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Benchmarking the economic, environmental and societal sustainability indicators of conventional, Fairtrade and organic banana crop in El Oro province, Ecuador

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Lorenzo Bonisoli

Departamento de Economía y Empresa

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Benchmarking the economic, environmental and societal sustainability indicators of conventional, Fairtrade and organic banana crop in El Oro province, Ecuador

Evaluación de indicadores de sostenibilidad económica, medioambiental y social para los cultivos de banana convencionales, de comercio justo y orgánico en la provincia de El Oro, Ecuador

Doctorando

Lorenzo Bonisoli

Directores

Emilio Galdeano-Gómez

Laura Piedra-Muñoz

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a Rita e Raffaele

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ABSTRACT

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The sustainability of agricultural systems is a critical issue in particular in developing countries where millions of people depend on agriculture as their primary source of income. In the last years, the demand for certified products, i.e. Fairtrade and organic, has grown considerably so that many producers have adapted their processes to certified standards. This study aims to evaluate the sustainability of the Ecuadorian banana agri-system benchmarking the conventional against Fairtrade and Organic production. The methodology includes a qualitative analysis directed to identify the criteria for the inclusion of an indicator in the evaluation and categorise the most critical sustainability assessment tools. The report results in the identification of SAFA as the most suitable framework to apply in the assessment. The qualitative analysis of both criteria and frameworks has been undergone with the Deconstruction, a methodology for qualitative analysis derived from philosophy that consists of revealing the implicit understandings and hidden assumption that underpin a framework. The investigation has been conducted comparing the results of two samples: an association of smallholders organic and Fairtrade producers and an organisation of medium and large conventional producers. The results show that, even if some characteristics of the agri-system affect both conventional and certified producers, the latter demonstrate more sustainable outcomes in governmental, environmental and economic dimension while conventional farms perform higher marks in the social dimension. The reason for this last conclusion may depend on the size of the farms; hence, the last part of this study focuses on the SAFA App, the smallholder version of the SAFA tool. Ten smallholders have been surveyed and evaluated using the SAFA App. As a result, the instrument showed its capacity to understand and adapt to the Ecuadorian banana smallholders and revealed that if the smallholders is a member of an efficient association, the results are higher. A future study may analyse in-depth the smallholder's sustainability to provide a basis for decision-makers for the system' sustainability improvement.

RESUMEN

RESUMEN

La sostenibilidad de los sistemas agrícolas es un asunto de importancia crucial especificadamente para los países en vía de desarrollo en donde millones de personas viven de los ingresos generados por la actividad agrícola. En los últimos años la demanda de productos certificados, es decir de comercio justo y de producción orgánica, ha crecido considerablemente de manera que más productores han adaptado sus procesos a los estándares de las empresas certificadoras. El presente estudio tiene el propósito de evaluar la sostenibilidad de la producción convencional comparándola con la de la producción de comercio justo y orgánica. La metodología utilizada incluye el análisis cualitativo para identificar por una parte los criterios de inclusión para que un indicador sea insertado en la evaluación, y por otra parte la categorización de los instrumentos más relevantes de evaluación de sostenibilidad. El resultado fue la identificación de SAFA como el más apto instrumento de evaluación. El análisis cualitativo de los criterios y de los instrumentos fue desarrollado gracias a la *Deconstrucción*, una metodología cualitativa derivada de la filosofía que consiste en revelar las convenciones implícitas y las suposiciones sobrentendidas que sustentan un instrumento específico. La investigación ha sido dirigida comparando los resultados de dos muestras: una asociación de pequeños productores de comercio justo y orgánico, y una organización de medianas y grandes haciendas de banano convencional. Los resultados muestran cómo, a pesar de que algunas características del sistema bananero afectan los dos tipos de producción, los productores certificados tienen resultados más sostenibles en las dimensiones de gobernanza, medioambiente y economía, mientras que los productores convencionales muestran mejores resultados en la dimensión social. La razón de esta última conclusión puede depender del tamaño de la producción y por esta razón en la última parte del estudio el enfoque es sobre los pequeños productores bananeros cuya sostenibilidad es evaluada por SAFA App, la versión de SAFA específica para las explotaciones de menor tamaño. Diez pequeños productores han sido entrevistados y evaluados con SAFA App que no solo revela su capacidad de adaptarse a ellos, sino también que si la finca es parte de una asociación de productores eficiente también los resultados serán más sostenibles. Una posible investigación futura podría analizar más en detalle la sostenibilidad de los

pequeños productores bananeros para proveer a los tomadores de decisiones de una base para el desarrollo de la sostenibilidad del sistema bananero.

CHAPTER 1

INTRODUCTION

INTRODUCTION

1. Sustainability in agriculture

Among all assertions it is possible to rise in agriculture, the most important is undoubtedly that human beings depend on it for their life. Despite the agriculture production increased with a higher rate than population's, and per capita, agricultural production has outpaced population growth (Hazell and Wood, 2008), in the early twenty-first century about 800 million people are still in hunger (Pretty, 2008).

In this scenario, the importance of food production and agriculture become crucial. Besides, as developed countries are not projected to grow in population and agriculture accounts for just 2% of UE GDP and less than 5% workforce (Di Felice et al., 2012), crop area are expected to rise in the less developed countries.

For this reason, in the last years, many authors have investigated the impact of agriculture on sustainability and focused on new concepts and expressions, such as: biodynamic, biologic products, community-based, eco-agriculture, environmentally sensitive, farm-fresh, free-range, low input, organic, permaculture, cross-cropping. In synthesis, most authors agreed to focus the analysis on three dimensions: the economic factor, i.e. the capacity of agriculture to be rentable for the people working in it; the environmental factor, i.e. the capacity of using environmental goods without harming these assets; and the social acceptance factor, that is a broad aspect that includes, for example, the capacity to generate labour and to use health-friendly substances (Dolman et al., 2014; Parra-López et al., 2008; Pretty, 2008).

The methodologies applied to analyse the sustainability of an agri-systems have been variegated, and authors implemented:

- List of indicators (Bockstaller et al., 2015, 2008; Bockstaller and Girardin, 2003; de Olde et al., 2016a; Girardin, 2000).
- Evaluation of environmentally sustainable alternatives, such as Life Cycle Assessment or Emergy models (Foteinis and Chatzisymeon, 2015; Guerrero and Muñoz, 2018; Spierling et al., 2019; Wu, Wu et al., 2014; Wu, Yang et al., 2014; Zhang et al., 2013).
- Eco-indexes (Acosta-Alba and Van der Werf, 2011; Dantsis et al., 2010).

- Linear programming models (Pacini and Giesen, 2002; Paracchini et al., 2011; Rossing et al., 2007).

Nevertheless, many works of sustainability evaluation have revealed some recurring shortcomings. According to Binder and Feola (2010), it is possible to identify at least the following:

- Authors generally fail incorrectly addressing the multifunctional character of agriculture (Rossing et al., 2007).
- Many studies, despite the evaluation of the three dimensions of sustainability, develop imbalanced assessments in which one dimension (generally environment) receives more attention (vonWirén-Lehr, 2001).
- The majority of analysis is focused on the identification of technologies that may foster more sustainable practices, but they miss to emphasise the implementation of those technologies (Groot et al., 2007).
- The results of many works are challenging to be used by decision-makers and hard to be understood by laypeople (Morse et al., 2001).

In the last years, the methodology used by the majority of authors focused on the use of indicators. Indicators/These are "synthetic variables describing complex systems" (Castoldi and Bechini, 2010), and each of them regards a particular aspect, such as the use of pesticides for hectare or no renewable energy consumption. Therefore, the analysis of sustainably requires several indicators.

This point leads to two critical problems: the first concerns the methodology that allows recognising the appropriate indicators; as sustainability regards different aspects, and all aspects are strictly related to the singular analysed agro-system, indicators must fit the particular features of the analysed system accurately. The second problem regards the data elaboration: all indicators must be integrated into just one evaluation model that allows synthesizing all different aspect in a measurable judgement in order to allow the public to understand the results.

Regarding the first topic, several authors considered the importance of the analysis of a specific situation and the consequent involvement of local farmers, policymakers, researchers, agroecological association. Interviews, focus groups, workshops, qualitative and quantitative analysis were the main procedures (Colomb et al., 2013). Moreover, indicators were pondered in order to match with methodological criteria such as policy relevance, measurability, validity/analytical soundness or level of aggregation/communication to the user. Then indicators were classified considering the five Sustainability Livelihood Assets, i.e. the “assets” or “capital” directly affected by agriculture: Natural capitals, e.g. water supply; Social capitals, e.g. cooperation, trust etc.; Human capitals, e.g. knowledge, skills; Physical capitals, e.g. infrastructures; Financial capitals, which can be defined as the accumulated claims on goods and services (Pretty, 2008). Finally, indicators were divided in external and internal, where the former represents those relevant to researchers' assessment of sustainability and the latter are those relevant and valid to the resource users (Fernandes and Woodhouse, 2008).

To cope with the variety of approaches, in the last years, many authors have developed a considerable number of frameworks directed to assess the sustainability of an agri-system. Frameworks (or Sustainability Assessment Tools, SATs) are approaches that provide a methodology and a focus and usually a list of indicators to be applied.

2. Ecuadorian agriculture

A first exploratory investigation of Ecuadorian agriculture has to consider that it is characterised by an unequal and unbalanced structured in which 63.5% of total 842,900 producers account for less than 5 ha each and sum just 6.5% of total cultivated land. Also, since the Sixty's arable land and pasture have increased considerably at the expenses of forest land, which decreased by 26%during the period 1960-2004 (Garcia Pascual, 2006).

Regarding production volume, Ecuadorian agricultural production improved by 27% in 1990-2004 and though it is heterogeneous in variety of yields there was a relevant augment in products for exportation and urban mass consumption such as fruits (29.6%), cereals (38%), or flowers (669%) and in the livestock sector poultry (206%), sheep (158%) and pork (76%). Despite that, the gap in productivity with developed countries rose dramatically, for example, the difference in cereals average output between the US and Ecuador increase about 22% during 1980-2004 (Garcia Pascual, 2006).

Two critical phenomena jeopardise the entire sector: out-migration and climate changes. Migration from rural areas undermined the traditional family farm structure and forced farmers to apply shift in agriculture strategies in order to face the demographic change (Gray, 2009). Climate changes weakened agriculture productivity with changes in hydrology, soil physical features and plague population (Perez et al., 2010).

Finally, poverty is still a pivotal issue in Ecuador, in 1999 62% of population lives under the poverty line, 27.1% of under five years old children suffer from chronic undernutrition, and 14.8 are underweight (Farrow et al., 2005).

Ecuadorian agriculture has been characterized in recent years for a tendency to labelled produce in their principal sub-sectors.

3. Labelled products

Over the past two decades, globalization has spread Neo-liberal policies around the world with a relevant increase in competitiveness, rivalry and predation. This process reshaped agriculture in particular in Latin America from a model in which more products were grown for the internal market to a model relied on few items massively prepared for the wealthy markets of developed countries. The growing importance of western multinational dealers undermined local governmental regulations and started a process of unplanned exploitation of environmental resources and social forces, such as labour force (Raynolds et al., 2007). Besides, even farmers and local peasants' health was endangered (Oyarzun et al., 2013).

In order to fill the absence of governmental regulation, many private institutions (non-governmental organizations, NGOs) rose in the last years intending to identify product standards that match a rising general concern about environmental sustainability and social justice. In particular, more and more western consumers expressed their purpose not to buy those products whose production process would not guarantee the respect of the environment and human rights (Raynolds, 2008). Private NGO effort did not relate only with productions standards identification but also with a direct effort to point out to consumers those brands which did not operate in respect of social and environmental responsibility. Those "name and shame" policies received substantial attention from both consumers and brands (Winston, 2002).

The significant impact of those policies resulted in a new formulation of the concept of "quality": if the conventional meaning regarded physical and measurable features, the new concept is mainly focused on the process and looks at conditions under which items are produced and commercialised (Dankers, 2003). Nevertheless, since process standards cannot be assessed by examining the final product, certifications and labelling are used to ensure compliance (Reynolds, 2008).

This study focuses in particular on two different but not mutually exclusive type of certification: Organic and Fairtrade.

Organic agriculture movements began to appear in the Sixties in Europe and the United States. Although there was no one definition of "organic" most movements struggled to create sustainable agriculture in respect of the environment and without the utilization of chemical fertilizers. (Raynolds, 2000) In 1972 most movements joined the IFOAM (International Federation of Organic Agriculture Movements) an "umbrella" that pursues the principles of local movements internationally. In 2012, organic agriculture was present in 164 countries accounting for 37.5 million (M) hectares (ha) of land (0.87% of total), while 1.9M producers grow organic goods for a market of 63.8M US$ that represents an increase of about 320% since 1999 (IFOAM, 2014).

Fairtrade (FT) movements rose in Europe during the Sixties. This organisation aimed to transform the North-South linkage from exploitation to sustainable development using a "not aid but trade" philosophy. From the Eighty's Major FT organisations start labelling products in order to show the added value to consumers. In 1997 the three leading FT organisations gathered in the fairtrade “umbrella” FLO (Fairtrade Labelling Organisation International). (Raynolds, 2000) In 2003 FLO created FLOCERT, the independent certification body of Fairtrade system. In 2013 FT agriculture accounts for 1.4M farmers and workers distributed in 74 countries where 80% are small farmers and 23% are women. Fairtrade products are sold in 125 countries with a sales turnover of 5.5bn € and a growth rate of 15% against 2012. Several farmers work with both Organic and Fairtrade process, FLO estimates that, for instance, 46%, 37% and 35% of Fairtrade producers of coffee, rice and banana respectively grow their crops organically (FLO, 2014).

In Ecuador, farmers with Fairtrade labels resulted in developing environmental and social friendly practises more effectively than their conventional counterpart. (Melo & Wolf, 2005). Nevertheless, the effectiveness of the FT label is amply discussed, if some authors convey that FT certification has a strong impact in improving smallholders' livelihood and workers' conditions (Reynolds, 2014; Ruben, 2008), others point out that the practice of exporting sustainability from rich to developing countries has definite limits: only a fractions of industries participate in certification programmes, and large sections of the population of firms are likely to remain unattractive and inaccessible to external resource providers (Melo & Wolf, 2007). In particular, Melo & Hollander (2013) demonstrates the unequal relationship in which what for consumers is a matter of choice, for producers is a matter of survival and, in some cases, for example, the cocoa production, external agencies implemented alternative trade schemes that resulted in the loss of profitability of small farmers.

4. Purpose and organization of the research

This study aims to analyse the choice of a tool for the sustainability assessment of an agri-system and compare the sustainability of certified and conventional agri-products. In this context, it expounds a qualitative methodology called deconstruction and also applies an original approach that operationalises SAFA (Sustainability Assessment of Food and Agriculture), a tool developed by FAO. As a case study, the present research implements the described methodology to the Ecuadorian banana agri-system, comparing the labelled (organic and Fairtrade) versus the conventional production in order to establish whether certifications may be considered as a solution to enhance the sustainability of the system.

To achieve this purpose, this study identifies the following specific objectives:

- The analysis of the criteria to include the indicators in the assessment.
- The categorisation of sustainability frameworks in order to identify key features and specific characteristics.
- The development of a dedicated methodology for the qualitative investigation.
- The analysis of the problems related to certification.
- The investigation of the sustainability certification process and its implementation in Ecuador.
- The revision of the key features of SAFA for its application.
- The application of SAFA in the Ecuadorian banana agri-system.
- The application of SAFA in the Ecuadorian banana smallholder’s system.

a. Structure

The first step of the analysis is the identification of the methodological instrument that allows completing the comparison. This identification is the purpose of Chapter 2. The study applies a particular methodology that is derived from philosophy: the deconstruction. Chapter 3 explains this methodological approach for qualitative investigation in order to allow researchers to employ it in other investigations. Then, the study must apply the instrument to two different samples that represent the labelled and conventional systems and show the results in a way that it is possible to draw relevant conclusions. This analysis is the purpose of Chapter 4. Finally, this study claims that smallholders represent a specific situation that needs the application of a specific tool. In Chapter 5, SAFA App, the FAO assessment tool mainly directed to evaluate the sustainability of smallholders, is examined and applied to a small number of small banana producers in order to check if the instrument successfully represents the particular features of smallholders.

Chapter 2

The Chapter 2 deal with a particular theme: since the academic literature presents a considerable number of frameworks to evaluate agri-systems sustainability, it is necessary to investigate the different approaches in order to select the most suitable to the analysis of the banana system. This analysis is developed in two steps: the first step is related to the criteria that the indicators employed in the assessment must match in order to be applied in the assessment. The second is the analysis of the different categories of the assessment tool in order to identify the features that must be considered in the framework selection process.

Regarding the first point, this study carries out the analysis of the articles that mention indicator’s criteria and examines similarity, consistencies and incongruities in order to identify nine criteria the assessment must match to be employed in the assessment. These criteria can be gathered in two groups: the essential requirement of the indicator and use of indicators. The first group is composed of the criteria: data availability, analytically valid, relevant, flexible to changes and measurable — the second group by the criteria: Policy relevant, understandable, implementable by farmers and acceptable.

Once the criteria that the frameworks must match are identified, it is necessary to categorise the frameworks by their features, this study encounters four categories of frameworks. The first category identifies those frameworks with a bottom-up approach that develops indicators and methodology with a participatory process that involves the stakeholders of the agri-system. The second category is formed by those frameworks that are directed to the academic researchers instead of farmers and local decision-makers. The third category grouped those frameworks that aggregate result per sustainability dimension and thus resume the assessment in just three or even one value. The fourth category is the most interesting since it gathers those frameworks that share the following feature: ease to be applied and understood by laypeople, quick to be applied and oriented to generate changes in the agri-system.

Among the last category, SAFA is the most recent framework to be created and the most complete concerning the sustainability aspects it examines, and for this reason, is the assessment tool selected for this evaluation.

Chapter 3

The analysis of the previous chapter develops a new methodological approach for qualitative investigation: the deconstruction, the methodology derived from philosophy and in particular from the works of the French philosopher Jacques Derrida (1930-2004).

Deconstruction is interested in the implicit assumption and hidden purposes that are at the basis of a given sustainability assessment tool (SAT), and for this reason, influence the result and meaning of the assessment. This methodology pursues the fundamental objective to identify the critical features of an assessment tool that influences the application in a given agri-system.

Deconstruction is based on three main assumptions:

- Each SAT is designed with a specific logic and purpose, and nothing in its construction is casual.
- Precise philosophical understandings underpin the logic behind the SAT construction.
- There is no "good" and "bad" philosophy; the purpose is to understand, not to judge.

Deconstruction has not a formal process to be followed but employs a variety of techniques such as author analysis, simulation or comparison.

Chapter 4

Chapter four is the development of the evaluation and comparison of sustainability between two different banana agri-system: the certified versus the conventional.

The first part of this chapter is focused on the presentation of certifications and the problems related to it. There are different certifiers, and the most popular in Ecuador are Global Gap, Rainforest Alliance, Fairtrade and IFOAM (organic production). The academic arena has studied these certifications but is far to reach a consensus on them. In particular, if some articles present a positive impact on the sustainability of certified products, other papers find adverse outcomes of certified practices on economic performances and societal wellbeing.

In the second part, the study explains the instrument SAFA in two steps: firstly, SAFA is discussed in its origins, structure and key features; secondly, the analysis reports the main papers that apply SAFA or some SAFA indicators to evaluate an agri-system.

Then the two-sample are presented. The first sample is an association of 89 smallholders whose cultivated land range is between 1 to 32 hectares. The association produce only banana under the Global Gap, Fairtrade and IFOAM certifications and sells the product principally in Western Europe. The second sample is a group of 22 medium and large producers with a total cultivated land of 941 has. The group produce conventional banana even if respect retailers' guidelines originally based on Rainforest Alliance's standards. The group sells mainly in Eastern Europe throw only two buyers.

Finally, the study presents the results, firstly by the four SAFA sustainability dimensions and then overall. The results show how certified banana producers results overcome conventional's in three out of four dimensions but perform lower outcomes in the social wellbeing dimension.

In the last part of this Chapter, some possible explanations of these results are drawn even if the study indicates the importance of further studies directed to examine this aspect.

Chapter 5

This chapter is the first possible way to deepen the analysis by examining the instrument SAFA App, the smallholder version of the instrument utilised in the previous chapter. In fact, in the conclusions of Chapter 4, it is stated that a possible explication of the low performance of certified farms in Social wellbeing dimension relies more on farm structure rather than the product since smallholders are more affected by markets dynamics and consumer trends than big enterprises are.

In this Chapter, SAFA App is introduced: it shares the same values, purpose and the 21 sustainability themes of the original tool. Nevertheless, it employs a more easy-to-manage structure based on a one hundred questions survey for the smallholder with three possible answers indicating an Unacceptable, a Limited or a Good level of sustainability. A dedicated application can operate the tool for portable devices that gives the results immediately to the farmer identifying the themes that deserve farmer's attention and a possible improvement in sustainability.

In this chapter, ten smallholders were surveyed in order to test the reliability of the tool. The results show that the practice of smallholders to gather in the association has a positive influence on sustainability performance. Even if all smallholders perform similarly in certain aspects, it is possible to see a relevant difference in other themes where the smallholders that are members of a producers' association achieve significantly better results than the remaining smallholders do.

Chapter 6

At the end of this investigation, the chapter of conclusions sums up the main outcomes of the research, identifies the limitation and addresses the reader for future studies.

CHAPTER 2

DECONSTRUCTING CRITERIA AND ASSESSMENT TOOLS TO BUILD AGRI-SUSTAINABILITY INDICATORS AND SUPPORT FARMERS' DECISION-MAKING PROCESS

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DECONSTRUCTING CRITERIA AND ASSESSMENT TOOLS TO BUILD AGRI-SUSTAINABILITY INDICATORS AND SUPPORT FARMERS' DECISION-MAKING PROCESS

Abstract

In the review of academic literature, numerous papers present either a list of indicator criteria or partially revised sustainability assessment tools of agri-food systems. However, neither a complete analysis and discussion about the criteria utilised by evaluators nor a compared examination and subsequent frameworks categorisation have been fully developed by researchers. This study aims to fill this twofold gap by investigating the main issues related to the choice of a tool for the sustainability assessment of an agri-system. This task is conducted in three steps: firstly, we analyse the criteria an indicator should match to be included in an evaluation; secondly, we categorise 15 of the most important agriculture sustainability frameworks to discuss effectiveness in evaluating sustainability for each category, finally, we compare the categories and emphasise differences to highlight the possible application of each framework and hence guide the practitioner in the framework selection process. Our analysis identifies the complementarity between bottom-up and top-down approach and the impossibility of identifying a priori the best framework, although a combination of both approaches could prove to be a valuable, alternative option.

Keywords: Agriculture sustainability; Sustainability indicators; Indicators' criteria; Sustainability assessment; Sustainability frameworks.

1. Introduction

In a world constantly focused on technological developments, in which technology has evolved and continues to change countless aspects of everyday life, human beings still depend on agriculture as a primary source of food. In recent years, scandals and crisis generated by risky and hazardous agricultural practices have jeopardised people's health and, as a result, made the safety and sustainability of agricultural systems a key issue of public concern. For these reasons, in the academic arena the application of sustainability principles to the agricultural sector has become a crucial subject of study.

Nevertheless, in spite of widespread agreement on its importance, sustainability in agriculture lacks a consensus on both its definition and evaluation (Binder et al., 2010), so much that some authors doubt the actual usefulness of this concept (Hansen, 1996). However, international organisations, such as FAO (Food and Agricultural Organization) and the European Community agreed on two essential features of agricultural sustainability, namely multi-dimensionality and multi-functionality. This means that sustainability assessment of agri-systems must account for the balance of environmental, economic and social dimensions and address several key issues such as food security, landscape maintenance, and biodiversity conservation (Commission of the European Communities [CEC], 1999; FAO, 2005).

In recent years, driven by apprehension among both public and policy makers, the academic debate on agricultural sustainability produced a wide variety of tools and methods to evaluate sustainability of agri-systems. According to Binder et al. (2010), these tools are, among others: i. indicators lists; ii. environmental assessments of production alternatives; iii. indexes or ecopoints; iv. linear programming tools, and, v. trade-off models. In the last years, the use of lists of indicators is considered the most common way of assessing agricultural sustainability (Roy and Weng Chan, 2012; van Asselt et al., 2014; Van Passel and Meul, 2012).

Indicators are defined as quantitative measures against which certain aspects of expected performance of a policy or management strategy can be assessed (Glenn and Pannell, 1998) and addressed, with the aim of improving decision making (Pannell and Glenn, 2000). In order to efficiently assess a system's sustainability, indicators must be checked against reference values, which can be determined in two main ways: identifying a minimum value for each indicator which represents the minimum accepted level of sustainability that a system is supposed to reach (vonWirén-Lehr, 2001), or benchmarking results between two systems, different either in spatial or time scale, to gauge which is the most sustainable (Van Passel and Meul, 2012).

The use of indicators has received considerable attention from authors. In general, indicators are used in three ways: individually, as part of a set, or combined into a composite index. Nevertheless, since the use of a single indicator may miss the opportunity to describe the complexity of a system, the use of a set of indicators, even when heterogeneous, is the preferred method (Bossel, 1999; Farrell and Hart, 1998; Van Passel and Meul, 2012).

However, the academic forum also revealed several problems that have arisen in recent years concerning the efficiency of indicator usage. Among others, the most relevant are the following:

- Indicator selection is not always clear and understandable, in particular for highly aggregated indicators (Bell and Morse, 2003). Moreover, certain lists of indicators are developed with a large number of traditional economic, environmental and social indicators, although without an underlying conceptual structure (Van Passel and Meul, 2012).
- Despite the conclusions of international organisations, most studies fail to consider the multi-functionality and the multi-dimensionality of models responsible for developing sustainability assessment; that not only they overlook the numerous functions of agriculture and its primary role of producing food and fibre (Rossing et al., 2007), but they also ignore one or two of the sustainability dimensions completely (Binder and Feola, 2010; vonWirén-Lehr, 2001).
- Authors often fail to either integrate data from different sources or to take into consideration the different needs and goals of different types of end-users (Bell and Morse, 2003; Binder et al., 2012; Seuring and Müller, 2008)
- Various research studies have focused on filling gaps in knowledge and technology but have not indicated the specific process for implementing said knowledge (Rossing et al., 2007) or for the practical utilisation of the results in decision-making. In particular, few studies contemplate the interaction and trade-off between indicators and, specially, the possibility of conflicting goals (Binder et al., 2012; Cornelissen et al., 2001; Lopez-Ridaura et al., 2002; Morse et al., 2001)

In order to correct some of these problems, in recent years, academic debate has produced a significant number of frameworks to assess agricultural sustainability (de Olde et al., 2016c; Schader et al., 2014; Schindler et al., 2015). Accordingly, a framework can be defined as a theoretical and procedural structure that underpins sustainability assessment. Firstly, frameworks select the indicators to include in the evaluation; then define the scale of assessment and identify the purpose of the study; and, finally, describe how data should be processed to generate results of interest.

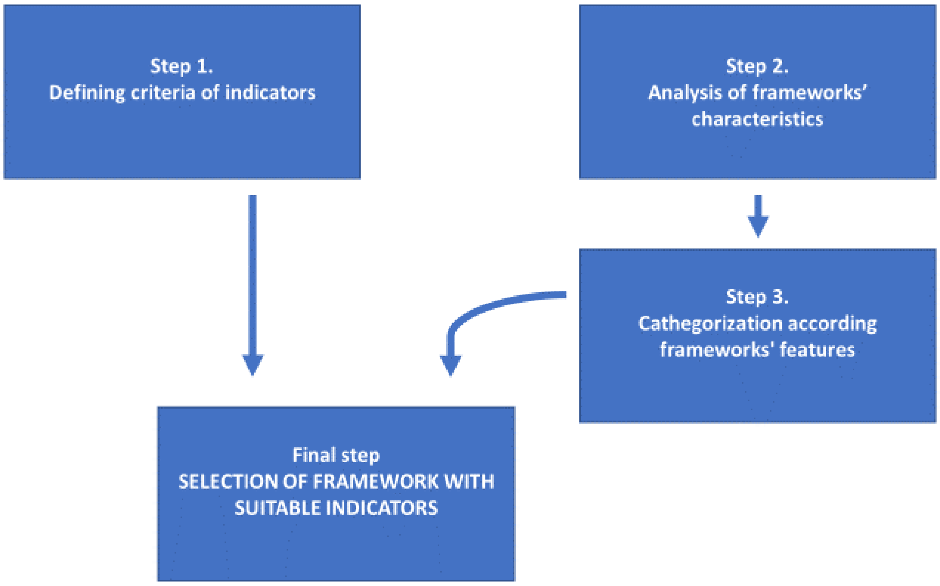
A general and superficial understanding of sustainability frameworks could possibly be directed towards the identification of the framework which "best" evaluates sustainability. Additionally, this selection process should consider, as thoroughly as possible, all the issues linked to the sustainability assessment and provide the most complete and in-depth assessment of what is and what is not sustainable. Such an assessment is quite difficult to achieve but the identification of the "best" framework must be regarded as ideal for at least three reasons. Firstly, frameworks are underpinned by a given definition of sustainability and there is no precise agreement on the concept of sustainability or sustainable agriculture (Roy and Weng Chan, 2012). Hence, since they diverge on a theoretical basis, different frameworks cannot be evaluated from an objective or technical perspective. Secondly, frameworks are generally aimed at different end-users who rarely share common goals and needs. For instance, while farmers are more interested in simple and implementable measures to enhance processes at farm or local level, decision makers are more focused on numerical results on a sector or regional scale; finally, frameworks are usually built to be implemented in a specific context or sector. For these reasons, it is highly improbable that a single framework can encompass such diverse and, at times, contrasting point of views (Van Passel and Meul, 2012).

Bearing in mind the variables expressed above, rather than identifying the "best" framework to evaluate sustainability, it would be better to find the most apt for assessing the sustainability of a given agri-system. Nevertheless, this selection process is complicated, mainly because few articles in the academic literature compare different frameworks and even when they do so, they are limited to analysing a small number of tools without justifying the reasons for excluding other frameworks.

This work bridges these gaps in the literature and aims to supply a valuable guide for practitioners for analysing the suitability of assessment tools from a more technical and objective perspective (considering the basic principles and features to construct them). Following deconstruction method, a deep analysis of criteria justification in indicators´ selection and normative-procedural characteristics of several agricultural sustainability frameworks are presented.

For this purpose, the study is carried out with a three-step approach (see Figure 1).

Figure 1. Process of selection of the most suitable assessment tool



In the review of academic literature, we find numerous studies in which indicator criteria are either listed or partially revised, yet only a few of them analyse and discuss criteria in depth. Moreover, frameworks rarely discuss and justify the selection of the indicators[1]. For these reasons, the first step of our work is the analysis of previous studies in order to identify and define the criteria upon which there is general agreement by authors. Thus, practitioners may apply said criteria to framework indicators and exclude those that do not match the requirements.

Once practitioners establish criteria inclusion and hence can effectively select the indicators to apply in the evaluation, practitioners must choose the most suitable framework at the system analysed. This selection needs two phases: firstly, frameworks must be analysed in their characteristics; secondly, they must be categorised according to their feature in order to highlight the possible application of each framework.

[1] Among the frameworks presented in this study, only SAFA presents a complete report that discusses and justifies each indicator included in the tool (FAO, 2013b).

For these reasons, steps 2 and 3 of our study regard respectively the analysis and the categorization of frameworks.

Thus, the final step of our approach is the selection of the framework that best fits the properties of a specific agri-system with the most suitable indicators (or with the indicators that match sounded criteria of inclusion).

The remainder of the paper is organised as follows: Section 2 explains the methodology; Section 3 illustrates and examines indicator criteria; Section 4 describes and compares the sustainability assessment tools; Section 5 discusses the most important types of frameworks and, lastly, Section 6 outlines the main conclusions drawn from the research.

2. Methods

A methodology involving a three-step search was applied to identify the most significant articles to include in this review. Initially, a general search for works on this topic in top journals was carried out, using the Web of Science (ISI, 2016) and Scopus databases. These databases were chosen because they are considered to be the most important source of data for scientific research and include titles from Emerald, Elsevier, Springer, Willey, Taylor & Francis, JStor, among others. At that first time, the terms searched were "sustainability agricultural framework*" and "sustainability indicators criteria*" in either the title or the abstract or the keywords. The symbol (*) has the function to include any variation on the terms searched, such as the plural. Secondly, the references of the 194 articles identified were reviewed in order to establish the most cited works in the field. Finally, when necessary, in-depth investigations on specific subjects (for example, local application of a certain framework) were conducted and, in this case, local studies and journals were included in the analysis. All the articles were carefully screened in order to exclude those unrelated to the topic or to the goals of the review.

We utilise the deconstruction approach to analyse the reference bibliography. This method, introduced by the French philosopher Jacques Derrida (1974, 1978), implies the analysis of the implicit assumption, hidden or unspoken purpose and structural contradiction of a specific question. In this study, the deconstruction approach was applied to sustainability criteria and assessment tools. In the first case, a list of criteria used in previous works was elaborated. Then, nine main criteria were identified. Finally, criteria were discussed in consideration of the context in which they were developed in order to recognise variances in meaning, purpose or assumptions. In the second case, sustainability assessment tools were first examined with an adapted version of the instrument built by (Binder et al., 2010) and they were categorised. Finally, the assessment tools were analysed by considering the case studies in which they were applied in order to identify implicit characteristics and differences.

3. Indicators criteria

The identification of the indicators for a system evaluation is a complex process, since indicators must be as few as possible but as many as necessary (Bossel, 1999). It was observed that when a small number of indicators are applied, essential aspect may be missed (Roy and Weng Chan, 2012). On the other hand, when a large number of indicators are used, concerns on framework usefulness and trust may arise (de Olde et al., 2016a)

A number of authors define the criteria according to which indicators should be drawn as a preliminary step prior to building a sustainability framework or evaluating a system. However, authors often dedicate only a few words to this topic (Andrieu et al., 2007; Gómez-Limón and Riesgo, 2010; Meul et al., 2008; Zahm et al., 2008), or, at times, ignore it completely (Giovannucci and Potts, 2008; Grenz et al., 2009; López-Ridaura et al., 2005, 2002)[2]. In these cases, criteria are generally listed without any in-depth examination of their significance, justification or reasoning.

By contrast, we consider criteria to be a pivotal issue in the theoretical construction of a sustainability evaluation model since they represent the link between indicators and the general concept behind agricultural sustainability.

Our investigation is the following: firstly, we reviewed several articles from the most recent literature that focus particularly, but not exclusively, on the last decade. Then, we identified nine criteria. In keeping with Roy & Weng Chan, (2012) we found that the first

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[2] In the case of MESMIS it is important to highlight that this framework does not present a formal list of criteria since according to its structure all indicators are completely developed by a participatory process with stakeholders.

five describe the intrinsic requirement an indicator must match, while the other four outline the usefulness of the indicator as follows:

Intrinsic requirement of the indicator

- Data availability
- Relevant
- Analytically valid
- Flexible to changes
- Measurable

Usefulness of the indicator

- Policy relevant
- Implementable by farmers
- Understandable
- Acceptable

These criteria are discussed in depth below (Table 1).

