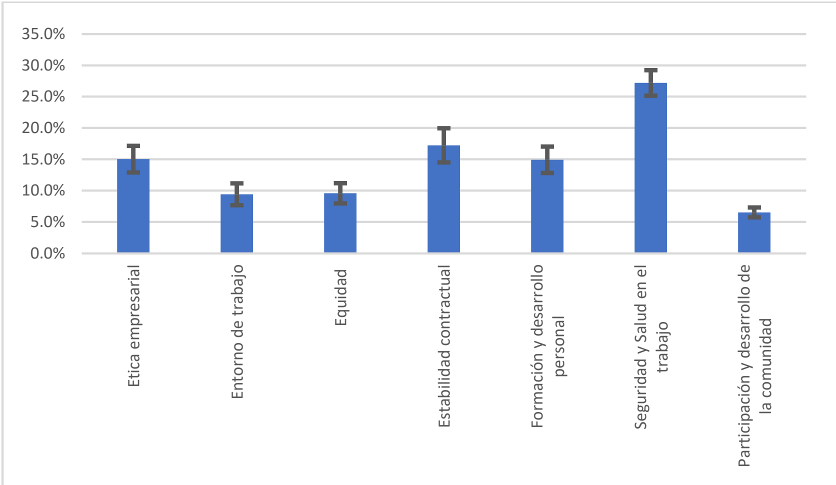

Figure 7. Weighting factor for the social indicators (significance).

Figure 8 depicts the economic indicator ranking based on the sectorial experts' weighting factors assigned (Figure 9) and expressed as the relative weight of each indicator in the overall sustainability performance assessment. Just as for the social dimension, when assessing the economic dimension, the economic feasibility has a significant weight compared to the other factors of the dimension. Agri-food sector sustainability and customer orientation and marketing greatly affect the economic sustainability of the company based on the weightings obtained. Same as in the previous case, awareness raising on some topics embodied in the general public opinion and behavior on the European and national strategies is reflected in the ranking obtained. Likewise, more traditional aspects such as food security and quality systems or productivity efficiency are still relevant to achieve the economic sustainability targeted. Finally, digital transformation and R&D and resilience hold a third level of relevance but still need to be addressed to achieve sustainability goals. In this case, although the digital transformation is not placed on the top of the ranking, national programs endorsed by the CAP will be quite relevant in the coming years [65].

The relative weight of the sub-indicators for the environmental dimension is depicted in Table 4. According to the results obtained, actions allocated to establish the environmental policy of the company—increasing the use of renewable energies [49], developing a GHG emission reduction plan or developing a low-carbon farming strategy [66] and management—will greatly contribute to increasing the environmental sustainability of the company and therefore the overall sustainable performance. Other aspects, such as fertilizer or phytosanitary control, in principle, seem to be key in vineyard exploitation management, but they are not because these parameters have been already targeted in the regulation, and it can be assumed that almost all the vineyard exploitations already address these issues appropriately [67]. For instance, fertilizer and phytosanitary products are reported and controlled, so no excesses occur that could endanger the environment. In line with this, other regulated aspects such as noise level are clear for any company and most likely will not need additional measures to comply with the requirements established. On the other hand, new risks such as the increasing use of packaging are reflected in the sub-indicator list which includes actions to reduce the weight of bottling and packing inputs as a response to the national and European policies but also general public awareness raising in this regard.

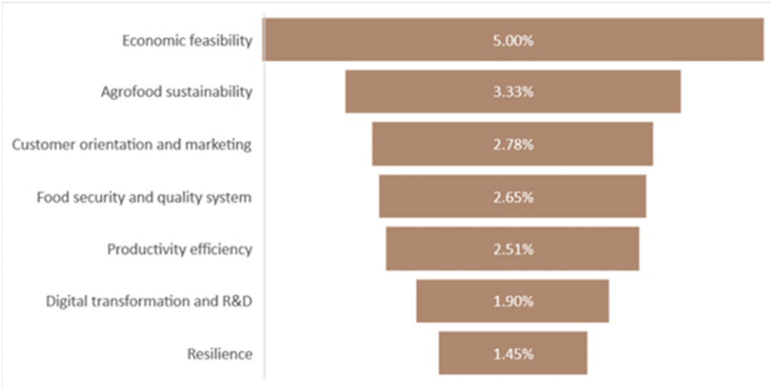

Figure 8. Ranking of the economic indicators (relative weight).

