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Theoretical framework to foster and assess sustainable agriculture practices: Drivers and key performance indicators

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ABSTRACT

Introducing sustainable practices in farms' value chains to transform their business models into sustainable business models (SBMs) is a priority for farmers and policymakers. This paper first aims to provide a framework for implementing sustainable agriculture practices. We explain managerial practices, key drivers, and the agents involved through different theories and in four main stages. Secondly, using a Systematic Literature Review (SLR), we offer an update and a complete list of 133 sustainable (economic, social, and environmental) key performance indicators, which can be used to measure farms' sustainability performance and the success of the SBM applied. Our insights show that there are different drivers that may affect farms' commitment to sustainability practices. However, the importance of these drivers is not equal. Similarly, not all the agents have the same relevance since this depends on the stage.

1. Introduction

Sustainability has been recognized as a cornerstone of societal behavior, business activities, and government policies in recent years (Jadoon et al., 2021). The Sustainable Development Goals (SDGs) proposed by the United Nations reinforce this idea, and managers are modifying the way sustainable and strategic practices (substantive or symbolic) are implemented in firms (Bothello et al., 2023). Traditional sustainability linked to Corporate Social Responsibility (CSR) practices has led to the emergence of Sustainable Business Models (SBMs) that integrate economic, social, and environmental practices in firms (Jadoon et al., 2021; Hausdorf and Timm, 2023; Peralta et al., 2019). A SBM aligns technological and social innovations with systemic sustainability goals, creating competitive advantage through superior customer value while fostering both company and societal sustainable development (Bocken et al., 2014; Geissdoerfer et al., 2018). In general, although better sustainable performance is one of the main goals of every firm, regardless of its sector or the country where it is located (Hausdorf and Timm, 2023), some sectors and countries are more sensitive to social and environmental strategies. The agrifood sector is one of these sensitive sectors due to the influence of sustainability on the environment, food security, and a healthy ecosystem, as well as its role as a raw material provider for other industries (Talukder et al., 2018; Xu et al., 2023). VanLoon et al. (2005) define sustainability in agriculture as "*the activity of growing food and fiber in a productive and economically efficient manner, using practices that maintain or enhance the quality of the local and surrounding environment – soil, water, air and all living things*" (VanLoon et al., 2005, p. 35). In terms of the consequences for the environment, 3,535,374.60 tons of pesticides were consumed by the agrifood sector in 2021, and 6490.62 million tons of carbon dioxide were emitted into the atmosphere in 2022 through agricultural activities (FAOSTAT, 2023). However, these negative effects contrast with the economic contribution these activities make to employment and the gross domestic product. For example, in 2022, employment in the agricultural sector represented 26% of total employment, and 4% of the world's GDP corresponded to agricultural activities in 2023. In less developed countries, it accounted for 25% of the GDP (FAOSTAT, 2023).

The economic relevance and sustainable impact of agricultural activities require greater sustainable efforts by firms and governments (Swaffield et al., 2019). Organizations such as FAO have launched initiatives like "The State of Food Security and Nutrition in the World" to present the key challenges and solutions to achieving goals like ending hunger and food insecurity in the context of the 2030 Agenda for Sustainable Development. Firms and governments all over the world know that creating a strong and sustainable agrifood sector is essential to ensure there is enough quality food to supply a growing population

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(Streimikis and Baležentis, 2020). Sustainable agriculture can play a crucial role in conserving the environment and biodiversity, as well as mitigating climate change (Latruffe et al., 2016). As a result, several agricultural firms have introduced sustainable practices in their value chains by using biopesticides, biofertilizers, changing the fuel they use (Xu et al., 2023), and reducing plastic and non-renewable materials in their production processes. In addition, they are introducing social practices that reinforce their connection with the environment and local populations, are becoming more diverse in terms of employees and managers and are collaborating with NGOs and consumer organizations. These sustainable practices have transformed their Business Models (BM) into Sustainable Business Models (SBMs), which address social and environmental concerns and recognize diverse stakeholders, including the environment and society, without losing sight of economic profits (Streimikis and Baležentis, 2020). Academics are paying more attention to the sustainable challenges occurring in the BMs of these agricultural firms, focusing on diverse managerial practices that increase sustainability (Swaffield et al., 2019).

Previous studies in this field began with the analysis of sustainability in agriculture taking "The Brundtland Report" (United Nations, 1987) as a reference. Some definitions of this concept have been proposed in this sector (see (Streimikis and Baležentis, 2020) for a review). Various studies have also attempted to develop a conceptual framework to assess sustainability in agriculture. Significant contributions have been made by Streimikis & Baležentis (Streimikis and Baležentis, 2020), Román-Cervantes et al. (Román-Cervantes et al., 2020), and Talukder et al. (2020). Román-Cervantes et al. (Román-Cervantes et al., 2020) indicate that to design a set of indicators in this area, the definition of sustainable development itself and, consequently, the ethical model on which it is based must be taken into account. They identified four levels to be considered: natural capital, physical capital, social capital, and well-being. Streimikis & Baležentis (Streimikis and Baležentis, 2020) propose a sustainable agriculture assessment framework based on different EU policies. Talukder et al. (2020) examine how sustainability can be assessed to create a holistic picture of separate and interrelated factors. In particular, they identify the issues and concerns that should be addressed during a sustainable agriculture assessment and categorize them into seven groups. Previous literature has also theoretically proposed indicators to assess sustainability levels (e.g. (Streimikis and Baležentis, 2020; Talukder et al., 2020; Jež-Rogelj et al., 2020; Roy and Chan, 2012; Santiago-Brown et al., 2015),).[1]

In this context, this paper has a three-fold aim. Firstly, we develop Framework for the Implementation of Sustainable Agriculture Practices (FISAP) through four main theories: Institutional Theory, Signaling Theory, Resource-Based-View Theory, and Stakeholders' Theory. Secondly, these theories allow us to identify the specific agents that take part in the corresponding stages of the business model. Finally, we carried out a Systematic Literature Review (SLR) to propose an updated and more complete list of sustainable (economic, social, and environmental) indicators. These Key Performance Indicators (KPIs) aim to assess firms' sustainability performance.

Therefore, our study makes two main contributions. Our first contribution is to provide a theoretical study with a framework (FISAP) to explain how to implement an SBM in agricultural firms. Previous literature has highlighted the need for ethical agricultural models (Román-Cervantes et al., 2020), the role of internal and external drivers in integrated agricultural systems (Talukder et al., 2020), stakeholders' relevance in this sector (Latruffe et al., 2016; Román-Cervantes et al., 2020), and the importance of farm resources (Xu et al., 2023; Swaffield et al., 2019; Streimikis and Baležentis, 2020) and the environment (Xu et al., 2023; Swaffield et al., 2019) when defining farm sustainability. However, these studies do not consider a holistic framework that distinguishes internal and external factors and links them to the theories underlying this sustainable behavior in the agrifood sector. Specifically, we consider both external and internal drivers of sustainability in this key sector. In addition, as a novelty, we propose four phases (Definition, Decision-Making, Implementation, and Evaluation) to guide theoretically and practically the introduction of sustainable practices. We also suggest main actors that participate in each phase and their role in this sustainable process.