Table 1. Analysis of Criteria an indicator should match in order to be included in an evaluation

Criteria Group	Criterion	Authors
Data availability	Accessibility to user at appropriate scale	(Fernandes and Woodhouse, 2008; Moller and Macleod, 2013)
	Data availability	(Berroterán and Zinck, 2000; Binder et al., 2008; Binder and Feola, 2010; Dantsis et al., 2010; Nardo et al., 2008; Niemeijer and Groot, 2008; Peano et al., 2014; Singh et al., 2012)
	Threshold value guideline	(Walter and Stützel, 2009a)
	Cost effectiveness	(Qiu et al., 2007; Sauvenier et al., 2005)
	Benchmarks are available to evaluate the indicator value (use of benchmarks)	(Meul et al., 2008)
	Availability of reference values	(Lebacq et al., 2013)
	Available (it must be relatively straightforward to collect the necessary data for the indicator)	(Bell and Morse, 2003)
	Cost-effective (it should not be a very expensive task to access the necessary data)	(Bell and Morse, 2003)
	Available and timely. Are the data available on a regular basis?	(Guy and Kibert, 1998)
Relevant	Significance in the study area	(Zhen et al., 2005)
	Important for agricultural development	(Ministery of Agriculture Fishery and Food, MAFF, 2000)
	Relevance for system sustainability	(Dantsis et al., 2010; Gómez-Limón and Riesgo, 2010; Sauvenier et al., 2005)
	Relevant to the case study	(Bélanger et al., 2015; Dantsis et al., 2010)
	Directly related to the theme	(van Asselt et al., 2014)
	System representation	(Binder et al., 2010; Lebacq et al., 2013)
	Relevant to environmental impact	(Binder et al., 2008)
	Relevance for the issue and target audience at hand	(Niemeijer and Groot, 2008)
	Do they measure something that is relevant?	(Guy and Kibert, 1998)
	Representative relevance. Do they cover the important dimensions of the area?	(Guy and Kibert, 1998)
Analytically valid	Validity or analytical soundness	(CORPEN, 2006; Fernandes and Woodhouse, 2008; Gómez-Limón and Riesgo, 2010; Lebacq et al., 2013; MAFF, 2000; Nambiar et al., 2001; Niemeijer and Groot, 2008; Peano et al., 2014; Sauvenier et al., 2005; Van Cauwenbergh et al., 2007; vonWirén-Lehr, 2001; Walter and Stützel, 2009b)
	Conceptual soundness	(van Calker et al., 2006; vonWirén-Lehr, 2001)
	Obvious and well-defined relationship between an indicator and the phenomenon being monitored (causality)	(Meul et al., 2008)
	The well-documented calculation method of the indicator value minimally depends on external factors (solidness)	(Meul et al., 2008)
	Specific – they are affected by relatively few factors so any shift in their measures can be more directly linked to causes of change	(Moller and Macleod, 2013)

	Robustness - Be relatively insensitive to expected source of interference	(Niemeijer and Groot, 2008)
	Stable and reliable. Are they compiled using a systematic method?	(Guy and Kibert, 1998)
Flexible to changes	Adaptation	(Gómez-Limón and Riesgo, 2010; van Calker et al., 2006; vonWirén-Lehr, 2001; Walter and Stützel, 2009b)
	Sensitive to variation	(Bélanger et al., 2015; CORPEN, 2006; Moller and Macleod, 2013; Nambiar et al., 2001; Niemeijer and Groot, 2008; Qiu et al., 2007)
	Suitable for different scale	(Nambiar et al., 2001)
	Flexibility in the indicator for allowing change, purpose, method and comparative application	(Singh et al., 2012)
	A change in the situation is reflected in a value change of the indicator (sensitivity)	(Meul et al., 2008)
	Sensitive - they detect changes in systems within the time frames and spatial scales relevant to decisions and risk management.	(Moller and Macleod, 2013)
	Discriminating power in time/space - Ability to discriminate in time / in space between changes due to external factors and changes due to management	(Sauvenier et al., 2005)
	Responsiveness	(Qiu et al., 2007)
	Data sensitivity to temporal change	(Berroterán and Zinck, 2000)
	Sensitive (must readily change as circumstances change)	(Bell and Morse, 2003)
	Responsive. Do they respond quickly and measurably to change?	(Guy and Kibert, 1998)
	Flexible. Will data be available in the future?	(Guy and Kibert, 1998)
Measurable	Easy measurability	(CORPEN, 2006; Dale and Beyeler, 2001; Dantsis et al., 2010; Fernandes and Woodhouse, 2008; Gómez-Limón and Riesgo, 2010; Lebacq et al., 2013; MAFF, 2000; Nambiar et al., 2001; Niemeijer and Groot, 2008; Roy et al., 2014; Roy and Weng Chan, 2012; Sauvenier et al., 2005; van Asselt et al., 2014; Van Cauwenbergh et al., 2007; vonWirén-Lehr, 2001)
	Measurable in qualitative or quantitative terms	(Niemeijer and Groot, 2008)
	Clearly defined, quantified and repeatable	(Moller and Macleod, 2013)
	Quantitative	(der Werf and Petit, 2002; Lebacq et al., 2013; van Calker et al., 2007)
	Measurable (implies that it must be a quantitative indicator)	(Bell and Morse, 2003)
Policy relevant	Policy relevance	(Fernandes and Woodhouse, 2008; Gómez-Limón and Riesgo, 2010; Guy and Kibert, 1998; Lebacq et al., 2013; Moller and Macleod, 2013; Nambiar et al., 2001; Sauvenier et al., 2005; van Calker et al., 2006; Van Cauwenbergh et al., 2007; vonWirén-Lehr, 2001; Walter and Stützel, 2009a)
Implementable by farmers	Effectiveness	(Qiu et al., 2007)
	Reproducible	(Dantsis et al., 2010)
	Goal orientation	(Binder and Feola, 2010; Nardo et al., 2008)
	Can easily be used by farmers	(Andrieu et al., 2007)
	Specific (must clearly relate to outcomes)	(Bell and Morse, 2003)
	Usable (practical)	(Bell and Morse, 2003)

	Clear definition of the objective that the indicators are meant to achieve	(Bell and Morse, 2003; Niemeijer and Groot, 2008)
	Transferability - The indicator should make sense in major farm types implementing common and/or alternative practices	(Lebacq et al., 2013; Niemeijer and Groot, 2008; Sauvenier et al., 2005)
	Performance based – they measure actual performance towards outcomes (rather than practices expected to promote sustainability and resilience)	(Moller and Macleod, 2013)
	Simplicity and preciseness	(Binder et al., 2008)
	Clarity and simplicity in its content, purpose, method, comparative application and focus	(Singh et al., 2012)
Understandable	Understandability	(Dantsis et al., 2010; Gómez-Limón and Riesgo, 2010; Qiu et al., 2007; Walter and Stützel, 2009a)
	Transparency - The meaning of an indicator should be easy to seize, clear, simple and unambiguous	(Sauvenier et al., 2005)
	Comprehensibility	(Binder et al., 2010; CORPEN, 2006; Lebacq et al., 2013; Niemeijer and Groot, 2008)
	Indicator values and scores are easily interpretable (comprehensibility)	(Meul et al., 2008)
	Understandable. Are they simple enough to be understood by lay persons?	(Guy and Kibert, 1998)
Accessible	Community involvement. Were they developed and acceptable by the stakeholders?	(Guy and Kibert, 1998)
	Accessible to many users	(Nambiar et al., 2001)
	Social validation - Recognition by end users	(Lebacq et al., 2013)
	Broadly accepted – they are selected objectively through collaboration with policymakers, key stakeholders and experts, unless serving specific local values.	(Moller and Macleod, 2013)

Source: Own elaboration

3.1. Data availability

The first criterion expresses that indicators must rely on data that are available to users. To fulfil this condition, indicators must match two requirements: availability and cost-effectiveness. Firstly, data must be available, namely, "it must be relatively straightforward to collect the necessary data for the indicator" (Bell and Morse, 2003). This initial criterion is important since it represents the idea that sustainability does not need to be evaluated theoretically but has to relate to a real and specific situation in which some important data might be unavailable. This criterion also represents a limit. In fact, since only structured organisations can supply the necessary data for an empirical evaluation, in many cases researchers are unable to investigate the sustainability of small and unstructured entities, such as rural family farms. Government organisations have the capacity to organise large-scale data campaigns in order to fill this gap, but this type of investigation is beyond the reach of an individual academic researcher. For this reason, the second condition is "cost-effectiveness" (Bell and Morse, 2003; Qiu et al., 2007), which relates to the unlikelihood of researchers sustaining considerable expenses.

A particular correction of this criteria is provided by Guy and Kibert (1998), who stressed the fact that data must also be available on a regular time basis.

In addition, another procedural criterion is identified. In fact, two methods are possible for the evaluation of a system's sustainability: either comparing the indicator values with recognised sustainable values, or contrasting two that are different in space or time scale scenarios. For this reason, some authors underline that an indicator should contain, to some extent, a guideline of the threshold value it must match (Walter and Stützel, 2009a) or a values benchmarking should be available (Meul et al., 2008).

3.2. Relevant

The criterion emphasises that the available research must be related to something *important*. This requirement may seem rather generic, so, to better understand what is meant by this term, it is necessary to ponder the main purposes that authors address. Some deem that indicators must be relevant for system sustainability (Dantsis et al., 2010; Gómez-Limón and Riesgo, 2010; Qiu et al., 2007), in particular for environmental impact (Binder et al., 2008) and in general for system representation (Binder and Feola, 2010) and agricultural development (MAFF, 2000). Furthermore, some authors specifically stress the importance of the indicators to understand the specific case in which the indicator is used: hence, indicators must be relevant for the case study (Bélanger et al., 2012; Dantsis et al., 2010; van Asselt et al., 2014) or for the study area (Guy and Kibert, 1998; Zhen et al., 2005). In conclusion, the importance of this criterion lies in the idea of sustainability as something relevant that may have a significant impact on systems and procedure and, consequently, on people lives.

3.3. Analytically Valid

The evaluation of sustainability is closely linked to the theoretical underpinnings of the evaluation process, the framework adopted for the process and the objectives the evaluators aspire to achieve. However, the process of sustainability evaluation must be carried out by using a solid and precise scientific methodology. In particular, as stated by Dale & Beyeler (2001), the absence of a scientific methodology when selecting indicators often results in a corresponding lack of scientific rigour in sustainability programmes. For this reason, there is a rather unanimous consensus among researchers on the consideration that an indicator must reach analytical soundness to be selected.

Some authors conduct further in-depth analyses and explicitly identify what analytical soundness truly means. For example, Meul et al. (2008), indicate two requirements that may help us to understand more about this criterion: causality and solidness. Whereas the former expresses the need to clearly identify the relationship between the indicator and the observed phenomenon, the latter focuses on the methodology that makes it possible for the indicator's value to depend only minimally on external factors. The same concept is reaffirmed by Niemeijer & Groot (2008), who agree with the second requirement and refer to "robustness" as the capacity of indicators to be independent of expected sources of change. Moreover, for this reason, we can concur with Moller & Macleod (2013), who synthesise the two requirements into one criterion and indicate that, to be selected, an indicator must show the capacity to be affected by few factors and directly link measures with cause of change.

3.4. Flexible to changes

If the previous criterion refers to stability and reliability (Guy and Kibert, 1998), this criterion expresses the need for indicators to show their capacity to adapt (Gómez-Limón and Riesgo, 2010; van Calker et al., 2006; vonWirén-Lehr, 2001; Walter and Stützel, 2009b) and respond (Nambiar et al., 2001; Qiu et al., 2007) to variations. Some authors emphasise that the adaptation to changes must be immediate for users in order to be consistently up to date (Bell and Morse, 2003; Guy and Kibert, 1998) while Berroterán and Zinck (2000) emphasise how important it is that indicators react to temporary changes and, by doing so, allow time benchmarks.

This criterion, which relates to adaptability, seems to contradict the previous one; in fact, while the latter claims stability as a requirement, this criterion refers to flexibility. To solve this paradox we must first discuss those authors that accept both criteria. For instance, Bell & Morse (2003) and Meul et al. (2008) expound that indicators must reflect changes in a situation, other authors emphasise that those changes refer to a modification in the time frame or spatial scale (Moller and Macleod, 2013; Sauvenier et al., 2005). In fact, since sustainability is a “situated concept” (Rigby and Caceres, 1997) in which time and space play an important role in evaluating what is sustainable, many evaluation tools compare the sustainability situation of systems that differ in either time frame or spatial scale. For these reasons, we can conclude that an indicator must detect changes of systems within the time and space dimension.

3.5. Measurable

According to the criterion of data availability presented above, some authors consider that data should be available and *easily* measurable (Fernandes and Woodhouse, 2008; van Asselt et al., 2014).

Particular attention must be paid to those authors, who stress that indicators must rely on quantitative data (Bell and Morse, 2003; Lebacq et al., 2013; Moller and Macleod, 2013). The reason given for why indicators should be quantitative is based on practical issues. For example, according to Moller & Macleod (2013), in order to provide comparable, verifiable and scientifically-acceptable information, the use of quantitative methods is preferable to qualitative. In agreement with this idea, van Calker et al. (2007) state that indicators must rely on quantitative data to be used in a model. On the other hand, der Werf & Petit (2002) contend that values are preferable to scores since the latter are dimensionless and hence cannot be compared to the data of another system.

In this case, even though quantitative data are more useful for an objective sustainability evaluation, it is necessary to consider that if such data successfully represent ecological and economic indicators, they are inadequate for social assessment since social indicators are usually represented by opinions, attitudes and perception rather than quantitative facts. Moreover, in some situations, it is difficult for researchers to obtain economic and environmental data because of farmers’ discretion or poor documented operations and consequently judgments and opinions based on scores are the only available data. So, we prefer to agree with Niemeijer & Groot (2008) and conclude that indicators must be measurable in either qualitative or quantitative terms.

The first criteria focus on the intrinsic requirements the indicators must match to be included in an evaluation of sustainability (see Table 1). However, it is possible to identify other criteria that are more concerned with indicators’ implementation. The following criteria belong to this group.

3.6. Policy relevant

This criterion appears as an extension of the "Relevant" group listed above but with one substantial difference: in this case, the users to whom indicators are addressed are the policy-makers. Considering this point, it is necessary to delve more deeply since not all sustainability frameworks are studied for the same type of end-users. In particular, Van Passel and Meul (2012) explain that there are at least two different kinds of frameworks: those studied for farmers and those addressed to policy makers. The difference is significant. While the former are generally applied at farm or local level and use visual integration tools that summarise results using graphs and tables, the latter are implemented at the regional or national level and prefer the adoption of numerical integration tools that assimilate values in an index.

Nonetheless, some authors think that a framework must investigate sustainability at farm *and* at region level in order to be of interest to different end-users and, by consequence, to accept this criteria as important (Gómez-Limón and Sanchez-Fernandez, 2010; Nambiar et al., 2001).

3.7. Implementable by farmers

A sustainable examination that does not deliver a precise list of actions to implement is useless thus an indicator must be both usable by farmers (Andrieu et al., 2007) and practical (Bell and Morse, 2003). There is general agreement among researchers in this respect. To be implementable and thus be useful to farmers, an indicator must first of all be simple, precise (Binder et al., 2008) and clear in its contents, purpose, method, comparative application and focus (Bell and Morse, 2003; Niemeijer and Groot, 2008; Singh et al., 2012).

In addition to simplicity, preciseness and clarity, some authors stress the fact that an indicator must reach a certain result in its applications. Hence, indicators must be goal oriented (Binder and Feola, 2010; Nardo et al., 2008; Qiu et al., 2007); specific, i.e., they must clearly define the outcomes they seek to achieve (Bell and Morse, 2003); and performance based, by measuring actual results towards outcomes rather than practices expected to promote sustainability and resilience (Moller and Macleod, 2013).

Finally, other authors explain that to be implementable, indicators must be applied to different situations and the methodology must be reproducible (Dantsis et al., 2010) in such a way that the indicator makes sense in a major farm type implementing common or alternative process (Lebacq et al., 2013; Niemeijer and Groot, 2008; Sauvenier et al., 2005).

3.8. Understandable

This criterion derives from the previous one. In order to be implementable by farmers, users must be able to understand the indicators (CORPEN, 2006).

Some authors specify what comprehensibility means and explain that indicators must be easy to understand (Sauvenier et al., 2005) and that its value and scores must be easy to interpret (Meul et al., 2008). Finally, it is possible to conclude that, in general, indicators must be simple enough to be understood by lay people (Guy and Kibert 1998) and policy makers.

3.9. Acceptable

The last criterion regards the community in which sustainability evaluation is developed. Even though few authors mention this criterion, we consider it useful for scenarios in which government effectively controls the physical territory and the possibility of imposing sustainability measures with no regard for farmers' acceptance is an actual option, though possibly not the best one. On the other hand, where government does not completely control the territory or does not demonstrate genuine interest in sustainability, the involvement of local stakeholders and their acceptance of sustainable practices is the only option.

According to the authors that accept this criterion, indicators must be accessible to many users, e.g. farmers, workers, policy makers, governmental and non-governmental institutions and researchers (Nambiar et al., 2001). Moreover, indicators must be recognised by end users (Lebacq et al., 2013) and the community must be involved in the process in such a way that indicators should be developed and accepted by stakeholders (Guy and Kibert, 1998). Thus, we can concur with Moller & Macleod (2013) that indicators must be selected through collaboration with policy makers, key stakeholders and experts, unless serving specific local values.

3.10. Final considerations

In sum, we identify nine criteria that indicators must respect to be included in a sustainability evaluation. More specifically, indicators must be based on data that are available at a reasonable cost, relevant in describing an aspect of reality, analytically valid, flexible to changes and measurable in qualitative or quantitative terms. In addition, indicators must be relevant for policy makers, feasible to be implemented by local users, easy to understand by non-experts and developed by collaboration between different stakeholders.

4. Analysis of frameworks characteristics

4.1. Overview

Once we have developed a generic revision of the criteria as a preliminary methodology that should be included in the process on any framework, we can undertake the second step of our study, i.e. the analysis of features and purposes of assessment tools. This step aims to group assessment tools by categories in order to make easier the selection of the most suitable one for its empiric implementation in a specific agri-system.

In the last fifteen years, the academic arena has produced a large number of assessment tools for the evaluation of sustainability on agriculture. Nevertheless, a common agreement among researchers is far from being achieved since tools differ in their assumptions, starting points and objectives (Marchand et al., 2014). Even though in the literature there are many papers and reviews that conduct a categorisation of sustainability assessment tools (Binder and Feola, 2010; Binder et al., 2010; Binder et al., 2013; De Olde et al., 2016; Gasparatos and Scolobig, 2012; Gasparatos, 2010; Gasparatos et al., 2008; Schader et al., 2014; Schindler et al., 2015; Singh et al., 2012; Singh et al., 2009), our specific aim is to gain insight that will make it possible to choose the most suitable framework that can evaluate a specific agri-system.

To identify the sample of frameworks that must be included in this study, we consider differences in terms of the sustainability dimensions they evaluate. In fact, while some frameworks consider the ecological, economic and societal dimension of sustainability, other instruments focus on one dimension, for example, the Life Cycle Assessment tool, INDIGO (Thiollet-Scholtus and Bockstaller, 2014) and TechnoGIN (Ponsioen et al., 2006). Still others include additional dimensions such as entrepreneurship (Marchand et al., 2014; Meul et al., 2008); governance (FAO, 2013a); or quality and culture (Peano et al., 2014).

Taking into account a holistic sustainability assessment is usually required for agricultural systems (Galdeano-Gómez et al., 2017), we selected the frameworks which evaluated at least the economic, ecological and social dimensions of a specific system after it has been implemented. These basic commons features allow us to an in-deep discussion of the substantial differences in suitability application to specific contexts. This selection resulted in 15 frameworks developed from 1993 to 2015[3].

4.2. Frameworks' insight

In order to analyse the frameworks, we adapted the instrument of Binder et al. (2010) that distinguishes normative, systemic and procedural aspects (Table 2). This instrument was selected as it provides a detailed analysis, correctly compares a wide range of features of sustainability assessment tools, and offers a valid understanding of the selection of tools (de Olde et al., 2016c). However, we adapted this instrument according to the analysis of Schader et al. (2014) as this study highlights certain important aspects, such as Assessment purpose and Geographical application. Finally, we introduced the aspects of Indicators criteria which are not present in the aforementioned studies.

With regard to the normative aspects, we considered:

- The theoretical basis of the concept of sustainability. The assessment depends on the definition of sustainability the research accepts; since there is no universally accepted definition of this concept, it is necessary to highlight the theoretical basis of the evaluation.
- Whether or not the framework provides specific criteria for the indicators' selection. We do not assess which criteria are accepted, but only whether criteria are explicitly mentioned.

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[3] In this selection we disagree in some cases with the reviews mentioned. In particular, we do not consider that the frameworks ISAP (Rigby et al., 2001), FARMSMART (Tzilivakis and Lewis, 2004), SPA (Lang et al., 2007) and SEEbalance (Saling et al., 2005) cover the three dimensions of sustainability but only the environmental (ISAP, SPA and SEEbalance) or the economic and environmental dimensions (FARMSMART).

- The goal setting of the tools, namely, whether the tools have: a *top-down* approach, whereby goals are predefined and usually theoretically derived from the definition of sustainability; a *bottom-up* perspective, in which goals and criteria are defined by the stakeholders in a participatory process; or a *transdisciplinary* approach, which combines bottom-up and top-down approaches.
- The assessment type, i.e. the way indicators can be assessed with respect to reference value, thresholds or ranges.

The systemic aspect (Binder and Feola, 2010) claims that a system must be represented with as much simplicity as possible (parsimony) and as much complexity as necessary (sufficiency). Moreover, to attain an adequate system representation, the most relevant relationships among the indicators have to be considered in the analysis as well (Wiek and Binder, 2005). Nevertheless, following de Olde et al. (2016), since tools tend to develop an understandable and useful assessment, few of them explicitly mention parsimony as a goal, although it is considered by all to be an implicit goal. Similarly, due to the obvious aim of representing a system, all tools implicitly use the necessary complexity. For this reason, considering that each tool either explicitly or implicitly uses parsimony and sufficiency, in the systemic aspect we only focus on whether the tool identifies interaction between indicators or considers them independently.

In the procedural dimension, we include the following variables:

- End-Users are the subjects directly interested in the evaluation as they are the ones who have to respond to the results in some way. It is important not to confuse end-users with model-users, who are the subjects applying the framework (Mey et al., 2011)
- Assessment purpose is the aim for which the tool was created. In general, tools may aim to simply assess the sustainability of a given farm, guide farmers and suggest certain improvements, or even provide instructions to policy makers.
- Level of assessment (Scale) is the level at which the analysis is supposed to generate results, i.e., at farm, region, sector or landscape level (Van Passel and Meul, 2012).
- The degree of participation of stakeholders in the assessment. There are different possible degrees of stakeholder involvement in the framework's application. For instance, stakeholders can play a central role in the development, application and

interpretation of indicators, as occurs with MESMIS. Otherwise stakeholders can be consulted by researchers in the validation process, in which indicators are adapted to a specific context, as is the case with DELTA. Finally, some models apply a completely top-down approach in which stakeholders' participation is not taken into account, which occurs with IDEA.

- The aggregation approach is the methodology applied to summarise results in comprehensive variables. A method frequently used is to aggregate per dimension and then per a unique variable so that the evaluation may be expressed by one aggregate index (Castoldi et al., 2010; Castoldi and Bechini, 2010; Gasparatos et al., 2008). By contrast, other tools aggregate results per indicator, making it possible to evaluate said results either together, for example in a spider graph, or separately.
- Geographical application indicates where the frameworks have been applied
- System Application specifies the sector to which the frameworks have been applied.

The results of our analysis of sustainability assessment tools is summarised in Table 2 in which every aspect is applied to each framework.

Table 2. Frameworks analysis

Framework	IDEA	SAFE	SSP	MMF	MESMIS
Name	Indicateurs de Durabilité des Exploitations Agricoles	Sustainability Assessment of Farming and the Environment	Sustainability Solution Space for Decision Making	Multiscale methodological framework	Marco para la evaluación de los sistemas de manejo de recursos naturales
Reference	(Zahm et al., 2008)	(Van Cauwenbergh et al., 2007)	(Wiek and Binder, 2005)	(López-Ridaura et al., 2005)	(Masera et al., 2000)
Normative dimension					
Sustainability concept (SC)	Theory based on Landais (1998)	Theory based on de Groot (1992); Lewandowski et al. (1999)	Defined on World Commission on Environment and Development [WCED] (1987)	Defined on 5 attributes: productivity, stability, reliability, resilience, adaptability	Defined on 7 attributes: productivity, stability, reliability, resilience, adaptability, equity, self-empowerment
Indicators criteria (IC)	Yes	Yes	Yes	Assessed in the process, not a priori	Assessed in the process, not a priori
Goal setting (GS)	Top-down	Top-down	Top down and bottom up	Bottom up	Bottom up
Assessment type (AT)	Threshold	Reference	Ranges	Stakeholders' evaluation and different techniques	Reference (benchmarking)
Systemic dimension					
Indicators interaction (II)	No	No	Yes	Yes	Yes
Procedural dimension					
End- Users	Farmers and policy makers	Researchers and policy makers	Multiple stakeholders	Multiple stakeholders	Multiple stakeholders
Assessment purpose (AP)	Self-assessment	Assessment at parcel to region level	Advice policy decision making	Farmers advice and scenario analysis	Assessment and farmer advice
Assessment Level (AL)	Farm	Region	Region	Region	Variable
Stakeholder participation (SP)	No	Partial	Whole process	Whole process	Whole process
Aggregation approach (AA)	Per dimension worth up to 100 each	Quantitative aggregation per indicators	Interaction between indicators	Not specified	Per indicator
Application					
Geographical application (GA)	France	Europe	Switzerland	Developing countries	Latin America
System application (SA)	General agriculture	General agriculture	General agriculture	General agriculture	All natural resources management systems

Table 2. (continued)

Framework	**MOTIFS**	**DELTA**	**DSI**	**SAEMETH**	**AVIBIO**
Name	Monitoring Tool for Integrated Farm Sustainability	No indicated	Dairyman Sustainability Index	Sustainable Agri-Food Evaluation Methodology	AVIBIO
Reference	(Meul et al., 2008)	(Bélanger et al., 2015)	(Elsäßer et al., 2013)	(Peano et al., 2015)	(Pottiez et al., 2012)
Normative dimension					
Sustainability concept (SC)	Defined on WCED (1987)	Theory based on Landais (1998)	Defined on WCED (1987)	Based on Slow Food Foundation for Biodiversity's Presidia	Defined on WCED, (1987)
Indicators criteria (IC)	Yes	Yes	Yes	Yes	Assessed in the process, not a priori
Goal setting (GS)	Top-down	Top-down	Top-down	Top down and bottom up	Bottom up
Assessment type (AT)	Reference	Threshold	Threshold	Reference	Threshold
Systemic dimension					
Indicators interaction (II)	No	No	No	No	No
Procedural dimension					
End-users	Farmers	Farmers	Farmers and policy makers	Small farms	Researchers
Assessment purpose (AP)	Assessment	Self-assessment	Assessment at farm and regional level	Assessment and farmer's advice	Assessment of sustainability of system's supply chain
Assessment level (AL)	Farm	Farm	Farm	Product	Chain
Stakeholder participation (SP)	In the indicators' validation	In the indicators' validation	No	In the indicators assessment	No
Aggregation approach (AA)	Per dimension that worth till 100 each	Per dimension that worth till 100 each	Per dimension that worth till 100 each	Per indicators	Per dimensions
Application					
Geographical application (GA)	Europe	Canada	NW Europe	Europe	France
System application (SA)	Dairy	Dairy	Dairy	Small scale agri-food systems	Organic Poultry

Table 2. (continued)

Framework	COSA	RISE	FESLM	PG Tool	SAFA
Name	Committee on Sustainability Assessment	Response-Inducing Sustainability Evaluation	A framework for Evaluating Sustainable Land Management	Public Goods Tool	Sustainability Assessment of Food and Agriculture systems
Reference	(Giovannucci and Potts, 2008)	(Häni et al., 2003)	(Smyth and Dumanski, 1993)	(Gerrard et al., 2012)	(FAO, 2013a)
Normative dimension					
Sustainability concept (SC)	2002 World Summit on Sustainable Development	(Stückelberger, 1999)	FESLM Working Party 2001	Concept of Public Goods Cooper et al. (2009)	Based on FAO councils (e.g. 1989)
Indicators criteria (IC)	No	No	No	No	No
Goal setting (GS)	Top-down	Top-down	Top-down	Bottom-up	Top-down
Assessment type (AT)	Threshold	Sustainability degree calculated as SD=S-D	Threshold	Threshold	Threshold
Systemic dimension					
Indicators interaction (II)	Yes	No	No	No	No
Procedural dimension					
End-users	Farmers and policy makers	Farmers	Policy makers	Farmers	Multiple stakeholders
Assessment purpose (AP)	Assessment and prediction	Assessment and prediction	Planning	Farmers advice	Multiple purpose
Assessment level (AL)	Farm	Farm	Landscape	Farm	Farm
Stakeholder participation (SP)	No	No	No	Yes	No
Aggregation approach (AA)	Per indicators	Per indicators	Per indicators	11 spurs, covering the 3 dimensions	Per indicators (themes)
Application					
Geographical application (GA)	Developing countries	Developing and developed countries	Global	UK	Global
System application (SA)	Coffee sector	General agriculture	General Agriculture	General agriculture	Agriculture, Fishery and Forestry

5. Discussion (frameworks categorisation)

The discussion of the results of the analysis follows a two-step structure: firstly, we analyse the results per dimension (normative, systemic and procedural), then we group frameworks in four categories and explore the features of each category in detail.

5.1. Normative Dimension

The Brundtland report (WCED, 1987), which states the most acknowledged and recognised formal definition of sustainable development[4], is the conceptual basis for most tools, even if in some cases the tool mentions other studies to complement or specify a particular aspect of the sustainability concept. Nevertheless, with the sole exception of MESMIS (and MMF, which is a sort of MESMIS re-elaboration), no tools directly link the concept of sustainability with framework development. This absence of theoretical investigation is also evident in the fact that indicator criteria are not always specified or are barely discussed. The process of goal setting is in general top-down and the assessment type is by threshold. These last two points are related to two aspects in the procedural dimension, namely stakeholder participation and aggregation approach. In fact, when goals are set with a bottom-up approach stakeholders' involvement is continuous throughout the whole process with a participatory methodology, while in the top-down approach stakeholders are only partially involved, usually in the validation process, or not involved at all. SSP and SAEMETH are the sole frameworks that use a mixed top-down and bottom-up approach even though stakeholders' evaluations are adjusted based on experts' opinions, making it an essentially top-down approach.

5.2. Systemic dimension

The relationship between indicators can provide an adequate picture of the sustainability issues of an agricultural sector or system analysed. How economic, social and ecological indicators interact, i.e. trade-offs and/or synergies, is an important shortcoming in the much of frameworks (Binder et al., 2010; Galdeano-Gómez et al., 2017)[5]. Nevertheless, this issue is rarely considered in the analysed frameworks. The interaction between indicators is a specific goal of SSP, whose methodology is based on the space (or interaction) created between ranges of sustainability indicators. MESMIS also considers indicator interaction a primary objective of the evaluation, while COSA

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[4] "Humanity has the ability to make development sustainable to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED 1987:27)

[5] E.g. indicators related with organic production methods that promote recovery of soil proprieties from a traditional agriculture technique could have a negative interaction with indicators relative to efficiency use of water with modern technologies (hydroponic in EU, for example) which have an improvement in economic and other ecological aspects (water usage or soil contamination).

regards it as a part of the analysis. The remaining tools analyse and evaluate indicators separately.

5.3. Procedural dimension

Farmers are the end-users towards whom all tools are directed. This is probably due to the innate purpose of tools to assess and advise farmers on possible sustainable changes; in this regard, IDEA and DELTA are intended to be used by farmers themselves as self-assessment tools. The two exceptions are SAFE, which is considered an assessment tool for researchers, and AVIBIO, which is the only framework aimed at evaluating the sector supply chain and, for this reason, its scope is beyond farmers. Finally, a particular group of frameworks is designed for multiple stakeholders or developed with multiple purposes as they do not have a specific sustainability target, but they may be adjusted to the specific needs of the context of application.

5.4. The four categories of frameworks

As exhaustively explained by Binder et al. (2010) and pointed out above, there are basically two different approaches in developing indicators for a sustainability evaluation. In the first one, indicators are developed by a group of experts and academic and then they are applied to an agri-system. This approach is generally known as *top-down*. In general, the differences among assessment tools that share this approach regard the purpose of the evaluation and the way data are aggregated, and we can distinguish among researcher addressed, dimension driven and indicators driven frameworks. On the other hand, in the second approach, known as *bottom-up*, indicators are identified by a participatory process in which key stakeholders are involved so that the farmers are participating in the whole process from the selection of indicators to the interpretation of the results of the assessment[6].

Bottom-up participatory frameworks

In this group, we include MESMIS, MMF, SSP and SAEMETH. These frameworks are based on a participatory process in which stakeholders are appointed to construct, along with evaluators, the assessment variable. Among those mentioned, the framework with the most widespread application is MESMIS (López-Ridaura et al., 2002; Masera et

[6] Except the case of SSP, every framework adopts either the *top-down* or the *bottom-up* approach.

al., 2000), which has been applied on several occasions in developing countries, especially in Latin America (Astier, 2006; Astier et al., 2011; Giraldo Díaz and Valencia, 2010; Merlín-Uribe Yair et al., 2012; Nicoloso et al., 2015; Speelman et al., 2007). The indicators are derived from seven general attributes, namely productivity, stability, reliability, resilience, adaptability, equity and self-empowerment, which underpin the entire sustainability assessment process. The latter is structured in a six-step cycle in which the first two are devoted to describing and determining the key factors of the management system under analysis. Another interesting point is that the framework does not indicate a precise methodology for data analysis but, instead, is open to multiple techniques that may include literature review, direct measurement, use of specific monitoring devices, matrix construction, simulation models, surveys, interviews, or other participatory tools. The sixth step is the synthesis and integration of results. There is no precise integration technique in this part of the process but the most suitable method must be identified according to the purpose and end-user of the assessment. However, after the final step is completed, the cycle can be repeated; in fact, the first cycle is intended to supply suggestions and measures to enhance system outcomes, hence, a new assessment may be applied to the already improved scenario. Finally, one last point worth highlighting relates to sustainability dimensions. If, on one hand, MESMIS encompasses economic, ecological and social factors, on the other hand, it does not model the assessment process based on those three dimensions. Thus, it effectively bypasses the problem of weighted data and aggregation, as aspect which we believe constitutes a significant limitation of other sustainability assessment tools.

Top-down researcher addressed frameworks

This group is comprised of tools that are intended for researchers so they may deepen the sustainability understanding of a system or a regional landscape; hence, their purpose extends beyond the farm level. FESLM, AVIBIO and SAFE constitute this group, yet the latter boasts more extensive application, particularly in Spain (Galdeano-Gómez et al., 2017; Gómez-Limón and Sanchez-Fernandez, 2010; Gómez-Limón and Riesgo, 2010).

FESLM (Smyth and Dumanski, 1993, 1995) is developed with the support of the FAO and is based on a previous FAO framework for land evaluation. They differ in that the latter is based on land suitability while FESLM is based on indicators of performance over time.

AVIBIO (Pottiez et al., 2012) is a framework designed for the poultry sector only. Surveys with different stakeholders are used to develop a set of nine indicators and their respective weight. Finally, scores of each indicator are averaged per dimension and sustainability is calculated against a maximal score of 180 points for each dimension.

SAFE (Van Cauwenbergh et al., 2007) is a holistic framework that considers the three sustainability pillars and can be applied on different scales from the parcel to the macro-regional level utilising a hierarchical top-down methodology that derives indicators from criteria and principles. The first level of the structure is represented by the *principles* whose definition depends on the concept of ecosystem functioning as expressed by de Groot (1992). The following hierarchical steps identified are the *criterion*, the *indicator*, and the reference values. The framework is typically top-down as it theoretically identifies a selected number of principles for each sustainability dimension, even if it considers possible stakeholder involvement in the process of generating indicators.

Top-down dimension driven frameworks

The frameworks of this group aggregate results per dimension. DELTA (Bélanger et al., 2015) is a self-assessment tool operating at farm level originally created for the evaluation of sustainability of Canadian dairy farms. It is regarded as a model and shares common features with the European tools IDEA (Zahm et al., 2008), MOTIFS (Meul et al., 2008), and DSI (Elsäßer et al., 2013). This tool analyses the sustainability performance of a farm in a one-year period with a typical top-down approach in which for each sustainability dimension a list of indicators is developed. Nevertheless, the methodology comprehends an end-user validation process where farmers are involved in order to assure a tool's practical usefulness and the possible implementation of the results.

The frameworks of this group were originally created for the dairy sector and, in the case of IDEA and MOTIFS, have been applied to other sector (Coteur et al., 2016; Triste et al., 2014).

Top-down indicators driven frameworks

The framework of this group was conceived with the aim of standardising sustainability assessment to cope with the large number of tools applied on different scales in different regions. RISE, COSA, PG Tools and SAFA, share the same feature:

they are sustained by governmental and no-governmental organisations, apply a predetermined set of indicators to allow a common ground for different systems comparison, use their own software to develop the assessment (except for PG Toll, which uses MS Excel) and have also been applied on numerous occasions thanks to the financial support they receive. However, from the point of view of the framework structure, they all aggregate results per indicator, in order to represent the evaluation in an easy-to-understand spider-graph.

RISE (Grenz et al., 2009; Häni et al., 2003), the first to be created, is a tool built by the School of Agricultural, Forest and Food Sciences, part of Bern University of Applied Sciences, and other partners in 2000; it has been implemented in several Countries in both developed and developing economies (de Olde et al., 2016b; Nestlé, 2014). This instrument selects a priori twelve sustainability indicators for each one determines the current condition of the specific indicator (S) and the degree of the estimated pressure the farming system places on the specific indicator (D). The S-D results for each indicator are plotted together on a spider graph. The instrument is not only rapid and highly comprehensible but it also allows researchers to show farmers the scenario resulting from possible changes.

If COSA is rather similar in his features to RISE, PG Tool reveals distinguishing characteristics. PG Tool (Gerrard et al., 2012) is a farmer-advice instrument operating at the farm level whose competitive advantage lies in its very fast process that in 2-4 hours allows researchers to supply the farmer with an insight into the sustainability status of the farm and practical advice on possible improvements. The process is fully top-down since basic *Public Goods*, sustainability areas of the agri-system, *key activities* of the farm, and constraints are all identified *a priori*. Then, the process is undertaken by a researcher asking the farmer several questions for each area. Data are then reported in a 5-point scale and results are shown to the farmer in a spider graph. The tool is very simple, fast, and easy to understand for farmers, but, in order to guarantee speed, it relies only on the data previously recorded by the farmer, since the process does not consider further investigations (Marchand et al., 2012).

These last frameworks mentioned share the obvious advantage that they synthesise and simplify the sustainability assessment, yet, their application is rather controversial. In particular, the fact that governmental organisations, and even multinational enterprises, finance the tool may be seen as a conflict of interests considering the multiple business and political issues in which those same organisations are involved.

The SAFA tool (FAO, 2013a) was prepared by the FAO with the collaboration of RISE's developers and it has been widely utilised (Gayatri et al., 2016; Hřebíček et al., 2013; Jawtusch et al., 2013; Ssebunya et al., 2016). This tool conducts an evaluation that uses 116 indicators whose results are aggregated per 21 themes which cover four sustainability dimensions: governance, environment, economy and social. Indicator value, which can be quantitative or qualitative, are then transferred to a 5-point scale according to provided reference values. The results are shown by a spider graph so that analysts and farmers can easily identify the areas with sustainable outcomes and those to be improved. All calculations are developed by user-friendly software that is offered via free-download on the SAFA website.

For this reason, SAFA is probably the most affordable and complete tool of its kind since it considers a more exhaustive concept of sustainability that includes the dimension of governance, it covers the majority of themes included in RISE (80%), PG Tool (58%) and IDEA (55%) (de Olde et al., 2017); and it did not receive private or governmental support.

Final consideration on frameworks

All top-down frameworks share three weak points that deserve consideration.

Top-down frameworks develop indicators prior to the evaluation process and regardless of the specific systems they intend to analyse so that the same set of indicators are applicable to different contexts and comparison is straightforward. Consequently, this process can miss some specific features such as the geographical context, social situation, or system structure. Some frameworks try to overcome this problem by focusing on just one sector (such as DSI for dairy and AVIBIO for poultry); but, this approach, too, lacks the capacity to compare heterogeneous situations, which is one of the main advantages of the top-down methodology.

Moreover, top-down frameworks assume that each indicator (in the case of indicator-driven frameworks) or each dimension (in dimension-driven frameworks) has equal importance. But this assumption represents the tool developers' concept of sustainability rather than the tool users and stakeholders' concept. In dimension-driven frameworks this problem is more evident as they reduce the sustainability assessment to only three values. As a result, this structure leads to subjective and discretionary judgments that can hardly be justified by the end-user's validation or the farmer's opinion. For example, in the DELTA case study, Bélanger et al. (2015) weights the indicator "Quality of life" 25% while "Fertilization management" 30%. Regarding the variables, "Health and stress" accounts for 5% while "Forage self-sufficiency" represents 10%. The reason why farmers consider the forage issue twice as important as the state of their health is probably due to the tool's structure rather than the actual farmers' thinking[7].

Finally, by using a fixed set of reference values, they assume a maximum level of sustainability, implying it cannot be improved.

Bottom-up frameworks, which involve local stakeholders, present several undeniable advantages: firstly, their flexible structure allows them to be applied to all natural resources management systems and not only to agriculture; secondly, bottom-up frameworks represent the specific situation itself and weight the actual stakeholders' thinking; and, finally, they do not assume a maximum level of sustainability.

Nevertheless, bottom-up frameworks also present practical vulnerabilities. Since they need to involve local stakeholders, the application of this framework is usually very complex to manage and needs financial and operational support from authorities or governmental institutions. Furthermore, the process takes a long time to produce results, possibly prompting stakeholders to leave the process. Finally, comparison between different systems is rather difficult and analysis is hardly reproducible (Binder et al., 2010).

Top-down frameworks represent an interesting alternative option to bottom-up. Nevertheless, top-down indicators driven frameworks are easier to be reproduced in different systems, user friendly and quicker in developing the analysis.