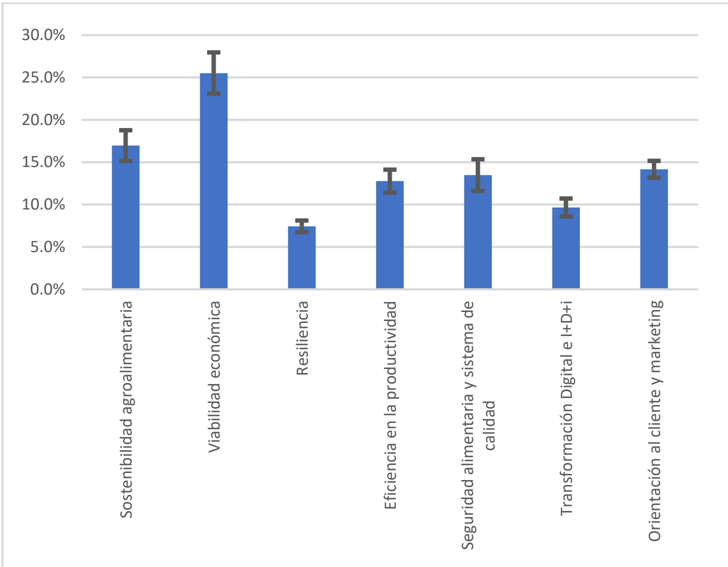

Figure 9. Weighting factor for the economic indicators (significance).

Table 5 shows the relative weight assigned to the social sub-indicators. The most relevant aspects, considering the weight allocated, are the CAP eligibility criteria fulfillment, the health and safety system implemented by the company and equity. In this case, it is worth mentioning that the most urgent aspects are all related to the legislation, policies or subsidy eligibility criteria. For the remaining aspects, the weights assigned present a greater homogeneity than for the previous sub-indicators. Aspects like the work–life balance and quality of life of workers, employment stability or training programs for entrepreneurs respond to the legislation improvements in this regard but also to the public awareness raising and demands. On the contrary, aspects such as depopulation risks, which is a priority addressed in rural development programs specifically, were not assigned a high rate in the present case. This could be due to a good balance regarding this aspect in the region compared to other regions of Spain or Europe. Areas in the Navarre region, where grape vineyard exploitation and wineries are located, have in general a fair development degree and life conditions appealing to the population and therefore do not suffer greatly from depopulation compared to other rural areas.

Table 4. Relative weight for the sub-indicators in the environmental dimension.

	Indicator	Sub-Indicators	Relative Weight
Dimension Environmental dimension	Environmental policy	Sustainable production certification	0.64
		Common Agricultural Policy	1.49
		Environmental policy	2.64
	Energy use	Energy consumption monitoring	0.76
		Actions to reduce energy consumption/increase energy efficiency	1.28
		Good practices and technologies for the efficient use of energy	1.63
		Renewable energies	3.91
	Greenhouse gas (GHG) emissions	GHG emission control	2.10
		GHG emission reduction plan	5.47
	Resource use	Fertilizer consumption control	0.43
		Phytosanitary consumption control	0.49
		Actions for fertilizer consumption reduction	1.47
		Actions for herbicide consumption reduction	1.28
		Phytosanitary pressure	1.56
		Actions to reduce enological resources	1.46
		Actions to reduce bottling and packing resources	1.87
	Water use	Water consumption control	0.67
		Fertilizing and watering common management	0.78
		Actions to reduce water consumption	1.49
		Good practices for the efficient use of water	1.90
		Water footprint	1.22
	Soil impact	Low-carbon farming	6.20
	Biodiversity maintenance	Local crop varieties	2.45
		Crop diversification	1.88
		Agroecology	2.86
	Circular economy	Vineyard and winemaking by-products	0.78
		Waste prevention	1.69
		Life cycle assessment (LCA)	1.26
		Eco-design	0.65
		Noise level	0.33
		Sustainable mobility	0.84
	Sustainable mobility	Worker's transport	0.29
		Growing optimization practices	0.78
		Travel optimization	0.51
		Fleet control	0.27

Table 5. Relative weight for the sub-indicators in the social dimension.

Dimension	Indicator	Sub-Indicators	Relative Weight
Social dimension	Business ethics	Transparency	0.42
		Code of conduct	0.28
		PAC eligibility criteria	2.16
		Legal risks	0.96
	Work environment	Information	0.22
		Internal communication and knowledge management	0.52
		Satisfaction with the company	0.29
		Work–life balance and quality of life of workers	1.37
	Equity	Equity	2.45
	Contractual stability	Good practices in hiring	1.10
		Remuneration	1.05
		Social responsibility	0.42
		Type of contract	0.58
		Employment stability	1.23
	Training and personal development	Entrepreneur training	1.28
		Worker training	1.03
		Advisory entities	0.61
		Career	0.87
	Security and health at work	Psychosocial evaluation	0.35
		Work accidents	1.05
		Accident or incidence in inspections	1.12
		Health and safety system	2.37
		Health and safety conditions	1.28
		Accessibility to work	0.76
	Community participation and development	Community collaboration	0.34
		Depopulation risk	0.49
		Social inclusion	0.82

Table 6 shows the relative weight assigned to the economic sub-indicators. In this case, the food chain law [68,69] sub-indicator is remarkably more relevant than the other sub-indicators, which is also linked to the fact that fulfillment of the requirements established by the law is mandatory, and therefore, it is necessary to set a red line where no vineyard exploitation or winery can achieve economic sustainability if this sub-indicator is not addressed properly. The expertise and capacity of the workers are also quite relevant as the weight assigned reflects. Expertise along the value chain steps will contribute to increasing efficiency. Aspects related to the company investment plan, allowing it to be adapted to new conditions in the coming decades, customer satisfaction or food security are also relevant and can significantly affect the economic performance of the company. It is noteworthy that aspects linked to sector digitalization, which is one of the objectives addressed by the new CAP, have a low rate compared to other sub-indicators; it could be expected that in the coming years, this parameter will increase its relevance concerning the economic sustainability of the company [17,70]. Just as for the social dimension, it can be noted that the weight assigned to the sub-indicators included in the economic dimension is more homogeneous than for the environmental case.