As a second contribution, and since a key issue in the last stage of the FISAP is how to assess sustainability levels, we combine the main characteristics about the KPIs that previous studies have considered separately into a single study when proposing sustainability indicators. Thus, in contrast to Jež-Rogelj et al. (Jež-Rogelj et al., 2020) and (Román-Cervantes et al., 2020), who focused on economic and social indicators, respectively, we consider economic, social, and environmental levels of sustainability in line with most of the studies on the topic (e.g. (Streimikis and Baležentis, 2020; Roy and Chan, 2012; Santiago-Brown et al., 2015; Van Cauwenbergh et al., 2007; Zhen and Routray, 2003),). As in Streimikis & Baležentis (Streimikis and Baležentis, 2020) and Talukder et al. (2020), we not only identify the indicator itself but also provide detailed information about it, such as its definition, units of analysis, and metrics. The sustainability indicators are also divided into subcategories for better understanding, and the indicators are applicable to any agricultural context. Moreover, in contrast what it was proposed in the study by Bracco et al. (2019) but considering the studies of Van Cauwenbergh et al. (Van Cauwenbergh et al., 2007) and Román-Cervantes et al. (Román-Cervantes et al., 2020), information related to stakeholders is included in the set of social indicators. Finally, although Bracco et al. (2019) also considers the economic, social and environmental levels this report is more oriented to the achievement of specific SDGs, and they considered 10 themes and 69 indicators, while we provide a more fine-grinner perspective of 16 themes and 133 sustainable indicators.

This paper is structured as follows. Firstly, we offer a theoretical section to explain the FISAP and its interconnection with academic theories and SBMs. Secondly, we define the KPIs and explain the methodology employed, offering a complete overview of the indicators chosen to assess sustainability in the agrifood sector. Finally, a discussion and conclusion section is provided.

2. Sustainability in the agrifood sector

Farms' transition toward more SBMs by implementing sustainable agriculture practices involves several key drivers and agents that play relevant roles in various stages. In this section, we use a holistic approach comprising different theories (i.e., the Institutional Theory, Signaling Theory, Stakeholders Theory and Resource Based View) to reach a better understanding of this process.

2.1. External and internal drivers

The main factors involved in this process can be internal and external. Using the traditional approach to the classification of stakeholders as a reference (Freeman, 1984), in our study, internal drivers are those that are part of the farm itself and might have an influence on the farm's development/implementation of sustainable agriculture practices. External key drivers are those related in some way to the farm and its activity without strictly being a part of it, but with possibilities of influence.

[1] In their review, Rasmussen et al. (2017) analyze the metrics and indicators of sustainability used in contemporary research on commodity agriculture to demonstrate that new sustainability indicators continue to be developed rapidly by researchers interested in the three principal pillars of sustainability (environmental, economic, and sociocultural). The bibliometric analyses carried out by Wohlenberg et al. (2022) on sustainability indicators in the context of family farming are also worth mentioning. Latruffe et al. (2016) analyze the process of constructing indicators, such as individual, aggregated, or composite indicators.

2.1.1. External drivers

The first key driver is firms' institutional context, which is demanding greater attention to sustainability criteria from them in recent years. According to the Institutional Theory (DiMaggio et al., 1991) external pressures can influence firm strategies and organizational decision-making as firms seek to adopt legitimate practices (Jennings and Zandbergen, 1995; North, 1990). International institutions, national governments, non-profit organizations, and publicly traded companies stress the importance of sustainability in its threefold perspective: economic, social, and environmental (Van Gorp and Van der Goot, 2012). In addition, companies in the same industry must behave similarly to retain their competitiveness and avoid being perceived as a business at risk (Banerjee et al., 2019).

Several examples of these kinds of pressures or key drivers prompting sustainable practices and SBMs by firms in the agrifood sector can be found within the umbrella of organizations such as the United Nations (UN), the Global Reporting Initiative (GRI), and the Ellen MacArthur Foundation (EMF). For instance, three of the 17 SDGs developed by the UN's 2030 Agenda (United Nations) are explicitly related to sustainable agricultural development: SDG 2.3, SDG 2.4, and SDG 12.3. There is a specific pack (GRI 13) within the GRI Standards (GRI) focused on the agriculture, aquaculture, and fishing sectors covering a wide range of economic, social, and environmental topics (e.g., economic inclusion, employment practices, food security, and pesticide use) aligned with the SDGs. Agricultural activities are also closely linked with the technical and biological cycles of the Circular Economy Scheme (Ellen MacArthur Foundation), contributing to a more sustainable production and consumption system through, for example, regenerating food production or reducing food waste.

Based on the PESTEL framework (see, for example (Yüksel, 2012),), we identified different factor categories to analyze the key drivers in the institutional context that could affect farms in their transition toward SBMs. For example, these include fair trade policies and funding opportunities (legal-political), interest rates and economic growth (economic), health threats and lifestyle attitudes (socio-cultural), artificial intelligence and patents (technological), and global warming and drought risks (environmental).

The Signaling Theory (Spence, 1973) can contribute to identify and explain the second external key driver that may have an influence on the transition process towards more SBMs. This theory, which states that firms' signals enable them to communicate their organizational image, intentions, behavior, and performance (Karaman et al., 2020), has gained relevance in the analysis of sustainability practices in the last decade. However, there is further research to be done in this area (Spence, 1973), especially in the field of agriculture, where it might help to explain what drives some farmers to adopt sustainable production practices (see, for example (Castro-Campos, 2022),), and consequently, enables them to develop a more sustainable BM.

As Dessart et al. (2019) state, signaling motives may push farmers to adopt more sustainable practices. Thus, leading farmers might become beacons for other farmers if their SBM activities appear to contribute to their success. These leading farmers could serve as role models and encourage others to become more sustainability-oriented. Similarly, farmers who decide to turn their business model into a more sustainable one might also serve as a reference to other parties (suppliers, consumers, society, etc.).

The third external key driver identified is related to the Stakeholders Theory. According to Freeman (Freeman, 1984, p. 46), stakeholders are broadly defined as "*any group or individual who can affect or is affected by the achievement of the organization's objectives*". Firms' interactions with stakeholders play a central role in their corporate strategy (Dentoni and Peterson, 2011) since stakeholders' engagement influences key aspects of their business management and the economic, social, and environmental value of a firm in the medium and long term (Kassinis and Vafeas, 2006; Werther and Chandler, 2011). Thus, it is important for firms to actively manage their relationships with all their stakeholders (Clarkson, 1995) by establishing lasting alliances with them (Rowley, 1997).