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[7] It is possible to find a similar example also in Zahm et al. (2008), where the indicator "Financial autonomy" scores two times higher than the indicator "Quality of life" (15/100 vs 6/100) or in Meul et al. (2008), where the indicator "Capital productivity" is weighted more than the indicator "Nature conservation" (10.5/100 vs 5.56/100).

Top-down dimension driven frameworks represent a possible compromise between bottom-up and top-down indicators driven framework since in respect to the latter they develop a deeper analysis and need just a portion of the time required by the former.

Finally, top-down researchers driven framework are tools thought for the academic debate. In this aspect relies their difference to the other tools. Our results are shown in the Table 3.

Table 3. Frameworks comparison

Features	**Classification**			
	Bottom-up participatory frameworks	**Top-down researcher addressed frameworks**	**Top-down dimension driven frameworks**	**Top-down indicators driven frameworks**
	MESMIS MMF SSP SAEMETH	SAFE FESLM AVIBIO	MOTIFS IDEA DSI DELTA	SAFA RISE COSA PG Tools
Reproducibility to different agricultural systems	Difficult to reproduce	Medium difficulty	Medium difficulty	Easy reproducible
System representation	Complete	Partial	Partial	Partial
Stakeholders representation	Complete	None	Minimal	None
User-friendly	Difficult to manage	Only for academic study	Medium difficulty	Easy to use
Speed	Slow process	Medium speed	Medium speed	Rapid process
Applicability to no-agricultural system	Yes	No	No	No
Assume a maximum sustainability level	No	Depends on the analysis	Yes	Yes

6. Conclusions

In this study, we have seen that the selection of the most suitable framework for the sustainability assessment of agri-systems is a complex issue. The present study aims to help practitioners guiding them in the selection of the most suitable tools for the sustainability assessment.

In the first portion of the present work, we have reviewed the most recognised literature in the field and identified nine essential criteria for indicator inclusion. In other terms, each indicator must rely on available data and identify something relevant. In addition, it must also be flexible to spatial or time change, analytically valid, measurable in either a quantitative or a qualitative manner, relevant for policy makers, implementable by farmers, understandable by lay people, and acceptable to different stakeholders.

As second step of our study, we carried out a framework categorization and we applied it to assessment tools which consider at least the ecological, economic and social dimension of sustainability.

Our categorization results in the identification of four groups of frameworks. The first group includes the bottom-up assessment tool, such as MESMIS, which applies a strong collaborative methodology with intense stakeholder participation both in the selection and application of the indicators. The remaining frameworks use a top-down approach with partial or minimal stakeholder interaction. The second group presents the framework specialised for the academic research, SAFE is a well-recognised example. The third group includes those frameworks that aggregate results per sustainability dimension, MOTIFS is a strongly-applied framework of this group. The last group is composed by the frameworks that aggregate results per indicators; SAFA is a good example of this last group.

Our analysis emphasises that bottom-up and top-down methodologies are complementary, hence, it is not possible to identify a priori the best approach. In particular, the comparison between the most acknowledged frameworks of each type reveals that while MESMIS is more exhaustive in representing natural resources management systems and efficient in characterising stakeholder participation, SAFA succeeds in developing a complete sustainability evaluation at a reasonable cost in terms of time, people and economic resources.

To benefit the current academic body of literature, more study is needed. Further investigations can evaluate the simultaneous application of these two frameworks to the same system in order to estimate the possibility of an integration of the two approaches, for instance, utilising SAFA indicators and aggregation methodology as a basis for debate with stakeholders.

CHAPTER 3

DECONSTRUCTION THE QUALITATIVE METHODOLOGY FOR THE ANALYSIS OF SUSTAINABILITY ASSESSMENT TOOLS OF AGRI-SYSTEM

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DECONSTRUCTION THE QUALITATIVE METHODOLOGY FOR THE ANALYSIS OF SUSTAINABILITY ASSESSMENT TOOLS OF AGRI-SYSTEM

Abstract

As sustainability is a philosophical concept, the evaluation of sustainability of an agri-system is underpinned by a philosophical understanding. Deconstruction is the qualitative methodology derived from philosophical science that allows to show what is hidden, to reveal the implicit meaning of a sustainability assessment tool (Table 1).

- Qualitative methodology of analysis.
- Applicable to all kind of qualitative analysis.
- Suitable for review article.

Table 1: Method overview

Subject area	*Select one of the following subject areas:* • *Environmental Science*
More specific subject area	*Agriculture sustainability*
Method name	*Deconstruction*
Name and reference of original method	Derrida, J. (1974). *Of Grammatology*, trans. Gayatri Spivak. Baltimore: The Johns Hopkins University Press. Derrida, J. (1978). *Writing and Difference*, trans. Alan Bass. Chicago: University of Chicago Press.
Resource availability	*No applicable*

1. Background

In recent years, in the academic arena the application of sustainability principles to the agricultural sector has become a crucial subject of study. However, despite a general accord on its relevance, the concept of sustainability lacks a consensus on its definition and in the methodology for its evaluation (Binder et al., 2010).

Regarding this last point, practitioners and analysts have developed in the last years several sustainability assessment tools (SAT) that employ a group of indicators to evaluate the sustainability of an agri-system(van Asselt et al., 2014).

Studies on SAT showed that these instruments can vary on different issues (Van Passel and Meul, 2012), for example the end-users they are addressed to (for instance they may be thought for practitioners, for policy makers or for academics), the aim they are designed to and the concept of sustainability underpinning the instrument.

In the analysis of the literature it is possible to find several studies about SAT (de Olde et al., 2016c) but just a minority of them discuss the evaluation process in depth while the great majority focuses on applications and results. In addition, since every SAT is underpinned by a precise concept of sustainability (Roy and Weng Chan, 2012), the evaluation process and results are implicitly shaped by this underlying philosophical concept. Because of this, it is difficult for practitioners to understand the reason why a SAT is used by other analysts and which SAT best fits the requirements of a specific agri-system; and the need of a methodology that allows to show the philosophical understanding.

In general, it is possible to state that in the literature a precise methodology for qualitative analysis is missed. This study aims to introduce a methodology for the qualitative evaluation derived from the philosophical sciences that allows practitioners and analysts to fully understand the SAT in order to choose the most suitable for a given agri-system.

Deconstruction is a methodology firstly developed by the French philosopher Jacques Derrida (1974, 1978) and originally applied to philosophical analysis. It is a qualitative methodology that allows researchers and practitioners to analyse SAT in order to choose the most appropriate for the evaluation's purpose (Bonisoli et al., 2018). Deconstruction is not only interested in the results of a sustainability evaluation, but it focuses in particular in the criteria for the indicators inclusion in the SAT and in its methodology.

2. Method details

This methodology relies on three basic assumptions:

First, in a SAT nothing is casual. This methodology considers that all conceptual tools are built using a precise logic that is functional to SAT purpose.

Second, the logic behind the SAT is underpinned by a precise philosophical understanding.

Third, there is not a “best” philosophical view, thus the purpose of the analyst is not to judge the different concepts of sustainability but to reveal the concept behind the instrument.

Deconstruction has not a formal set of steps for its application but can uses different tactics. An example of them can be:

Comparison

A first tactic is to compare different SAT in order to find the differences and to interrogate the consequence those differences lead. In this way, SAT can be compared regarding the indicators they use, for example, the number of indicators, the dimensions they cover, or if they are qualitative or quantitative. Moreover, SAT can be compared in the aggregate approach employed in the evaluation and the methods to show the results to end-users. Finally, SAT may be compared in the way stakeholders are involved in the process or if it is possible for farmer to enhance the sustainability of the enterprise using the results of the assessment.

Simulation

Other tactic is to apply the SAT with extreme and fictional input in order to analyse the possible results. For example, practitioners can imagine situation in which an evident unsustainable problem occurs (for example, unfair price negotiation or raising unemployment rate) to check whether the SAT identifies or to which extent the results are affected by the problem.

Author analysis

This tactic considers investigating other article of the same authors to check if there are relationships among different studies. It is possible that the same author that in an article presents a new SAT, in another study is claiming the need for a certification of sustainable product similar to the certification of organic product; thus, the aim of the

SAT is probably to be the instrument to evaluate a future certification in a project of a certification business.

CHAPTER 4

BENCHMARKING AGRI-FOOD SUSTAINABILITY CERTIFICATIONS: EVIDENCE FROM APPLYING SAFA IN THE ECUADORIAN BANANA AGRI-SYSTEM

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BENCHMARKING AGRI-FOOD SUSTAINABILITY CERTIFICATIONS: EVIDENCE FROM APPLYING SAFA IN THE ECUADORIAN BANANA AGRI-SYSTEM

Abstract

Certified products are a possible way to obtain and improve sustainability. Nevertheless, their effectiveness in enhancing agri-system sustainability is strongly questioned in the academic arena. This study aims to examine in depth the effect of certification on sustainability achievement. For this purpose, organic and Fairtrade Ecuadorian banana is analysed against the conventional banana. This study employs an original approach that operationalises SAFA (Sustainability Assessment of Food and Agriculture). This tool was chosen for the analysis because of the wide spectrum of sustainability issues considered in the evaluation, along with the fact that it is easy for producers and decision makers to implement and understand, and offers the consequential possibility to identify precise measures to enhance sustainability in the short term. Results show that organic and Fairtrade farms achieve more sustainable performance than those of conventional farms in terms of governance, environmental and economic dimensions. Nevertheless, conventional farms display better outcomes in matters of social sustainability. The reason most likely lies in the size and processes of farms rather than their certification standards. This study may be used by practitioners as a valid benchmark for the implementation of SAFA to other agri-systems and by decision-makers as a guide for the regulation of agri-sector processes.

Keywords: Certifications, SAFA, Fairtrade, Organic, Ecuador

1. Introduction

In recent years, several certification schemes have been created to assess product sustainability for customers. This trend is not only present in agriculture but also a wide range of sectors, such as fishery, forestry, and tourism (Dietz et al., 2018; Tröster and Hiete, 2018; Wibowo et al., 2018). Nevertheless, the effect of certification on system sustainability is strongly debated and a common consensus is far from being reached.

In fact, with regard to this academic debate, several studies have confirmed the benefit of certifications on improving agriculture sustainability as a whole (Barham and Weber, 2012; de Olde et al., 2016b; Torres et al., 2016), soil quality (Pritchett et al., 2011), farm profitability (Haggar et al., 2017), energy and material usage (La Rosa et al., 2008), animal welfare (Boggia et al., 2010), biodiversity (Underwood et al., 2011) and workforce wellbeing (Krumbiegel et al., 2018).

However, other studies have reported that, in some cases, the impact of certifications is not completely clear. In particular, data on soil quality (Leifeld, 2012), environmental impact (Foteinis and Chatzisymeon, 2015; Patil et al., 2014) and societal sustainability of certified farms (van Calker et al., 2007) are not as positive as expected, revealing a clear necessity to analyse this issue in depth.

This study engages in this academic discussion by completing an extensive evaluation and comparison of the sustainability of certified and conventional agri-products. To do so, an original approach was developed which combined manager interviews, farm visits and producer and worker surveys to operationalise the FAO's Sustainability Assessment of Food and Agriculture (SAFA; FAO, 2013a).

SAFA is the instrument chosen for this study as it offers three critical advantages: the wide spectrum of sustainability themes considered in the evaluation, the ease with which it can be used and understood by producers and decision makers, and, the consequential possibility to identify precise measures to improve system sustainability in the short term.

This study applies the described methodology to the Ecuadorian banana agri-system. Ecuador is a country that is highly dependent on the exportation of raw material, where the banana is the top exported agri-product, representing 23.13% of the overall non-oil based exportation of the country (AEBE, 2017). For this reason, it is important to evaluate the sustainability of this system, considering that most producers have adopted private certifications and changed their production to match the growing demand for certified products in western countries. Furthermore, this particular market constitutes a rather interesting subject due to both the existence of several certifications that are strongly influenced by market trends and the absence of studies on sustainability, especially concerning the various certified productions and their comparison with conventional banana.

Although several studies discuss the sustainability of certified products, most of them either focus on a specific sustainability aspect or employ an only-for-experts method (Fess and Benedito, 2018). The present study contributes to the debate in three main ways: evaluating the four sustainability dimensions of certified and conventional agri-systems, applying an original approach that operationalises SAFA, and providing comprehensible results that may be translated into practical suggestions for producers and decision makers for the improvement of the sustainability of agri-food sectors.

The article is organised as follows: firstly, the debate on certification and related issues are analysed; secondly, an overview of the Ecuadorian agri-system and the main certifiers it is described; thirdly, the methodology is presented; fourthly, the results of the evaluation are reported and discussed; and finally, conclusions are drawn and further lines of research are suggested.

2. Certified products

In the last decade, a growing number of farmers have arranged their production process in order to obtain a private institution quality certification. Certification, even if it is not the sole route for sustainable agriculture, provides controlled planning to make progress in the sustainability of agricultural practices through the implementation of well-defined indicators and auditing instruments (Tayleur et al., 2017). More specifically, certification could be a valid solution for small farmers in developing countries, where the government does not always completely control territory and agricultural procedures (Barrett et al., 2001).

With regard to the most contentious issues that have emerged in the academic debate, this section first examines those certifications whose primary purpose is to enhance the well-being of producers and then addresses the organic product certifications.

1.1. Social well-being certifications

In the last thirty years, the wide implementation of neoliberal policies in Latin American agri-sector has brought about the transformation of agriculture from a Fordist national model of mass-market food production and consumption (Friedmann and McMichael, 1989) to a speciality item oriented production aimed at wealthy consumers in the global market (Raynolds, 2008). In this context, alternative food networks developed as a countermeasure to “the unsustainable industrial food system and the exploitative trading relations embedded in global supply chains” (Goodman et al., 2011).

The first key issue related to certifications is efficiency. Several studies show that certified products are, in general, more sustainable than those that are not certified. For example, in the Ecuadorian banana agri-system, organic production results in better outcomes, both for the environmental point of view and in terms of producer revenues (Castro et al., 2015; Melo, 2005; Melo and Wolf, 2007; Ruben et al., 2008). Moreover, evidence shows that Fairtrade (FT) agriculture enhances women participation to networks benefits, farming practices and cash access in both Latin American (Lyon et al., 2010) and African (Bassett, 2010) agri-systems. Finally, certification is effective in enhancing producers’ sustainability, as it is for fishery (Borland and Bailey, 2019), it increases occupational health and safety for rural communities in forestry (Şen and Güngör, 2018) and it strengthens revenues in the tourism industry (Hellmeister and Richins, 2019).

Despite the previously-mentioned benefits, a significant number of studies have identified several aspects related to sustainability certification efficiency that deserve further analysis.

The first topic of interest related to certified products is their acceptance within the destination market, i.e. the North. In general, although the majority of European consumers claim to be seriously interested in the social and environmental sustainability of the products they purchase, giving ethical aspects priority in the selection of products, economic factors still prove crucial in the selection process (Gracia and de Magistris, 2008). Moreover, there are many variables which bring into question whether said claim (a commitment to sustainable products) actually generates real purchase; in particular, certified product sales are affected by scarce availability and deficient communication on store shelves (Annunziata and Scarpato, 2014). Furthermore, certifications result to have low visibility and scarce level of understanding (Annunziata et al., 2019b) so that they are rarely considered in the consumer’s decision process (Peschel et al., 2019). Finally, the level of professionalism in the sale of certified products is generally low (Bellucci et al., 2012).

Another aspect that has undermined the capacity of the certified products market to improve the sustainability of agri-systems is the proliferation of certifications that complement, substitute or compete with each other (Lambin and Thorlakson, 2018). As in the case of the Dutch coffee market, FT has not become the standard for the market but it was used by the key stakeholders (such as retailers and roasting companies) as a benchmark for developing new standards that prove more feasible for their business models (Ingenbleek and Reinders, 2013).

Big companies play a crucial role in the certified products market. In fact, in general, big companies that are found to be less interested in sustainable marketing than the small mission-driven firms (Howard and Jaffee, 2013), entered this market demanding high standards products and expensive certifications (Raynolds, 2008) or creating self-owned certification process (Fridell et al., 2008). For this reason, and to compete with the top Fairtrade certifier, Max Havelaar, other institutions created less demanding standard certificates, such as Utz Kapeh, Rainforest Alliance (RA) (Bacon, 2005; Bacon et al., 2008) and 4C (Ingenbleek and Reinders, 2013). In the case of RA, in order to minimise producers' expenses, labelled products that contained only partially certified matter (Ingenbleek and Reinders, 2013) and, in some cases, it failed to generate better environmental outcomes (Bellamy et al., 2016). The situation resulted in lower producer incomes (Minten et al., 2018), the indebtedness of small-holder farmers (Wilson, 2010) and a higher rate of people below the poverty line among the certified producers with respect to their conventional counterparts (Bassett, 2010; Beuchelt and Zeller, 2011).

To understand this contradiction, it is necessary to take a step back and direct the analysis of the whole process at the so-called "ethical commodities". Mutersbaugh and Lyon (2010) define ethical commodities as those for whom a significant portion of their value relies on ethical qualities that are proven by widely accepted and verifiable standards. Hence, since those qualities are extrinsic to the product and thus not detectable by commodities testing, a certification process is necessary to make ethical qualities visible to consumers. Nevertheless, the resulting certification supply-chain, from the point-of-origin to ethical consumers, incurs an ethical contradiction; in fact, despite its ethical intentions, the market of certified products assumes neoliberal beliefs according to which the consumer rather than public institutions should be the driver of development and sustainability (Moberg, 2014). In addition, since the logic of a certification process reflects consumer concerns and values of developed countries, the FT market often neglects specific features of the point-of-origin’s social, environmental and economic situations and forces it to match external standards (Wilson and Jackson, 2016).

By doing so, the market of certified products reproduced a neo-colonial situation in which what for consumers is a matter of choice, for producers is a matter of survival (Melo and Hollander, 2013), as explained, for instance, by Raynolds and Ngcwangu (2010). These authors explored a case study of South African rooibos tea and demonstrated how US consumers shaped the production at the point-of-origin.

1.2. Organic products certification

There is an extensive literature that explores a variety of aspects on organic products. This study focuses on some key topics related to the consumption of this kind of product. The first aspect addressed is the environmental impact of organic agriculture as it is traditionally the main reason why sustainability researchers have concentrated their attention on this type of production system. The second point of interest studied is the supposed increased profitability that Organic Agriculture (OA) should generate for farmers. Once the sustainability of OA at the point-of-origin is discussed, the study investigates the demand that drives the implementation of OA, namely the perception and acceptance of Organic products among consumers.

OA is considered to be a benefit to the environment by enhancing climatic resilience (Scialabba and Müller-Lindenlauf, 2010), reducing soil degradation (Niggli et al., 2007), improving pest resistance (Birkhofer et al., 2008) and soil fertility (Bonanomi et al., 2016), creating a more efficient use of natural resources such as water (Thierfelder and Wall, 2009), demanding less energy inputs (Pimentel et al., 2005) and contributing to food safety (Azadi et al., 2011). Nevertheless, some authors point out certain limitations to the belief that "organic is always better". In particular, Tuomisto et al. (2012) conclude that if on one hand organic production records higher soil organic matter content, lower nutrient loss and lower energy requirements, on the other hand, it results in higher nitrogen leaching and ammonia and nitrous oxide emissions per product unit than those generated by conventional crops. In addition, because yields are lower (at least 20% according to De Ponti et al., 2012), organic farming needs more land use and is therefore unlikely to supply the worldwide food demand (Connor, 2008). Furthermore, Hole et al. (2005) find that OA contributes to biodiversity even if it is unclear whether OA would offer greater benefits to biodiversity than carefully targeted prescriptions applied to conventional farming. Finally, Templer et al. (2018) conclude that ecological farm health is reinforced only if organic processes overtake basic labelling requirements, thus the positive effects of organic certification on agroecosystem health cannot be taken for granted.

Organic farming increases farmers' income (Parvathi and Waibel, 2016), contributes to the reduction of poverty among small farmers (Ayuya et al., 2015), generates a higher return on investment (ROI) (Kleemann et al., 2014) and proves to be less risky than conventional methods (Pimentel et al., 2005). However, even in this case, it is possible to report some in-depth analysis. For instance, contrary to the above investigation, Ibanez and Blackman (2016) and Froehlich et al. (2018) conclude that if OA results in improved environmental benefits, there is no evidence that it positively affects farmers' economy. A possible explication of this conclusion may be found in the research of Kleemann and Abdulai (2013), whose findings indicate that economic returns of organic farms are substantial only if farmers go beyond the organic-by-default step and intensively implement agri-ecological practices. Finally, Veldstra et al. (2014) find that in some cases farmers who undertake organic practices prefer not to certify their products because of the high cost of the certification process.

The studies on the acceptance of Organic Products (OP) among consumers focused on two different points: the profile of the OP consumers (*who*) and the reasons for consuming OP (*why*) (Monier-Dilhan and Bergès, 2016).

Regarding the first aspect (*who*), with the aim of establishing a profile of OP consumers, it was found that, in general, the propensity to purchase OP tended to increase with social status and the presence of young children in a household (Wier et al., 2008), a higher education level (Monier et al., 2009) family structure, access to organic products and higher expense capacity (Dimitri and Dettmann, 2012). Furthermore, the rate of OP consumers is higher among education and health professionals (Vehapi and Dolićanin, 2016), while it is lower among elder householders and African Americans (Dettmann and Dimitri, 2010). It is notable that the cluster analysis of Rodrigues et al. (2016) and Oroian et al. (2017), conducted in Brazil and Romania respectively, obtain similar findings in that they identify three groups of consumers: Greeners, which associate OP to sustainable development and are represented by older people; GMO-Freers, more interested in healthy food and generally younger; and those who do not have interest in OP or simply focus on taste of food.

This last study mentioned leads to the second question (*why*), which has generally aroused more interest among academics. In fact, it is possible to identify two different possible reasons: an "egoistic" reason that corresponds to concerns about food safety, which is based on the belief that OP is healthier than conventional produce, and an "altruistic" reason that associates OP with a better positive "environmental" impact (Yadav, 2016). Nonetheless, the results seem to considerably vary according to country and age. In fact, even if the two reasons always have a positive impact on all OP consumers (Yadav and Pathak, 2016), French (Monier-Dilhan and Bergès, 2016), German and US (Rana and Paul, 2017) consumers, for example, are more driven by environmental impact reasons, while Indian (Yadav, 2016), Malaysian (Rana and Paul, 2017), Turkish, Iranian and Pakistani (Asif et al., 2018) are more conditioned by personal health values.

Finally, three studies on consumer intentions are particularly remarkable in the sense that they approach the exploration of said intentions in selecting OP from a different perspective. The research of Hwang (2016), for example, takes a psychological angle and finds how self-presentation, namely the component of self-identity, whose goal is the management of the self in social settings, is one of the major factors that drive older consumers' purchase intentions, while ethical self-identity, which reflects the extent to which ethical issues are related to private consumption practices, does not improve purchase intention. With another approach, in order to explain the gap between consumers' claims of interest in OP and their actual behaviour, the study by Chekima et al. (2017) focuses on consumption rather than purchase and finds that consumption of OP is higher when consumers are more concerned about the future, so producers and marketers should advertise future gains of OP in order to foster consumption. Subsequently, Apaolaza et al. (2017), rather than focusing on health as a motivation for the acceptance of OP, state that better health is a consequence of OP consumption, because it shapes consumers' lifestyle.

3. Case Study: Banana sector in Ecuador

This section presents two aspects are presented: an overview of the Ecuadorian banana agri-system and the main certifiers that operate in it.

3.1.Ecuadorian banana agri-system

Macroeconomic figures in 2018 show that Ecuador has the lowest inflation rate of all Latin America (1.12%), an unemployment rate of 5.4%, and an external debt of 33.8% of GDP, one of the lowest values with respect to the main South American economies, such as Argentina (10.0%; 8.4%; 35.3%), Brazil (5.4%; 11.5%; 18.0%), Chile (3.0%; 6.5%; 66.3%), Colombia (3.2%; 9.2%; 42.5%) and Peru (3.7%; 6.7%; 38.4%) (Focus Economics, 2018).

Nevertheless, poverty is still an important issue. Although in the 2007-2017 period the poverty rate (less than 84.5 USD per month according to BCE, 2017a) had decreased by 41.41%, in December 2017 it reached the value of 21.5% of total Ecuadorian population, in other figures, 3.62 million (m) people were living below the poverty line. The extreme poverty rate (less than 47.6 USD per month according to BCE, 2017a) has also decreased in the last ten years by approximately 52.12%, and in December 2017 it accounted for 7.9% of the Ecuadorian population, i.e. 1.33 m people (BCE, 2017a). Poverty is more common in rural areas, where poverty rate accounts for 39.3%, while in urban areas it is considerably lower, i.e. 13.2 (BCE, 2017a). Inequality is also an important issue, even if Ecuadorian governmental action in the last decade has managed to reduce the rich-poor gap. In fact, the Gini coefficient has decreased from 0.54 to 0.46 in the period 2004-2015 (BCE, 2017b).

This study focuses on the Ecuadorian banana agri-sector. Ecuador's exportations, which in 2016 represented about 19% of GDP, depend primarily on raw materials. The main exported product is petroleum, which accounts for 32.5% of total exportation, followed by banana (15.61%), (AEBE, 2017).

Banana plantations are concentrated in three Ecuadorian provinces (91.8% of national production), namely, Los Rios (58,219 ha. of production), Guayas (47,388 ha.) and El Oro (43,165 ha.). The present study focuses on the last province (Figure 1).

Figure 1. El Oro province location

In 2016, with $2.62 billion (b), banana accounted for 15.61% of the total Ecuadorian exportation (AEBE, 2017). The principal destination of Ecuadorian banana is the European Union (EU) with 31.86% of the exported product in 2016; Russia (22.55), United States (14.86) and Middle East (10.12) are the other main destinations. However, in the period 2010-2016, there is a notable negative trend in trade with United States (US), whose trade decreased 13.25%, while there is remarkable growth in exportation to Russia (+36.3%), Turkey (+11%), EU (+6.22%), New Zealand (from 28.7 to 72.6 k tons), Japan (from 46 to 157.8 k tons), and China (from 2.2 to 173.9 k tons).

3.2.Principal certifiers in the Ecuadorian banana agri-system

In Ecuador, in the banana agri-sector, there are at least four main private certifications: Global Gap, Rainforest Alliance, Fairtrade Labelling Organization (FT) and Organic product (IFOAM):

Global Gap was born as EUROGAP in 1997 as an initiative by the retailers' group Euro-Retailer Produce Working Group in response to the growing demand of many UK retailers for harmlessness of food and the respect of fair principles in production practices. In 2007, the name changed to Global Gap (Gap stays for Good Agricultural Policies) as the focus spread from European to Worldwide producers. As of 2017, this certification was present in 125 countries (GlobalGap, 2018).

Rainforest Alliance was born in 1986 as a project launched by a group of volunteers led by Daniel Katz who were concerned about the problem of deforestation. The project consisted of creating standards for farmers and economic advantages for certified products (Rainforest Alliance, 2018). In 1990, RA established the standards for the banana sector and two years later certified its first banana farms. In 2015, RA Rainforest Alliance certification covers 1.2 million farms in 42 countries, growing 101 different crops on about 3.5 million hectares (ha). Moreover, it certifies 15.1% of the total world production of tea, 13.6% of cocoa and more than 5% of both coffee and bananas (Milder and Newsom, 2015).

Fairtrade movements rose in Europe during the fifties. The aim of these organisations was to transform the North-South linkage from exploitation to sustainable development using a “not aid but trade” philosophy (Raynolds, 2000).

In 1997, the main FT organisations gathered under the Fairtrade “umbrella” called Fairtrade Labelling Organisation International (Raynolds, 2000), which in 2003 created FLOCERT, the independent certification body of the Fairtrade system (Flocert, 2018). In 2016, FT agriculture accounted for 1.6m farmers and workers and raised 150m euros of FT premium for sustainability and training initiatives, community education and health resources, and equipment (FLO, 2017). Banana is the principal crop in FT production with 579,081 million metric tons of sold product, 58% of which corresponds to organic banana. In Ecuador, in 2018, FT paid a bonus of USD 1.00 per commercial box of 19.4 kg of Fairtrade banana, which represented an extra 16.12% over the conventional price of USD 6.20 fixed by MAGAP for the exportation banana box (El Telegrafo, 2017).

Organic agriculture movements began to appear in the sixties in Europe and the United States. Although there was no single definition of "organic", most movements struggled to create sustainable agriculture which respected the environment and without the utilization of chemical fertilizers (Raynolds, 2000).

In 2015, organic agriculture was present in 179 countries, accounting for 90.6 m ha of agricultural land (1.10% of total agricultural land), 2.4 m producers and market size of USD 81.6 billion (bn) with a per capita consumption of USD 11.1 (IFOAM, 2016). The consumption of Organic products (OP) has risen exponentially worldwide in the past decade (Rana and Paul, 2017).

4. Methodology

The instrument to evaluate the difference between systems sustainability is SAFA. In this section, SAFA is explained in detail, and the academic literature implementing SAFA is discussed.

4.1.SAFA framework

SAFA is a FAO project, which was developed between February 2011 and June 2013 that involved more than 250 stakeholders from 61 countries. It consists of four tools. The first is the guidelines that explain the sustainability principles used in the elaboration of the framework (FAO, 2013a). The second is a detailed list of 116 sustainability indicators which cover 58 sub-themes, 21 themes and 4 sustainability dimensions (FAO, 2013b). The third is the software that elaborates the results in order to describe the sustainability of the analysed system using a polygon organised in the 21 themes and in five levels of sustainability, from an "unacceptable sustainability" red level to an "optimal sustainability" dark green level (FAO, 2014). Finally, the brand new tool is an application for smartphones, designed specifically for small farms since it uses a lower number of indicators and an even easier process (FAO, 2015).

4.1.1. Users, purposes and principles

As explained by FAO (2013a), SAFA is a holistic framework whose main competitive advantage in relation to other SATs is its flexibility. SAFA relies on the methodological principles of holism, relevance, rigour, efficiency, performance-orientation, transparency, adaptability and continuous improvement. SAFA is designed for multiple users, from farms to governments, and for multiple purposes, from self-assessment to implementation of regional planning.

4.1.2. SAFA dimensions and themes

SAFA is a holistic framework that applies a hierarchical structure in which, at the more general level, there are four sustainability dimensions: Good Governance, Environmental Integrity, Economic Resilience, and Social Well-being. The second level is comprised of 21 sustainability themes and the third level consists of 58 sub-themes. Finally, the most specific level corresponds to 116 indicators that quantitatively or qualitatively investigate precise verifiable data or facts. Each indicator is supported by a guide that explains how to measure the item and the thresholds that must be referenced to assign a score on a 5-point scale. Details of SAFA structure and SAFA dimensions and themes are given in Tables 1 and 2.

Table 1. SAFA structure

Dimension	Themes	Sub-themes	Indicators
Good Governance	5	14	19
Environmental Integrity	6	14	52
Economic Resilience	4	14	26
Social Well-being	6	16	19
Total	**21**	**58**	**116**

Source: FAO (2013a)

Table 2. SAFA dimensions and themes

Dimensions	Themes
Good governance	G1. Corporate Ethics
	G2. Accountability
	G3. Participation
	G4. Rule of Law
	G5. Holistic Management
Environmental integrity	E1. Atmosphere
	E2. Water
	E3. Land
	E4. Biodiversity
	E5. Materials and Energy
	E6. Animal Welfare
Economic resilience	C1. Investment
	C2. Vulnerability

	C3. Product Quality and Information
	C4. Local Economy
Social well-being	S1. Decent Livelihoods
	S2. Fair Trading Practices
	S3. Labour Rights
	S4. Equity
	S5. Human Health
	S6. Cultural Diversity

Source: FAO (2013a)

4.1.3. SAFA key competitive advantages

According to the literature, SAFA reveals some key competitive advantages:

- Flexibility. SAFA can be implemented in different contexts, at different scales or levels by different users and multiple purposes (Kassem et al., 2017).
- High credibility, since it was developed by an independent UN organisation without the support of private corporations or NGOs (Bonisoli et al., 2018; Jawtusch et al., 2013).
- User-friendly. SAFA is very user-friendly, both in its application (time and cost saving) and its results comprehensibility. In addition, suggestions for possible improvements are clearly linked to the established thresholds of sub-themes and may directly motivate change (Gayatri et al., 2016).
- Comprehensiveness. The 116 indicators make the assessment detailed and highly thorough; it even identifies those sustainability aspects of which users are unaware (de Olde et al., 2017; Gayatri et al., 2016; Jawtusch et al., 2013).
- Finally, SAFA can be implemented with other sustainability tools such as quality certifications (for example Fairtrade) or other SATs (for example COSA and RISE) (Schader et al., 2014).

4.1.4. Indicators assessment

SAFA employs three kinds of indicators: indicators that evaluate whether the organisation has set a sustainability target to achieve, indicators that assess which sustainability practices the organisation has developed, and finally indicators that examine the sustainability performance of the organisation. Generally speaking, the latter group is the most important, which is why the majority of the indicators belong to this group. Nevertheless, since some performance is difficult to assess or impossible to measure, SAFA considers the practices implemented, and when there are no relevant practices, or there is limited evidence, the assessment focuses on targets (FAO, 2013a).

For example, the Environmental integrity indicators E 1.1.1, E 1.1.2 and E 1.1.3 compose the sub-theme Greenhouse Gases (E 1.1). The first indicator is a target-base that investigates whether the organisation has a formal written plan for the reduction of GHG. The second indicator lists a series of practices and asks which are implemented. Finally, the third indicator calculates the organisation's GHG emissions (FAO, 2013b).

The weight of indicators is different: a full sustainable target-based indicator has a quantified score of 1, a practice-based indicator a score of 2, and a performance-based a score of 3 points. Then, SAFA calculates the percentage of points achieved on possible points per dimension and provides the result following the scheme (see Table 3):

Table 3. Indicators score

Percentage points achieved / points achievable	SAFA Colour	This study score
> 80%	Dark green	> 4.1
60 – 80 %	Light green	3.1 to 4.0
40 – 60 %	Yellow	2.1 to 3.0
20 – 60 %	Orange	1.1 to 2.0
< 20 %	Red	< 1.0

Source: own elaboration

4.1.5. Studies that implement SAFA methodology

Because of its key competitive advantage, SAFA has received a widespread acceptance among both researchers and users. It is possible to group some of the most relevant studies that implement SAFA methodology into five groups (results shown in Table 4):

- Sustainability assessment of an agri-system using the complete SAFA framework. In this group, it is important to mention Jawtusch et al. (2013), which is a pilot study that implements the 2012 version of the framework and is aimed at evaluating users' reaction to the new approach. Furthermore, two other studies demonstrate the vast capacity of SAFA to be applied in developing countries: Gayatri et al. (2016), who apply the framework to beef cattle farming in Indonesia; and Ssebunya et al. (2016), who focus on the small-holder coffee producers in Uganda. Finally, of particular interest are the works of Landert et al. (2017), who apply SAFA to evaluate the sustainability of the urban food system in Basel, Switzerland, and Al Shamsi et al. (2018), who apply SAFA in order to assess food sovereignty in an Italian and Emirates agri-system.
- Partial sustainability assessment using SAFA. It is the case of Theurl et al. (2017), who analyse greenhouse gas emissions along vegetable supply chains in Austria using the SAFA indicators that address this topic.
- Sustainability assessment using some of the SAFA indicators. Notable among this group are two related studies implemented in the Czech Republic: Hřebíček et al. (2013), which aims to find a list of sustainability indicators to be aimed at both farmers and policymakers; and Kassem et al. (2017), which identify a set of indicators to be applied to small farmers. Similar to the latter, Gaviglio et al. (2017) use the Good Governance SAFA indicators along with other frameworks to establish a set of indicators for the evaluation of an Italian agri-system.
- SAFA applied in synergy with other frameworks. Two examples are Hřebíček et al. (2015), who apply SAFA along with GRI to study the topic of sustainability reporting, and Gasso et al. (2015), which evaluate the sustainability of Danish maize for biogas systems in synergy with two other specific frameworks. Finally, having significant bearing on the scope of this study is the work of Schader et al. (2014), who employ SAFA as a third referee to detect differences and trade-offs of six different sustainability frameworks. A particular case is the study of Dabkiene, (2016) who evaluates the usefulness of the information provided by the European agricultural database FADN (Farm Accountancy Data Network) using SAFA indicators as a benchmark.

- SMART application. SMART (Sustainability Monitoring and Assessment Routine Sustainability) is an indicator-based tool that operationalises SAFA. In the work of Jawtusch et al. (2013) the tool is presented and explained, and in Schader et al. (2016) SMART is detailed, explained and applied to a sample of a case study. Finally, Ssebunya et al. (2018) applied SMART to evaluate and compare the sustainability of organic and conventional coffee in Uganda.

Table 4. References implementing SAFA methodology

Group	References
Complete sustainability assessment using SAFA	Gayatri et al. (2016) Ssebunya et al. (2016) Landert et al. (2017) Al Shamsi et al. (2018)
Partial sustainability assessment using SAFA	Theurl et al. (2017)
Sustainability assessment using some of the SAFA indicators	Hřebíček et al. (2013) Kassem et al. (2017) Gaviglio et al. (2017)
SAFA applied in synergy with other frameworks	Hřebíček et al. (2015) Gasso et al. (2015) Schader et al. (2014) Dabkiene (2016)
SMART applications	Jawtusch et al. (2013) Schader et al. (2016) Ssebunya et al. (2018)

Source: own elaboration

4.1.6. SAFA process

SAFA follows a four-step process:

- Mapping. The first step is the mapping of the analysed system in order to describe key relationships among the system's members. The aim is to identify players, procedures, time-space boundaries and recognise the main goal of the evaluation.

- Contextualization. In this second step, the user must revise the sub-theme in order to identify those that can be applicable to the system from those that are either not relevant for the system or dependent on unavailable data and information.
- Indicators. In this step, the necessary documentation and information are collected and the indicators that have been selected are rated according to a 5-point scale whose thresholds are established by the framework guideline. Because the rating depends on the user's judgement, it is necessary that he or she explain the reason for each indicator’s score.
- Reporting. In the last step, scores are entered in the SAFA Tool Software and a polygon is created to show the results. In this step, it is important that the user clarify the evaluation outcomes and suggest possible improvements.

4.2.Sample

To compare the effect of certification on sustainability assessment, two different organisations were considered. The first (identified with the letter *A*) is a group of 89 small farmers whose property range is from 1 to 32.23 hectares. These farmers belong to an association, which in 2013 began a programme to obtain both FT and Organic certification along with GlobalGap. Thanks to economic results, the association experienced rapid growth that resulted in tripling the number of members in a three-year period. The association sells directly to European retailers without intermediaries and its clients are mostly located in Germany and Italy.