Table 6. Relative weight for the sub-indicators in the economic dimension.

	Indicator	Sub-Indicators	Relative Weight
Dimension Economic dimension	Agri-food sustainability	Codes of good business practices	0.33
		Sustainable procurement protocol	0.39
		Food chain law	2.61
	Economic feasibility	User-driven business model	0.54
		Company investment plan	0.81
		Vineyard exploitation professionalism	1.77
		PAC aid	1.87
	Resilience	Agricultural insurance system	0.67
		Financial advisory services procurement	0.16
		Climate change adaptation plan	0.32
		Contingency plan	0.30
	Productivity and efficiency	Productivity efficiency monitoring	1.43
		Growth objectives and monitoring	0.62
		Improvement measures	0.46
	Food security and quality system	Quality system	0.49
		Certification	0.44
		Food security	1.01
		Education for responsible consumption	0.28
		Communication on nutritional quality	0.43
	Digital transformation and R&D&I	Level of digitalization	0.33
		Reinforcement of R&D	0.31
		Digitalization-driven improvement	0.31
		Technology 4.0	0.28
		Collaboration with innovation institutes and AKIS network	0.29
		Knowledge transfer networks	0.40
	Customer orientation and marketing	Responsible practices	0.60
		Customer satisfaction	0.74
		Marketing channels adapted	0.28
		Additional services	0.21
		Invasive advertising practices	0.22
		Inclusive communication strategy	0.26
		Information transfer about impact related to the activity	0.49

It is important to highlight that the result of the sustainability performance assessment will vary over time, as the KPI system will be changed to be adapted to new regulations and wine sector strategies (at local and national levels), and could include new relevant aspects related to sustainability, including the stakeholders' sustainable priorities, which might move following the market needs and the region context. In addition to that, the AHP methodology will be applied every certain period when the aforementioned changes are present enough in the sector that could change the sustainable performance of the vineyard and the wineries. By considering this sustainability perspective, innovation paths will be integrated into the winery sector to overcome market needs [70]. At the same time, the involvement of different experts from the whole value chain and with different expertise and awareness levels, with respect to specific topics (environmental, economic and social), gives a very interesting enrichment and coherence to the KPI system, with different wine sector knowledge compiled and different sectorial perspectives addressed.

4. Conclusions

The KPI definition and AHP method application to the wine sector were deterministic to detect the critical aspects to focus on in order to improve the sustainability performance in the sector.

Regarding the environmental dimension, the most relevant aspects coming up during the analysis deal with the use of resources in terms of inputs for the vineyard and winery processes; in this sense, GHG, which is directly related to the use of energy, is the second aspect that should be considered. Biodiversity maintenance and soil impact were weighted lower than the previous ones; correct management of soil, and wine varieties, together with water use will be helpful to adapt the exploitation to the climate and to achieve more sustainable production.

Respecting the social dimension, based on the AHP assessment of the KPIs, there is a high significance of the security and health at work indicator compared with the rest of the indicators, followed by the contractual stability, business ethics and training program issues, which were slightly highlighted to be more important than the equity, work environment and community participation and development.

Related to the economic dimension, the most pressing issue is linked to the regulation requirements established in the food chain law, followed by the CAP aid dependence, the expertise of the workers and the productivity and efficiency monitoring as a tool to improve the economic profitability of the company. Other aspects dealing with the company's investment plan to adapt to new conditions in the coming years, customer satisfaction or food-security-related aspects also have relevance in economic terms.

Further research will be conducted by implementing the KPI system to demo case/s in order to test the system with one or several winery and vineyard cases and obtain further conclusions regarding the real usability and reliability of the system for the Navarrese wine sector, both as an information transferring tool and as a marketing tool to increase the market visibility of the wine makers and producers. Additionally, the approach could be replicated for the wine sector in other regions, once the sector-specific characteristics in those regions are assessed in detail. In this sense, considering policy implications, the Farm to Fork [10] strategy, one of the main components of the New Green Deal, proposes a transition toward more sustainable food production models. The definition of a set of social, economic and environmental indicators is in alignment with this aim and is also being used as an element for discussion in the drafting of the upcoming regulation on the certification of sustainable food production, which is being designed by the European Commission. A new regulation is about to be published in 2024 that will give homogeneity to this definition in the EU territory, which, as indicated, will be based on the development of the three pillars and the participation of the whole food chain.

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