The firm-stakeholder relationship is found in any sector of activity, including the agrifood sector. Considering the previous arguments, it seems that developing SBMs in this sector requires the engagement of all a farm's stakeholders to reap the benefits. Stakeholders can be classified into two groups: internal and external (Mitroff, 1983). In this sub-section, we focus on the first group (external stakeholders), while internal stakeholders will be analyzed in the next section.

External stakeholders (e.g., suppliers, customers, associations, technical advisors, government, local communities, and the environment) are those who are not directly part of the farm but are in some way related to it and its activities (Delmas, 2001). These stakeholders may also play a role in developing and implementing sustainable practices (Delmas and Toffel, 2004) that lead farmers to more SBMs. For example, these processes could not be carried out without a stable, long-lasting, and trusting relationship with suppliers, who provide the raw materials and other supplies needed to carry out production. Similarly, they would not be possible without customers who value and buy the products resulting from farmers' sustainable production practices. The involvement of the local community and associations and institutions that support farmers (through advice, expertise, financial resources, etc.) and the infrastructure and other elements that make it easier for farmers to implement sustainable practices and SBMs are also crucial.

2.1.2. Internal drivers

Farmers' behavioral factors are part of our first set of internal key drivers that may affect the decision-making processes leading to SBMs. According to Dessart et al. (2019), three types of behavioral factors can be distinguished: dispositional, cognitive, and social. Dispositional factors are relatively stable and include individuals' internal variables such as personality, motivations, values, beliefs, general preferences, and objectives (Malle and Chadee, 2011). Cognitive factors are related to learning and reasoning. They include farmers' perceptions of the relative benefits, costs, and risks associated with a particular sustainable practice and whether they feel they are skilled enough to adopt this practice. Finally, social factors involve farmers' interactions with other individuals (e.g., other farmers or advisors), and they include social norms and signaling motives. Regarding the social factors, two points should be taken into account. Firstly, social norms and signaling motives have been previously analyzed as part of leading farms' behavior. Secondly, farmers' interactions have been described in terms of the Stakeholder Theory when interactions between farmers and external and internal stakeholders are analyzed.

These threefold behavioral factors can influence farmers' activities. For example, sustainability-oriented farmers (dispositional factor), farmers' perceptions of the lower risks associated with more sustainable agricultural practices (cognitive factor), their perceptions of the benefits associated with sustainability (cognitive factor) and/or a reliable network of advisors providing farmers with support on sustainability issues (social factor) might encourage sustainable changes in farmers' business models.

The second set of internal key drivers that we have identified refers to farmers' objectives. In this regard, as Thompson et al. (2022) state, is important to note that, not only objectives at the strategic, competitive, and functional levels should be considered when analyzing farmers' objectives. The higher-level goals that farmers seek to achieve, i.e., their mission, vision, and values closely related to their organizational culture, must also be taken into account. As Cyert & March (Cyert and March 1963) state, firms' objectives can be understood as the result of negotiation and adjustment among the different groups involved so that all of them feel their particular objectives have been sufficiently met. Thus, it seems that farmers' objectives, general goals, and values must align with the objectives or demands of their principal (external and internal) stakeholders. Since the decision to adopt sustainable production practices should be seen as a tool to help farmers achieve their objectives and transition to a more SBM, these sustainable practices must be coherent and perfectly aligned with these objectives. As Galpin et al. (2015) state, the more a farmer is oriented toward sustainability and the more sustainable the values that underpin his or her mission, vision, and strategic objectives, the more likely the farmer will be to make the transition toward a more sustainable production process.

The Resource-Based View is linked to the third set of internal key drivers. This theory states that firms are a heterogeneous combination of resources and capabilities that are not available to all firms under the same circumstances (Barney, 1991). This is precisely what can help firms achieve a competitive advantage (Barney and Hesterly, 2018; Peteraf and Barney, 2003) and their business objectives as long as they can efficiently manage their resources and capabilities.

According to Barney & Hesterly (Barney and Hesterly, 2018), resources are the available stocks of tangible and intangible assets. In the agrifood sector, tangible resources refer to land, machinery, plants, distribution networks, proximity to inputs and markets, financial resources, information technology infrastructure, trucks, vehicles, and raw materials, to give some examples. These assets add economic value to the farm by facilitating product production and distribution efficiently and cost-effectively (Barney et al., 2011). Intangible resources connote the non-physical resources or assets that a firm has at its disposal (Barney et al., 2011). In this case, they include the knowledge, experience, motivation, commitment, etc., that workers put at the disposal of the farm and the landowner, as well as the production processes and other technologies needed to manage the farm.

Capabilities are the abilities used by firms to identify and transform resources to achieve a particular result (Aghazadeh et al., 2022). Thus, some examples of capabilities can be the abilities of farm owners, managers, family members, and employees to manage farms more sustainably and innovatively. This implies the ability to identify changes in the environment and deal with them as quickly and flexibly as possible while taking advantage of the opportunities the environment provides (e.g., further development of sustainable production technology) and minimizing the effects of threats (e.g., water resource depletion).

Finally, the four set of internal key drivers identified refers to the previously mentioned Stakeholders Theory. As we explained before, the interaction and the establishment of long-lasting relationships between farms and their external stakeholders are vitally important. However, it is also true for internal stakeholders. These internal stakeholders are part of the farm itself (e.g., owners, managers, family members, and employees), and they are fundamental to the development and implementation of sustainable production practices (Meixell and Luoma, 2015) and to making the transition from a more "traditional" business model to an SBM. Owners and managers should be sustainability-oriented and embrace sustainability in its triple-bottom-line (TBL): economic, social, and environmental. They should also be able to efficiently manage the resources and capabilities needed to undertake these practices and possess the know-how to transmit and share these values with other farm members (family and employees) to gain their involvement and commitment to this process (Sarkis et al., 2011). All of these internal stakeholders are undoubtedly key players in developing and implementing sustainable production practices and consolidating SBMs.

2.2. Stages and agents involved in the sustainable implementation

Given the key drivers previously identified, we propose the FISAP to guide agrifood actors, particularly farmers, in assessing the benefits of moving toward a more SBM from a threefold perspective: economic, social, and environmental. The FISAP is an iterative process that guides farmers through the stages from identifying the baseline situation and potential problems to developing and implementing sustainable production practices to obtain better results.