The second institution (identified with *B*) is a group of 22 producers that sell their products to a single export firm that was created four years ago to cope with the demand of a great European retailer. At the moment, the group sells its conventional banana to two big European retailers whose clients are located in Eastern Europe, mainly in Russia, Czech Republic and Turkey. They respect the private quality standards established by the retailers that were originally based on Rainforest Alliance standards, but they do not have other certifications (see Table 5).

To undertake the investigation, an original approach was developed for the operationalisation of SAFA that consists of three basic steps. The first involved a series of structured interviews with seven managers and employees of the two organisations to obtain the bulk of the Good Governance and Economic Resilience dimensions and a part of the Environmental Integrity dimension. Then, farm visits were conducted to control the application of rules and procedures required to fulfil the Environmental Integrity dimension. Finally, two surveys, which were applied to a random sample of 27 farmers and 440 workers, were the basis for fulfilling the Social Well-being dimension.

Table 5. Sample features

Features	**Group *A***	**Group *B***
Members	89	22
Total hectares	586.78	941.08
Hectares range	1.00 – 32.23	1.95 – 130
Hectares mean and s.d.	6.59 – 5.61	42.78 – 34.57
Location	El Oro province	El Oro province
Production	Organic	Conventional
Certifications	FLO – IFOAM – Global Gap	Retailers certifications
Product destination	Western Europe	Eastern Europe

5. Results

The way SAFA calculates the score for each theme is the arithmetic mean. Nevertheless, SAFA rounded the score to the next integer so that, for example, 3.1 and 3.9 both score 4. This study prefers to keep one decimal digit, hence in Table 6 and Figures 2-5 scores are shown with decimals, while in Figures 6-8 scores are described as they appear in the SAFA report. Table 6 shows a summary of the main results by dimensions.

Table 6. Analysis results summary[8]

Theme	***A* – score**	***B* – score**	***Main differences between A and B scores***
		Good governance	
G1: Corporate ethics	3.7	3.3	The mission statement is not known by all employees in *B*. *A* has a committee of needs analysis and a process for security regulation.
G2: Accountability	4	4	-
G3: Participation	1.5	1.5	-
G4: Rule of law	3.0	2.0	Some members of *B* do not fully respect workers' rights. In *B* there is a lobbying activity endorsed by dealers that tries to influence government without stakeholder participation.
G5: Holistic management	4.5	4.5	-
		Environmental integrity	
E1: Atmosphere	2.3	2.0	*A* land-cover change to more complex and diverse systems, such as organic agriculture.
E2: Water	4.4	3.9	*A* does not use highly hazardous chemicals that have potential adverse effects on aquatic life.
E3: Land	4.3	3.4	*B* presents a considerable amount of degraded land.
E4: Biodiversity	2.0	1.8	Presence of mix-cropping in *A*.
E5: Material and energy	2.8	1.9	The inspection found the use of fire to dispose of waste in *B*.
E6: Animal well-being	-	-	
		Economic resilience	
C1: Investments	4.3	3.0	The premium of FT results in better returns of *A*.
C2: Vulnerability	3.0	2.0	Better cash flow trend and available financial net for *A*.
C3: Product quality and information	4.4	4.0	The total organic process of *A* results in better quality food.
C4: Local economy	4.5	4.5	-
		Social wellbeing	

[8] For the full results of the evaluation see Appendix 1

S1: Decent livelihood	3.1	3.5	*B*'s farmers and workers declare to be better off than *A*'s.
S2: Fair trading practices	4.0	5.0	Under the box price restitution agreement found in *A* process.
S3: Labour rights	3.3	4.5	Presence of illegally hired workers and child labour found in *A*.
S4: Equity	3.3	4.3	*A*'s farmers less willing to hire women and disabled people.
S5: Human safety and health	4.5	4.5	*A* show a higher rate of accidents but also a formal plan aimed at not contaminating the surroundings.
S6: Cultural diversity	2.0	2.0	-

5.1.Good Governance (G) dimension results

In this dimension, the results of the two organisations are quite similar as they differ consistently only on one theme out of five (see Figure 2).

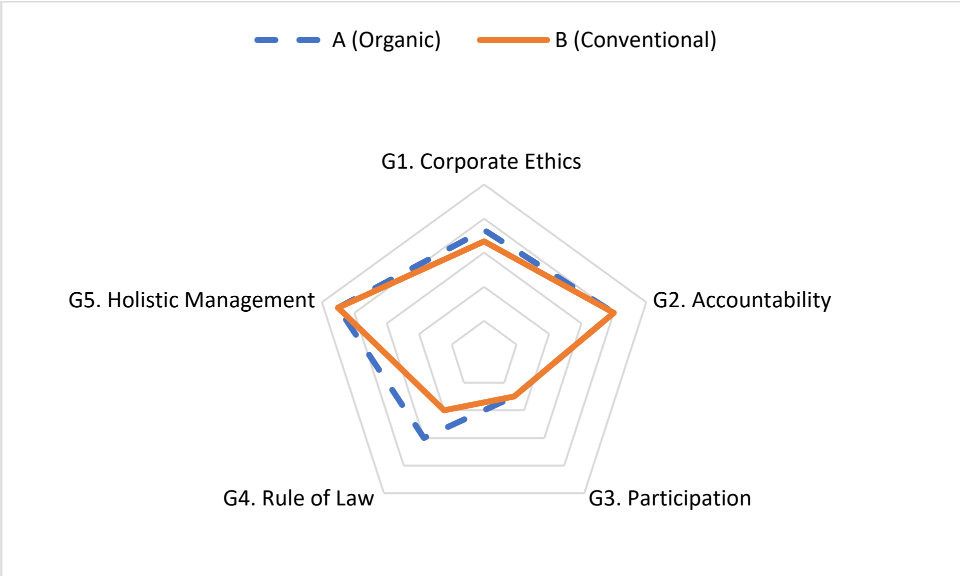
The difference regarding theme G1 is in the mission statement: in both cases a mission statement is present, but only in *A* it is known by all employees. Nevertheless, in both cases, the mission statement seems to be a general requirement imposed from above (certifier bodies) rather than a real guideline the organisation wants to follow. On the other hand, *B* endorses a partial risk analysis provided by the private certifier, while there is no evidence of a formal risk for *A*.

An interesting result was obtained in theme G3. In fact, both organisations fail to identify and involve stakeholders in their information and decision-making processes. More importantly, even the concept of "stakeholders" itself is unknown to these organisations.

The only significant difference in this dimension was found in theme G4: in this case, two indicators display a slight variance in performance. Firstly, *A* does not undertake any lobbying activity, while *B* does, albeit not intensively; secondly, in some case, some farms of *B* were found to partially breach workers' rights, even if, in general, *B* complies with all work regulations. This last point is possible as *B* members are mostly medium and big size farms where rights violations are more easily detected, while for small-holder *A* members, workers' issues are arranged in a personal manner and hence are more difficult to detect. Thus, the fact that the same right violation is made by both organisations is quite probable.

G2 and G5 show very similar results.

Figure 2. Good Governance (G) dimension results



5.2.Environmental (E) Integrity dimension results

The combination of organic production and FT standard along with the presence of 20 agri-forest farms is the most likely explanation for the better results of *A* in relation to those of *B* in all themes (see Figure 3).

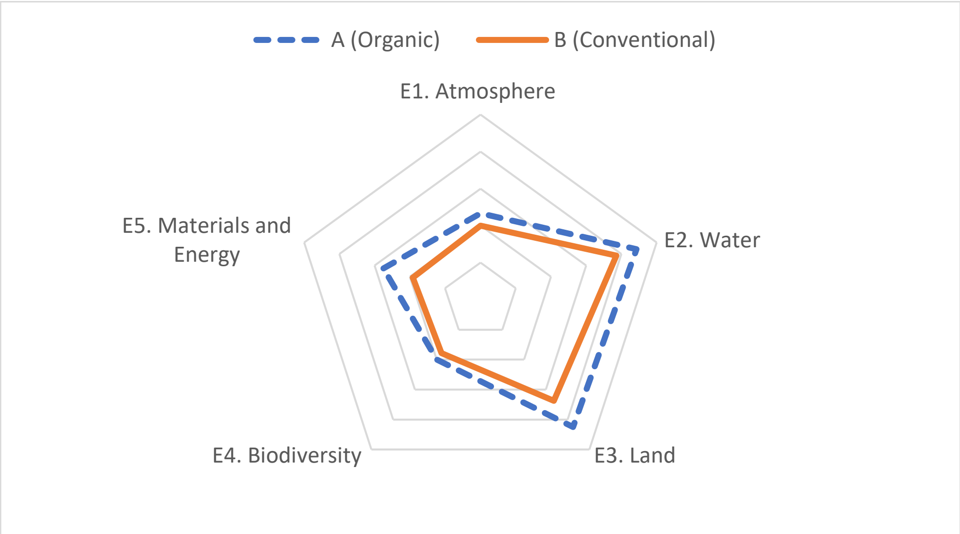
Regarding E1, the lack of a precise plan for lowering GHG and air pollutant emissions and information on the air quality in the area could explain why both organisation registered rather low scores. Nevertheless, the above-mentioned factors, i.e. organic process and agri-forest farms, give an advantage to *A*.

B achieves good performance in both Water and Soil themes since practices and performance in these organisations are substantially positive. *B* implemented a process by which water used in banana handling is recycled for irrigation and imposed 30-metre buffer zones to prevent water contamination. Regarding soil quality, decades of pesticides resulted in a poor organic matter level for both organisations since the organic crop is a recent introduction in the local environment. However, the soil analysis that both organisations carry out every two years reveals chemical and biological results in accordance with locally established standards. The difference between the two organisations is the presence in *B* of 40 has. of degraded land whose status is yet to be defined as all efforts to restore it produced insignificant outcomes.

Biodiversity is a very weak point for both *A* and *B*. The demands of a monocrop and the intensive exploitation of rural areas had a strong impact on biodiversity. Wild animals almost disappeared, along with local endogenous plant species. Despite plans protect and restore wildlife in accordance with market requirements, the situation is far from sustainable. Organic standards that demand a minimum presence of intercropping and agri-forest farms that implement a high rate mixed cropping with the presence of not cultivated land result in a slight difference between *A* and *B* scores. In fact, while the effect of the organic process is limited by intensive cropping, agri-forest farms are just a small percentage of the total farms of *A*. Hence, the results outline how only agri-forest is a system that may be sustainable for biodiversity.

Finally, the attitude of farms towards using raw non-renewable material and energy from non-renewable sources weakens the performance in the last theme since both organisations have planned to substitute the use of diesel with electricity as the primary source of energy. The difference in results is due to some infractions of certifiers' regulations, which took place during on-site visits to *B* (such as the use of fire to dispose of waste).

Figure 3. Environmental (E) Integrity dimension results



5.3.Economic resilience (C) dimension results

Organic banana reaches a higher price than conventional and FT certification implies extra cash for social and production investment. Consequently, the organic sector is more profitable than the conventional sector. This situation is reflected in the results of the economic dimension (see Figure 4).

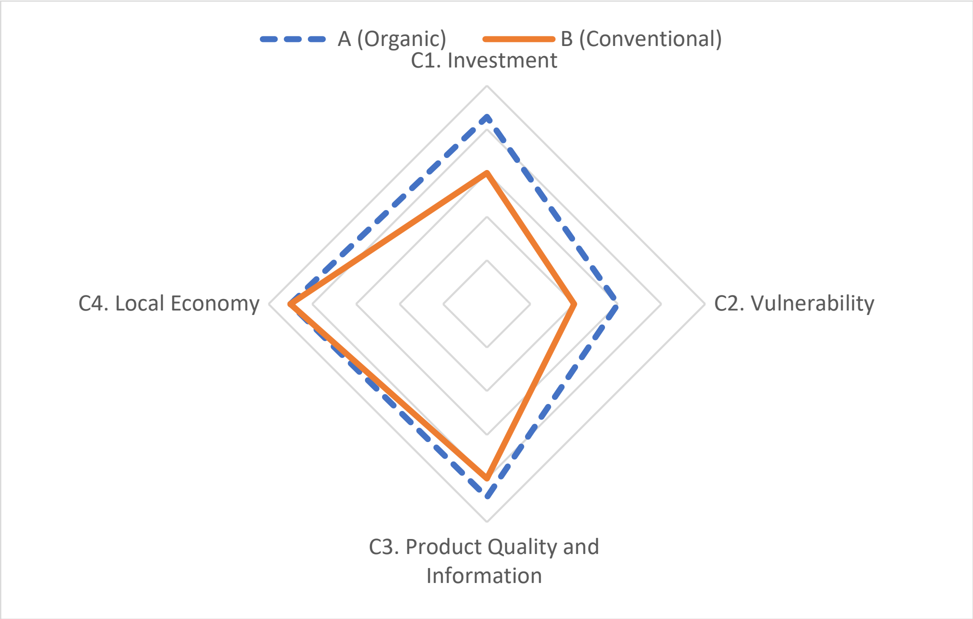
A proves to be sustainable in three out of four themes. In C1, the Fairtrade premium is USD 1.00 per banana box and accounts for USD 0.5m per year to be spent on technological or social improvements. Thanks to this aid, *A* implemented several improvements such as the introduction of new machinery (e.g. water recycling, bunch transportation) and implementation of social services (e.g. farmers health service). In addition, *A* bought a 20has farm to manage directly.

C2 shows the common situation of high vulnerability. The main reason is the dependence on one single crop. Monoculture is the basis of the entire banana sector and only agri-forest farms grow a consistent percentage of other crops along with banana trees. Other points of vulnerability include the scarce number of customers, which in the case of *B* are only two big retailers, the lack of financial risk analysis and a product scarcity prevention plan. However, *A* is less vulnerable than *B* as it has access to a financial net (provided by the *Banco de Crédito*) and a more reliable cash flow trend in the last five years.

Slight differences emerged in theme C3, in fact, both certifiers and customers require measures that ensure food quality and contamination prevention. The gap in the results is due to the fully organic process implemented by *A* that does not use any chemical product.

Results in C4 are totally identical; both organisations pay all taxes due and hire only local workforce. Regarding this last point, it is important to underline that in the last decade some farms hire immigrant workers at lower wages; nevertheless, this practice resulted in a drop in productivity and product quality since banana plantations require an expert workforce and tacit knowledge that was impossible to find in unskilled workers. For this reason, at present, no farm hires foreign workers.

Figure 4. Economic Resilience (C) dimension results



5.4.Social (S) Well-being dimension results

If in the previous dimensions *A* equals or exceeds *B*'s results, in the Social Well-being dimension the results of *B* reveal a more sustainable scenario than that represented by *A*'s performance. In particular, *B* surpasses *A* in four out of six themes (see Figure 5).

Theme S1 addresses life conditions of workers and farmers. Since *B*'s producers are bigger, it comes as no surprise that their workers are also better off than *A*'s. Also, *B*'s workers declare a higher income, as 77% of them declare they can satisfy the needs of their families with their wages versus 39% of *A*'s.

Theme S2 addresses fair trade with customers. Even though, in general, *A* enjoys fair relationships with customers and prices are established by the government, there is evidence of the unofficial price arrangement once or twice a year when buyers expect sellers to return part of the regular price "under the table". This happens when small farms sell to big exporters, but there is no evidence that this arrangement occurs with big farms too, thus *B* is probably immune to this practice.

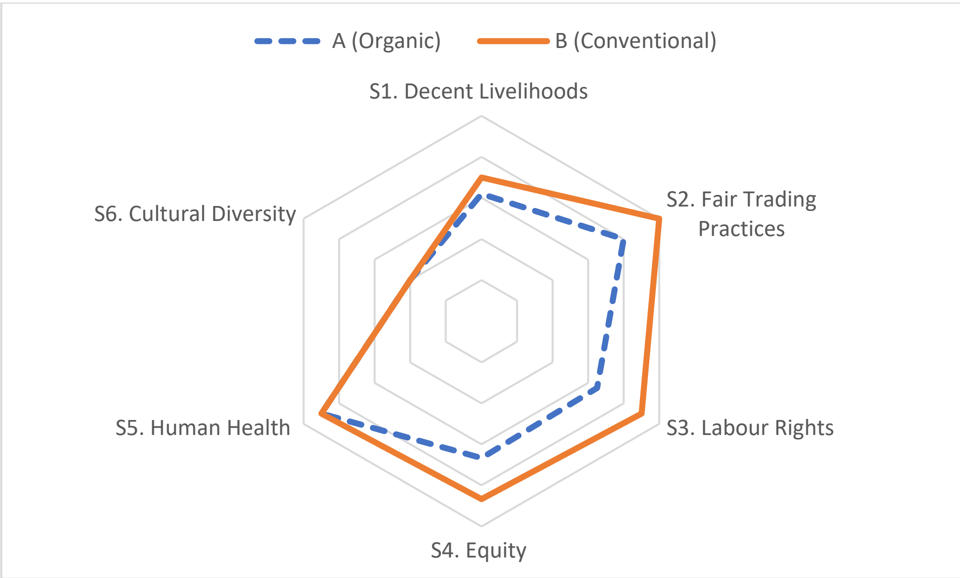
Theme S3 is linked to labour rights. In this case, the difference in size is the source of the difference in the results. In fact, big farms are more likely to be subject to workers' rights inspections than small-holder farms, because the latter are usually located far from villages and personal arrangements between employers and workers are preferred to formal regulation. For this reason, the analysis reveals 25% illegally contracted workers in the farms of *A* and the presence of child labour, in particular among employers' family members.

Theme S4 is related to equity with respect to minorities, women and disabled individuals. The difference is the fact that not all *A*'s farmers claimed to respect women's right to maternity leave, but a third of them prefer to hire a man rather than a woman to avoid this situation. Similarly, *A*'s farmers did less to reduce the gap in hiring disabled people than *B*'s farmers did.

Theme S5 relates to health and safety. Although both organisations supposedly provide training courses in first aid and safety, a higher rate of accidents was found in *A*. This fact is probably related to the less strict observance of safety regulations of small farms. Nevertheless, *A* performs better than *B* as it possesses, according to FT standards, a formal plan aimed at not contaminating the surrounding environment, even though in both *A* and *B*, there is no evidence of surrounding contamination.

As for theme S6, which is related to indigenous knowledge and local species, it is rather interesting that both *A* and *B* obtained the same results. In both cases, records show very poor outcomes as no plans or contracts take into account indigenous intellectual property and plant species respond to market demand rather than local needs.

Figure 5. Social (S) Well-being dimension results



5.5.Overview

However, SAFA is a tool that allows different levels of depth. In fact, the analysts may refer to very high-quality data or simply personal estimations. The accuracy of the score is reported on a 3-point scale for each theme in the spider graph (Figure 6).

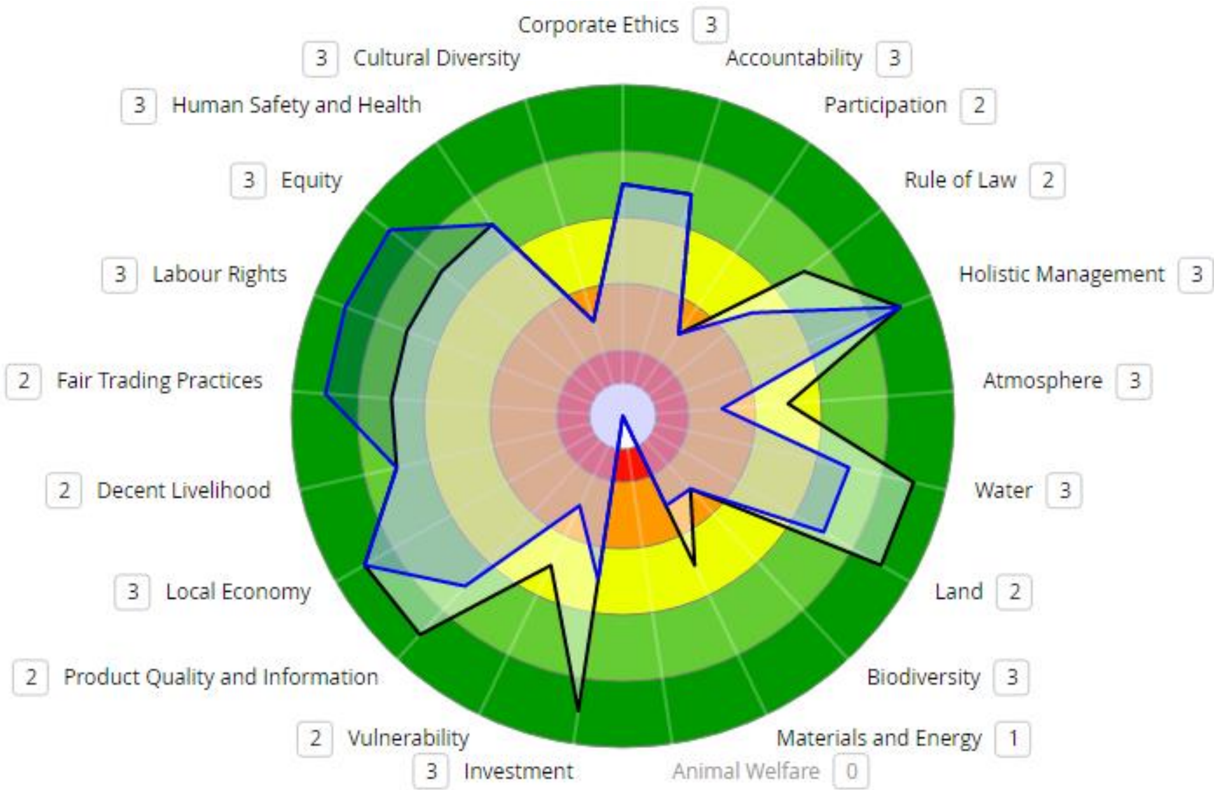
The way SAFA calculates the score for each theme is through arithmetic mean. The present analysis kept one decimal digit. In contrast, SAFA rounded the score to the next integer so that, for example, 3.1 and 3.9 both score 4. The scores are displayed below as they appear in the SAFA tool.

An overall view of the evaluation results shows how no theme is rated "unacceptable", so it is possible to conclude that certification and government effort succeeded in guaranteeing a minimum level of sustainability.

At the same time, it is important to observe that 9 out of 20 themes report the same score for both organisations; 8 themes reveal progress for *A* over *B*, and 3 themes display an advantage of *B* over *A* (see Table 7).

In addition, *A* achieves the "Best" scores 6 times, while in 3 themes it scores the lowest rate of "Limited" (see Figure 7). However, *B* scores "Best" 5 times and "Limited" 6 times (see Figure 8).

Figure 6. Overall SAFA results



A (Organic) ———

B (Conventional) ———

Rating:

Best

Good

Moderate

Limited

Unacceptable

Not relevant

Accuracy score: 0 no data; 1 – low quality data; 2 – moderate quality data; 3 – high quality data.

Table 7. Results comparison

Comparison *A* (Organic) vs *B* (Conventional)	**Code**	**Theme name**
A is more sustainable than B	G4	Rule of law
	E1	Atmosphere
	E2	Water
	E3	Land
	E5	Materials and energy
	C1	Investment
	C2	Vulnerability
	C3	Product quality and information
A and B are equally sustainable	G1	Corporate Ethics
	G2	Accountability
	G3	Participation
	G5	Holistic management
	E4	Biodiversity
	C4	Local economy
	S1	Decent livelihood
	S5	Human safety and health
	S6	Cultural diversity
B is more sustainable than A	S2	Fair trading practices
	S3	Labour rights
	S4	Equity

Figure 7. *A* scores per themes

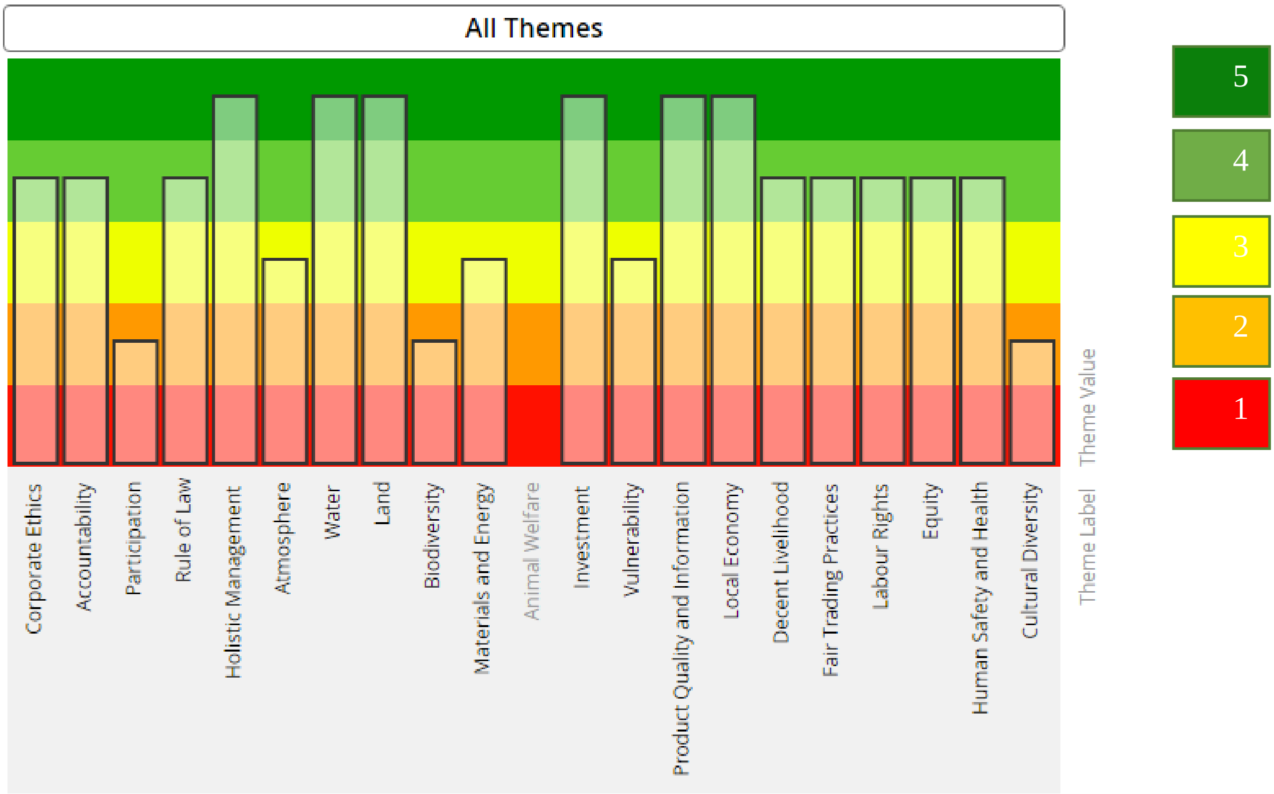
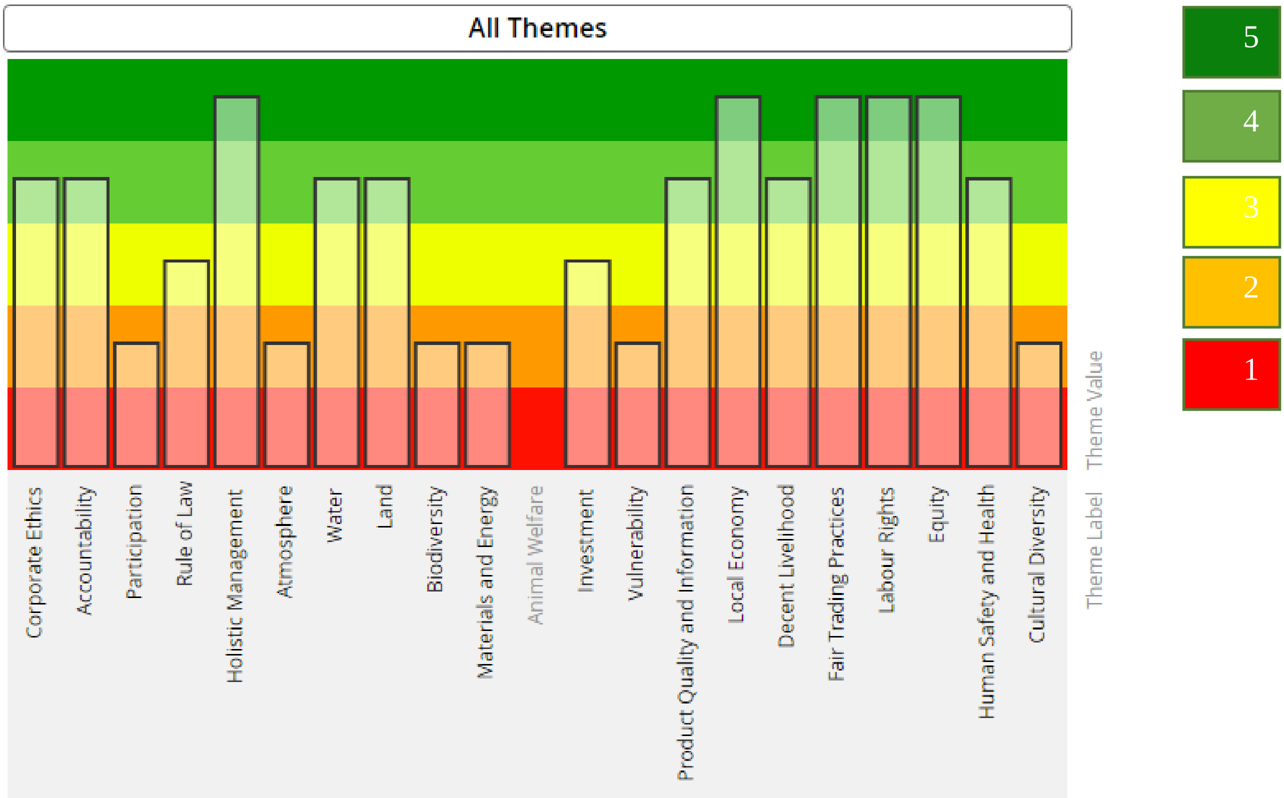


Figure 8. *B* scores per themes



Rating:

Best
Good
Moderate
Limited
Unacceptable
Not relevant

6. Discussion

These results generate the need for an in-depth analysis of three main aspects: firstly, the main objective of this study, i.e. the effect of certification on banana agri-system sustainability; secondly, the actual situation of the banana agri-system; and, finally, the effectiveness of SAFA.

6.1.Certifications

The positive effect of certification on sustainability is indubitable: both organisations would have scored considerably worse if they had not respected certifiers standards. Furthermore, the difference between the two organisations is generally ascribable to better standards implemented by *A*.

In particular, if in the Environment dimension, the organic process of *A* results in better performance in atmosphere, water land and energy themes, FT standards generate better achievements in Economic and Governance dimensions.

Interestingly, *B* surpasses *A* in three social well-being themes. The fact that FT is stricter than private standards seems not automatically lead to a better level of sustainability. There may be different explanations for this outcome, but two seem the most probable: the first is that FT standards are matched by private standards; the second is that the cause of this result is more likely to be found in other aspects, for example, in the size and processes of the single farm rather than in the certification standards. The latter is precisely the line of study in Clercx and Huyghe (2013), who remark how certifications are more concerned with the product than land and thus underrate complex social dynamics at, for instance, workforce level.

Nevertheless, to investigate this situation more in depth, it is necessary to conduct another study focused on social sustainability at worker level, since this group represents the weakest participants in the system.

6.2.The banana agri-system

The analysis reveals some interesting aspects of the agri-system. First of all, sustainability is an issue that has only received attention from stakeholders in recent years as a consequence of consumers' interest and requirements. A deep interest in the sustainability of local agriculture from producers and key stakeholders appears to be far from being achieved.

Specifically, the weakest points in the evaluation were shown to depend more on the situation of the agri-system rather than on a single organisation. In fact, in three themes both *A* and *B* have the lowest mark: the lack of performance in Participation, Biodiversity and Cultural diversity reflects backwardness of the entire system and the use of land in the past (Clercx et al., 2015).

In the last decade, the government has developed policies focused on sustainable development (Santos et al., 2016; SENPLADES, 2013) that are more the result of from-above planning rather than the product of a collective stakeholders' agreement.

Hence, the implementation of a bottom-up sustainability programme is once again a solution recommended by the present study.

6.3.Sustainability assessment tools

SAFA demonstrates its capacity to represent an agri-system. The 114 indicators applied in this study (the five indicators of theme E6 were not applied as the farms do not grow livestock) cover a wide spectrum of aspects, so all relevant factors were analysed. Hence, SAFA fully demonstrates its capacity to evaluate in depth a specific agri-system and its approach allows for a sound evaluation that is easily understood by both researchers and, more important, farmers. In fact, the visual representation of scores leads farmers to ask for the reason why a specific indicator scored badly and the possible way to improve the performance and raise the mark.

Nonetheless, the high variety of themes is the main obstacle to its application since the analysis of the four dimensions requires a process where several steps are necessary to plan the analysis and different instruments must be applied simultaneously. In this study, a novel approach for the operationalisation of SAFA was applied. It consists of set structured interviews with seven managers and employees of both organisations, inspections of farms to control the application of rules and procedures and two surveys of farmers and workers. The process took a total of nine months; thus, the instrument cannot be considered as quick and agile as it seemed initially. However, since a relevant part of the time was spent designing the operational approach, practitioners applying the same approach could conduct the analysis more rapidly.

Moreover, the framework reflects the limitations of the top-down approach. In particular, since farmers are not involved in the process of defining indicators, they could not understand the logic and relevance of some indicators.

For example, indicator S6.1 refers to indigenous communities and asks if farmers respect indigenous rights and intellectual property. In this case, farmers state that they have no contact with indigenous people since those communities are present in other parts of the country and not in the province. However, in particular in the case of small farmers, although they do not belong to the native community, they may consider themselves as indigenous, since their ancestors were the first to cultivate those lends. Thus, the indicator proved difficult for researchers to manage and irrelevant to farmers.

For this reason, as recommended by Bonisoli et al. (2018), a solution could be a combination of SAFA and a bottom-up approach, MESMIS for instance, so that SAFA indicators could be the basis for a participative process involving key stakeholders in indicators recognition.

7. Conclusions

The present study presents an analysis of the sustainability of certified agri-food produce. This analysis contributes to the academic debate concerning the comparison between certified and conventional agri-systems in three key ways: it develops an exhaustive evaluation that comprehends the four sustainability dimensions, employs an original approach that operationalises SAFA, and delivers a detailed evaluation whose results can be transformed into actions to improve the sustainability of a system that strongly depends on market demand.

The study utilised SAFA as an instrument to assess and compare the sustainability of the certified and conventional banana agri-systems because of the wide spectrum of sustainability themes considered in the evaluation, it can be easily implemented and understood by producers and decision makers, and the consequential possibility to identify precise measures to enhance sustainability in the short term.

The results demonstrate that the certified banana system performs at a higher level of sustainability in the governance, environmental and economic dimensions, yet it leads to lower sustainability outcomes in the social dimension. This finding is particularly important since it calls into question whether certification schemes actually achieve one of their two main objectives, i.e. the improvement of stakeholder's well-being.

Nevertheless, SAFA reveals that the agri-system displays certain flaws regardless of the type of production. For instance, with the sole exclusion of agri-forest farms, all producers are growing a monoculture, and intercropping is not considered an option since the introduction of a second crop would mean a drop of revenues. This fact increases vulnerability and jeopardises soil quality. Moreover, there is no evidence of any air contamination control or air contamination awareness among farmers and workers as the vast majority of farms still use fuel-based energy generators rather than renewable-based ones. Finally, most of the material utilised is raw and non-renewable, and a satisfactory waste recycling scheme is a target still far from being reached.

The present study has the limitation that it analyses a specific sector of Ecuadorian agriculture. However, the depth and set of factors analysed offers a methodology that can be extended to the assessment of sustainability in other agri-systems, particularly in those where there may be controversy between different certifications. Furthermore, this paper applies an original approach for the operationalisation of SAFA, which could possibly be implemented by other practitioners, although its detailed presentation is beyond the scope of this analysis.

Additionally, this study discloses, on one hand, a general higher level of sustainability of certified farms and, on the other hand, the need for ensuring demand for certified products in destination markets. Hence, further studies could target at least three possible subjects. Since certified producers obtain lower results in social sustainability, an initial issue to address could be the analysis of reasons and the identification of possible measures that might improve performance in this dimension. Secondly, due to the high scores in environmental and economic sustainability, future research should consider the most suitable marketing tools aimed at enhancing demand for certified products in both local and foreign markets. Finally, since the decisive performance in all sustainability dimension of agri-forest farms, an in-depth inquiry targeting decision-makers is required, one which contemplates large-scale financial and operational aid for a possible conversion of conventional farms to agri-forest. In the three cases, SAFA could provide a reliable basis for carrying out said research.

CHAPTER 5

SAFA APP AND THE EVALUATION OF SUSTAINABLE PRACTICES OF ECUADORIAN BANANA SMALL PRODUCERS

SAFA APP AND THE EVALUATION OF SUSTAINABLE PRACTICES OF ECUADORIAN BANANA SMALL PRODUCERS

Abstract

To evaluate an agri-system with a Sustainable Assessment Tool (SAT) able to identify flaws and suggest improvements is the main aim of several researchers and institutions. Nevertheless, SATs are generally designed for medium and large enterprises with structured, available information, while small and micro agri-producers are generally excluded from the evaluation process. SAFA (Sustainability Assessment of Food and Agriculture) App is the first SAT directly designed to evaluate sustainability for little and micro-producers, but the academic arena still misses a revision of the empiric implementation of this tool. This article fills this gap, evaluating the application of SAFA App in assessing the sustainability of small agri-producers. For that purpose, it is tested in ten small banana producers in the El Oro province of Ecuador. Results show that if SAFA App is useful in catching the specific features of small producers, it should be improved in flexibility and details identification in order to be taken as a benchmark for government in sustainability policies.

Keywords: small farms, sustainability, SAFA App, banana, Ecuador.

1. Introduction

In the last decade, the academic forum has recorded the creation of a considering number of indicators-based Sustainability Assessment Tools (SATs) directed to evaluate the sustainability of a given agri-system (Röös et al., 2019). Among those SATs, it is possible to recognise four main groups: bottom-up participatory frameworks, top-down researchers addressed frameworks, top-down dimension driven frameworks and top-down indicators driven frameworks (Bonisoli et al., 2018).

The first group includes SATs as MESMIS[9] (López-Ridaura et al., 2002) and MMF[10] (López-Ridaura et al., 2005). The SATs of this group share the characteristic of generating the indicators through a participatory process that involves the system's stakeholders in order to effectively represent the particular features of a system; nevertheless, they require a considerable amount of time and effort to be developed.

The second group, that includes SATs as SAFE[11] (Van Cauwenbergh et al., 2007), is addressed to evaluate the sustainability from an academic point of view. For this reason, the SATs applied sophisticated quantitative methodologies that, albeit analyse significant synergies between indicators, are quite incomprehensible to lay people.

The third group, that includes SATs as IDEA[12] (Zahm et al., 2008) and MOTIFS[13] (Meul et al., 2008), aggregates the results per dimension of sustainability, i.e. economy, environment and society.

The last group gathers those SATs, such as COSA[14] (Giovannucci and Potts, 2008) , RISE[15] (Häni et al., 2003) and PG tool[16] (Gerrard et al., 2012), focus their process on three key points: speed, ease and clarity. In this group, the last framework that has been created is SAFA[17] (FAO, 2013a) that was produced by FAO with the collaboration of RISE inventors. This framework presents three main advantages at the respect of the other tools of the same group: it applies a wider spectrum of indicators that cover four sustainability dimensions, i.e. good governance, economic resilience, environmental and social wellbeing; it considers the majority of themes included in RISE (80%), PG Tool (58%) and IDEA (55%) (de Olde et al., 2017), and it has not received private funding for its realization.

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[9] Marco para la Evaluación de los Sistemas de Manejo de los Recursos Naturales

[10] Multiscale Methodological Framework

[11] Sustainability Assessment of Farming and Environment

[12] Indicateur de Durabilité des Explotacion Agricole

[13] Monitoring Tool for Integrated Farm Sustainability

[14] Committee on Sustainability Assessment

[15] Response-Inducing Sustainability Evaluation

[16] Public Goods Tool

[17] Sustainability Assessment of Food and Agriculture Systems

Although SAFA presents considerable advantages that make it, probably, the most suitable indicators-based SAT, it shares with the other SATs of its group a critical weakness: it was projected for structured organizations, and thus it is deficient in assessing sustainability at small or micro farms level. To cope with this problem, FAO produced in 2015 a simplified version of SAFA shaped for small farms evaluation and thought to be performed in mobile devices: SAFA App (FAO, 2015).

Since in developing countries regulations on sustainability are usually light, sustainability standards are established by third-party certifications and driven by western markets demand (Raynolds, 2000). Nevertheless, the efficiency of certification in the food market is vigorously debated (Chiputwa et al., 2015), in particular for the unpredictability of consumers' habit (Dimitri and Dettmann, 2012) and the consequence of it for the producers' wellbeing (Beuchelt and Zeller, 2011). Hence, it is necessary a tool that allows the inclusion of producers in the sustainability assessment process in order to generate in them the intention to sustainability improvement.

This study aims to examine the efficiency of SAFA App in evaluating the sustainability of smallholders and suggest possible improvements in the tool. For that purpose, it is tested in ten banana small farms in the Ecuadorian province of El Oro. The importance of this analysis also relies on the fact that the vast majority of banana producers in Ecuador are small farms of less than 30 has.

Accordingly, the rest of this work is structured as follows: Section 2 this study illustrates the critical features of banana crop; in section 3, SAFA App is presented and examined in depth; in section 4, the results are displayed and interpreted; finally, in section 5, the conclusions are drawn, and future studies suggested.

2. Description of banana crop

Banana is a perennial crop extensively cultivated in tropical countries, where it represents an essential source of food and job for many people. Considering its worldwide gross production value, banana is the fourth crop after rice, wheat and corn. During 2016 the production of banana reached the 113.2 m tons worldwide with India (29m) and China (13m) accounting for 38% of the global production (FAOSTAT, 2018).

As a food, banana, considering all varieties of this fruit, is a crucial source of nutrients for a large number of people, especially in developing countries. As a product, banana is the world most important fruit crop in term of harvested metric tons (Guerrero and Muñoz, 2018), the most exported fresh fruit in the world and a key source of GDP for many developing countries, such as Ecuador, Cameroon and Philippines (Orellana et al., 2008).

The plant (*Musa acuminata*), originally from the humid regions of South East Asia, was introduced in America in 1516. The banana plantation is a monoculture spread by a plant structure called "sucker". After planting it takes nine months until the first bunch of bananas is harvested. Then the plant is cut in order to allow the new plant, the "son", to grow just next to it. In 13 weeks, the son also has a bunch ready for the harvest, and the cycle can start again (Iriarte et al., 2014). For this reason, farmers say that the banana is a “walking plant” since over the years the plant to harvest grows far from the place occupied by the first plant harvested.

The fruit is rich of essential nutrients such as vitamins C, B1 (thiamine), B2 (riboflavin) and B3 (niacin), carbohydrates and proteins, iron, silver, high quantity of potassium, medium calcium and phosphorus and low sodium (see Table 1).

Table 1. Nutrients for 100g of banana pulp

Nutrients	**Quantity (g)**
Water	58 – 80
Sugar	15.1 – 22.4
Carbohydrates	3.0
Fibres	0.3 – 3.4
Proteins	1.1 – 2.7
Fat	0 – 0.4

Source: Orellana et al. (2008).

Banana arrived in Ecuador from Africa (the term "banana" is an African word), but the explosion of its production was only from 1948 when pests and diseases devasted Centre American crops. In a few years, banana plantations extensively covered massive areas of the coast region of Ecuador both substituting cocoa crops and producing deforestation of virgin areas (Orellana et al., 2008). For about a decade, the banana was the pivot of national development centred in agro-exportation that results in the improvement of international trade, the growth of the industrial sector related to exportation and the enhancement of workers' wage (Ayala, 2008).

The climatic settings of the coastal area of Ecuador allow the production of banana to be possible all the year (AEBE, 2017). Moreover, the specific conditions of Ecuadorian land represent an advantage to other countries since land structure, constant temperature (between 25 to 30° C), light exposure and internal drainage capacity avoid heavy use of chemical fertilizers (Orellana et al., 2008).

The banana plantation is concentrated in three Ecuadorian provinces, namely, Los Rios (58,219 ha. of production), Guayas (47,388 ha.) and El Oro (43,165 ha.), accounting together 91.8% of national production. In 2016, with $2.62 billion (b), banana accounted for 15.61% of total Ecuadorian exportation (AEBE, 2017).

The ultimate destination of Ecuadorian banana is the European Union (EU) with 31.86% of the exported product in 2016; Russia (22.55), United States (14.86) and Middle East (10.12) are the other main destinations. However, in the period 2010-2016 it is notable the negative trend in trade with United States (US), whose trade decreased 13.25%, while it is remarkable a growth in exportation with Russia (+36.3%), Turkey (+11%), EU (+6.22%), New Zealand (from 28.7 to 72.6 k tons), Japan (from 46 to 157.8 k tons), and China where Ecuadorian banana rose from 2.2 to 173.9 k tons. The results in these last three countries are exciting since those markets were traditionally served by the Philippines, the second more significant world banana producer (AEBE, 2017).

Figure 1: Los Rios, Guayas and El Oro provinces in Ecuador

3. Methodology

SAFA App is an elaboration of SAFA focused on small farms that share with this latter the same principle and indicators scheme.

3.1.Users

SAFA is thought for multiple users and purposes so that it is suitable for self-assessment as well as for regional analysis and planning (Table 2).

Table 2. User and purposes of SAFA

Users	Purposes
Food and agriculture enterprises (individual or associations in the crop, livestock, fisheries, aquaculture and forestry sub-sectors)	Self-assessment for evaluating the sustainability of operations and identifying hot-spots for performance improvement; Gap analysis with existing sustainability schemes for the improvement of the thematic coverage; Managing or benchmarking suppliers to improve sustainable procurement;
NGOs and sustainability standards and tools community	Monitoring outcomes of impacts of projects; Sharing of, and global learning on, best practices and thresholds; Gap analysis with existing checklists on all aspects of sustainability;
Governments, investors and policy-makers: informing the establishment of Sustainable Development Goals	Implementation of regional planning, local procurement, investment or the development of legislation; Providing global guidance on sustainable requisites for global supply chains to governments; Informing the establishment of Sustainable Development Goals.

Source: FAO (2013)

3.2.Principles

As explained by FAO (2013), SAFA is a holistic framework that has in flexibility its main competitive advantage with other SATs. SAFA relies on the methodological principles of holistic, relevance, rigour, efficiency, performance-orientation, transparency, adaptability and continuous improvement; and on the implementation principles of building in an existing tool, taking place in an open and learning system, and accessibility (Table 3).

Table 3. Methodological and implementation principles

Methodological principles	**Characteristics**
Holistic	Undertaking a SAFA addresses all four dimensions of sustainability: good governance, environmental integrity, economic resilience and social well-being, and includes all aspects within the sphere and influence of the entity.
Relevance	SAFA goals are aligned with globally agreed principles and international reference documents, including Agenda 21 framework and goals.
Rigour	All SAFA goals should be in line with the current state of scientific knowledge on the economic, environmental, social and governance impacts of human activities. SAFAs are implemented to deliver quality outcomes and an accurate picture of the sustainability.
Efficiency	In order to leave a maximum of resources for improvement measures, the cost of doing a SAFA is minimized by making the best use of existing data from other sustainability, environmental and social management and auditing systems. Companies that participate in systems with sustainability claims can use the SAFA Guidelines to identify areas not yet covered by their sustainability management.
Performance-orientation	SAFA emphasis is on common outcome-oriented objectives enabling different approaches and uses. Undertaking a SAFA serves to assess the sustainable performance of an agricultural or food system entity. Commitments and management plans alone do not suffice to qualify an entity as sustainable.
Transparency	The disclosure of system boundaries, the indicators are chosen, data sources and stakeholder relations are an essential aspect of the SAFA Performance Report.
Adaptability	The Guidelines are generic in nature in order to be applicable worldwide and across the whole diversity of situations that exist in the agriculture and food sector. This principle supports “Accessibility” through the adaptation to all contexts and sizes of agriculture, livestock, aquaculture, fishery and forestry operations by adapting the generic set of themes and sub-themes indicators to different socio-economic and environmental circumstances, type of entity and data availability.
Continuous improvement	SAFA is not intended as a minimum performance benchmark, but a tool to assess performance and identify areas for improvement. In addition, the SAFA Guidelines will be adjusted over time to continually raise the bar, as knowledge and technology permit.

Implementation principles	Characteristics
Build on existing tools	SAFA recognizes that there is equivalence in different approaches, and collaboration is driven by the recognition that problems and solutions have to be shared. No SAFA goal, objective or indicator should contradict rules and principles that emanate from national law and relevant international agreements. The conduction of a SAFA must comply with all applicable legal provisions, in particular concerning privacy protection.
Take place in an open and learning system	The SAFA Guidelines are developed and hosted by FAO and are freely available to any interested party. They are the result of a continuing, open development process, contributions to which are welcome from all who have a stake in the sustainable development of food and agriculture systems. SAFA participation must always be voluntary. Implementing SAFA is in itself a learning pathway to create change and ultimately, deliver sustainability.
Accessibility	Fair playing field by tailoring requirements to remove barriers to implementation. SAFA is conceived primarily for self-evaluation, without necessarily resorting to experts or third-party assistance

Source: FAO (2013).

3.3.Dimensions, Themes, Sub-themes and Indicators

SAFA employs a hierarchical structure composed by four sustainability dimensions: Good Governance, Environmental Integrity, Economic Resilience and Social Well-being (Table 4). The second level contemplates 21 sustainability themes (Table 5) and at the third level, 58 sub-themes itemise the themes. Finally, the last level considers 116 indicators that quantitatively or qualitatively examine data or facts. Each indicator is rated by the analyst with a score on a 5-point scale.

Table 4. SAFA structure

Dimension	Themes	Sub-themes	Indicators
Good Governance	5	14	19
Environmental Integrity	6	14	52
Economic Resilience	4	14	26
Social Well being	6	16	19
Total	**21**	**58**	**116**

Source: FAO (2013)

Table 5. SAFA dimensions and themes

Dimensions	Themes
Good governance	G1. Corporate Ethics
	G2. Accountability
	G3. Participation
	G4. Rule of Law
	G5. Holistic Management
Environmental integrity	E1. Atmosphere
	E2. Water
	E3. Land
	E4. Biodiversity
	E5. Materials and Energy
	E6. Animal Welfare
Economic resilience	C1. Investment
	C2. Vulnerability
	C3. Product Quality and Information
	C4. Local Economy
Social well-being	S1. Decent Livelihoods
	S2. Fair Trading Practices
	S3. Labour Rights
	S4. Equity
	S5. Human Health
	S6. Cultural Diversity

Source: FAO (2013a)

3.4.SAFA App

In order to address the specific features of small farms, SAFA App improves that ease to be applied which is a crucial point of its parent tool. The SAFA App is composed of a survey of 100 questions that the analyst presents to the smallholder producer. Each question has three chances possible answers: one corresponding to plenty of sustainable practice, one corresponding to partially sustainable practice and finally one corresponding to a no-sustainable practice. To answer the question, the interviewee does not need to revise documents or show evidence, but his or her immediate judgement is the only base for the answer.

The survey data are processed by a mobile application that gives the results immediately. Results are shown both visually and in text form and assort the themes in three groups: green (plenty sustainable), yellow (partially sustainable) and red (no sustainable).

The purpose of SAFA App is “raising awareness amongst small-scale producers about specific sustainability hotspots in their agricultural activities, with a view to building capacities and improving their performance” (FAO, 2015; p. 3). For this reason, SAFA App appears not only a potent tool to describe the sustainability of a system, but also the opportunity to involve small producers in a process that may generate improvements in sustainability that are not depending on a third party, such as certifications.

3.5.The problems related to certification

In the last years, driven by rising demand for certified products in the western markets, more and more producers have invested in adapting the process to certifiers' standards. Nevertheless, it is still doubtful the real effect of these practices on the sustainability of the agri-system. In fact, if on one hand several, studies underline the positive effect of some certifications, for example in generating more sustainable practices (Torres et al., 2016), or in augmenting workforce wellbeing (Krumbiegel et al., 2018), or in generating extra profitability (Haggar et al., 2017), on the other hand other studies evidence more questionable results. For example, certifications show to be scarcely visible to customers (Annunziata et al., 2019a) and thus barely effective in affecting market demand (Peschel et al., 2019), in particular, because of the vast number of private certifiers competing each other (Lambin and Thorlakson, 2018). Furthermore, organic certification not always is capable of improving the farm's income (Froehlich et al., 2018) if farmers do not go beyond basic certifier’s standards (Kleemann and Abdulai, 2013).

For this reason, it is possible to conclude that certifications are not always undebatable generators of more sustainable practices thus it is necessary to raise in the same farmers the intention of the improvement of sustainable farm’s performances.

3.6.Sample

This study investigates a group of ten smallholder banana producers, whose farm's width is between 6 and 17 has located in the province El Oro in Ecuador. The selection of the sample was aleatory, and the interviewees were surveyed in their workplace. The results were showed immediately after the interview and sent to interviewees' mobile. In all cases, results provoke a general discussion that identified a set of concrete actions of immediate application that may improve the sustainability of the farm's process.

4. Results and discussion

Table 6 shows the results of the investigation. For each SAFA theme, the tool calculates the score that describes how sustainable is the performance of the farm.

Table 6. SAFA App results per themes and farms

SAFA Themes	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10
G1. Corporate Ethics	G	U	G	L	G	G	G	G	G	G
G2. Accountability	G	G	G	G	G	G	L	G	G	G
G3. Participation	G	L	G	G	G	G	U	G	L	L
G4. Rule of Law	L	U	L	L	L	L	L	L	L	L
G5. Holistic Management	G	U	G	G	G	G	U	G	U	U
E1. Atmosphere	L	L	U	L	U	L	L	L	U	U
E2. Water	G	L	L	G	L	G	G	G	L	L
E3. Land	L	L	U	L	U	L	L	L	L	L
E4. Biodiversity	L	L	U	L	U	L	L	L	L	L
E5. Materials and Energy	L	L	L	L	L	L	L	L	L	L
E6. Animal Welfare	I	I	I	I	I	I	I	I	I	I
C1. Investment	G	U	L	G	L	G	G	G	U	U
C2. Vulnerability	L	L	U	L	U	L	L	L	L	U
C3. Product Quality and Information	L	L	L	L	L	L	L	L	L	L
C4. Local Economy	G	G	G	G	G	G	G	G	G	G
S1. Decent Livelihoods	L	L	L	L	L	L	L	L	L	L
S2. Fair Trading Practices	G	U	G	G	G	G	G	G	G	G
S3. Labour Rights	G	U	L	G	L	G	G	G	U	U
S4. Equity	L	L	G	L	G	L	L	L	L	L
S5. Human Health	G	U	L	G	L	G	G	G	U	U
S6. Cultural Diversity	G	L	G	G	G	G	G	G	L	G

Note: Description of scores: G (Good), L (Limited), U (Unacceptable), I (Irrelevant, does not apply)

The first sight to the result table concludes that there is a general coherence among farms. In fact, in 12 out of 20 themes (theme E6 does not apply since no farm breeds livestock) between 100 and 80% of the farms score the same result. To understand in depth the results, it is necessary to analyse each theme.

G1 – G5 Good governance themes

The first theme "G1 – Corporate Ethics" is evaluated by just one question of the 100 questions SAFA App survey. Farmers were asked if they have a statement of mission and objective entirely understandable by all workers. Eight out of ten answers that they have even if in general, they refer to the mission statement of the association the farms in related with. It is difficult to understand the real usefulness of this theme since in general small enterprise do not have a mission statement, or when they have, it is a formal document that hardly directs real processes and decisions.

"G2 – Accountability" theme is evaluated by a single question, i.e. whether the farm keeps accurate records of its process. In general, farms' processes are recorded by the Association they relate to; thus it is not surprising if the results are 90% good.

"G3 – Participation" theme is composed by two parts: the first asks about relation with an association of producer and its effectiveness; the second the capacity of the farmer to resolve possible conflict with stakeholders. Two parts are quite correlated since an efficient association has the purpose of dealing with stakeholders on behalf of the farmers. So, in general, associations are useful for 6 out of 10 farms, but this result reveals that not all associations are a real strength for the farmers.

"G4 – Rule of Law" theme scores generally limited results for almost all farms. However, in this case, the cause of this mark is the incapacity of the farmer to understand the question. Regulatory issues are in general, managed by the association; hence, farmers are not entirely aware of those problems.

"G5 – Holistic Management" theme relates to the existence of a plan to guide processes and developments for the farms. Producers associations generally managed plans for farmers, so it is not surprising that those farms that score weak in G3, also score low in this theme, since they belong to not completely efficient associations.

E1 – E5 Environmental integrity themes

Environmental integrity themes performed weak scores overall, with the partial exception of E2 (water) where the analysis shows the sole 5 “good” marks. The causes of this situation are three:

i) There is neither control nor available record of air contamination. Electricity is scarce in the countryside, and often farmers use gasoline electricity generators.

ii) Every interviewed farmer grows banana as a monoculture; hence soil quality and fertilizer usage are strongly affected by this situation. Moreover, monoculture strongly jeopardises biodiversity of the system. On the other hand, from the farmers' point of view, any other crops except banana would represent a decrease in earning since this crop is the well paid by foreign markets.

iii) The positive aspects are related to the fact that many farmers have implemented processes for the recycling of water.

C1 – C4 Economic resilience themes

In these themes, it is possible to see three different situations. Themes C2 and C3 report general weak performance. The reason for that relies on the fact that farms grow only one crop and thus do not enjoy a product diversification. Moreover, if banana exportation price is established by the government, it is possible for farms not belonging to a producer association to be exposed to opportunistic behaviour by export enterprises. Finally, it is difficult for small farmers to have financial nets in case of a drop of demand, thus, in general, the system is quite vulnerable.

On the other hand, theme C4 reports quite positive results since farmers rely on local workforce and prefer a long-run relationship with workers rather than cheaper foreigner workers. This fact depends on the complexity of the activities undergone in the farms and in the attitude of farmers to employ friends or relatives.

Finally, theme C1 reports diverse scores so that it is not possible to formulate a joint statement. Farms #1, #4, #6, #7 and #8 belong to an efficient association with the prime of certifications invested in process improvement, such as the water recycle process. The other farms do not have this opportunity and hence developed scarce investments.

S1 – S6 Social wellbeing themes

In this dimension, it is possible to notice three different results. Themes S1 and S4 show 18 “limited” marks out of 20. Farmers can experience a no-high-pressure job in which working time allows to have free time to spend for the families of private issues. Moreover, personal relationships between farmers and workers are the base for a mutual aid attitude.

Nevertheless, wages are quite low, and both smallholder farmers and workers can respond only to the basic needs of their families. Regarding S4, it is essential to underline that women are present in this industry but not as permanent workers. While full-time workers are almost always men, there are many women employed in banana box preparation activities the day of shipping, generally once a week.

The positive results of S2 reflect the control that in that last years, the government and producers’ associations have developed as price controllers; hence farmers are quite satisfied for the reliability of prices along the year.

S3 and S5 report the same situation: when farmers are a member of an efficient association that apply private certifications standards (e.g. Fairtrade), workers enjoy an above-the-average treatment in term of health protection, contract rights and child labour; in the other situation some not-fair behaviour is still possible.

S6 deserves a particular mention since this theme regards ancestral and indigenous knowledge. The mark is generally high because farmers, that live in the countryside since the Ecuadorian agrarian reform of the sixties, consider themselves as the indigenous and original owner of their land even if they do not belong to the indigenous people that lived in those land during last centuries. Even in this case, the theme seems to do not completely adapt to the specific situation of small banana producers.

5. Conclusion

This study examines the efficiency of SAFA App in evaluating the sustainability of smallholders. This SAT is the version for small farmers of the well-known SAFA the SAT prepared by the FAO in 2013. For this purpose, ten banana smallholder have been interviewed using the 100 questions SAFA App survey that covers 21 sustainability themes. For each farm, results have been reported in a three-point scale that correspond to Good, Limited or Unacceptable scores.

The analysis of the result enlightens how SAFA App correctly represents the agri-system since in 12 out of 20 themes, the results are similar among the farms. Moreover, the questions were in general understandable and farmers do not show problems in answering them. Nevertheless, some improvement could be undergone. In particular, themes G1 and S6 were found weak and not adaptable to the system.

Results show that for banana smallholders, there are many points of weaknesses, in particular in three main issues. Firstly, if on the one hand, the banana monoculture maximises revenues from the other hand, it jeopardises soil fertility and increases economic vulnerability. Secondly, investments are scarce when smallholders are not a member of an efficient producers' association. Finally, if producers are wholly warranted in the product's price stability, they only enjoy basic wages, so that they can only satisfy the basic needs of their family.

This analysis has some limitations which could serve as a reference for future research. First of all, the sample is quite limited and should be augmented. Farmers could also be grouped depending on the type of association they belong to; and finally, would be important analysed whether farmers apply a certification scheme. Nevertheless, since this study demonstrates that SAFA App can represent the system of smallholder banana, it would be essential implementing a broader analysis, involving a vaster number of smallholders in order to obtain a solid base for possible public intervention and regulation.

CHAPTER 6

CONCLUSIONS

CONCLUSIONS

1. Results discussion

This study aimed to evaluate the most suitable sustainability assessment tool for the comparison between conventional and certified banana ion the El Oro province of Ecuador. The methodology focused to the analysis of the different tools was the Deconstruction, a qualitative methodology derived from philosophy. SAFA, the brand-new FAO's tool was chosen and applied to two organizations that gather conventional and organic/Fairtrade farmers. To apply SAFA, it was developed an original approach directed to operationalise the tool.

The results of this analysis may be summed up in the following three main points.

1.1.Sustainability assessment tools

The first question this study raised concerns the way to assess system sustainability. There are several approaches to evaluate sustainability. Nonetheless, the methodology that applies a set of indicators organised in a sustainability framework is the one that most attracts the attention of analysis. Thus, the selection of the framework must consider at least two fundamental aspects: firstly, the indicators must match nine criteria to be included in the assessment and, secondly, the analysis must select the framework whose features are consistent to the purpose of the assessment.

Regarding the first point, this study revised the academic forum in order to analyse whether it is possible to identify a consensus on this topic and encountered nine criteria the indicator must accomplish in order to be included in the assessment:

- Rely on available data.
- Evaluate a relevant aspect of the system's sustainability.
- Have an analytical validity.
- Consider possible changes in the system's characteristics.
- Be clearly defined, quantified and measured.
- Be relevant for decision and policymakers.
- Clear in its content, purpose, method, comparative application and focus.

- Understandable by stakeholders.
- Accepted by end-users.

This analysis results essential for a twofold reason: first of all, the analysis provides the analyst a guide to not waste time and resources in applying irrelevant or useless indicators. Secondly, the criteria are implicitly describing a shared definition of sustainability and, by consequence, directing sustainability investigations towards a common goal.

Regarding the second point, this study screened the more recent literature and recognised four groups of sustainability assessment tools:

The first group is formed by those frameworks that employ a participative approach that involves keys stakeholders to detect the indicators, methodology, purpose and way to display the results of the assessment. Those frameworks are particularly popular in Latin America, where the most implemented of these, MESMIS, was created. The bottom-up approach is undoubtedly related to the Latin American culture where agriculture is an activity developed by peasant communities often far from urban settlement and government control. Hence, a community of end-users, rather than a panel of expert, is the most suitable player of a self-defined process of sustainable development. Nevertheless, this approach finds in the Latin American culture its definition but also its limitation: in fact, the process involved many people, different types of stakeholders and require a massive amount of time to achieve practical conclusions. For this reason, MESMIS and its European extension MMF, encountered scarce application out of Latin America, in particular in Europe, where time-saving and individualistic attitude discourages the reception of these frameworks.

The second group is formed by those frameworks created by and for academia. The sophisticated methodology represents the principal features generally implemented and the quantitative focus. The frameworks of this group are instrumental in deepening the analysis and investigating “below-the-line” of a more coherent framework and have their substantial importance in underpinning the quantitative analysis of other frameworks and orienting decision-makers. Their limitation is in their purpose since they have a marginal effect on farmers’ mindset.

The third group is represented by those frameworks that generate their indicators through an experts-only process and then apply the indicators indistinctly to each system they evaluate. This approach is called Top-Down. The second characteristic of these frameworks is the aggregation of results per sustainability dimension, namely economy, environment and society. These frameworks rely on two underlying assumptions: all dimensions are equally important, and a "sustainable" system should reach an equilibrium between dimensions. This study claims that in these assumptions can be seen a general flaw: sustainability dimensions are not objective facts that can be measured or checked but general points of view that describe sustainable aims rather than actual evidence. For this reason, the subsumption of different indicators (or facts) in an abstract dimension is an arbitrary process that not necessarily represent a given agri-system.

The last group is formed by those frameworks that by applying a top-down approach show the results per measurable indicators. These frameworks share a set of specific features: they are easily understandable by farmers, quick in being applied and giving results and they give actual implementable suggestions that may enhance the sustainability at farm, region or system level.

SAFA is the brand-new framework that has been elaborated by the FAO. SAFA is the framework selected for this study for three main reasons: it employs a broader concept of sustainability that includes four dimensions; it uses a user-friendly platform.

1.2.Deconstruction

The second conclusion of this study is the definition of a new approach in researching secondary data. The analysis of literature is a critical issue in all investigations, but it acquires a critical relevance when the analyst has to select a specific methodology to assess the sustainability of a given system, and he or she must choose the approach that minimises time and resources spending and maximises outcomes.

The deconstruction is the methodology that has its origins in the philosophy of French authors Jacques Derrida (1930-2004). This method aims to discover the implicit assumptions and hidden mindset that underpin the elaboration of a given framework. (As we have concluded) Deconstruction is based on three main postulations:

- In a sustainability framework, nothing is casual, but each aspect is sustained by a precise logic that is functional to the framework's purpose.
- This logic is based on a specific philosophical concept of sustainability
- There is not a priori a "best" philosophical view. Thus the objective is not to judge the framework but to reveal the philosophy behind the instrument.

Deconstruction has not a formal set of steps to be applied but employs a multidimensional approach that may include, for instance:

- The analysis of the authors, their previous collaboration and studies.
- The comparison of different frameworks and the question: Which is the competitive advantage of this particular framework against the others?
- The simulation. What happens if a variable change? Which factor is going to be affected?

This methodology is the base of the analysis of the second chapter of this study.

1.3.The assessment

There are many issues related to certifications. Many authors encounter that certifications enhance the sustainability of the agri-system and the growing demand for organic food and Fairtrade product drives the improvement of practices toward more sustainable solutions. Nevertheless, other authors come to different conclusions: organic practices jeopardise the economic sustainability of smallholders; customers are more interested in the health effects than in the social effects of certified products. Thus Fairtrade products receive less attention from the market; certifications' standards diverge substantially from label to another even if customers are not entirely aware of it. For these reasons, it is crucial to evaluate whether in the Ecuadorian banana agri-system certifications play an essential role in enhancing sustainability.

Two main aspects must be considered: firstly, the sample, then the instrument.

The samples are identified in two organisations: the first is an association of smallholders that produced banana with Organic, Fairtrade and Global Gap certifications. The second is a group of medium-sized farms that produce conventional banana without any third-part certification but under the standards of their primary client.

The chosen instrument is SAFA. Nevertheless, in order to apply SAFA, it was necessary to develop a brand-new approach to operationalise the SAFA. This approach allows organising the evaluation of each indicator in a set of actions to undergo, such as revision of organisation's documents, structured interviews to crucial stakeholders, visiting of farms and process analysis.

The evaluation achieves these main results:

- In general, certified farms reach more sustainable outcomes than those reached by conventional farms. So, it is possible to sustain that certified products are more sustainable than conventional.
- The system of Ecuadorian banana shows some key aspects that affect the sustainability of the whole system, independently if the farm applies a certification protocol. In particular, the broad adoption of monoculture, the scarce monitoring of air pollution, the underestimation of stakeholders are substantial limitations to the improvement of the sustainability of the banana sector.
- From the environment aspect, a relevant number of farms are implementing two main improvements: the process of change from fossil fuel to electric engine energy generators and the system of water recycling.
- Agri-forest farms, despite their small number, show outcomes considerably higher than those of traditional producers. In particular, agri-forest producers show the following features:
    - Implement an intercropping approach that includes different culture in the same field.
    - Grow traditional along with exportation focused plant breeds, thus enhance the preservation of local species.
    - No invasive impact with the biodiversity since wild animals are not distressed by farms operations.
- Fairtrade premium and organic extra-prize fortify the economic profitability of certified farms and resulted in investment for better practices.
- Certified farms show better results in three dimensions out of four but lower scores in the social wellbeing dimension. This fact may have various explications, for example, the stricter controls of larger conventional organisations or the personal (often family) relationships between members of small certified farms.

2. Limitations and future studies

This study identifies several points that could be extended in future works. In particular, three main lines may be followed.

Firstly, this study applies SAFA that showed its capacity to represent the banana agri-system. Nevertheless, SAFA presents the typical limitations of the top-down approach, namely format thought by and for Occidental analysist, and the applicability of pre-determined indicators that may scarcely represent some peculiar features. To develop a more extensive and in-depth analysis, SAFA should be completed with a bottom-up approach, such as MESMIS, that in Latin America has found a broad acceptation.

Furthermore, social sustainability is a critical factor since the discussion of what is socially sustainable is debated more strongly than other dimensions. Since this study has found a scarce application of the empiric methodology, a future analysis could consider an empirical approach to in evaluating social sustainability.

Finally, the SAFA App demonstrates impressive results in representing the smallholders' peculiarity. Further studies could undergo the same analysis with a vaster sample in order to contrast the conclusion of this study.

3. Final considerations

This study has been ambitious. The purpose has focused on the clarification of a very critical issue: the sustainability of the Ecuadorian banana agri-system. It seems it is a local issue, but it is not. It is a global affair. Ecuadorian banana is just an example of a massive plantation directed to the global exportation. Wood, cocoa, coffee, shrimps, tuna fish, olives, are other such examples. Agriculture is still a primary source of resources for many families in developing countries but is more and more marginal in developed countries. For this reason, the sustainability of agri-systems in developing countries is crucial also for developed countries since they depend on the former to have food.

The neo-liberal approach distrusts public organisations control; it prefers when the market drives changes. Economic interests must lead ethical concerns, environmental problems and social justice. In this view, the solution to the problem of agri-system sustainability is certification. Informed and conscious customers guide the change towards a more sustainable world by making responsible decisions in their purchase. The entire supply chain, from producers to retailers, must make the maximum effort to make the customer aware and thus give him or her the opportunity to make the right selection. Of course, if the customer wants to.

The dependence of the entire sustainability of the supply chain to the customer's judgement is obviously the weakest point since this judgement may rely on unsubstantial issues like fashion, momentary economic capacity or personal concerns. For this reason, it is necessary to develop an analysis that considers the wider scenario and evaluates objectively the "certifications-solution" considering the factual sustainability improvements in the production level.

Another way to say sustainability is "balance". Because a human activity be called "sustainable" it must be balanced, i.e. all the stakeholders involved must have their fair return for what they have invested in the activity. Otherwise, the activity is going to be interrupted. In the last decades the academic research has recorded a decisive reduction in agriculture population and even more young people are attracted to this activity for their future.

But in 2019 and probably in the next future, human beings depend on agriculture to live. So, it is necessary to ensure a sustainable development for the agriculture sector in order to ensure environmental integrity, economic resilience and social wellbeing for the people of the countryside.

At the same time developed countries have to re-think a new approach with the North-South linkage in order to induce both the economic and social ambition of developing countries and the need of environment preservation.

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APPENDICES

APPENDIX 1

FULL SAFA EVALUATION RESULTS

Theme	**Description** (taken from FAO, (2013a)	***A* – score**	***B* – score**
G1: Corporate ethics	It refers to the sustainability principle being embedded in the fabric of the whole enterprise. Sub-themes included are: Mission Statement; and Due Diligence.	**3.7** *A* has a clear and available mission statement that is known by all employees. Nevertheless, the mission is not clearly understood by all employees and seems to be a "requirement done". The governance body identifies examples of sustainable action such as the health service *A* provides to members. Finally, there is a committee of needs analysis every two years. As well as there is a process for security regulation. There is not, however, a clear risks analysis.	**3.3** *B* has a clear and available mission statement, but it is not known by employees and farmers. The governance body is able to identify examples of sustainable action such as the health service *B* provides to members. Finally, the private certification supplies a partial risk analysis.
G2: Accountability	It is the disclosure of credible information about strategy, goals and performance to those who base their actions and decisions on this information.	**4** *A* receives on regular basis the auditions of the body of certification such as Fair Trade and Global Gap but there are no evidences of the involvement of all possible stakeholders. *A* takes care of the stability of prices and farms economy and the respect of the norms of certification. Finally, just some information is available to all stakeholders but the more sensible is restricted to a strict number of subjects.	**4** *B* receives on regular basis the auditions of the body of certification but there is no evidence of the involvement of all possible stakeholders. *B* takes care of the stability of prices and farms economy and the respect of the norms of certification. Finally, just some information is available to all stakeholders but the more sensible is restricted to a strict number of subjects.
G3: Participation	It relies on the need for outreach to, and ensuring the potential for	**1.5**	**1.5**

	involvement of, interested parties, in particular those who are materially affected. This includes the ability to actively take part in decision making.	The company is unable to understand the concept of "stakeholders" and does not have any plan towards them. Nevertheless, the FT certification requires some general objectives towards stakeholders. Finally, *A* is unable to demonstrate that stakeholders has been engaged in decision making.	The company is unable to understand the concept of "stakeholders" and does not have any plan towards them. Nevertheless, the retailers' certification requires some general objectives towards stakeholders. Finally, *B* is unable to demonstrate that stakeholders has been engaged in decision making.
G4: Rule of law	It is compliance with legislation. In SAFA, the rule of law is considered in a business context, its central aim being the protection of the individual and group rights of all.	**3.0** *A* shows neither branches in law compliance nor faults in restorations activities. However, stakeholders are not involved. There is also no evidence of lobbing activities. *A* can show evidence of restoration. and doesn't show awareness of pre-existing stakeholders' access to land and water and records of due diligence over tenure right.	**2.0** There are examples in *B* of some members that don't fully respect workers' rights. Moreover, there is a lobbying activity endorsed by dealers that tries to influence government without stakeholders´ participation. Anyway, it is not a strong effort. Finally, *B* doesn't show awareness of pre-existing stakeholders' access to land and water and records of due diligence over tenure right.
G5: Holistic management	It is the management that aims at the continuous improvement of environmental integrity, economic resilience, social well-being and good governance, with the ultimate goal of operations being fully in line with a sustainable development of society.	**4.5** FT provides *A* with a sustainability plan with standards and requirements. *A* reports a full-cost accounting even if no information is available for stakeholders.	**4.5** *B*'s customers provide a sustainability plan with standards and requirements. It reports a full-cost accounting even if no information is available for stakeholders.
E1: Atmosphere	It refers to the integrity and preservation of clean air. Priority	**2.3** *A* has implemented the following practices:	**2.0**

	atmospheric issues include climate change, stratospheric ozone depletion, acidification and eutrophication, urban air quality and tropospheric ozone.	• Soil fertility management with organic materials. • Land-cover change to more complex and diverse systems, such as organic agriculture. • Intercropping. • Implementation of sound agroforestry practices (in about 20% of farms). Nevertheless, there is neither a plan nor implemented practices directed to the reduction of GHG emission and air pollutants.	*B* has a plan with a set target for the reduction of GHG emissions and air pollutants, but no steps have been yet made towards. Moreover, the plan is not available for all stakeholders. In addition, *B* has implemented the following practices: • The use of organic fertilizer in addition to chemical one. • Water recycle tools. • Restoration of degraded areas. • Minimization of nitrogen fertilizer.
E2: Water	Fresh water is naturally occurring water on the earth's surface in ice sheets, ice caps, glaciers, bogs, ponds, lakes, rivers and streams, and underground as groundwater in aquifers and underground streams.	**4.4** *A* has targets and has implemented steps towards water conservation and pollution prevention, however this has not been put into writing. *A* implemented the following measures: • Non-use of highly hazardous chemicals that have potential adverse effects on aquatic life. • Protecting hedgerows, water courses, wells, boreholes and springs by not cultivating adjacent to them or leaving at least 3 meters of distance with buffer strips. • Implementation of cleaning and recycle of water used for shipping.	**3.9** *B* has targets and has implemented steps towards water conservation and pollution prevention, however this has not been put into writing. Water recycle and buffer zones are implemented. There are no evidences of water scarcity due to *B*'s operations. Finally, analysis of water quality and pollutants show values under threshold line.
E3: Land	The part of the earth not covered by water is land and for the purposes of SAFA is essentially the soil resources.	**4.3** Analysis reveal soil quality indicators match standards thresholds. Chemical soil conditions are considered excellent. Key sustainable practices include	**3.4** *B* has implemented these measures: • Wise application of mineral fertilizers to improve soil fertility (to improve the PH).