As depicted in Fig. 1, the FISAP comprises four main stages: 1) definition, 2) decision-making, 3) implementation, and 4) evaluation. The following sections elaborate on these four stages, identifying the (internal and external) key drivers to be considered, and the internal or external stakeholders that may play an active or passive role depending on the stage. As will be explained below, the key drivers become more

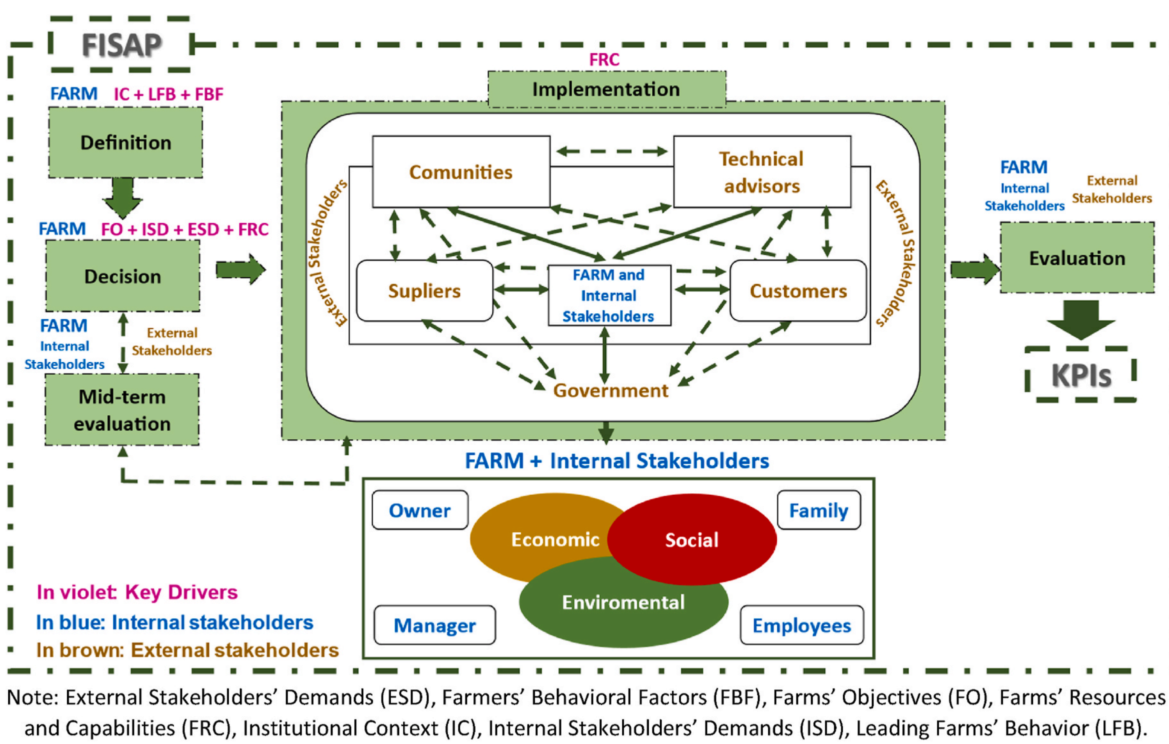

Fig. 1. Framework to implement sustainable agriculture practices (FISAP)
Note: External stakeholders' demands (ESD), farmers' behavioral factors (FBF), farms' objectives (FO), farms' resources and capabilities (FRC), institutional context (IC), internal stakeholders' demands (ISD), leading farms' behavior (LFB).

relevant in some stages than in others depending on each stage's performed actions and stakeholders' expectations/objectives and resources and capacities. In addition, following Mahoney's classification (Mahoney, 1994) to define agents' involvement and, consequently, their different role in each stage, we use the "active and passive" terminology. Active stakeholders are those who seek to participate in the organization's activities, being or not part of the organization's formal structure, that is, those who are more directly involved with the farm's business activity and have a greater capacity for decision-making and action in the short term (for example management, employees, family members or even some parties from outside an organization such as environmental pressure groups). Passive stakeholders, in contrast, are those who do not normally seek to participate in an organization's policy making, that is, they do not wish to take an active part and make decisions in the short term about the organization's strategy. This type of stakeholder will include, for example, government, technical advisors, or local communities.

2.2.1. Definition

The definition stage refers to key drivers that might influence farmers' decision-making processes when they consider developing and implementing sustainable production practices to move toward more SBMs. This stage includes both external and internal drivers.

Farmers are the main active agents in this stage. As the application of sustainable practices is highly context specific (Nawaz and Koç, 2018) the starting point is to define and analyze the context of the farmers' activity and consider initiating a transition toward SBMs. Farmers must be aware of the key external drivers (i.e., institutional context and leading farmers' behavior) that might influence their decisions, identify these external drivers, and be ready to exploit the potential they offer. In the institutional context, for example, a new law obliging farms to become more environmentally friendly (e.g., banning the use of certain pesticides) or advances in technology (e.g., helping to save water in irrigation systems) might be considered key factors in bringing more sustainable changes to farmers' business activities. According to the Signaling Theory, leading farms serve as role models and facilitators for other farms since they have already overcome some barriers that other companies will no longer have to face or will be able to overcome more easily. Additionally, farmers must be aware of their own behavioral factors (key internal drivers) since these factors can make the transition process easier (e.g., farmers who are sustainability-oriented) or more complex (e.g., farmers who perceive more sustainable agrifood practices as risky).

2.2.2. Decision-making

This second stage includes three fundamental steps of which farmers should be aware of: 1) context diagnosis; 2) identification of available sustainable practices, and 3) selection of the best suitable alternative.

Regarding the diagnosis of farms' context, pushed by the set of key drivers previously mentioned (institutional context, signals sent by leading farmers, and farmers' behavioral factors), which are part if this context, farmers tend to be more sustainability-oriented and more willing to apply sustainable practices in their production activities. This means that farmers need to be clear about their own principal objectives (internal drivers) and their (internal and external) stakeholders' demands in order to determine what kind of available sustainable production practices are the most suitable (Baumgartner and Rauter, 2017). In this regard, some relevant issues should be born in mind, such as how farms can grow and create value through their business models (farm's objectives) while meeting employees' expectations in terms of working conditions (internal stakeholders' demands) and satisfying customers' needs concerning product quality (external stakeholders' demands). Moreover, this first step entails that farmers must be aware of the resources and capabilities necessary to develop and implement sustainable practices leading to more SBMs and how to manage them efficiently (Nawaz and Koç, 2018). This implies, for example, implementing and using new technologies to reduce resource consumption (i.e., energy, raw materials, etc.), improving farmers' and workers' sustainability knowledge and training, and working with suppliers who meet specific sustainability criteria, among others. The identification of the available sustainable agrifood practices is a relevant second step to bridge the gap between farmers' intention to transform their agrifood activities in SBMs and perform this kind of behavior. This means that farmers should get knowledge on different available agrifood sustainable practices that could be applied to their BMs, considering their internal and external context. Finally, the last step is focused on the actual decision-making process in which farmers must choose what type of practice or practices are most appropriate to apply on their farms.