		implementation of organic fertilizer, buffer zone and living fences. Despite the conversion to organic, the area has not lost its productivity (O.M. is considered low 1.5-1.8%).	• Application of organic fertilizers (gallinaza) to enhance soil organic matter content, improve crop nutrient supply and stimulate soil life. • Better drainage and/or sub-soiling to increase nutrient availability and water retention. • Planting of living fences, such as windbreaks and enhancement of soil surface roughness (e.g. by mulching) to prevent wind erosion. Based on the soil analysis operated by external agencies, no quality soil indicator exceeds standards. The amount of O.M. is considered low (1.7-1.85%), hence there are practices to augment this value.
E4: Biodiversity	It is the diversity of ecosystems, of species in these ecosystems and of the genome within these species. Agricultural biodiversity encompasses the variety and variability of animals, plants and micro-organisms which are necessary to sustain the functions of the agri-ecosystem, its structure and processes for, and in support of, food security.	**2.0** *A* has conservation plan and steps have been taken but no information is available to stakeholders. *A* has a high dark green score in all E4 indicators only for the farms that implemented an agri-forest crop system.	**1.8** *B* has a conservation plan and steps have been taken towards achieving its targets. However, the plan is not available for all stakeholders. The system is primarily a monoculture in which different farm are adjacent with minor connection between habitats. Traditional or local seeds are not grown since they are no suitable for exportation and there is scarce information about the conservation of endogenous species.
E5: Material and energy	It refers to the material input into an economy delivered by the natural	**2.8** *A* implemented the following practices:	**1.9** *B* has implemented the following practices:

	environment, the transformation and use of that input in economic processes (extraction, conversion, manufacturing, consumption) and its return to the natural environment as residuals or wastes.	• Implementation of new more efficient machinery. • Usage of organic fertilizer produced by *A*. About 80% of material used in the process comes from virgin no renewable source. Nitrogen balance is positive. *B* has a plan with a set renewable energy target as long as a plan for reduction of waste but in both case no steps have been made towards achieving the target, furthermore the plans are not available to all stakeholders. Waste is generally treated in a secure way: all organic is recycled as organic fertilizer or animal feed; plastic tools are reused (separators) or stored for external recycler agency. Fire is strictly forbidden.	• Replacement of materials with non-renewable, insecure supply by renewable options (cane for plastic cords). • New and more efficient machinery have been introduced. Nevertheless, around 80% of material used in the process comes from virgin no renewable source and nitrogen balance is negative. *B* has a plan with a set renewable energy target as long as a plan for reduction of waste but in both cases no steps have been made towards achieving the target, furthermore the plans are not available to all stakeholders. The energy consumption plan considers the conversion from diesel to tillage as source of electricity.
E6: Animal wellbeing	It is the physical and psychological well-being of animals.	Does not apply since *A* does not breed livestock	Does not apply since *B* does not breed livestock
C1: Investments	Investments at the enterprise, community and value chain level are considered.	**4.3** All financial records of *A* are positive in the last 5 years period. Sales and earnings have grown by 15% in the last year. Furthermore, *A* has bought a farm and manages it directly. Price are fixed by a yearly government negotiation with buyers.	**3.0** Only some farms of *B* have endorsed some investment to improve profitability. Financial performance is positive even if *B* has suffered a decline in profitability due to the governmental taxation policy. Price are fixed by a yearly government negotiation with buyers.
C2: Vulnerability	It relates to exposure, sensitivity and adaptive capacity of both human	**3.0**	**2.0**

	and natural systems. Thus, it includes the degree of exposure to risk (hazard, shock) and uncertainty, and the capacity of households or individuals to prevent, mitigate or cope with risk.	*A* only has 2 suppliers and is independent regarding other supplied product (for example self produces the organic fertilizer it needs). *A* produces only one product except agri-forest farms. No plans for agri-forest conversion but desire to add agri-forest member in the association. There is not a formal risks analysis, but cash flow is positive in the last 5 years period and financial safety net are available and used it in the past. There is not a plan to cope with possible scarcity in production.	70% of suppliers have not changed in the last 5 years and leading supplier account for 25% of total. *B* relies only on two big customers. *B* produces just one product with no plan for production diversification. There is no formal risk analysis nor a plan to guarantee production levels. Cash flow is positive in the last 5 years period, but no financial nets are available.
C3: Product quality and information	It is "the totality of features and characteristics of a product that bear on its ability to satisfy stated or implied needs."	**4.4** Safety of product is guaranteed by the respect of the certification standards of GG, FT and Organic. Measures are applied to prevent food contamination; quality product is doubled controlled by buyers and product is completely traceable. Nevertheless, there is no information of supplier certification.	**4.0** Safety product is guaranteed by certification standards, but the production is not organic and B uses chemical fertilizer, even though avoiding dangerous ones. Quality product is double checked, and product is fully traceable. No information on supplier certification
C4: Local economy	It is considered from the perspective of the enterprise and the contributions that the enterprise makes to local economic development.	**4.5** All workforce is locally hired since the required level of knowledge does not allow hire bargain but fixed workers. As part of certification standards, all workforce is fully paid according to law.	**4.5** Same situation of *A*.
S1: Decent livelihood	It comprises the capabilities, assets (including both material and social resources) and activities required for a means of living that meets the basic	**3.1** Producers and workers consider that they do not feel limitation in expressing their opinion, religious beliefs and political view. Training course are available for producers	**3.5** Producers and workers consider that they do not feel limitation in expressing their opinion, religious beliefs and political view. Training course are

	needs to maintain a safe, decent standard of living within the community and have the ability to save for future needs and goals.	in particular (74%) but less frequently for workers (27%). 67% of producers declare they have a living wage while only 39% of workers can satisfy the needs of their family.	available for producers in particular (74%) but less frequently for workers (27%). All producers declare they have a living wage while 77% of workers can satisfy only the basic needs of their family.
S2: Fair trading practices	It includes both legal and human rights that allow farmers, pastoralists, fishers, craftspeople and other primary producers to have access to markets where fair prices are negotiated, stable, based on true costs, agreements are long-term and where contracts, whether written or verbal, include a process for settling disputes free from retaliation in a mutually agreed manner.	**4.0** Thanks to *A* all producers declare a fair relationship with buyers even though in a particular part of the year some “under the table” agreements are possible.	**5.0** Fair and clear relationship with buyers and fair price are stated.
S3: Labour rights	It refers to the group of legal rights and claimed human rights having to do with labour relations between workers and their employers, usually obtained under labour and employment law.	**3.3** All workers are hired respecting the law. No forced labour is detected. Child labour is possible only for family members of farmers but are not detected. Only 10% workers are member of workers associations.	**4.5** Workers are contracted according to law benefits and no child or forced labour are allowed nor detected. About 55% of workers are member of workers associations.
S4: Equity	It involves the degree of fairness and inclusiveness with which resources are distributed,	**3.3** No evidence of discrimination was found in the interviews with employees, even if only 22% of farmers have a code of conduct and 66% states that there is not this	**4.3** No evidence of discrimination was detected but no farmers have a code of conduct. About 21% of workers are female and paid maternity is guaranteed.

	opportunities afforded, and decisions made.	problem. 16% of workers are female and farmers recognise the right to paid maternity. Only 48% of farmers have done some investment for disable people.	50% farmers have implemented some measures for disabled people.
S5: Human safety and health	It is the promotion and maintenance of the highest degree of physical, mental and social well-being of workers in all occupations.	**4.5** According to certification standards, workplace is safety, workers and farmers received safety and first aid training, and workers are hired with state medical benefits. Farmers also have a medical assistance delivered by a private company contracted by *A*. 25.6% workers refer at least a serious accident in the last 5 years.	**4.5** According to retailers' certification standards, workplace are safety, workers and farmers received safety and first aid training and workers are hired with state medical benefits. 19.8% workers refer at least a serious accident in the last 5 years.
S6: Cultural diversity	It is composed of ethnicity, language and religion and cultural diversity referred to the innumerable forms taken through the process of acculturation, included but not limited to age, sexual orientation, economic status, spiritual belief and political affiliation.	**2.0** Farmers of *A* do not have relationship or links with indigenous people (American natives) and even if they generally respect their knowledge, no plans or contract mention their intellectual property. Finally, producers do not use local seeds but those demanded by the market (in general cavedish type).	**2.0** Same situation of *A*.

APPENDIX 2

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Review

Deconstructing criteria and assessment tools to build agri-sustainability indicators and support farmers' decision-making process

Lorenzo Bonisoli [a, *], Emilio Galdeano-Gómez [b], Laura Piedra-Muñoz [b]

[a] Unidad Académica de Ciencias Empresariales, Universidad Técnica de Machala, Km.5 1/2 Vía Pasaje, 070151 Machala, Ecuador
[b] Department of Economics and Business, University of Almería (Agrifood Campus of International Excellence, ceiA3), Ctra. Sacramento s/n, 04120 Almería, Spain

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ABSTRACT

In the review of academic literature, numerous papers present either a list of indicator criteria or partially revised sustainability assessment tools of agri-food systems. However, neither a complete analysis and discussion about the criteria utilised by evaluators nor a compared examination and subsequent frameworks categorization have been fully developed by researchers. This study aims to fill this twofold gap by investigating the main issues related to the choice of a tool for the sustainability assessment of an agri-system. This task is conducted in three steps: firstly, we analyse the criteria an indicator should match to be included in an evaluation; secondly, we categorise 15 of the most important agriculture sustainability frameworks to discuss effectiveness in evaluating sustainability for each category, finally, we compare the categories and emphasise differences to highlight the possible application of each framework and hence guide the practitioner in the framework selection process. Our analysis identifies the complementarity between bottom-up and top-down approach and the impossibility of identifying a priori the best framework, although a combination of both approaches could prove to be a valuable, alternative option.

Contents

* Corresponding author.
E-mail addresses: lbonisoli@utmachala.edu.ec (L. Bonisoli), galdeano@ual.es (E. Galdeano-Gómez), lapiedra@ual.es (L. Piedra-Muñoz).

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1. Introduction

In a world constantly focused on technological developments, in which technology has evolved and continues to change countless aspects of everyday life, human beings still depend on agriculture as a primary source of food. In recent years, scandals and crisis generated by risky and hazardous agricultural practices have jeopardised people's health and, as a result, made the safety and sustainability of agricultural systems a key issue of public concern. For these reasons, in the academic arena the application of sustainability principles to the agricultural sector has become a crucial subject of study.

Nevertheless, in spite of widespread agreement on its importance, sustainability in agriculture lacks a consensus on both its definition and evaluation (Binder et al., 2010), so much that some authors doubt the actual usefulness of this concept (Hansen, 1996). However, international organisations, such as FAO (Food and Agricultural Organization) and the European Community agreed on two essential features of agricultural sustainability, namely multi-dimensionality and multi-functionality. This means that sustainability assessment of agri-systems must account for the balance of environmental, economic and social dimensions and address several key issues such as food security, landscape maintenance, and biodiversity conservation (Commission of the European Communities [CEC], 1999; FAO, 2005).

In recent years, driven by apprehension among both public and policy makers, the academic debate on agricultural sustainability produced a wide variety of tools and methods to evaluate sustainability of agri-systems. According to Binder et al. (2010), these tools are, among others: i. Indicators lists; ii. Environmental assessments of production alternatives; iii. Indexes or ecopoints; iv. Linear programming tools, and, v. Trade-off models. In the last years, the use of lists of indicators is considered the most common way of assessing agricultural sustainability (Roy and Weng Chan, 2012; van Asselt et al., 2014; Van Passel and Meul, 2012).

Indicators are defined as quantitative measures against which certain aspects of expected performance of a policy or management strategy can be assessed (Glenn and Pannell, 1998) and addressed, with the aim of improving decision making (Pannell and Glenn, 2000). In order to efficiently assess a system's sustainability, indicators must be checked against reference values, which can be determined in two main ways: identifying a minimum value for each indicator which represents the minimum accepted level of sustainability that a system is supposed to reach (vonWirén-Lehr, 2001), or benchmarking results between two systems, different either in spatial or time scale, to gauge which is the most sustainable (Van Passel and Meul, 2012).

The use of indicators has received considerable attention from authors. In general, indicators are used in three ways: individually, as part of a set, or combined into a composite index. Nevertheless, since the use of a single indicator may miss the opportunity to describe the complexity of a system, the use of a set of indicators, even when heterogeneous, is the preferred method (Bossel, 1999; Farrell and Hart, 1998; Van Passel and Meul, 2012).

However, the academic forum also revealed several problems that have arisen in recent years concerning the efficiency of indicator usage. Among others, the most relevant are the following:

- Indicator selection is not always clear and understandable, in particular for highly aggregated indicators (Bell and Morse, 2003). Moreover, certain lists of indicators are developed with a large number of traditional economic, environmental and social indicators, although without an underlying conceptual structure (Van Passel and Meul, 2012).
- Despite the conclusions of international organisations, most studies fail to consider the multi-functionality and the multi-dimensionality of models responsible for developing sustainability assessment; that not only they overlook the numerous functions of agriculture and its primary role of producing food and fibre (Rossing et al., 2007), but they also ignore one or two of the sustainability dimensions completely (Binder and Feola, 2010; vonWirén-Lehr, 2001).
- Authors often fail to either integrate data from different sources or to take into consideration the different needs and goals of different types of end-users (Bell and Morse, 2003; Binder et al., 2012; Seuring and Müller, 2008)
- Various research studies have focused on filling gaps in knowledge and technology but have not indicated the specific process for implementing said knowledge (Rossing et al., 2007) or for the practical utilisation of the results in decision-making. In particular, few studies contemplate the interaction and trade-off between indicators and, specially, the possibility of conflicting goals (Binder et al., 2012; Cornelissen et al., 2001; Lopez-Ridaura et al., 2002; Morse et al., 2001)

In order to correct some of these problems, in recent years, academic debate has produced a significant number of frameworks to assess agricultural sustainability (de Olde et al., 2016c; Schader et al., 2014; Schindler et al., 2015). Accordingly, a framework can be defined as a theoretical and procedural structure that underpins sustainability assessment. Firstly, frameworks select the indicators to include in the evaluation; then define the scale of assessment and identify the purpose of the study; and, finally, describe how data should be processed to generate results of interest.

A general and superficial understanding of sustainability frameworks could possibly be directed towards the identification of the framework which “best” evaluates sustainability. Additionally, this selection process should consider, as thoroughly as possible, all the issues linked to the sustainability assessment and provide the most complete and in-depth assessment of what is and what is not sustainable. Such an assessment is quite difficult to achieve but the identification of the "best" framework must be regarded as ideal for at least three reasons. Firstly, frameworks are underpinned by a given definition of sustainability and there is no precise agreement on the concept of sustainability or sustainable agriculture (Roy and Weng Chan, 2012). Hence, since they diverge on a theoretical basis, different frameworks cannot be evaluated from an objective or technical perspective. Secondly, frameworks are generally aimed at different end-users who rarely share common goals and needs. For instance, while farmers are more interested in simple and implementable measures to enhance processes at farm or local level, decision makers are more focused on numerical results on a sector or regional scale; finally, frameworks are usually built to be implemented in a specific context or sector. For these reasons, it is highly improbable that a single framework can encompass such diverse and, at times, contrasting point of views (Van Passel and Meul, 2012).

Bearing in mind the variables expressed above, rather than identifying the "best" framework to evaluate sustainability, it would be better to find the most apt for assessing the sustainability of a given agri-system. Nevertheless, this selection process is complicated, mainly because few articles in the academic literature compare different frameworks and even when they do so, they are limited to analysing a small number of tools without justifying the reasons for excluding other frameworks.

This work bridges these gaps in the literature and aims to supply a valuable guide for practitioners for analysing the suitability of assessment tools from a more technical and objective perspective (considering the basic principles and features to construct them). Following deconstruction method, a deep analysis of criteria justification in indicators' selection and normative-procedural characteristics of several agricultural sustainability frameworks are presented.

For this purpose, the study is carried out with a three-step approach (see Fig. 1).

In the review of academic literature, we find numerous studies in which indicator criteria are either listed or partially revised, yet only a few of them analyse and discuss criteria in depth. Moreover, frameworks rarely discuss and justify the selection of the indicators.[1] For these reasons, the first step of our work is the analysis of previous studies in order to identify and define the criteria upon which there is general agreement by authors. Thus, practitioners may apply said criteria to framework indicators and exclude those that do not match the requirements.

Once practitioners establish criteria inclusion and hence can effectively select the indicators to apply in the evaluation, practitioners must choose the most suitable framework at the system analysed. This selection needs two phases: firstly, frameworks must be analysed in their characteristics; secondly, they must be categorised according to their feature in order to highlight the possible application of each framework.

For these reasons, steps 2 and 3 of our study regard respectively the analysis and the categorization of frameworks.

Thus, the final step of our approach is the selection of the framework that best fits the properties of a specific agri-system with the most suitable indicators (or with the indicators that match sounded criteria of inclusion).

The remainder of the paper is organised as follows: Section 2 explains the methodology; Section 3 illustrates and examines indicator criteria; Section 4 describes and compares the sustainability assessment tools; Section 5 discusses the most important types of frameworks and, lastly, Section 6 outlines the main conclusions drawn from the research.

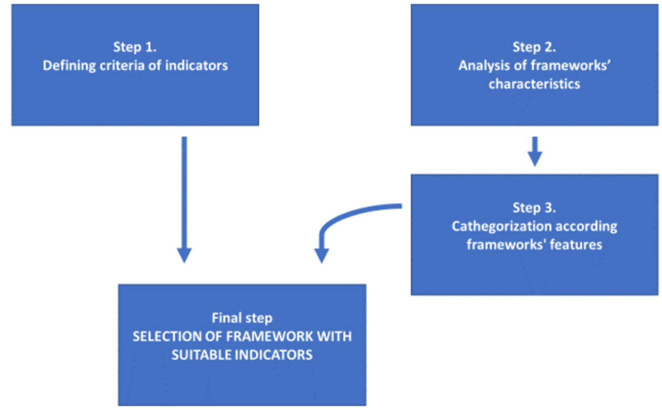

Fig. 1. Process of selection of the most suitable assessment tool.

2. Methods

A methodology involving a three-step search was applied to identify the most significant articles to include in this review. Initially, a general search for works on this topic in top journals was carried out, using the Web of Science (ISI, 2016) and Scopus databases. These databases were chosen because they are considered to be the most important source of data for scientific research and include titles from Emerald, Elsevier, Springer, Willey, Taylor & Francis, JStor, among others. At that first time, the terms searched were "sustainability agricultural framework*" and "sustainability indicators criteria*" in either the title or the abstract or the keywords. The symbol (*) has the function to include any variation on the terms searched, such as the plural. Secondly, the references of the 194 articles identified were reviewed in order to establish the most cited works in the field. Finally, when necessary, in-depth investigations on specific subjects (for example, local application of a certain framework) were conducted and, in this case, local studies and journals were included in the analysis. All the articles were carefully screened in order to exclude those unrelated to the topic or to the goals of the review.

We utilise the deconstruction approach to analyse the reference bibliography. This method, introduced by the French philosopher Derrida (1974, 1978), implies the analysis of the implicit assumption, hidden or unspoken purpose and structural contradiction of a specific question. In this study, the deconstruction approach was applied to sustainability criteria and assessment tools. In the first case, a list of criteria used in previous works was elaborated. Then, nine main criteria were identified. Finally, criteria were discussed in consideration of the context in which they were developed in order to recognise variances in meaning, purpose or assumptions. In the second case, sustainability assessment tools were first examined with an adapted version of the instrument built by (Binder et al., 2010) and they were categorised. Finally, the assessment tools were analysed by considering the case studies in which they were applied in order to identify implicit characteristics and differences.

3. Indicators criteria

The identification of the indicators for a system evaluation is a complex process, since indicators must be as few as possible but as

[1] Among the frameworks presented in this study, only SAFA presents a complete report that discusses and justifies each indicator included in the tool (FAO, 2013b).

many as necessary (Bossel, 1999). It was observed that when a small number of indicators are applied, essential aspect may be missed (Roy and Weng Chan, 2012). On the other hand, when a large number of indicators are used, concerns on framework usefulness and trust may arise (de Olde et al., 2016a).

A number of authors define the criteria according to which indicators should be drawn as a preliminary step prior to building a sustainability framework or evaluating a system. However, authors often dedicate only a few words to this topic (Andrieu et al., 2007; Gómez-Limón and Riesgo, 2010; Meul et al., 2008; Zahm et al., 2008), or, at times, ignore it completely (Giovannucci and Potts, 2008; Grenz et al., 2009; López-Ridaura et al., 2005, 2002).[2] In these cases, criteria are generally listed without any in-depth examination of their significance, justification or reasoning.

By contrast, we consider criteria to be a pivotal issue in the theoretical construction of a sustainability evaluation model since they represent the link between indicators and the general concept behind agricultural sustainability.

Our investigation is the following: firstly, we reviewed several articles from the most recent literature that focus particularly, but not exclusively, on the last decade. Then, we identified nine criteria. In keeping with Roy & Weng Chan (2012) we found that the first five describe the intrinsic requirement an indicator must match, while the other four outline the usefulness of the indicator as follows:

Intrinsic requirement of the indicator

- Data availability
- Relevant
- Analytically valid
- Flexible to changes
- Measurable

Usefulness of the indicator

- Policy relevant
- Implementable by farmers
- Understandable
- Acceptable

These criteria are discussed in depth below (Table 1).

3.1. Data availability

The first criterion expresses that indicators must rely on data that are available to users. To fulfil this condition, indicators must match two requirements: availability and cost-effectiveness. Firstly, data must be available, namely, “it must be relatively straightforward to collect the necessary data for the indicator” (Bell and Morse, 2003). This initial criterion is important since it represents the idea that sustainability does not need to be evaluated theoretically but has to relate to a real and specific situation in which some important data might be unavailable. This criterion also represents a limit. In fact, since only structured organisations can supply the necessary data for an empirical evaluation, in many cases researchers are unable to investigate the sustainability of small and unstructured entities, such as rural family farms. Government organisations have the capacity to organise large-scale data campaigns in order to fill this gap, but this type of investigation is beyond the reach of an individual academic researcher. For this reason, the second condition is “cost-effectiveness” (Bell and Morse, 2003; Qiu et al., 2007), which relates to the unlikelihood of researchers sustaining considerable expenses.

A particular correction of this criteria is provided by Guy and Kibert (1998), who stressed the fact that data must also be available on a regular time basis.

In addition, another procedural criterion is identified. In fact, two methods are possible for the evaluation of a system's sustainability: either comparing the indicator values with recognised sustainable values, or contrasting two that are different in space or time scale scenarios. For this reason, some authors underline that an indicator should contain, to some extent, a guideline of the threshold value it must match (Walter and Stützel, 2009a) or a values benchmarking should be available (Meul et al., 2008).

3.2. Relevant

The criterion emphasises that the available research must be related to something *important*. This requirement may seem rather generic, so, to better understand what is meant by this term, it is necessary to ponder the main purposes that authors address. Some deem that indicators must be relevant for system sustainability (Dantsis et al., 2010; Gómez-Limón and Riesgo, 2010; Qiu et al., 2007), in particular for environmental impact (Binder et al., 2008) and in general for system representation (Binder and Feola, 2010) and agricultural development (MAFF, 2000). Furthermore, some authors specifically stress the importance of the indicators to understand the specific case in which the indicator is used: hence, indicators must be relevant for the case study (Bélanger et al., 2012; Dantsis et al., 2010; van Asselt et al., 2014) or for the study area (Guy and Kibert, 1998; Zhen et al., 2005). In conclusion, the importance of this criterion lies in the idea of sustainability as something relevant that may have a significant impact on systems and procedure and, consequently, on people lives.

3.3. Analytically valid

The evaluation of sustainability is closely linked to the theoretical underpinnings of the evaluation process, the framework adopted for the process and the objectives the evaluators aspire to achieve. However, the process of sustainability evaluation must be carried out by using a solid and precise scientific methodology. In particular, as stated by Dale and Beyeler (2001), the absence of a scientific methodology when selecting indicators often results in a corresponding lack of scientific rigour in sustainability programmes. For this reason, there is a rather unanimous consensus among researchers on the consideration that an indicator must reach analytical soundness to be selected.

Some authors conduct further in-depth analyses and explicitly identify what analytical soundness truly means. For example, Meul et al. (2008), indicate two requirements that may help us to understand more about this criterion: causality and solidness. Whereas the former expresses the need to clearly identify the relationship between the indicator and the observed phenomenon, the latter focuses on the methodology that makes it possible for the indicator's value to depend only minimally on external factors. The same concept is reaffirmed by Niemeijer and Groot (2008), who agree with the second requirement and refer to “robustness” as the capacity of indicators to be independent of expected sources of change. Moreover, for this reason, we can concur with Moller and Macleod (2013), who synthesise the two requirements into one criterion and indicate that, to be selected, an indicator must show the capacity to be affected by few factors and directly link measures with cause of change.

[2] In the case of MESMIS it is important to highlight that this framework does not present a formal list of criteria since according to its structure all indicators are completely developed by a participatory process with stakeholders.

Table 1
Analysis of Criteria an indicator should match in order to be included in an evaluation.

Criteria Group	Criterion	Authors
Data availability	Accessibility to user at appropriate scale	(Fernandes and Woodhouse, 2008; Moller and Macleod, 2013)
	Data availability	(Berroterán and Zinck, 2000; Binder et al., 2008; Binder and Feola, 2010; Dantsis et al., 2010; Nardo et al., 2008; Niemeijer and Groot, 2008; Peano et al., 2014; Singh et al., 2012)
	Threshold value guideline	(Walter and Stützel, 2009a)
	Cost effectiveness	(Qiu et al., 2007; Sauvenier et al., 2005)
	Benchmarks are available to evaluate the indicator value (use of benchmarks)	(Meul et al., 2008)
	Availability of reference values	(Lebacq et al., 2013)
	Available (it must be relatively straightforward to collect the necessary data for the indicator)	(Bell and Morse, 2003)
	Cost-effective (it should not be a very expensive task to access the necessary data)	(Bell and Morse, 2003)
	Available and timely. Are the data available on a regular basis?	(Guy and Kibert, 1998)
Relevant	Significance in the study area	(Zhen et al., 2005)
	Important for agricultural development	(Ministery of Agriculture Fishery and Food, MAFF, 2000)
	Relevance for system sustainability	(Dantsis et al., 2010; Gómez-Limón and Riesgo, 2010; Sauvenier et al., 2005)
	Relevant to the case study	(Bélanger et al., 2015; Dantsis et al., 2010)
	Directly related to the theme	(van Asselt et al., 2014)
	System representation	(Binder et al., 2010; Lebacq et al., 2013)
	Relevant to environmental impact	(Binder et al., 2008)
	Relevance for the issue and target audience at hand	(Niemeijer and Groot, 2008)
	Do they measure something that is relevant?	(Guy and Kibert, 1998)
	Representative relevance. Do they cover the important dimensions of the area?	(Guy and Kibert, 1998)
Analytically valid	Validity or analytical soundness	(CORPEN, 2006; Fernandes and Woodhouse, 2008; Gómez-Limón and Riesgo, 2010; Lebacq et al., 2013; MAFF, 2000; Nambiar et al., 2001; Niemeijer and Groot, 2008; Peano et al., 2014; Sauvenier et al., 2005; Van Cauwenbergh et al., 2007; vonWirén-Lehr, 2001; Walter and Stützel, 2009b)
	Conceptual soundness	(van Calker et al., 2006; vonWirén-Lehr, 2001)
	Obvious and well-defined relationship between an indicator and the phenomenon being monitored (causality)	(Meul et al., 2008)
	The well-documented calculation method of the indicator value minimally depends on external factors (solidness)	(Meul et al., 2008)
	Specific – they are affected by relatively few factors so any shift in their measures can be more directly linked to causes of change	(Moller and Macleod, 2013)
	Robustness - Be relatively insensitive to expected source of interference	(Niemeijer and Groot, 2008)
	Stable and reliable. Are they compiled using a systematic method?	(Guy and Kibert, 1998)
Flexible to changes	Adaptation	(Gómez-Limón and Riesgo, 2010; van Calker et al., 2006; vonWirén-Lehr, 2001; Walter and Stützel, 2009b)
	Sensitive to variation	(Bélanger et al., 2015; CORPEN, 2006; Moller and Macleod, 2013; Nambiar et al., 2001; Niemeijer and Groot, 2008; Qiu et al., 2007)
	Suitable for different scale	(Nambiar et al., 2001)
	Flexibility in the indicator for allowing change, purpose, method and comparative application	(Singh et al., 2012)
	A change in the situation is reflected in a value change of the indicator (sensitivity)	(Meul et al., 2008)
	Sensitive - they detect changes in systems within the time frames and spatial scales relevant to decisions and risk management.	(Moller and Macleod, 2013)
	Discriminating power in time/space - Ability to discriminate in time/in space between changes due to external factors and changes due to management	(Sauvenier et al., 2005)
	Responsiveness	(Qiu et al., 2007)
	Data sensitivity to temporal change	(Berroterán and Zinck, 2000)
	Sensitive (must readily change as circumstances change)	(Bell and Morse, 2003)
	Responsive. Do they respond quickly and measurably to change?	(Guy and Kibert, 1998)
	Flexible. Will data be available in the future?	(Guy and Kibert, 1998)
Measurable	Easy measurability	(CORPEN, 2006; Dale and Beyeler, 2001; Dantsis et al., 2010; Fernandes and Woodhouse, 2008; Gómez-Limón and Riesgo, 2010; Lebacq et al., 2013; MAFF, 2000; Nambiar et al., 2001; Niemeijer and Groot, 2008; Roy et al., 2014; Roy and Weng Chan, 2012; Sauvenier et al., 2005; van Asselt et al., 2014; Van Cauwenbergh et al., 2007; vonWirén-Lehr, 2001)
	Measurable in qualitative or quantitative terms	(Niemeijer and Groot, 2008)
	Clearly defined, quantified and repeatable	(Moller and Macleod, 2013)
	Quantitative	(der Werf and Petit, 2002; Lebacq et al., 2013; van Calker et al., 2007)
	Measurable (implies that it must be a quantitative indicator)	(Bell and Morse, 2003)
Policy relevant	Policy relevance	(Fernandes and Woodhouse, 2008; Gómez-Limón and Riesgo, 2010; Guy and Kibert, 1998; Lebacq et al., 2013; Moller and Macleod, 2013; Nambiar et al., 2001; Sauvenier et al., 2005; van Calker et al., 2006; Van Cauwenbergh et al., 2007; vonWirén-Lehr, 2001; Walter and Stützel, 2009a)
Implementable by farmers	Effectiveness	(Qiu et al., 2007)
	Reproducible	(Dantsis et al., 2010)
	Goal orientation	(Binder and Feola, 2010; Nardo et al., 2008)

Table 1 (*continued*)

Criteria Group	Criterion	Authors
	Can easily be used by farmers	(Andrieu et al., 2007)
	Specific (must clearly relate to outcomes)	(Bell and Morse, 2003)
	Usable (practical)	(Bell and Morse, 2003)
	Clear definition of the objective that the indicators are meant to achieve	(Bell and Morse, 2003; Niemeijer and Groot, 2008)
	Transferability - The indicator should make sense in major farm types implementing common and/or alternative practices	(Lebacq et al., 2013; Niemeijer and Groot, 2008; Sauvenier et al., 2005)
	Performance based – they measure actual performance towards outcomes (rather than practices expected to promote sustainability and resilience)	(Moller and Macleod, 2013)
	Simplicity and preciseness	(Binder et al., 2008)
	Clarity and simplicity in its content, purpose, method, comparative application and focus	(Singh et al., 2012)
Understandable	Understandability	(Dantsis et al., 2010; Gómez-Limón and Riesgo, 2010; Qiu et al., 2007; Walter and Stützel, 2009a)
	Transparency - The meaning of an indicator should be easy to seize, clear, simple and unambiguous	(Sauvenier et al., 2005)
	Comprehensibility	(Binder et al., 2010; CORPEN, 2006; Lebacq et al., 2013; Niemeijer and Groot, 2008)
	Indicator values and scores are easily interpretable (comprehensibility)	(Meul et al., 2008)
	Understandable. Are they simple enough to be understood by lay persons?	(Guy and Kibert, 1998)
Accessible	Community involvement. Were they developed and acceptable by the stakeholders?	(Guy and Kibert, 1998)
	Accessible to many users	(Nambiar et al., 2001)
	Social validation - Recognition by end users	(Lebacq et al., 2013)
	Broadly accepted – they are selected objectively through collaboration with policymakers, key stakeholders and experts, unless serving specific local values.	(Moller and Macleod, 2013)

Source: Own elaboration.

3.4. Flexible to changes

If the previous criterion refers to stability and reliability (Guy and Kibert, 1998), this criterion expresses the need for indicators to show their capacity to adapt (Gómez-Limón and Riesgo, 2010; van Calker et al., 2006; vonWirén-Lehr, 2001; Walter and Stützel, 2009b) and respond (Nambiar et al., 2001; Qiu et al., 2007) to variations. Some authors emphasise that the adaptation to changes must be immediate for users in order to be consistently up to date (Bell and Morse, 2003; Guy and Kibert, 1998) while Berroterán and Zinck (2000) emphasise how important it is that indicators react to temporary changes and, by doing so, allow time benchmarks.

This criterion, which relates to adaptability, seems to contradict the previous one; in fact, while the latter claims stability as a requirement, this criterion refers to flexibility. To solve this paradox we must first discuss those authors that accept both criteria. For instance, Bell and Morse (2003) and Meul et al. (2008) expound that indicators must reflect changes in a situation, other authors emphasise that those changes refer to a modification in the time frame or spatial scale (Moller and Macleod, 2013; Sauvenier et al., 2005). In fact, since sustainability is a “situated concept” (Rigby and Caceres, 1997) in which time and space play an important role in evaluating what is sustainable, many evaluation tools compare the sustainability situation of systems that differ in either time frame or spatial scale. For these reasons, we can conclude that an indicator must detect changes of systems within the time and space dimension.

3.5. Measurable

According to the criterion of data availability presented above, some authors consider that data should be available and *easily* measurable (Fernandes and Woodhouse, 2008; van Asselt et al., 2014).

Particular attention must be paid to those authors, who stress that indicators must rely on quantitative data (Bell and Morse, 2003; Lebacq et al., 2013; Moller and Macleod, 2013). The reason given for why indicators should be quantitative is based on practical issues. For example, according to Moller and Macleod (2013), in order to provide comparable, verifiable and scientifically-acceptable information, the use of quantitative methods is preferable to qualitative. In agreement with this idea, van Calker et al. (2007) state that indicators must rely on quantitative data to be used in a model. On the other hand, der Werf and Petit (2002) contend that values are preferable to scores since the latter are dimensionless and hence cannot be compared to the data of another system.

In this case, even though quantitative data are more useful for an objective sustainability evaluation, it is necessary to consider that if such data successfully represent ecological and economic indicators, they are inadequate for social assessment since social indicators are usually represented by opinions, attitudes and perception rather than quantitative facts. Moreover, in some situations, it is difficult for researchers to obtain economic and environmental data because of farmers' discretion or poor documented operations and consequently judgments and opinions based on scores are the only available data. So, we prefer to agree with Niemeijer and Groot (2008) and conclude that indicators must be measurable in either qualitative or quantitative terms.

The first criteria focus on the intrinsic requirements the indicators must match to be included in an evaluation of sustainability (see Table 1). However, it is possible to identify other criteria that are more concerned with indicators' implementation. The following criteria belong to this group.

3.6. Policy relevant

This criterion appears as an extension of the “Relevant” group listed above but with one substantial difference: in this case, the users to whom indicators are addressed are the policy-makers. Considering this point, it is necessary to delve more deeply since not all sustainability frameworks are studied for the same type of end-users. In particular, Van Passel and Meul (2012) explain that there are at least two different kinds of frameworks: those studied for farmers and those addressed to policy makers. The difference is significant. While the former are generally applied at farm or local level and use visual integration tools that summarise results using graphs and tables, the latter are implemented at the regional or national level and prefer the adoption of numerical integration tools that assimilate values in an index.

Nonetheless, some authors think that a framework must investigate sustainability at farm *and* at region level in order to be of interest to different end-users and, by consequence, to accept this criteria as important (Gómez-Limón and Sanchez-Fernandez, 2010; Nambiar et al., 2001).

3.7. Implementable by farmers

A sustainable examination that does not deliver a precise list of actions to implement is useless thus an indicator must be both usable by farmers (Andrieu et al., 2007) and practical (Bell and Morse, 2003). There is general agreement among researchers in this respect. To be implementable and thus be useful to farmers, an indicator must first of all be simple, precise (Binder et al., 2008) and clear in its contents, purpose, method, comparative application and focus (Bell and Morse, 2003; Niemeijer and Groot, 2008; Singh et al., 2012).

In addition to simplicity, preciseness and clarity, some authors stress the fact that an indicator must reach a certain result in its applications. Hence, indicators must be goal oriented (Binder and Feola, 2010; Nardo et al., 2008; Qiu et al., 2007); specific, i.e., they must clearly define the outcomes they seek to achieve (Bell and Morse, 2003); and performance based, by measuring actual results towards outcomes rather than practices expected to promote sustainability and resilience (Moller and Macleod, 2013).

Finally, other authors explain that to be implementable, indicators must be applied to different situations and the methodology must be reproducible (Dantsis et al., 2010) in such a way that the indicator makes sense in a major farm type implementing common or alternative process (Lebacq et al., 2013; Niemeijer and Groot, 2008; Sauvenier et al., 2005).

3.8. Understandable

This criterion derives from the previous one. In order to be implementable by farmers, users must be able to understand the indicators (CORPEN, 2006).

Some authors specify what comprehensibility means and explain that indicators must be easy to understand (Sauvenier et al., 2005) and that its value and scores must be easy to interpret (Meul et al., 2008). Finally, it is possible to conclude that, in general, indicators must be simple enough to be understood by lay people (Guy and Kibert, 1998) and policy makers.

3.9. Acceptable

The last criterion regards the community in which sustainability evaluation is developed. Even though few authors mention this criterion, we consider it useful for scenarios in which government effectively controls the physical territory and the possibility of imposing sustainability measures with no regard for farmers' acceptance is an actual option, though possibly not the best one. On the other hand, where government does not completely control the territory or does not demonstrate genuine interest in sustainability, the involvement of local stakeholders and their acceptance of sustainable practices is the only option.

According to the authors that accept this criterion, indicators must be accessible to many users, e.g. farmers, workers, policy makers, governmental and non-governmental institutions and researchers (Nambiar et al., 2001). Moreover, indicators must be recognised by end users (Lebacq et al., 2013) and the community must be involved in the process in such a way that indicators should be developed and accepted by stakeholders (Guy and Kibert, 1998). Thus, we can concur with Moller and Macleod (2013) that indicators must be selected through collaboration with policy makers, key stakeholders and experts, unless serving specific local values.

3.10. Final considerations

In sum, we identify nine criteria that indicators must respect to be included in a sustainability evaluation. More specifically, indicators must be based on data that are available at a reasonable cost, relevant in describing an aspect of reality, analytically valid, flexible to changes and measurable in qualitative or quantitative terms. In addition, indicators must be relevant for policy makers, feasible to be implemented by local users, easy to understand by non-experts and developed by collaboration between different stakeholders.