As in the first stage (definition), in this second phase, key external and internal drivers come into play and farmers still are the main active actors involved, as they are the decision-makers. However, it should be noted that stakeholders (both internal and external) indirectly begin to take also center stage as their demands, objectives, and interests must also be considered in this decision-making process.

2.2.3. Implementation

This is the stage in which farmers must implement the strategies and actions defined in the decision-making stage by efficiently managing their resources and capabilities. Thus, farmers are relevant and active agents in this stage since they assume most of the responsibility, and one of their main functions is to guide the transition toward implementing more sustainable practices. In this stage, other external and internal stakeholders also play significant active roles by supporting and complementing the decisions taken by farmers. As several studies state (Ferraro and Beunza, 2018; Haleem et al., 2022; Nygaard et al., 2021), it would be neither possible nor realistic to implement sustainable practices or set up SBMs without stakeholders' cooperation. Only through active communication and coordination between both parties (farmer and stakeholders) are farmers able to develop and implement sustainable production practices that are truly mutually beneficial and likely to succeed.

Furthermore, it is important to highlight the influence of one of the previously mentioned internal key drivers, i.e., farms' resources and capabilities, such as financial assets and land or innovation skills, which farmers must efficiently coordinate. Although these resources and capacities are intrinsic to the farm itself, as the extended Resource-Based View (Barney, 2001; Lavie, 2006) states, resources can also be derived from interrelations with the farm's external stakeholders.

2.2.4. Evaluation

Once farmers have implemented the previously selected sustainable agriculture practices, it is essential to monitor them in an evaluation stage. The primary purpose of this stage is to assess the impact these sustainable practices have on crops with a TBL using a set of KPIs.

At this point, it is important to highlight two issues. Firstly, as in other management processes (see for example (Nawaz and Koç, 2018)), the FISAP should not be considered a rigid linear framework where the four stages mentioned above (definition, decision-making, implementation, and evaluation) take place consecutively, ending with the evaluation. The FISAP should be understood as iterative, flexible, and adaptable involving feedback to emerge from each phase (Lindenmayer and Likens, 2009) to improve and enhance the FISAP as a whole. Secondly, it should be noted that the evaluation stage should not necessarily be performed only after the implementation stage, as can be seen in Fig. 1. A mid-term evaluation could be carried out during the implementation stage to inform the farm owner/manager about how the process is going and whether it needs to be redirected (Nawaz and Koç, 2018).

Farmers and internal stakeholders play the main roles of carrying out the evaluation process in this stage. They must analyze the data obtained through the KPIs and assess crop performance by comparing the results obtained before, during, and after implementing sustainable agriculture practices. It should also be noted that external stakeholders (e.g., customers and suppliers), without whose valuable feedback the evaluation would be impossible to perform, can play also important and active roles in this phase.

3. Key performance indicators

3.1. Concept

From a conceptual point of view, a KPI is a metric measuring how well an organization or individual performs an operational, tactical, or strategic activity that is critical for the current and future success of the organization (Kerzner, 2011). It is a quantifiable measure of performance over time for a specific objective. It provides targets for teams to aim for, milestones to gauge progress, and insights that help people throughout the organization make better decisions (Vintila, 2022). As stated in Domínguez et al. (Domínguez et al., 2019), KPIs can be used for purposes that can be classified into two groups, depending on whether they aim to evaluate the past or present economic performance (Pintzos et al., 2012) of a monitored system or predict the future behavior of a system. Specifically, we propose a list of KPIs that may help monitor the impact of sustainable farm activities. By using KPIs, in addition to economic performance, every farm owner will be aware of his or her farm's impact on the environment and society as a whole (Vintila, 2022).

When analyzing KPIs, it is necessary to consider the different perspectives of the performance measures, the reasons or rationale why an indicator has to be defined must be exposed, and, finally, the scope considered in each case. Firstly, regarding performance assessment perspectives, there are various existing approaches. According to Looy & Shafagatova (Van Looy and Shafagatova, 2016), four criteria for perspective definition can be mentioned: domain, focus, target groups, and organizational level. The domain criterion is related to the performance measures' strategic context (Booth et al., 2021). An example of the second criterion (focus) is the differentiation between drivers and outcomes. The third criterion is the target group, distinguishing among shareholders and top management, customers, suppliers, society, the environment, and employees. The fourth criterion is the organizational level at which the KPI is defined. For example, this criterion is used by Estampe et al. (2013) to differentiate three perspectives: strategic, tactical, and operational. Secondly, the rationale of a KPI is the description of why it is necessary to define the performance measure (Livieri et al., 2014). Thirdly, concerning scope, generic (i.e., transversal to different contexts) or specifically defined KPIs can be considered. The scope of the KPIs can also be focused only on particular areas of application (Domínguez et al., 2019).

To define and develop a specific KPI, different features can be taken into account. These properties include basic characteristics (KPI identifier, its name, and its textual description in natural language), aspects of calculation (e.g., the hardness of a KPI, which may be related to its subjective or objective nature, the specific formula that determines the calculation, the type of data expressing the KPI, and the unit of measure), related human resources, and the relationships among the KPIs. In this sense, another aspect to consider is that when KPIs are developed, different people, roles, and even departments within an organization are involved in their development (related human resources). Finally, it is necessary to state that dependencies among KPIs (relationships) can be explicitly specified by representing the components used in the computation formula (Diamantini et al., 2014). These relationships among components can lead to basic, compound, derived (such as the sum or ratio of two existing indicators), or aggregated KPIs (for example, the average of other indicators).

3.2. Methodology to build the KPIs

As mentioned earlier, KPIs should be included in the fourth stage of the FISAP to assess the farm's sustainable performance. To do this, a SLR is carried out as a way of managing a growing number of studies and ensuring that no relevant research has been overlooked (Pereira et al., 2014). According to Thomé et al. (2016), SLR surpasses narrative reviews in the sense that it adopts a more rigorous and well-defined review process, which follows clear guidelines to ensure more transparency, reliability and reproducibility of findings. Our SLR is in line with the SALSA protocol (Booth et al., 2021). This protocol is a framework to analyze whether an analysis methodology guarantees a comprehensive analysis based on four characteristics: systematic, complete, explicit, and reproducible. The acronym SALSA comes from the following acronyms associated with the protocol stages: Search, Appraisal, Synthesis, and Analysis. Finally, this SLR follows five main steps which are described below according to the orientations of Colicchia & Strozzi (Colicchia and Strozzi, 2012), Jesson et al. (2011), Thomé et al. (Thomé et al., 2016), and Tranfield et al. (2003).

Step 1: Question formulation

Aiming to achieve the objective of the study, i.e. explored the most frequently KPIs used in the agricultural practices, a review question was addressed: What are the KPIs used in the context of agrifood sector?

Step 2: Locating studies

We critically analyzed academic and practice literature as well as internationally recognized standards focused on assessing economic, social, and environmental performance. Although we did not limit ourselves to the agricultural context in this initial search, specific literature in this context took priority. Economic indicators include proxies for an organization's impact on resources, mainly at the shareholder level. Social indicators deal with labor practices, human rights, and broader social issues affecting a wide range of stakeholders. Environmental indicators deal with assessing an organization's impact on the environment via its products and services and activities (Hřebíček et al., 2012). During the period September 2022–January 2023, we relied upon Google Scholar, the Scopus academic database, and Science Direct, and based on the constructs embedded into the review question, keywords were listed to develop search queries. Specifically, we entered keywords such as "sustainability indicators," "sustainability assessment, " "sustainable performance," "economic indicators," "social indicators," "environmental indicators," "sustainable KPIs," "economic KPIs," "social KPIs," and "environmental KPIs," in combination with "agricultural sector," "agriculture," "agrifood," and "farming." The keywords included several variations of the original keywords, for example, singular and plural variations, synonyms, and combinations of keywords. This literature search generated articles that provided useful information about how to assess sustainable performance in the agrifood sector. Websites of leading organizations in sustainability (e.g., GRI) or sustainability in the food sector (e.g., FAO) were also checked. Regarding the environmental indicators, the European guidelines for monitoring the environmental impact of activities were reviewed, and indicators derived from the Product Environmental Footprint (PEF) guide were added to the initial set (Manfredi et al., 2012).

Step 3: Study selection and evaluation

From the 347 articles identified in the first search, 184 were selected after checking if the content in the titles and abstracts are related to KPIs, and also eliminating the duplicates (1st selection). The introductions and conclusions were then read to choose only articles that would certainly help answer the proposed review question, reaching the number of 81 articles (2nd selection). Finally, after reading the full articles, they were evaluated into general assessment criteria (3rd selection). At the end, 70 articles were selected to finally answer the proposed research question.

Step 4: Analysis and synthesis

Each of these documents was carefully reviewed to identify different ways of assessing agricultural sustainability. We first grouped the KPIs under the three sustainability domains. It is necessary to mention that although there might be overlaps between the KPIs and their domains, the KPIs are grouped according to their most direct impact. In cases where similar indicators were shown in more than one paper, we grouped them together.

Step 5: Presentation of results

The final stage is presenting the findings, which answers the review question by listing the KPIs found in the literature. Initially, we derived a set of 326 potentially relevant and sustainable KPIs. In the second step, we tried to structure these 326 KPIs into a condensed but complete set of indicators following a three-step approach. Starting with the three sustainability domains, we coded the themes of the KPIs to further develop the structure. As the majority of economic and environmental indicators may only have the farm itself and/or the shareholders/owner as targets, the theme was considered the first reference level of analysis for this type of indicator. For social indicators, stakeholder-related issues were considered; that is, at the first level, several farm-related stakeholders (both internal and external) were identified, and themes for each of them were coded. The literature review showed that several stakeholders might be affected by a farm's social commitment and practices, and, therefore, social indicators were grouped at this double level (stakeholders and theme). We must also mention that the 326 initial indicators were reduced to 133 KPIs for the following reasons. Firstly, the indicators focusing on specific crops or sectors were dropped because they could not be used to evaluate all the agricultural firms. Secondly, when several indicators captured the same magnitude using different measures, we decided to keep the most relevant measure, which was more often found in the previous literature. Finally, we dropped the indicators that evaluated specific aspects of one theme or stakeholder to obtain a more objective measure and avoid over-representing some themes. Thus, we ended up with 33 economic KPIs, 61 social KPIs, and 39 environmental KPIs (a total of 133 KPIs).

In addition, we derived a hierarchical structure (i.e., the KPI tree) that is consistent with some notable frameworks used to assess different types of performance dimensions (e.g., the SCOR framework by the Supply Chain Council), and it is coherent with the structure of several sustainable performance frameworks (e.g., SLCA and SAFA). For each KPI, its basic characteristics have been described (identifier, name, and textual description). Regarding the calculation features, both hard and soft variables have been proposed since, in some cases, the indicator is qualitative (e.g., assessing whether the inter-generational continuation of farming activity is ensured or whether a farm helps to improve its community in terms of education, working conditions, and quality of life). In other cases, it is a measurable and quantitative variable (e.g., farm total sales revenue or the total number of employees). Furthermore, the type of data in which the KPI is expressed and its unit of measure are provided (e.g., local currency for economic variables, tons for mass production, percentages, a five-point Likert Scale for the most subjective and qualitative measures, etc.). The specific formulas that determine the calculation are also shown when needed. In some cases, there is a relationship or dependency among some KPIs or the items used to build them.

3.3. Description of the KPIs

A comprehensive list of indicators to be considered in the last stage of the FISAP was derived from the initial analysis of the existing frameworks. As stated before, to structure the KPIs, we grouped them by themes. For the *economic domain* (Table 1), the set of KPIs has been divided into six themes (competitiveness, economic independence, financial and economic performance, innovation, investment, and resource use) based on the issues-categories proposed by Warhurst (2002) and Zahm et al. (2008). These themes capture the capacity of the firm to compete in the market and to obtain financial results, evaluating aspects such as national and international sales, assets and liabilities, and subsides. In addition, they evaluate the productivity of the firm in terms of physical and human resources, but also considering the efficacy and efficiency of the company in terms of labor and material costs, prices, gross added value, and mass production. Finally, the farms' investments in fixed assets, human training, and innovation were evaluated.

Table 1
Overview of economic KPIs.