4. Analysis of frameworks characteristics

4.1. Overview

Once we have developed a generic revision of the criteria as a preliminary methodology that should be included in the process on any framework, we can undertake the second step of our study, i.e. the analysis of features and purposes of assessment tools. This step aims to group assessment tools by categories in order to make easier the selection of the most suitable one for its empiric implementation in a specific agri-system.

In the last fifteen years, the academic arena has produced a large number of assessment tools for the evaluation of sustainability on agriculture. Nevertheless, a common agreement among researchers is far from being achieved since tools differ in their assumptions, starting points and objectives (Marchand et al., 2014). Even though in the literature there are many papers and reviews that conduct a categorization of sustainability assessment tools (Binder and Feola, 2010; Binder et al., 2010, 2013; de Olde et al., 2016a,b,c; Gasparatos and Scolobig, 2012; Gasparatos, 2010; Gasparatos et al., 2008; Schader et al., 2014; Schindler et al., 2015; Singh et al., 2009, 2012), our specific aim is to gain insight that will make it possible to choose the most suitable framework that can evaluate a specific agri-system.

To identify the sample of frameworks that must be included in this study, we consider differences in terms of the sustainability dimensions they evaluate. In fact, while some frameworks consider the ecological, economic and societal dimension of sustainability, other instruments focus on one dimension, for example, the Life Cycle Assessment tool, INDIGO (Thiollet-Scholtus and Bockstaller, 2014) and TechnoGIN (Ponsioen et al., 2006). Still others include additional dimensions such as entrepreneurship (Marchand et al., 2014; Meul et al., 2008); governance (FAO, 2013a); or quality and culture (Peano et al., 2014).

Taking into account a holistic sustainability assessment is usually required for agricultural systems (Galdeano-Gómez et al., 2017), we selected the frameworks which evaluated at least the economic, ecological and social dimensions of a specific system after it has been implemented. These basic commons features allow us to an in-deep discussion of the substantial differences in suitability application to specific contexts. This selection resulted in 15 frameworks developed from 1993 to 2015.[3]

4.2. Frameworks' insight

In order to analyse the frameworks, we adapted the instrument of Binder et al. (2010) that distinguishes normative, systemic and procedural aspects (Table 2). This instrument was selected as it provides a detailed analysis, correctly compares a wide range of features of sustainability assessment tools, and offers a valid understanding of the selection of tools (de Olde et al., 2016c). However, we adapted this instrument according to the analysis of Schader et al. (2014) as this study highlights certain important aspects, such as Assessment purpose and Geographical application. Finally, we introduced the aspects of Indicators criteria which are not present in the aforementioned studies.

With regard to the normative aspects, we considered:

- The theoretical basis of the concept of sustainability. The assessment depends on the definition of sustainability the research accepts; since there is no universally accepted definition of this concept, it is necessary to highlight the theoretical basis of the evaluation.
- Whether or not the framework provides specific criteria for the indicators' selection. We do not assess which criteria are accepted, but only whether criteria are explicitly mentioned.
- The goal setting of the tools, namely, whether the tools have: a *top-down* approach, whereby goals are predefined and usually theoretically derived from the definition of sustainability; a *bottom-up* perspective, in which goals and criteria are defined by the stakeholders in a participatory process; or a *transdisciplinary* approach, which combines bottom-up and top-down approaches.
- The assessment type, i.e. the way indicators can be assessed with respect to reference value, thresholds or ranges.

The systemic aspect (Binder and Feola, 2010) claims that a system must be represented with as much simplicity as possible (parsimony) and as much complexity as necessary (sufficiency). Moreover, to attain an adequate system representation, the most relevant relationships among the indicators have to be considered in the analysis as well (Wiek and Binder, 2005). Nevertheless, following de Olde et al. (2016a,b,c), since tools tend to develop an understandable and useful assessment, few of them explicitly mention parsimony as a goal, although it is considered by all to be an implicit goal. Similarly, due to the obvious aim of representing a system, all tools implicitly use the necessary complexity. For this reason, considering that each tool either explicitly or implicitly uses parsimony and sufficiency, in the systemic aspect we only focus on whether the tool identifies interaction between indicators or considers them independently.

In the procedural dimension, we include the following variables:

- End-Users are the subjects directly interested in the evaluation as they are the ones who have to respond to the results in some way. It is important not to confuse end-users with model-users, who are the subjects applying the framework (Mey et al., 2011)
- Assessment purpose is the aim for which the tool was created. In general, tools may aim to simply assess the sustainability of a given farm, guide farmers and suggest certain improvements, or even provide instructions to policy makers.
- Level of assessment (Scale) is the level at which the analysis is supposed to generate results, i.e., at farm, region, sector or landscape level (Van Passel and Meul, 2012).
- The degree of participation of stakeholders in the assessment. There are different possible degrees of stakeholder involvement in the framework's application. For instance, stakeholders can play a central role in the development, application and interpretation of indicators, as occurs with MESMIS. Otherwise stakeholders can be consulted by researchers in the validation process, in which indicators are adapted to a specific context, as is the case with DELTA. Finally, some models apply a completely top-down approach in which stakeholders' participation is not taken into account, which occurs with IDEA.
- The aggregation approach is the methodology applied to summarise results in comprehensive variables. A method frequently used is to aggregate per dimension and then per a unique variable so that the evaluation may be expressed by one aggregate index (Castoldi et al., 2010; Castoldi and Bechini, 2010; Gasparatos et al., 2008). By contrast, other tools aggregate results per indicator, making it possible to evaluate said results either together, for example in a spider graph, or separately.
- Geographical application indicates where the frameworks have been applied
- System Application specifies the sector to which the frameworks have been applied.

The results of our analysis of sustainability assessment tools is summarised in Table 2 in which every aspect is applied to each framework.

5. Discussion (frameworks categorization)

The discussion of the results of the analysis follows a two-step structure: firstly, we analyse the results per dimension (normative, systemic and procedural), then we group frameworks in four categories and explore the features of each category in detail.

5.1. Normative dimension

The Brundtland report (WCED, 1987), which states the most acknowledged and recognised formal definition of sustainable development,[4] is the conceptual basis for most tools, even if in some cases the tool mentions other studies to complement or specify a particular aspect of the sustainability concept. Nevertheless, with the sole exception of MESMIS (and MMF, which is a sort of MESMIS re-elaboration), no tools directly link the concept of sustainability with framework development. This absence of theoretical investigation is also evident in the fact that indicator criteria are not always specified or are barely discussed. The process of goal setting is in general top-down and the assessment type is by threshold. These last two points are related to two aspects in the procedural dimension, namely stakeholder participation and aggregation approach. In fact, when goals are set with a bottom-up approach stakeholders' involvement is continuous throughout

[3] In this selection we disagree in some cases with the reviews mentioned. In particular, we do not consider that the frameworks ISAP (Rigby et al., 2001), FARMSMART (Tzilivakis and Lewis, 2004), SPA (Lang et al., 2007) and SEEbalance (Saling et al., 2005) cover the three dimensions of sustainability but only the environmental (ISAP, SPA and SEEbalance) or the economic and environmental dimensions (FARMSMART).

[4] "Humanity has the ability to make development sustainable to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987:27).

Table 2
Frameworks analysis.

Framework	IDEA	SAFE	SSP	MMF	MESMIS
Name	Indicateurs de Durabilité des Exploitations Agricoles	Sustainability Assessment of Farming and the Environment	Sustainability Solution Space for Decision Making	Multiscale methodological framework	Marco para la evaluación de los sistemas de manejo de recursos naturales
Reference	(Zahm et al., 2008)	(Van Cauwenbergh et al., 2007)	(Wiek and Binder, 2005)	(López-Ridaura et al., 2005)	(Masera et al., 2000)
Normative dimension					
Sustainability concept (SC)	Theory based on Landais (1998)	Theory based on de Groot (1992); Lewandowski et al. (1999)	Defined on World Commission on Environment and Development [WCED] (1987)	Defined on 5 attributes: productivity, stability, reliability, resilience, adaptability	Defined on 7 attributes: productivity, stability, reliability, resilience, adaptability, equity, self-empowerment
Indicators criteria (IC)	Yes	Yes	Yes	Assessed in the process, not a priori	Assessed in the process, not a priori
Goal setting (GS)	Top-down	Top-down	Top down and bottom up	Bottom up	Bottom up
Assessment type (AT)	Threshold	Reference	Ranges	Stakeholders' evaluation and different techniques	Reference (benchmarking)
Systemic dimension					
Indicators interaction (II)	No	No	Yes	Yes	Yes
Procedural dimension					
End- Users	Farmers and policy makers	Researchers and policy makers	Multiple stakeholders	Multiple stakeholders	Multiple stakeholders
Assessment purpose (AP)	Self-assessment	Assessment at parcel to region level	Advice policy decision making	Farmers advice and scenario analysis	Assessment and farmer advice
Assessment Level (AL)	Farm	Region	Region	Region	Variable
Stakeholder participation (SP)	No	Partial	Whole process	Whole process	Whole process
Aggregation approach (AA)	Per dimension worth up to 100 each	Quantitative aggregation per indicators	Interaction between indicators	Not specified	Per indicator
Application					
Geographical application (GA)	France	Europe	Switzerland	Developing countries	Latin America
System application (SA)	General agriculture	General agriculture	General agriculture	General agriculture	All natural resources management systems
Framework	**MOTIFS**	**DELTA**	**DSI**	**SAEMETH**	**AVIBIO**
Name	Monitoring Tool for Integrated Farm Sustainability	No indicated	Dairyman Sustainability Index	Sustainable Agri-Food Evaluation Methodology	AVIBIO
Reference	(Meul et al., 2008)	(Bélanger et al., 2015)	(Elsäßer et al., 2013)	(Peano et al., 2015)	(Pottiez et al., 2012)
Normative dimension					
Sustainability concept (SC)	Defined on WCED (1987)	Theory based on Landais (1998)	Defined on WCED (1987)	Based on Slow Food Foundation for Biodiversity's Presidia	Defined on WCED (1987)
Indicators criteria (IC)	Yes	Yes	Yes	Yes	Assessed in the process, not a priori
Goal setting (GS)	Top-down	Top-down	Top-down	Top down and bottom up	Bottom up
Assessment type (AT)	Reference	Threshold	Threshold	Reference	Threshold
Systemic dimension					
Indicators interaction (II)	No	No	No	No	No
Procedural dimension					
End-users	Farmers	Farmers	Farmers and policy makers	Small farms	Researchers
Assessment purpose (AP)	Assessment	Self-assessment	Assessment at farm and regional level	Assessment and farmer's advice	Assessment of sustainability of system's supply chain
Assessment level (AL)	Farm	Farm	Farm	Product	Chain
Stakeholder participation (SP)	In the indicators' validation	In the indicators' validation	No	In the indicators assessment	No
Aggregation approach (AA)	Per dimension that worth till 100 each	Per dimension that worth till 100 each	Per dimension that worth till 100 each	Per indicators	Per dimensions
Application					
Geographical application (GA)	Europe	Canada	NW Europe	Europe	France
System application (SA)	Dairy	Dairy	Dairy	Small scale agri-food systems	Organic Poultry
Framework	**COSA**	**RISE**	**FESLM**	**PG Tool**	**SAFA**
Name	Committee on Sustainability Assessment	Response-Inducing Sustainability Evaluation	A framework for Evaluating Sustainable Land Management	Public Goods Tool	Sustainability Assessment of Food and Agriculture systems

Table 2 (*continued*)

Reference	(Giovannucci and Potts, 2008)	(Häni et al., 2003)	(Smyth and Dumanski, 1993)	(Gerrard et al., 2012)	(FAO, 2013a)
Normative dimension					
Sustainability concept (SC)	2002 World Summit on Sustainable Development	(Stückelberger, 1999)	FESLM Working Party 2001	Concept of Public Goods Cooper et al. (2009)	Based on FAO councils (e.g. 1989)
Indicators criteria (IC)	No	No	No	No	No
Goal setting (GS)	Top-down	Top-down	Top-down	Bottom-up	Top-down
Assessment type (AT)	Threshold	Sustainability degree calculated as SD=S-D	Threshold	Threshold	Threshold
Systemic dimension					
Indicators interaction (II)	Yes	No	No	No	No
Procedural dimension					
End-users	Farmers and policy makers	Farmers	Policy makers	Farmers	Multiple stakeholders
Assessment purpose (AP)	Assessment and prediction	Assessment and prediction	Planning	Farmers advice	Multiple purpose
Assessment level (AL)	Farm	Farm	Landscape	Farm	Farm
Stakeholder participation (SP)	No	No	No	Yes	No
Aggregation approach (AA)	Per indicators	Per indicators	Per indicators	11 spurs, covering the 3 dimensions	Per indicators (themes)
Application					
Geographical application (GA)	Developing countries	Developing and developed countries	Global	UK	Global
System application (SA)	Coffee sector	General agriculture	General Agriculture	General agriculture	Agriculture, Fishery and Forestry

the whole process with a participatory methodology, while in the top-down approach stakeholders are only partially involved, usually in the validation process, or not involved at all. SSP and SAEMETH are the sole frameworks that use a mixed top-down and bottom-up approach even though stakeholders' evaluations are adjusted based on experts' opinions, making it an essentially top-down approach.

5.2. Systemic dimension

The relationship between indicators can provide an adequate picture of the sustainability issues of an agricultural sector or system analysed. How economic, social and ecological indicators interact, i.e. trade-offs and/or synergies, is an important shortcoming in the much of frameworks (Binder et al., 2010; Galdeano-Gómez et al., 2017).[5] Nevertheless, this issue is rarely considered in the analysed frameworks. The interaction between indicators is a specific goal of SSP, whose methodology is based on the space (or interaction) created between ranges of sustainability indicators. MESMIS also considers indicator interaction a primary objective of the evaluation, while COSA regards it as a part of the analysis. The remaining tools analyse and evaluate indicators separately.

5.3. Procedural dimension

Farmers are the end-users towards whom all tools are directed. This is probably due to the innate purpose of tools to assess and advise farmers on possible sustainable changes; in this regard, IDEA and DELTA are intended to be used by farmers themselves as self-assessment tools. The two exceptions are SAFE, which is considered an assessment tool for researchers, and AVIBIO, which is the only framework aimed at evaluating the sector supply chain and, for this reason, its scope is beyond farmers. Finally, a particular group of frameworks is designed for multiple stakeholders or developed with multiple purposes as they do not have a specific sustainability target, but they may be adjusted to the specific needs of the context of application.

5.4. The four categories of frameworks

As exhaustively explained by Binder et al. (2010) and pointed out above, there are basically two different approaches in developing indicators for a sustainability evaluation. In the first one, indicators are developed by a group of experts and academic and then they are applied to an agri-system. This approach is generally known as *top-down*. In general, the differences among assessment tools that share this approach regard the purpose of the evaluation and the way data are aggregated, and we can distinguish among researcher addressed, dimension driven and indicators driven frameworks. On the other hand, in the second approach, known as *bottom-up*, indicators are identified by a participatory process in which key stakeholders are involved so that the farmers are participating in the whole process from the selection of indicators to the interpretation of the results of the assessment.[6]

5.4.1. Bottom-up participatory frameworks

In this group, we include MESMIS, MMF, SSP and SAEMETH. These frameworks are based on a participatory process in which stakeholders are appointed to construct, along with evaluators, the assessment variable. Among those mentioned, the framework with the most widespread application is MESMIS (López-Ridaura et al., 2002; Masera et al., 2000), which has been applied on several occasions in developing countries, especially in Latin America (Astier, 2006; Astier et al., 2011; Giraldo Díaz and Valencia, 2010;

[5] E.g. indicators related with organic production methods that promote recovery of soil proprieties from a traditional agriculture technique could have a negative interaction with indicators relative to efficiency use of water with modern technologies (hydroponic in EU, for example) which have an improvement in economic and other ecological aspects (water usage or soil contamination).

[6] Except the case of SSP, every framework adopts either the *top-down* or the *bottom-up* approach.

Merlín-Uribe et al., 2012; Nicoloso et al., 2015; Speelman et al., 2007). The indicators are derived from seven general attributes, namely productivity, stability, reliability, resilience, adaptability, equity and self-empowerment, which underpin the entire sustainability assessment process. The latter is structured in a six-step cycle in which the first two are devoted to describing and determining the key factors of the management system under analysis. Another interesting point is that the framework does not indicate a precise methodology for data analysis but, instead, is open to multiple techniques that may include literature review, direct measurement, use of specific monitoring devices, matrix construction, simulation models, surveys, interviews, or other participatory tools. The sixth step is the synthesis and integration of results. There is no precise integration technique in this part of the process but the most suitable method must be identified according to the purpose and end-user of the assessment. However, after the final step is completed, the cycle can be repeated; in fact, the first cycle is intended to supply suggestions and measures to enhance system outcomes, hence, a new assessment may be applied to the already improved scenario. Finally, one last point worth highlighting relates to sustainability dimensions. If, on one hand, MESMIS encompasses economic, ecological and social factors, on the other hand, it does not model the assessment process based on those three dimensions. Thus, it effectively bypasses the problem of weighted data and aggregation, as aspect which we believe constitutes a significant limitation of other sustainability assessment tools.

5.4.2. Top-down researcher addressed frameworks

This group is comprised of tools that are intended for researchers so they may deepen the sustainability understanding of a system or a regional landscape; hence, their purpose extends beyond the farm level. FESLM, AVIBIO and SAFE constitute this group, yet the latter boasts more extensive application, particularly in Spain (Galdeano-Gómez et al., 2017; Gómez-Limón and Riesgo, 2010; Gómez-Limón and Sanchez-Fernandez, 2010).

FESLM (Smyth and Dumanski, 1993, 1995) is developed with the support of the FAO and is based on a previous FAO framework for land evaluation. They differ in that the latter is based on land suitability while FESLM is based on indicators of performance over time.

AVIBIO (Pottiez et al., 2012) is a framework designed for the poultry sector only. Surveys with different stakeholders are used to develop a set of nine indicators and their respective weight. Finally, scores of each indicator are averaged per dimension and sustainability is calculated against a maximal score of 180 points for each dimension.

SAFE (Van Cauwenbergh et al., 2007) is a holistic framework that considers the three sustainability pillars and can be applied on different scales from the parcel to the macro-regional level utilising a hierarchical top-down methodology that derives indicators from criteria and principles. The first level of the structure is represented by the *principles* whose definition depends on the concept of ecosystem functioning as expressed by de Groot (1992). The following hierarchical steps identified are the *criterion*, the *indicator*, and the reference values. The framework is typically top-down as it theoretically identifies a selected number of principles for each sustainability dimension, even if it considers possible stakeholder involvement in the process of generating indicators.

5.4.3. Top-down dimension driven frameworks

The frameworks of this group aggregate results per dimension. DELTA (Bélanger et al., 2015) is a self-assessment tool operating at farm level originally created for the evaluation of sustainability of Canadian dairy farms. It is regarded as a model and shares common features with the European tools IDEA (Zahm et al., 2008), MOTIFS (Meul et al., 2008), and DSI (Elsäßer et al., 2013). This tool analyses the sustainability performance of a farm in a one-year period with a typical top-down approach in which for each sustainability dimension a list of indicators is developed. Nevertheless, the methodology comprehends an end-user validation process where farmers are involved in order to assure a tool's practical usefulness and the possible implementation of the results.

The frameworks of this group were originally created for the dairy sector and, in the case of IDEA and MOTIFS, have been applied to other sector (Coteur et al., 2016; Triste et al., 2014).

5.4.4. Top-down indicators driven frameworks

The framework of this group was conceived with the aim of standardising sustainability assessment to cope with the large number of tools applied on different scales in different regions. RISE, COSA, PG Tools and SAFA, share the same feature: they are sustained by governmental and no-governmental organisations, apply a predetermined set of indicators to allow a common ground for different systems comparison, use their own software to develop the assessment (except for PG Toll, which uses MS Excel) and have also been applied on numerous occasions thanks to the financial support they receive. However, from the point of view of the framework structure, they all aggregate results per indicator, in order to represent the evaluation in an easy-to-understand spider-graph.

RISE (Grenz et al., 2009; Häni et al., 2003), the first to be created, is a tool built by the School of Agricultural, Forest and Food Sciences, part of Bern University of Applied Sciences, and other partners in 2000; it has been implemented in several Countries in both developed and developing economies (de Olde et al., 2016b; Nestlé, 2014). This instrument selects a priori twelve sustainability indicators for each one determines the current condition of the specific indicator (S) and the degree of the estimated pressure the farming system places on the specific indicator (D). The S-D results for each indicator are plotted together on a spider graph. The instrument is not only rapid and highly comprehensible but it also allows researchers to show farmers the scenario resulting from possible changes.

If COSA is rather similar in his features to RISE, PG Tool reveals distinguishing characteristics. PG Tool (Gerrard et al., 2012) is a farmer-advice instrument operating at the farm level whose competitive advantage lies in its very fast process that in 2–4 h allows researchers to supply the farmer with an insight into the sustainability status of the farm and practical advice on possible improvements. The process is fully top-down since basic *Public Goods*, sustainability areas of the agri-system, *key activities* of the farm, and constraints are all identified a priori. Then, the process is undertaken by a researcher asking the farmer several questions for each area. Data are then reported in a 5-point scale and results are shown to the farmer in a spider graph. The tool is very simple, fast, and easy to understand for farmers, but, in order to guarantee speed, it relies only on the data previously recorded by the farmer, since the process does not consider further investigations (Marchand et al., 2012).

These last frameworks mentioned share the obvious advantage that they synthesise and simplify the sustainability assessment, yet, their application is rather controversial. In particular, the fact that governmental organisations, and even multinational enterprises,

Table 3
Frameworks comparison.

Features	Classification			
	Bottom-up participatory frameworks	Top-down researcher addressed frameworks	Top-down dimension driven frameworks	Top-down indicators driven frameworks
	MESMIS MMF SSP SAEMETH	SAFE FESLM AVIBIO	MOTIFS IDEA DSI DELTA	SAFA RISE COSA PG Tools
Reproducibility to different agricultural systems	Difficult to reproduce	Medium difficulty	Medium difficulty	Easy reproducible
System representation	Complete	Partial	Partial	Partial
Stakeholders representation	Complete	None	Minimal	None
User-friendly	Difficult to manage	Only for academic study	Medium difficulty	Easy to use
Speed	Slow process	Medium speed	Medium speed	Rapid process
Applicability to no-agricultural system	Yes	No	No	No
Assume a maximum sustainability level	No	Depends on the analysis	Yes	Yes

finance the tool may be seen as a conflict of interests considering the multiple business and political issues in which those same organisations are involved.

The SAFA tool (FAO, 2013a) was prepared by the FAO with the collaboration of RISE's developers and it has been widely utilised (Gayatri et al., 2016; Hřebiček et al., 2013; Jawtusch et al., 2013; Ssebunya et al., 2016). This tool conducts an evaluation that uses 116 indicators whose results are aggregated per 21 themes which cover four sustainability dimensions: governance, environment, economy and social. Indicator value, which can be quantitative or qualitative, are then transferred to a 5-point scale according to provided reference values. The results are shown by a spider graph so that analysts and farmers can easily identify the areas with sustainable outcomes and those to be improved. All calculations are developed by user-friendly software that is offered via free-download on the SAFA website.

For this reason, SAFA is probably the most affordable and complete tool of its kind since it considers a more exhaustive concept of sustainability that includes the dimension of governance, it covers the majority of themes included in RISE (80%), PG Tool (58%) and IDEA (55%) (de Olde et al., 2017); and it did not receive private or governmental support.

5.4.5. Final consideration on frameworks

All top-down frameworks share three weak points that deserve consideration.

Top-down frameworks develop indicators prior to the evaluation process and regardless of the specific systems they intend to analyse so that the same set of indicators are applicable to different contexts and comparison is straightforward. Consequently, this process can miss some specific features such as the geographical context, social situation, or system structure. Some frameworks try to overcome this problem by focusing on just one sector (such as DSI for dairy and AVIBIO for poultry); but, this approach, too, lacks the capacity to compare heterogeneous situations, which is one of the main advantages of the top-down methodology.

Moreover, top-down frameworks assume that each indicator (in the case of indicator-driven frameworks) or each dimension (in dimension-driven frameworks) has equal importance. But this assumption represents the tool developers' concept of sustainability rather than the tool users and stakeholders' concept. In dimension-driven frameworks this problem is more evident as they reduce the sustainability assessment to only three values. As a result, this structure leads to subjective and discretionary judgments that can hardly be justified by the end-user's validation or the farmer's opinion. For example, in the DELTA case study, Bélanger et al. (2015) weights the indicator "Quality of life" 25% while "Fertilization management" 30%. Regarding the variables, "Health and stress" accounts for 5% while "Forage self-sufficiency" represents 10%. The reason why farmers consider the forage issue twice as important as the state of their health is probably due to the tool's structure rather than the actual farmers' thinking.[7]

Finally, by using a fixed set of reference values, they assume a maximum level of sustainability, implying it cannot be improved.

Bottom-up frameworks, which involve local stakeholders, present several undeniable advantages: firstly, their flexible structure allows them to be applied to all natural resources management systems and not only to agriculture; secondly, bottom-up frameworks represent the specific situation itself and weight the actual stakeholders' thinking; and, finally, they do not assume a maximum level of sustainability.

Nevertheless, bottom-up frameworks also present practical vulnerabilities. Since they need to involve local stakeholders, the application of this framework is usually very complex to manage and needs financial and operational support from authorities or governmental institutions. Furthermore, the process takes a long time to produce results, possibly prompting stakeholders to leave the process. Finally, comparison between different systems is rather difficult and analysis is hardly reproducible (Binder et al., 2010).

Top-down frameworks represent an interesting alternative option to bottom-up. Nevertheless, top-down indicators driven frameworks are easier to be reproduced in different systems, user friendly and quicker in developing the analysis.

Top-down dimension driven frameworks represent a possible compromise between bottom-up and top-down indicators driven framework since in respect to the latter they develop a deeper analysis and need just a portion of the time required by the former.

Finally, top-down researchers driven framework are tools thought for the academic debate. In this aspect relies their difference to the other tools.

Our results are shown in Table 3.

6. Conclusions

In this study, we have seen that the selection of the most suitable framework for the sustainability assessment of agri-systems is a complex issue. The present study aims to help practitioners

[7] It is possible to find a similar example also in Zahm et al. (2008), where the indicator "Financial autonomy" scores two times higher than the indicator "Quality of life" (15/100 vs 6/100) or in Meul et al. (2008), where the indicator "Capital productivity" is weighted more than the indicator "Nature conservation" (10.5/100 vs 5.56/100).

guiding them in the selection of the most suitable tools for the sustainability assessment.

In the first portion of the present work, we have reviewed the most recognised literature in the field and identified nine essential criteria for indicator inclusion. In other terms, each indicator must rely on available data and identify something relevant. In addition, it must also be flexible to spatial or time change, analytically valid, measurable in either a quantitative or a qualitative manner, relevant for policy makers, implementable by farmers, understandable by lay people, and acceptable to different stakeholders.

As second step of our study, we carried out a framework categorization and we applied it to assessment tools which consider at least the ecological, economic and social dimension of sustainability.

Our categorization results in the identification of four groups of frameworks. The first group includes the bottom-up assessment tool, such as MESMIS, which applies a strong collaborative methodology with intense stakeholder participation both in the selection and application of the indicators. The remaining frameworks use a top-down approach with partial or minimal stakeholder interaction. The second group presents the framework specialised for the academic research, SAFE is a well-recognised example. The third group includes those frameworks that aggregate results per sustainability dimension, MOTIFS is a strongly-applied framework of this group. The last group is composed by the frameworks that aggregate results per indicators; SAFA is a good example of this last group.

Our analysis emphasises that bottom-up and top-down methodologies are complementary, hence, it is not possible to identify a priori the best approach. In particular, the comparison between the most acknowledged frameworks of each type reveals that while MESMIS is more exhaustive in representing natural resources management systems and efficient in characterising stakeholder participation, SAFA succeeds in developing a complete sustainability evaluation at a reasonable cost in terms of time, people and economic resources.

To benefit the current academic body of literature, more study is needed. Further investigations can evaluate the simultaneous application of these two frameworks to the same system in order to estimate the possibility of an integration of the two approaches, for instance, utilising SAFA indicators and aggregation methodology as a basis for debate with stakeholders.

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Method Article

Deconstruction: the qualitative methodology for the analysis of sustainability assessment tools of agri-system

Lorenzo Bonisoli[a,b,*], Emilio Galdeano-Gómez[b], Laura Piedra-Muñoz[b]

[a] *Universidad Técnica de Machala (Unidad Académica de Ciencias Empresariales), Ecuador*
[b] *University of Almería (Agrifood Campus of International Excellence, ceiA3), Spain*

A B S T R A C T

As sustainability is a philosophical concept, the evaluation of sustainability of an agri-system is underpinned by a philosophical understanding. Deconstruction is the qualitative methodology derived from philosophical science that allows to show what is hidden, to reveal the implicit meaning of a sustainability assessment tool.

- Qualitative methodology of analysis.
- Applicable to all kind of qualitative analysis.
- Suitable for review article.

A R T I C L E I N F O
Method name: Deconstruction
Keywords: Agriculture sustainability, Sustainability assessment tools, Sustainability indicators
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Specifications Table

Subject area	*Select one of the following subject areas:* • *Environmental Science*
More specific subject area	*Agriculture sustainability*
Method name	*Deconstruction*

* Corresponding author at: Universidad Técnica de Machala, Av. Panamericana Km. 5 1/2 Vía a Pasaje, Machala, El Oro, Ecuador.
E-mail address: lbonisoli@utmachala.edu.ec (L. Bonisoli).

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Name and reference of original method	Derrida, J. (1974). *Of Grammatology*, trans. Gayatri Spivak. Baltimore: The Johns Hopkins University Press. Derrida, J. (1978). *Writing and Difference*, trans. Alan Bass. Chicago: University of Chicago Press.
Resource availability	*No applicable*

Background

In recent years, in the academic arena the application of sustainability principles to the agricultural sector has become a crucial subject of study. However, despite a general accord on its relevance, the concept of sustainability lacks a consensus on its definition and in the methodology for its evaluation [1].

Regarding this last point, practitioners and analysts have developed in the last years several sustainability assessment tools (SAT) that employ a group of indicators to evaluate the sustainability of an agri-system [2].

Studies on SAT showed that these instruments can vary on different issues [3], for example the end-users they are addressed to (for instance they may be thought for practitioners, for policy makers or for academics), the aim they are designed to and the concept of sustainability underpinning the instrument.

In the analysis of the literature it is possible to find several studies about SAT [4] but just a minority of them discuss the evaluation process in depth while the great majority focuses on applications and results. In addition, since every SAT is underpinned by a precise concept of sustainability [5], the evaluation process and results are implicitly shaped by this underlying philosophical concept. For this reason it is difficult for practitioners to understand the reason why a SAT is used by other analysts and which SAT best fits the requirements of a specific agri-system; and the need of a methodology that allows to show the philosophical understanding.

In general it is possible to state that in the literature a precise methodology for qualitative analysis is missed. This study aims to introduce a methodology for the qualitative evaluation derived from the philosophical sciences that allows practitioners and analysts to fully understand the SAT in order to choose the most suitable for a given agri-system.

Deconstruction is a methodology firstly developed by the French philosopher Jacques Derrida [6,7] and originally applied to philosophical analysis. Deconstruction is a qualitative methodology that allows researchers and practitioners to analyse SAT in order to choose the most appropriate for the evaluation's purpose. Deconstruction is not only interested in the results of a sustainability evaluation, but it focuses in particular in the criteria for the indicators inclusion in the SAT and in its methodology [8].

Method details

This methodology relies on three basic assumptions:

First, in a SAT nothing is casual. This methodology considers that all conceptual tools are built using a precise logic that is functional to SAT purpose.

Second, the logic behind the SAT is underpinned by a precise philosophical understanding.

Third, there is not a "best" philosophical view, thus the purpose of the analyst is not to judge the different concepts of sustainability but to reveal the concept behind the instrument.

Deconstruction has not a formal set of steps for its application but can uses different tactics. A possible process could be (see Chart 1):

Comparison

A first tactic is to compare different SAT in order to find the differences and to interrogate the consequence those differences lead. In this way SAT can be compared regarding the indicators they

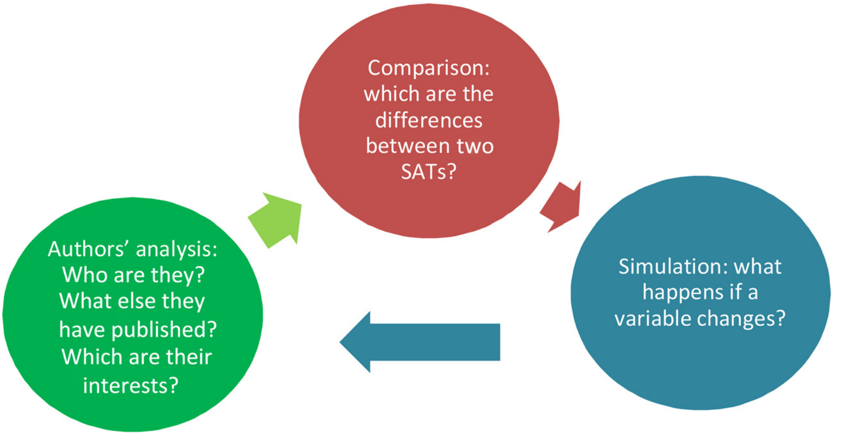

Chart 1. Deconstruction process.

use, for example, the number of indicators, the dimensions they cover, if they are qualitative or quantitative. Moreover SAT can be compare in the aggregate approach employed in the evaluation and the methods to show the results to end-users. Finally, SAT may be compared in the way stakeholders are involved in the process or if it is possible for farmer to enhance the sustainability of the enterprise using the results of the assessment.

Simulation

Other tactic is to apply the SAT with extreme and fictional input in order to analyse the possible results. For example practitioners can imagine a situation in which an evident unsustainable problem occurs (for example: unfair price negotiation or raising unemployment rate) to check whether the SAT identifies or to which extent the results are affected by the problem.

Author analysis

This tactic considers to investigate other article of the same authors to check if there are relationships among different studies. It is possible that the same author who in an article presents a new SAT, in another study is claiming the need for a certification of sustainable product similar to the certification of organic product; thus, the aim of the SAT is probably to be the instrument to evaluate a future certification in a project of a certification business.

Example: MESMIS and MMF

MESMIS, Framework for Assessing the Sustainability of Natural Resource Management Systems [9,10], and MMF, Multiscale Methodological Framework [11], are two similar SATs that are usually treated together because of the similar structure and the fact that professor López-Ridaura is among the main authors of both SATs.

In this case the first deconstruction approach to apply is the comparison since we need to understand the reason why a professor who is one of the leading developers of a SAT elaborates a similar but alternative SAT just three years after the introduction of the first SAT in the global academic debate.

Both SATs rely in a set of sustainability attributes that underpin the sustainability evaluation process. Those attributes for MESMIS are: productivity, stability, resilience, reliability, adaptability, equity and self-reliance. MMF shares the same attributes with the exception of equity and self-reliance with the following justification: "Other attributes such as empowerment, equity and adaptability have explicitly been included in attempts to integrate the social dimension in the analysis, rather than as basic attributes of sustainable systems which are independent of the disciplinary approach" ([11], p. 54). The authors do not mention why self-reliance is not included, however, they refers that some of the excluded attributes have "disciplinary bias" ([11], p. 54), so it is possible that this MESMIS attribute has this flaw.

From the attributes, both SATs develop a set of indicators. This process in MESMIS is carried out through the identification of system critical points, such as the sustainability issues of the analysed system that are related to the attributes. On the other hand, in MMF this process is developed with the interaction between analysists and key stakeholders.

These two kind of differences between MESMIS and MMF (i.e. the exclusion of two sustainability attributes and different process for indicators identification) leads to a relevant variance in the analysis. In fact, while MESMIS sets indicators of equity for each sustainability dimension, MMF may completely underrate not only equity as a sustainability attribute but the social dimension as a whole.

The evidence of that is the set of general indicators shown by the case study presented by MMF in which no social indicators at all are applied to evaluate the sustainability at the farm scale of the agriculture system in Purhepecha Region of Michoacán, Mexico ([11], p. 65).

In conclusion, this brief comparison shows how the desire of MMF to be more close to stakeholders´ needs may lead to an underestimation of key sustainability issues such as social equity.

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Benchmarking agri-food sustainability certifications: Evidences from applying SAFA in the Ecuadorian banana agri-system

Lorenzo Bonisoli [a, b, *], Emilio Galdeano-Gómez [b], Laura Piedra-Muñoz [b], Juan Carlos Pérez-Mesa [b]

[a] Unidad Académica de Ciencias Empresariales, Universidad Técnica de Machala, Km.5 1/2 Vía Pasaje, 070222, Machala, El Oro, Ecuador
[b] Department of Economics and Business, University of Almería (Mediterranean Research Center on Economy and Sustainable Development, CIMEDES), Ctra. Sacramento s/n, 04120, Almería, Spain

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Ecuador

A B S T R A C T

Certified products are a possible way to obtain and improve sustainability. Nevertheless, their effectiveness in enhancing agri-system sustainability is strongly questioned in the academic arena. This study aims to examine in depth the effect of certification on sustainability achievement. For this purpose, organic and Fairtrade Ecuadorian banana is analysed against the conventional banana. This study employs an original approach that operationalises SAFA (Sustainability Assessment of Food and Agriculture). This tool was chosen for the analysis because of the wide spectrum of sustainability issues considered in the evaluation, along with the fact that it is easy for producers and decision makers to implement and understand, and offers the consequential possibility to identify precise measures to enhance sustainability in the short term. Results show that organic and Fairtrade farms achieve more sustainable performance than those of conventional farms in terms of governance, environmental and economic dimensions. Nevertheless, conventional farms display better outcomes in matters of social sustainability. The reason most likely lies in the size and processes of farms rather than their certification standards. This study may be used by practitioners as a valid benchmark for the implementation of SAFA to other agri-systems and by decision-makers as a guide for the regulation of agri-sector processes.

1. Introduction

In recent years, several certification schemes have been created to assess product sustainability for customers. This trend is not only present in agriculture but also a wide range of sectors, such as fishery, forestry, and tourism (Dietz et al., 2018; Tröster and Hiete, 2018; Wibowo et al., 2018). Nevertheless, the effect of certification on system sustainability is strongly debated and a common consensus is far from being reached.

In fact, with regard to this academic debate, several studies have confirmed the benefit of certifications on improving agriculture sustainability as a whole (Barham and Weber, 2012; de Olde et al., 2016; Torres et al., 2016), soil quality (Pritchett et al., 2011), farm profitability (Haggar et al., 2017), energy and material usage (La Rosa et al., 2008), animal welfare (Boggia et al., 2010), biodiversity (Underwood et al., 2011) and workforce wellbeing (Krumbiegel et al., 2018).