Theme	Number of KPIs	Issues
Competitiveness	4	Market activity, market share, total production, weight yield of crop
Economic independence	6	Farm diversification I, farm diversification II, debt to equity, liquidity, solvency, subsidy dependency
Financial and economic performance	10	Production cost, production cost per hectare, income (price), market indicator, profitability I, profitability II, economic results I, economic results II, economic results III, economic results IV
Innovation	1	R&D Investment
Investments	2	Investment in farms I, investment in farms II
Resource use	10	Productivity (labor), productivity (land), plan lifespan, resource efficiency (energy), resource efficiency (labor), resource efficiency (land) I, resources efficiency (land) II, resource efficiency (operational), resource efficiency (production), resource efficiency (water)

Source: Own Elaboration

In the *social domain*, different themes cover the effects on different stakeholders, including the actors impacted by farmers' activities. Social themes, therefore, include aspects connected to seven stakeholders (the owner, employees, suppliers, customers, associations, local community, and the environment). Firstly, we identified 16 social themes that evaluate the personal characteristics of the owner by analyzing aspects such as his/her level of education and autonomy, capacity to accept suggestions and advice from external parties, and satisfaction and motivation. Secondly, social indicators consider whether employees have enough job opportunities and evaluate their health and labor risks. The diversity in the company and employees' satisfaction and training were also included. Thirdly, in these social themes, we evaluated the stability of the relationship between the company and its suppliers, the freedom to choose local and international suppliers, and their responsible practices. Fourthly, customers' satisfaction with the quality of the foodstuff produced, the value system and ethics of the firm, and the amount of information customers have about the sustainable practices of the company were included. Finally, companies can be evaluated according to their involvement in associations linked to the environment, their commitment to professional associations, their relationships with the community, the number of jobs created, their participation in each level of government, and the degree of a farm's commitment to social and environmental practices. It is worth mentioning that a possible gender bias occurs in this domain since women seem to be more ethical and committed to corporate social responsibility and sustainability (Bear et al., 2010; Cabeza-García et al., 2018; Post et al., 2011), and their traditional participation in agricultural activities also has an influence (Singh, 2014). Specifically, the number of female employees on farms, gender-based wage differentials, and the involvement of women in agricultural decision-making processes have been taken into account when defining the KPIs. The specific number of indicators and themes considered for each stakeholder is summarized in Table 2 and shown in the Appendix.

Finally, in the *environmental domain,* we consider the main environmental aspects affected by agricultural practices. Through environmental indicators, it is possible to better understand the complex issues involved in agriculture and the environment, to show developments over time, and to provide quantitative information. These indicators can also be tools to analyze the sustainability of productive systems since the effects of crop management on the environment and human health can be compared. Different aspects can be investigated with agro-ecological indicators, starting with nutrient management, fossil energy use, pesticide and fertilizer use, organic matter use, pollutant emissions, crop rotation, biodiversity, and landscape assessment. Table 3 shows the 6 themes (Human Health, Air, Soil, Biodiversity, Energy, and Water) considered in the environmental domain. These themes can be measured through 20 KPIs to evaluate individuals' exposure to chemical products and the chemical pressure put on fields. We also analyze the amount of greenhouse gases directly or indirectly released into the atmosphere and the Ecological and Carbon Footprint as a consequence of firm activities. Moreover, we consider the percentage of organic matter contained in the soil and the risk of soil compaction through firm activities. We assess the chemical ecosystem hazard score, the farm's use of fuel from renewable sources, the types of water used for crop irrigation, radiative forcing as global warming potential, and human exposure efficiency relative to U-235. Finally, to provide a complete vision of a firm's effect on the environment, we assess abiotic resource depletion – ADP ultimate reserves. These indicators can help transform the physical and monetary data about human activities and the state of the environment into information that guides decisions, highlighting the most sustainable practices to be implemented in the field.

The Appendix shows a complete list of the KPIs of each domain and theme. It is supplemented with the individual bibliographic sources from which we derived the metrics and the description of the KPIs. In some cases, the bibliographic references for the metrics and descriptions were refined according to the specific nature of our context, where we were careful to maintain a balance between thoroughness and the effort required for assessment.

Finally, Fig. 2 shows the hierarchical structure of the KPI assessment framework, including the organization in the three primary levels of the hierarchy.

4. Conclusions

This study proposes a framework (FISAP) for SBMs in the agrifood sector consisting of four main stages (definition, decision-making, implementation, and evaluation). For each stage, several drivers have been analyzed to foster farms' sustainable performance. We also point out the divergent external and internal drivers of sustainable practices and explain the effects exerted by each of these key drivers using several management theories, such as the Institutional Theory, Signaling Theory, Resource-Based View, and Stakeholder Theory, among others. In addition, considering a lack of consensus in previous literature about the most relevant KPIs to assess the effects of sustainable practices on farm performance, we provide a complete set of 133 KPIs to be applied in different agricultural contexts in the evaluation stage.

Based on the *Institutional Theory,* in line with the results of the previous literature (Jennings and Zandbergen, 1995; North, 1990), we conclude that different external factors involving farms' institutional contexts (e.g., fair trade policies, public health concerns, resource scarcity, and extreme weather conditions) might influence farmers' decisions to gain legitimacy by implementing sustainable agriculture practices. Similarly, considering mimetic isomorphism within the framework of the Institutional Theory, we suggest that a greater focus on farm sustainability may also result from peer industry pressure as farmers wish to retain their competitiveness, as previous studies have stated (Banerjee et al., 2019). At the same time, by applying the *Signaling Theory* to analyze the role played by farms that are pioneers in implementing sustainable agriculture practices, we propose, in line with previous research (Castro-Campos, 2022; Dessart et al., 2019), that actions such as water-efficient technologies and sustainable supplier agreements can be seen as key drivers for other farms to move toward more SBMs. In terms of internal factors, according to the previous literature on strategic management and competitive strategy (Barney and Hesterly, 2018; Peteraf and Barney, 2003; Barney et al., 2011), we have introduced the *Resource-Based View* in our analysis, thereby stressing the importance of farmers efficiently managing their resources and capabilities (e.g., land, technology, and employees' skills) to achieve their sustainable objectives while meeting their main (external and internal) stakeholders' demands. As far as stakeholders are concerned, *the Stakeholder Theory* has been used to explain the influence of other potential internal and external key drivers on farm sustainability. Our proposed framework (FISAP) highlights that (internal and external) stakeholders' influence is crucial to firms' corporate strategy and other aspects of their business activity (United Nations; Kassinis and Vafeas, 2006; Werther and Chandler, 2011) and especially in developing and implementing sustainable practices (Meixell and Luoma, 2015; Sarkis et al., 2011). Therefore, it is relevant for firms to actively manage their relationships with their main stakeholders (Rowley, 1997). Since SBMs

Table 2
Overview of social KPIs.

Stakeholder	Number of KPIs	Themes or Issues
Owner	10	Support, education and training, autonomy, management, motivation, satisfaction, wage and income level
Employees	23	Career, diversity, labor, satisfaction, education and training, wage and income level
Supplies	5	Diversity, autonomy, budget, network, responsible practices
Customers	6	Food, networks
Associations	4	Networks
Local community	10	Networks, labor, social commitment
Environment	3	Environmental commitment

Source: Own Elaboration

Table 3
Orview of environmental KPIs.

Theme	Number of KPIs	Issues
Human Health	3	Human tox score, dose area index, treatment frequency index
Air	2	Carbon footprint, carbon sequestration
Soil	5	Ecological footprint, organic matter, soil coverage, erosion, soil compaction
Biodiversity	2	Biodiversity (land use-based), eco tox score
Energy	3	Fuel use, renewable fuel, waste
Water	5	Water footprint, water supply, water use technical efficiency, acidification I, eutrophication
Product Environmental Footprint (PEF)	19	Climate change, climate change (fossil), climate change (biogenic), climate change (land use and transformation), ozone depletion, human toxicity (non-cancer effects), human toxicity (human cancer effects), respiratory inorganics, ionizing radiation HH, photochemical ozone formation, acidification II, terrestrial eutrophication, freshwater eutrophication, marine eutrophication, freshwater ecotoxicity, land use, water scarcity, resource use (energy carriers), resource use (mineral and metals)

Source: Own Elaboration

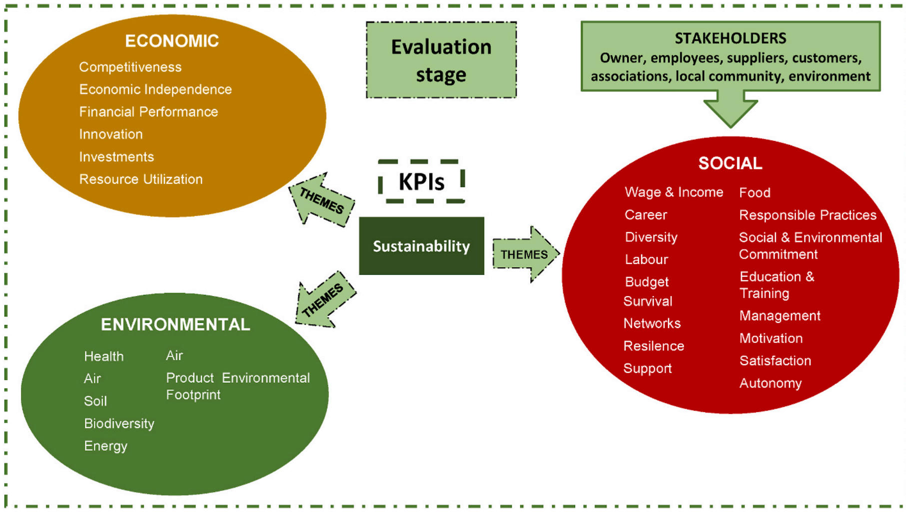

Fig. 2. Framework to implement sustainable agriculture practices (FISAP).

require a strong connection among all the internal and external agents, we can conclude that paying more attention to all these agents is essential in the agrifood sector due to their impact and implications not only for farms but also for society. The conceptual and practical framework developed (FISAP) allows us to determine the relevance of each agent in each of the stages toward a more SBM. It seems that farmers play the primary role in the first two stages (*definition* and *decision-making*), where they should be aware of the key internal and external factors (farmer's behavior and institutional context, respectively) that can make them more sustainability-oriented and support them in the transition process toward SBMs. While farmers continue to play a key role in the two following stages (*implementation* and *evaluation*), the roles of their internal and external stakeholders (employees' and shareholders' behavior, and citizens and community, respectively) are relevant. Without the support of these stakeholders, it would be impossible to implement sustainable agriculture practices and perform a TBL assessment of the process.

Regarding the set of KPIs, we propose a more complete set in terms of variety (TBL), depth (definition, measurement), and approach (complementary and integrative perspective) than previous studies. Thus, these KPIs can serve as a guide for researchers, managers, farmers, and policymakers to assess sustainable agriculture practices. The fact that these indicators are also classified into different themes allows all the agents involved in the process to evaluate farmers' performance for each dimension of the TBL and propose specific recommendations to improve the implementation of sustainable practices.

Our study has several implications for farmers, managers, policymakers, and academics. Firstly, the framework (FISAP) and the KPIs provided in the study are practically oriented to improve farms' transition from "traditional" BMs to SBMs. The FISAP serves as a guide for farmers to implement sustainable practices in their farms and allows them to evaluate their (economic, social, and environmental) performance. The KPIs also provide farmers with recommendations about sustainable practices to be implemented in their farms. These sustainable indicators are in line with private and public certifications such as B Corp certification or the evaluation proposed by the FAO. They can serve as a tool to audit and orient farms to comply with external certifications, and, at the same time, they can be used by public organizations to evaluate degrees of sustainability in the agricultural sector. Secondly, managers from the agrifood and other sectors can use this FISAP and the KPIs since they can serve as a baseline for future sustainable projects, i.e., applied to specific crops or contexts. Thirdly, this study's orientation toward sustainability and, in particular, the framework proposed and the KPIs could help policymakers understand the role they should play to support the agrifood sector in enhancing sustainability. The potential economic, social, and environmental benefits for the institutional context derived from implementing sustainable agriculture practices might help policymakers design measures to support these practices, for example, by providing subsides according to companies' sustainable contribution or funding investments to reinforce the sustainable strategies proposed by sustainable farms. Finally, academia might be especially interested in the results of the present study, i.e., the updated literature review and the theoretical contribution of linking and applying several management theories and developing a practical framework with a complete set of KPIs. All of this contributes to filling the research gap on sustainability in the agrifood sector. Connecting traditional theories, sustainable practices, internal and external drivers, and the agents involved in the process contributes to linking theoretical studies and empirical practices. Moreover, the KPIs complement previous theoretical and empirical studies, showing a more complete and integrated view of sustainable indicators.

The current study is not free of limitations. The sustainable agriculture assessment framework (FISAP) has not been empirically applied, nor has a case study been performed. Thus, for future research, it would be interesting to carry out qualitative studies to corroborate the efficiency of the FISAP through an ongoing process and thus incorporate possible improvements as a result of real farm experiences. The evaluation of the BM proposed in this paper can also be complemented with the SWOT analysis or analyzing the competitive landscape, the cost structure or the revenues obtained. Moreover, apart from economic, social and environmental indicators, other types of measure could be included such as cultural or ethical.

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CRediT authorship contribution statement

Daniel Alonso-Martínez: Writing – original draft, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Beatriz Jiménez-Parra:** Writing – review & editing, Writing – original draft, Investigation, Conceptualization. **Laura Cabeza-García:** Writing –

review & editing, Methodology, Formal analysis, Conceptualization.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

Daniel Alonso-Martinez reports financial support was provided by Partnership for Research and Innovation in the Mediterranean Area. Daniel Alonso-Martinez reports financial support was provided by Spain Ministry of Science and Innovation. Beatriz Jimenez-Parra reports financial support was provided by Spain Ministry of Science and Innovation. Beatriz Jimenez-Parra reports financial support was provided by Partnership for Research and Innovation in the Mediterranean Area. Laura Cabeza-Garcia reports financial support was provided by Partnership for Research and Innovation in the Mediterranean Area. Laura Cabeza-Garcia reports financial support was provided by Spain Ministry of Science and Innovation. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

No data was used for the research described in the article.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.indic.2024.100434.

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