However, other studies have reported that, in some cases, the impact of certifications is not completely clear. In particular, data on soil quality (Leifeld, 2012), environmental impact (Foteinis and Chatzisymeon, 2015; Patil et al., 2014) and societal sustainability of certified farms (van Calker et al., 2007) are not as positive as expected, revealing a clear necessity to analyse this issue in depth.

This study engages in this academic discussion by completing an extensive evaluation and comparison of the sustainability of certified and conventional agri-products. To do so, an original approach was developed which combined manager interviews, farm visits and producer and worker surveys to operationalise the FAO's Sustainability Assessment of Food and Agriculture (SAFA; FAO, 2013a).

SAFA is the instrument chosen for this study as it offers three critical advantages: the wide spectrum of sustainability themes

* Corresponding author. Unidad Académica de Ciencias Empresariales, Universidad Técnica de Machala, Km.5 1/2 Vía Pasaje, 070222, Machala, El Oro, Ecuador.
E-mail addresses: lbonisoli@utmachala.edu.ec (L. Bonisoli), galdeano@ual.es (E. Galdeano-Gómez), lapiedra@ual.es (L. Piedra-Muñoz), juancarl@ual.es (J.C. Pérez-Mesa).

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considered in the evaluation, the ease with which it can be used and understood by producers and decision makers, and, the consequential possibility to identify precise measures to improve system sustainability in the short term.

This study applies the described methodology to the Ecuadorian banana agri-system. Ecuador is a country that is highly dependent on the exportation of raw material, where the banana is the top exported agri-product, representing 23.13% of the overall non-oil based exportation of the country (AEBE, 2017). For this reason, it is important to evaluate the sustainability of this system, considering that most producers have adopted private certifications and changed their production to match the growing demand for certified products in western countries. Furthermore, this particular market constitutes a rather interesting subject due to both the existence of several certifications that are strongly influenced by market trends and the absence of studies on sustainability, especially concerning the various certified productions and their comparison with conventional banana.

Although several studies discuss the sustainability of certified products, most of them either focus on a specific sustainability aspect or employ an only-for-experts method (Fess and Benedito, 2018). The present study contributes to the debate in three main ways: evaluating the four sustainability dimensions of certified and conventional agri-systems, applying an original approach that operationalises SAFA, and providing comprehensible results that may be translated into practical suggestions for producers and decision makers for the improvement of the sustainability of agri-food sectors.

The article is organised as follows: firstly, the debate on certification and related issues are analysed; secondly, an overview of the Ecuadorian agri-system and the main certifiers it is described; thirdly, the methodology is presented; fourthly, the results of the evaluation are reported and discussed; and finally, conclusions are drawn and further lines of research are suggested.

2. Certified products

In the last decade, a growing number of farmers have arranged their production process in order to obtain a private institution quality certification. Certification, even if it is not the sole route for sustainable agriculture, provides controlled planning to make progress in the sustainability of agricultural practices through the implementation of well-defined indicators and auditing instruments (Tayleur et al., 2017). More specifically, certification could be a valid solution for small farmers in developing countries, where the government does not always completely control territory and agricultural procedures (Barrett et al., 2001).

With regard to the most contentious issues that have emerged in the academic debate, this section first examines those certifications whose primary purpose is to enhance the well-being of producers and then addresses the organic product certifications.

2.1. Social well-being certifications

In the last thirty years, the wide implementation of neoliberal policies in Latin American agri-sector has brought about the transformation of agriculture from a Fordist national model of mass-market food production and consumption (Friedmann and McMichael, 1989) to a speciality item oriented production aimed at wealthy consumers in the global market (Raynolds, 2008). In this context, alternative food networks developed as a countermeasure to “the unsustainable industrial food system and the exploitative trading relations embedded in global supply chains” (Goodman et al., 2011).

The first key issue related to certifications is efficiency. Several studies show that certified products are, in general, more sustainable than those that are not certified. For example, in the Ecuadorian banana agri-system, organic production results in better outcomes, both for the environmental point of view and in terms of producer revenues (Castro et al., 2015; Melo, 2005; Melo and Wolf, 2007; Ruben et al., 2008). Moreover, evidence shows that Fairtrade (FT) agriculture enhances women participation to networks benefits, farming practices and cash access in both Latin American (Lyon et al., 2010) and African (Bassett, 2010) agri-systems. Finally, certification is effective in enhancing producers’ sustainability, as it is for fishery (Borland and Bailey, 2019), it increases occupational health and safety for rural communities in forestry (Şen and Güngör, 2018) and it strengthens revenues in the tourism industry (Hellmeister and Richins, 2019).

Despite the previously-mentioned benefits, a significant number of studies have identified several aspects related to sustainability certification efficiency that deserve further analysis.

The first topic of interest related to certified products is their acceptance within the destination market, i.e. the North. In general, although the majority of European consumers claim to be seriously interested in the social and environmental sustainability of the products they purchase, giving ethical aspects priority in the selection of products, economic factors still prove crucial in the selection process (Gracia and de Magistris, 2008). Moreover, there are many variables which bring into question whether said claim (a commitment to sustainable products) actually generates real purchase; in particular, certified product sales are affected by scarce availability and deficient communication on store shelves (Annunziata and Scarpato, 2014). Furthermore, certifications result to have low visibility and scarce level of understanding (Annunziata et al., 2019) so that they are rarely considered in the consumer's decision process (Peschel et al., 2019). Finally, the level of professionalism in the sale of certified products is generally low (Bellucci et al., 2012).

Another aspect that has undermined the capacity of the certified products market to improve the sustainability of agri-systems is the proliferation of certifications that complement, substitute or compete with each other (Lambin and Thorlakson, 2018). As in the case of the Dutch coffee market, FT has not become the standard for the market but it was used by the key stakeholders (such as retailers and roasting companies) as a benchmark for developing new standards that prove more feasible for their business models (Ingenbleek and Reinders, 2013).

Big companies play a crucial role in the certified products market. In fact, in general, big companies that are found to be less interested in sustainable marketing than the small mission-driven firms (Howard and Jaffee, 2013), entered this market demanding high standards products and expensive certifications (Raynolds, 2008) or creating self-owned certification process (Fridell et al., 2008). For this reason, and to compete with the top Fairtrade certifier, Max Havelaar, other institutions created less demanding standard certificates, such as Utz Kapeh, Rainforest Alliance (RA) (Bacon, 2005; Bacon et al., 2008) and 4C (Ingenbleek and Reinders, 2013). In the case of RA, in order to minimise producers' expenses, labelled products that contained only partially certified matter (Ingenbleek and Reinders, 2013) and, in some cases, it failed to generate better environmental outcomes (Bellamy et al., 2016). The situation resulted in lower producer incomes (Minten et al., 2018), the indebtedness of small-holder farmers (Wilson, 2010) and a higher rate of people below the poverty line among the certified producers with respect to their conventional counterparts (Bassett, 2010; Beuchelt and Zeller, 2011).

To understand this contradiction, it is necessary to take a step back and direct the analysis of the whole process at the so-called “ethical commodities”. Mutersbaugh and Lyon (2010) define ethical commodities as those for whom a significant portion of their value relies on ethical qualities that are proven by widely accepted and verifiable standards. Hence, since those qualities are extrinsic to the product and thus not detectable by commodities testing, a certification process is necessary to make ethical qualities visible to consumers. Nevertheless, the resulting certification supply-chain, from the point-of-origin to ethical consumers, incurs an ethical contradiction; in fact, despite its ethical intentions, the market of certified products assumes neoliberal beliefs according to which the consumer rather than public institutions should be the driver of development and sustainability (Moberg, 2014). In addition, since the logic of a certification process reflects consumer concerns and values of developed countries, the FT market often neglects specific features of the point-of-origin's social, environmental and economic situations and forces it to match external standards (Wilson and Jackson, 2016).

By doing so, the market of certified products reproduced a neocolonial situation in which what for consumers is a matter of choice, for producers is a matter of survival (Melo and Hollander, 2013), as explained, for instance, by Raynolds and Ngcwangu (2010). These authors explored a case study of South African rooibos tea and demonstrated how US consumers shaped the production at the point-of-origin.

2.2. Organic products certification

There is an extensive literature that explores a variety of aspects on organic products. This study focuses on some key topics related to the consumption of this kind of product. The first aspect addressed is the environmental impact of organic agriculture as it is traditionally the main reason why sustainability researchers have concentrated their attention on this type of production system. The second point of interest studied is the supposed increased profitability that Organic Agriculture (OA) should generate for farmers. Once the sustainability of OA at the point-of-origin is discussed, the study investigates the demand that drives the implementation of OA, namely the perception and acceptance of Organic products among consumers.

OA is considered to be a benefit to the environment by enhancing climatic resilience (Scialabba and Müller-Lindenlauf, 2010), reducing soil degradation (Niggli et al., 2007), improving pest resistance (Birkhofer et al., 2008) and soil fertility (Bonanomi et al., 2016), creating a more efficient use of natural resources such as water (Thierfelder and Wall, 2009), demanding less energy inputs (Pimentel et al., 2005) and contributing to food safety (Azadi et al., 2011). Nevertheless, some authors point out certain limitations to the belief that "organic is always better". In particular, Tuomisto et al. (2012) conclude that if on one hand organic production records higher soil organic matter content, lower nutrient loss and lower energy requirements, on the other hand, it results in higher nitrogen leaching and ammonia and nitrous oxide emissions per product unit than those generated by conventional crops. In addition, because yields are lower (at least 20% according to De Ponti et al., 2012), organic farming needs more land use and is therefore unlikely to supply the worldwide food demand (Connor, 2008). Furthermore, Hole et al. (2005) find that OA contributes to biodiversity even if it is unclear whether OA would offer greater benefits to biodiversity than carefully targeted prescriptions applied to conventional farming. Finally, Templer et al. (2018) conclude that ecological farm health is reinforced only if organic processes overtake basic labelling requirements, thus the positive effects of organic certification on agroecosystem health cannot be taken for granted.

Organic farming increases farmers' income (Parvathi and Waibel, 2016), contributes to the reduction of poverty among small farmers (Ayuya et al., 2015), generates a higher return on investment (ROI) (Kleemann et al., 2014) and proves to be less risky than conventional methods (Pimentel et al., 2005). However, even in this case, it is possible to report some in-depth analysis. For instance, contrary to the above investigation, Ibanez and Blackman (2016) and Froehlich et al. (2018) conclude that if OA results in improved environmental benefits, there is no evidence that it positively affects farmers' economy. A possible explication of this conclusion may be found in the research of Kleemann and Abdulai (2013), whose findings indicate that economic returns of organic farms are substantial only if farmers go beyond the organic-by-default step and intensively implement agri-ecological practices. Finally, Veldstra et al. (2014) find that in some cases farmers who undertake organic practices prefer not to certify their products because of the high cost of the certification process.

The studies on the acceptance of Organic Products (OP) among consumers focused on two different points: the profile of the OP consumers (*who*) and the reasons for consuming OP (*why*) (Monier-Dilhan and Bergès, 2016).

Regarding the first aspect (*who*), with the aim of establishing a profile of OP consumers, it was found that, in general, the propensity to purchase OP tended to increase with social status and the presence of young children in a household (Wier et al., 2008), a higher education level (Monier et al., 2009) family structure, access to organic products and higher expense capacity (Dimitri and Dettmann, 2012). Furthermore, the rate of OP consumers is higher among education and health professionals (Vehapi and Dolićanin, 2016), while it is lower among elder householders and African Americans (Dettmann and Dimitri, 2010). It is notable that the cluster analysis of Rodrigues et al. (2016) and Oroian et al. (2017), conducted in Brazil and Romania respectively, obtain similar findings in that they identify three groups of consumers: Greeners, which associate OP to sustainable development and are represented by older people; GMO-Freers, more interested in healthy food and generally younger; and those who do not have interest in OP or simply focus on taste of food.

This last study mentioned leads to the second question (*why*), which has generally aroused more interest among academics. In fact, it is possible to identify two different possible reasons: an "egoistic" reason that corresponds to concerns about food safety, which is based on the belief that OP is healthier than conventional produce, and an "altruistic" reason that associates OP with a better positive "environmental" impact (Yadav, 2016). Nonetheless, the results seem to considerably vary according to country and age. In fact, even if the two reasons always have a positive impact on all OP consumers (Yadav and Pathak, 2016), French (Monier-Dilhan and Bergès, 2016), German and US (Rana and Paul, 2017) consumers, for example, are more driven by environmental impact reasons, while Indian (Yadav, 2016), Malaysian (Rana and Paul, 2017), Turkish, Iranian and Pakistani (Asif et al., 2018) are more conditioned by personal health values.

Finally, three studies on consumer intentions are particularly remarkable in the sense that they approach the exploration of said intentions in selecting OP from a different perspective. The research of Hwang (2016), for example, takes a psychological angle and finds how self-presentation, namely the component of self-identity, whose goal is the management of the self in social settings, is one of the major factors that drive older consumers' purchase intentions, while ethical self-identity, which reflects the extent to which ethical issues are related to private consumption practices, does not improve purchase intention. With another approach, in order to explain the gap between consumers' claims of interest in OP and their actual behaviour, the study by Chekima et al. (2017) focuses on consumption rather than purchase and finds that consumption of OP is higher when consumers are more concerned about the future, so producers and marketers should advertise future gains of OP in order to foster consumption. Subsequently, Apaolaza et al. (2017), rather than focusing on health as a motivation for the acceptance of OP, state that better health is a consequence of OP consumption, because it shapes consumers' lifestyle.

3. Case study: banana sector in Ecuador

This section presents two aspects are presented: an overview of the Ecuadorian banana agri-system and the main certifiers that operate in it.

3.1. Ecuadorian banana agri-system

Macroeconomic figures in 2018 show that Ecuador has the lowest inflation rate of all Latin America (1.12%), an unemployment rate of 5.4%, and an external debt of 33.8% of GDP, one of the lowest values with respect to the main South American economies, such as Argentina (10.0%; 8.4%; 35.3%), Brazil (5.4%; 11.5%; 18.0%), Chile (3.0%; 6.5%; 66.3%), Colombia (3.2%; 9.2%; 42.5%) and Peru (3.7%; 6.7%; 38.4%) (Focus Economics, 2018).

Nevertheless, poverty is still an important issue. Although in the 2007–2017 period the poverty rate (less than 84.5 USD per month according to BCE, 2017a) had decreased by 41.41%, in December 2017 it reached the value of 21.5% of total Ecuadorian population, in other figures, 3.62 million (m) people were living below the poverty line. The extreme poverty rate (less than 47.6 USD per month according to BCE, 2017a) has also decreased in the last ten years by approximately 52.12%, and in December 2017 it accounted for 7.9% of the Ecuadorian population, i.e. 1.33 m people (BCE, 2017a). Poverty is more common in rural areas, where poverty rate accounts for 39.3%, while in urban areas it is considerably lower, i.e. 13.2 (BCE, 2017a). Inequality is also an important issue, even if Ecuadorian governmental action in the last decade has managed to reduce the rich-poor gap. In fact, the Gini coefficient has decreased from 0.54 to 0.46 in the period 2004–2015 (BCE, 2017b).

This study focuses on the Ecuadorian banana agri-sector. Ecuador's exportations, which in 2016 represented about 19% of GDP, depend primarily on raw materials. The main exported product is petroleum, which accounts for 32.5% of total exportation, followed by banana (15.61%), (AEBE, 2017).

Banana plantations are concentrated in three Ecuadorian provinces (91.8% of national production), namely, Los Rios (58,219 ha of production), Guayas (47,388 ha) and El Oro (43,165 ha). The present study focuses on the last province (Fig. 1).

In 2016, with $2.62 billion (b), banana accounted for 15.61% of the total Ecuadorian exportation (AEBE, 2017). The principal destination of Ecuadorian banana is the European Union (EU) with 31.86% of the exported product in 2016; Russia (22.55), United States (14.86) and Middle East (10.12) are the other main destinations. However, in the period 2010–2016, there is a notable negative trend in trade with United States (US), whose trade decreased 13.25%, while there is remarkable growth in exportation to Russia (+36.3%), Turkey (+11%), EU (+6.22%), New Zealand (from 28.7 to 72.6 k tons), Japan (from 46 to 157.8 k tons), and China (from 2.2 to 173.9 k tons).

3.2. Principal certifiers in the Ecuadorian banana agri-system

In Ecuador, in the banana agri-sector, there are at least four main private certifications: Global Gap, Rainforest Alliance, Fairtrade Labelling Organization (FT) and Organic product (IFOAM):

Global Gap was born as EUROGAP in 1997 as an initiative by the retailers' group Euro-Retailer Produce Working Group in response to the growing demand of many UK retailers for harmlessness of food and the respect of fair principles in production practices. In 2007, the name changed to Global Gap (Gap stays for Good Agricultural Policies) as the focus spread from European to Worldwide producers. As of 2017, this certification was present in 125 countries (GlobalGap, 2018).

Rainforest Alliance was born in 1986 as a project launched by a group of volunteers led by Daniel Katz who were concerned about the problem of deforestation. The project consisted of creating standards for farmers and economic advantages for certified products (Rainforest Alliance, 2018). In 1990, RA established the standards for the banana sector and two years later certified its first banana farms. In 2015, RA Rainforest Alliance certification covers 1.2 million farms in 42 countries, growing 101 different crops on about 3.5 million hectares (ha). Moreover, it certifies 15.1% of the total world production of tea, 13.6% of cocoa and more than 5% of both coffee and bananas (Milder and Newsom, 2015).

Fairtrade movements rose in Europe during the fifties. The aim of these organisations was to transform the North-South linkage from exploitation to sustainable development using a "not aid but trade" philosophy (Raynolds, 2000).

In 1997, the main FT organisations gathered under the Fairtrade "umbrella" called Fairtrade Labelling Organisation International (Raynolds, 2000), which in 2003 created FLOCERT, the independent certification body of the Fairtrade system (Flocert, 2018). In 2016, FT agriculture accounted for 1.6 m farmers and workers and raised 150 m euros of FT premium for sustainability and training initiatives, community education and health resources, and equipment (FLO, 2017). Banana is the principal crop in FT production with 579,081 million metric tons of sold product, 58% of which corresponds to organic banana. In Ecuador, in 2018, FT paid a bonus of USD 1.00 per commercial box of 19.4 kg of Fairtrade banana, which represented an extra 16.12% over the conventional price of USD 6.20 fixed by MAGAP for the exportation banana box (El Telegrafo, 2017).

Organic agriculture movements began to appear in the sixties in Europe and the United States. Although there was no single definition of "organic", most movements struggled to create sustainable agriculture which respected the environment and without the utilization of chemical fertilizers (Raynolds, 2000).

In 2015, organic agriculture was present in 179 countries, accounting for 90.6 m ha of agricultural land (1.10% of total agricultural land), 2.4 m producers and market size of USD 81.6 billion (bn) with a per capita consumption of USD 11.1 (IFOAM, 2016). The consumption of Organic products (OP) has risen exponentially worldwide in the past decade (Rana and Paul, 2017).

4. Methodology

The instrument to evaluate the difference between systems sustainability is SAFA. In this section, SAFA is explained in detail, and the academic literature implementing SAFA is discussed.

4.1. SAFA framework

SAFA is a FAO project, which was developed between February 2011 and June 2013 that involved more than 250 stakeholders from 61 countries. It consists of four tools. The first is the guidelines that explain the sustainability principles used in the elaboration of the framework (FAO, 2013a). The second is a detailed list of 116 sustainability indicators which cover 58 sub-themes, 21 themes and 4 sustainability dimensions (FAO, 2013b). The third is the software that elaborates the results in order to describe the sustainability of the analysed system using a polygon organised in the 21 themes and in five levels of sustainability, from an "unacceptable sustainability" red level to an "optimal sustainability" dark green level (FAO, 2014). Finally, the brand new tool is an application for

Fig. 1. El Oro province location.

smartphones, designed specifically for small farms since it uses a lower number of indicators and an even easier process (FAO, 2015).

4.1.1. *Users, purposes and principles*

As explained by FAO (2013a), SAFA is a holistic framework whose main competitive advantage in relation to other SATs is its flexibility. SAFA relies on the methodological principles of holism, relevance, rigour, efficiency, performance-orientation, transparency, adaptability and continuous improvement. SAFA is designed for multiple users, from farms to governments, and for multiple purposes, from self-assessment to implementation of regional planning.

4.1.2. *SAFA dimensions and themes*

SAFA is a holistic framework that applies a hierarchical structure in which, at the more general level, there are four sustainability dimensions: Good Governance, Environmental Integrity, Economic Resilience, and Social Well-being. The second level is comprised of 21 sustainability themes and the third level consists of 58 subthemes. Finally, the most specific level corresponds to 116 indicators that quantitatively or qualitatively investigate precise verifiable data or facts. Each indicator is supported by a guide that explains how to measure the item and the thresholds that must be referenced to assign a score on a 5-point scale. Details of SAFA structure and SAFA dimensions and themes are given in Tables 1 and 2.

Table 1
SAFA structure.

Dimension	Themes	Sub-themes	Indicators
Good Governance	5	14	19
Environmental Integrity	6	14	52
Economic Resilience	4	14	26
Social Well-being	6	16	19
Total	**21**	**58**	**116**

Source: FAO (2013a).

4.1.3. *SAFA key competitive advantages*

According to the literature, SAFA reveals some key competitive advantages:

- Flexibility. SAFA can be implemented in different contexts, at different scales or levels by different users and multiple purposes (Kassem et al., 2017).

Table 2
SAFA dimensions and themes.

Dimensions	Themes
Good governance	G1. Corporate Ethics
	G2. Accountability
	G3. Participation
	G4. Rule of Law
	G5. Holistic Management
Environmental integrity	E1. Atmosphere
	E2. Water
	E3. Land
	E4. Biodiversity
	E5. Materials and Energy
	E6. Animal Welfare
Economic resilience	C1. Investment
	C2. Vulnerability
	C3. Product Quality and Information
	C4. Local Economy
Social well-being	S1. Decent Livelihoods
	S2. Fair Trading Practices
	S3. Labour Rights
	S4. Equity
	S5. Human Health
	S6. Cultural Diversity

Source: FAO (2013a).

- High credibility, since it was developed by an independent UN organisation without the support of private corporations or NGOs (Bonisoli et al., 2018; Jawtusch et al., 2013).
- User-friendly. SAFA is very user-friendly, both in its application (time and cost saving) and its results comprehensibility. In addition, suggestions for possible improvements are clearly linked to the established thresholds of sub-themes and may directly motivate change (Gayatri et al., 2016).
- Comprehensiveness. The 116 indicators make the assessment detailed and highly thorough; it even identifies those sustainability aspects of which users are unaware (de Olde et al., 2017; Gayatri et al., 2016; Jawtusch et al., 2013).
- Finally, SAFA can be implemented with other sustainability tools such as quality certifications (for example Fairtrade) or other SATs (for example COSA and RISE) (Schader et al., 2014).

4.1.4. Indicators assessment

SAFA employs three kinds of indicators: indicators that evaluate whether the organisation has set a sustainability target to achieve, indicators that assess which sustainability practices the organisation has developed, and finally indicators that examine the sustainability performance of the organisation. Generally speaking, the latter group is the most important, which is why the majority of the indicators belong to this group. Nevertheless, since some performance is difficult to assess or impossible to measure, SAFA considers the practices implemented, and when there are no relevant practices, or there is limited evidence, the assessment focuses on targets (FAO, 2013a).

For example, the Environmental integrity indicators E 1.1.1, E 1.1.2 and E 1.1.3 compose the sub-theme Greenhouse Gases (E 1.1). The first indicator is a target-base that investigates whether the organisation has a formal written plan for the reduction of GHG. The second indicator lists a series of practices and asks which are implemented. Finally, the third indicator calculates the organisation's GHG emissions (FAO, 2013b).

The weight of indicators is different: a full sustainable target-based indicator has a quantified score of 1, a practice-based indicator a score of 2, and a performance-based a score of 3 points. Then, SAFA calculates the percentage of points achieved on possible points per dimension and provides the result following the scheme (see Table 3):

Table 3
Indicators score.

Percentage points achieved/points achievable	SAFA Colour	This study score
>80%	Dark green	>4.1
60–80%	Light green	3.1 to 4.0
40–60%	Yellow	2.1 to 3.0
20–60%	Orange	1.1 to 2.0
<20%	Red	<1.0

Source: own elaboration

4.1.5. Studies that implement SAFA methodology

Because of its key competitive advantage, SAFA has received a widespread acceptance among both researchers and users. It is possible to group some of the most relevant studies that implement SAFA methodology into five groups (results shown in Table 4):

- Sustainability assessment of an agri-system using the complete SAFA framework. In this group, it is important to mention Jawtusch et al. (2013), which is a pilot study that implements the 2012 version of the framework and is aimed at evaluating users' reaction to the new approach. Furthermore, two other studies demonstrate the vast capacity of SAFA to be applied in developing countries: Gayatri et al. (2016), who apply the framework to beef cattle farming in Indonesia; and Ssebunya et al. (2016), who focus on the small-holder coffee producers in Uganda. Finally, of particular interest are the works of Landert et al. (2017), who apply SAFA to evaluate the sustainability of the urban food system in Basel, Switzerland, and Al Shamsi et al. (2018), who apply SAFA in order to assess food sovereignty in an Italian and Emirates agri-system.
- Partial sustainability assessment using SAFA. It is the case of Theurl et al. (2017), who analyse greenhouse gas emissions along vegetable supply chains in Austria using the SAFA indicators that address this topic.
- Sustainability assessment using some of the SAFA indicators. Notable among this group are two related studies implemented in the Czech Republic: Hřebíček et al. (2013), which aims to find a list of sustainability indicators to be aimed at both farmers and policymakers; and Kassem et al. (2017), which identify a set of indicators to be applied to small farmers. Similar to the latter, Gaviglio et al. (2017) use the Good Governance SAFA indicators along with other frameworks to establish a set of indicators for the evaluation of an Italian agri-system.
- SAFA applied in synergy with other frameworks. Two examples are Hřebíček et al. (2015), who apply SAFA along with GRI to study the topic of sustainability reporting, and Gasso et al. (2015), which evaluate the sustainability of Danish maize for biogas systems in synergy with two other specific frameworks. Finally, having significant bearing on the scope of this study is the work of Schader et al. (2014), who employ SAFA as a third referee to detect differences and trade-offs of six different sustainability frameworks. A particular case is the study of Dabkiene (2016) who evaluates the usefulness of the information provided by the European agricultural database FADN (Farm Accountancy Data Network) using SAFA indicators as a benchmark.
- SMART application. SMART (Sustainability Monitoring and Assessment Routine Sustainability) is an indicator-based tool that operationalises SAFA. In the work of Jawtusch et al. (2013) the tool is presented and explained, and in Schader et al. (2016) SMART is detailed, explained and applied to a sample of a case study. Finally, Ssebunya et al. (2018) applied SMART to evaluate and compare the sustainability of organic and conventional coffee in Uganda.

4.1.6. SAFA process

SAFA follows a four-step process:

- Mapping. The first step is the mapping of the analysed system in order to describe key relationships among the system's members. The aim is to identify players, procedures, time-space boundaries and recognise the main goal of the evaluation.
- Contextualization. In this second step, the user must revise the sub-theme in order to identify those that can be applicable to the system from those that are either not relevant for the system or dependent on unavailable data and information.
- Indicators. In this step, the necessary documentation and information are collected and the indicators that have been selected are rated according to a 5-point scale whose thresholds are established by the framework guideline. Because the rating depends on the user's judgement, it is necessary that he or she explain the reason for each indicator's score.
- Reporting. In the last step, scores are entered in the SAFA Tool Software and a polygon is created to show the results. In this

Table 4
References implementing SAFA methodology.

Group	References
Complete sustainability assessment using SAFA	Gayatri et al. (2016) Ssebunya et al. (2016) Landert et al. (2017) Al Shamsi et al. (2018)
Partial sustainability assessment using SAFA	Theurl et al. (2017)
Sustainability assessment using some of the SAFA indicators	Hřebíček et al. (2013) Kassem et al. (2017) Gaviglio et al. (2017)
SAFA applied in synergy with other frameworks	Hřebíček et al. (2015) Gasso et al. (2015) Schader et al. (2014) Dabkiene (2016)
SMART applications	Jawtusch et al. (2013) Schader et al. (2016) Ssebunya et al. (2018)

Source: own elaboration

step, it is important that the user clarify the evaluation outcomes and suggest possible improvements.

4.2. Sample

To compare the effect of certification on sustainability assessment, two different organisations were considered. The first (identified with the letter *A*) is a group of 89 small farmers whose property range is from 1 to 32.23 ha. These farmers belong to an association, which in 2013 began a programme to obtain both FT and Organic certification along with GlobalGap. Thanks to economic results, the association experienced rapid growth that resulted in tripling the number of members in a three-year period. The association sells directly to European retailers without intermediaries and its clients are mostly located in Germany and Italy.

The second institution (identified with *B*) is a group of 22 producers that sell their products to a single export firm that was created four years ago to cope with the demand of a great European retailer. At the moment, the group sells its conventional banana to two big European retailers whose clients are located in Eastern Europe, mainly in Russia, Czech Republic and Turkey. They respect the private quality standards established by the retailers that were originally based on Rainforest Alliance standards, but they do not have other certifications (see Table 5).

To undertake the investigation, an original approach was developed for the operationalisation of SAFA that consists of three basic steps. The first involved a series of structured interviews with seven managers and employees of the two organisations to obtain the bulk of the Good Governance and Economic Resilience dimensions and a part of the Environmental Integrity dimension. Then, farm visits were conducted to control the application of rules and procedures required to fulfil the Environmental Integrity dimension. Finally, two surveys, which were applied to a random sample of 27 farmers and 440 workers, were the basis for fulfilling the Social Well-being dimension.

Table 5
Sample features.

Features	Group *A*	Group *B*
Members	89	22
Total hectares	586.78	941.08
Hectares range	1.00–32.23	1.95–130
Hectares mean and s.d.	6.59–5.61	42.78–34.57
Location	El Oro province	El Oro province
Production	Organic	Conventional
Certifications	FLO – IFOAM – Global Gap	Retailers certifications
Product destination	Western Europe	Eastern Europe

5. Results

The way SAFA calculates the score for each theme is the arithmetic mean. Nevertheless, SAFA rounded the score to the next integer so that, for example, 3.1 and 3.9 both score 4. This study prefers to keep one decimal digit, hence in Table 6 and Figs. 2–5 scores are shown with decimals, while in Figs. 6–8 scores are described as they appear in the SAFA report. Table 6 shows a summary of the main results by dimensions.

5.1. Good Governance (G) dimension results

In this dimension, the results of the two organisations are quite similar as they differ consistently only on one theme out of five (see Fig. 2).

The difference regarding theme G1 is in the mission statement: in both cases a mission statement is present, but only in *A* it is known by all employees. Nevertheless, in both cases, the mission statement seems to be a general requirement imposed from above (certifier bodies) rather than a real guideline the organisation wants to follow. On the other hand, *B* endorses a partial risk analysis provided by the private certifier, while there is no evidence of a formal risk for *A*.

An interesting result was obtained in theme G3. In fact, both organisations fail to identify and involve stakeholders in their information and decision-making processes. More importantly, even the concept of “stakeholders” itself is unknown to these organisations.

The only significant difference in this dimension was found in theme G4: in this case, two indicators display a slight variance in performance. Firstly, *A* does not undertake any lobbying activity, while *B* does, albeit not intensively; secondly, in some case, some farms of *B* were found to partially breach workers' rights, even if, in general, *B* complies with all work regulations. This last point is possible as *B* members are mostly medium and big size farms where rights violations are more easily detected, while for smallholder *A* members, workers’ issues are arranged in a personal manner and hence are more difficult to detect. Thus, the fact that the same right violation is made by both organisations is quite probable.

G2 and G5 show very similar results.

5.2. Environmental (E) integrity dimension results

The combination of organic production and FT standard along with the presence of 20 agri-forest farms is the most likely

Table 6
Analysis results summary.

Theme	*A* – score	*B* – score	*Main differences between A and B scores*
Good governance			
G1: Corporate ethics	3.7	3.3	The mission statement is not known by all employees in *B*. *A* has a committee of needs analysis and a process for security regulation.
G2: Accountability	4	4	-
G3: Participation	1.5	1.5	-
G4: Rule of law	3.0	2.0	Some members of *B* do not fully respect workers' rights. In *B* there is a lobbying activity endorsed by dealers that tries to influence government without stakeholder participation.
G5: Holistic management	4.5	4.5	–
Environmental integrity			
E1: Atmosphere	2.3	2.0	*A* land-cover change to more complex and diverse systems, such as organic agriculture.
E2: Water	4.4	3.9	*A* does not use highly hazardous chemicals that have potential adverse effects on aquatic life.
E3: Land	4.3	3.4	*B* presents a considerable amount of degraded land.
E4: Biodiversity	2.0	1.8	Presence of mix-cropping in *A*.
E5: Material and energy	2.8	1.9	The inspection found the use of fire to dispose of waste in *B*.
E6: Animal well-being	–	–	
Economic resilience			
C1: Investments	4.3	3.0	The premium of FT results in better returns of *A*.
C2: Vulnerability	3.0	2.0	Better cash flow trend and available financial net for *A*.
C3: Product quality and information	4.4	4.0	The total organic process of *A* results in better quality food.
C4: Local economy	4.5	4.5	–
Social wellbeing			
S1: Decent livelihood	3.1	3.5	*B*'s farmers and workers declare to be better off than *A*'s.
S2: Fair trading practices	4.0	5.0	Under the box price restitution agreement found in *A* process.
S3: Labour rights	3.3	4.5	Presence of illegally hired workers and child labour found in *A*.
S4: Equity	3.3	4.3	*A*'s farmers less willing to hire women and disabled people.
S5: Human safety and health	4.5	4.5	*A* show a higher rate of accidents but also a formal plan aimed at not contaminating the surroundings.
S6: Cultural diversity	2.0	2.0	–

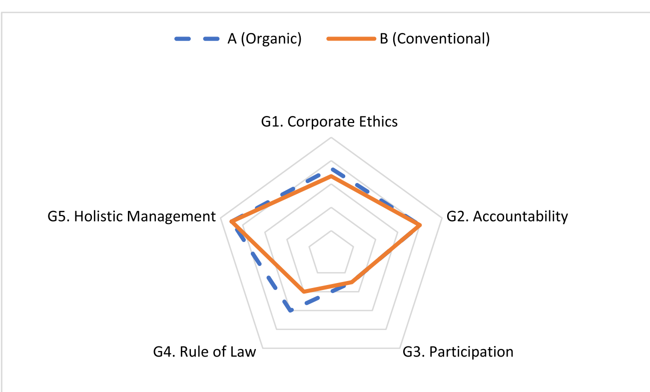

Fig. 2. Good Governance (G) dimension results.

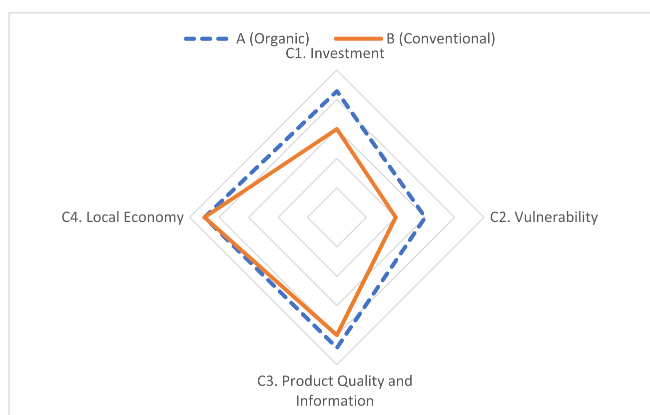

Fig. 4. Economic Resilience (C) dimension results.

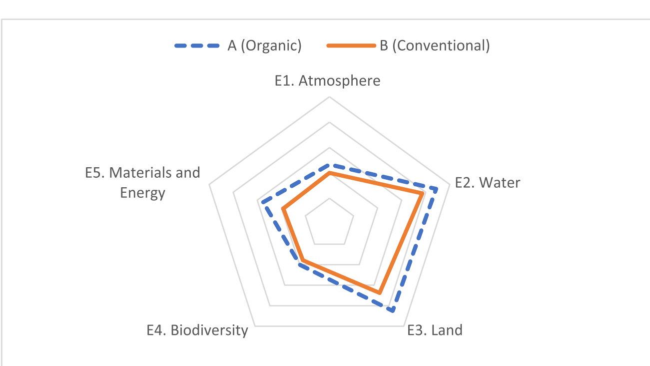

Fig. 3. Environmental (E) Integrity dimension results.

explanation for the better results of *A* in relation to those of *B* in all themes (see Fig. 3).

Regarding E1, the lack of a precise plan for lowering GHG and air pollutant emissions and information on the air quality in the area could explain why both organisation registered rather low scores. Nevertheless, the above-mentioned factors, i.e. organic process and agri-forest farms, give an advantage to *A*.

B achieves good performance in both Water and Soil themes since practices and performance in these organisations are substantially positive. *B* implemented a process by which water used in banana handling is recycled for irrigation and imposed 30-m buffer zones to prevent water contamination. Regarding soil quality, decades of pesticides resulted in a poor organic matter level for both organisations since the organic crop is a recent introduction in the local environment. However, the soil analysis that both organisations carry out every two years reveals chemical and biological

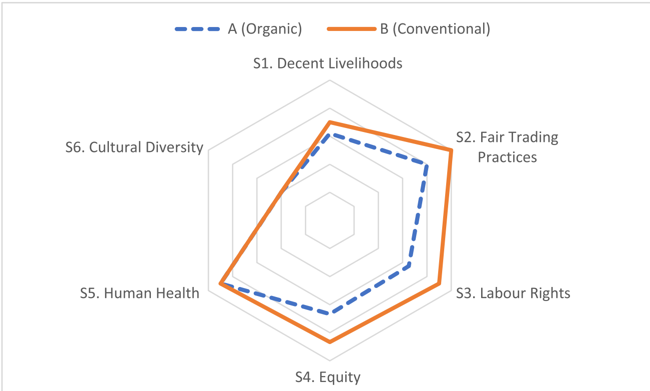

Fig. 5. Social (S) Well-being dimension results.

results in accordance with locally established standards. The difference between the two organisations is the presence in *B* of 40 has. of degraded land whose status is yet to be defined as all efforts to restore it produced insignificant outcomes.

Biodiversity is a very weak point for both *A* and *B*. The demands of a monocrop and the intensive exploitation of rural areas had a strong impact on biodiversity. Wild animals almost disappeared, along with local endogenous plant species. Despite plans protect and restore wildlife in accordance with market requirements, the situation is far from sustainable. Organic standards that demand a minimum presence of intercropping and agri-forest farms that implement a high rate mixed cropping with the presence of not cultivated land result in a slight difference between *A* and *B* scores. In fact, while the effect of the organic process is limited by intensive cropping, agri-forest farms are just a small percentage of the total farms of *A*. Hence, the results outline how only agri-forest is a system that may be sustainable for biodiversity.

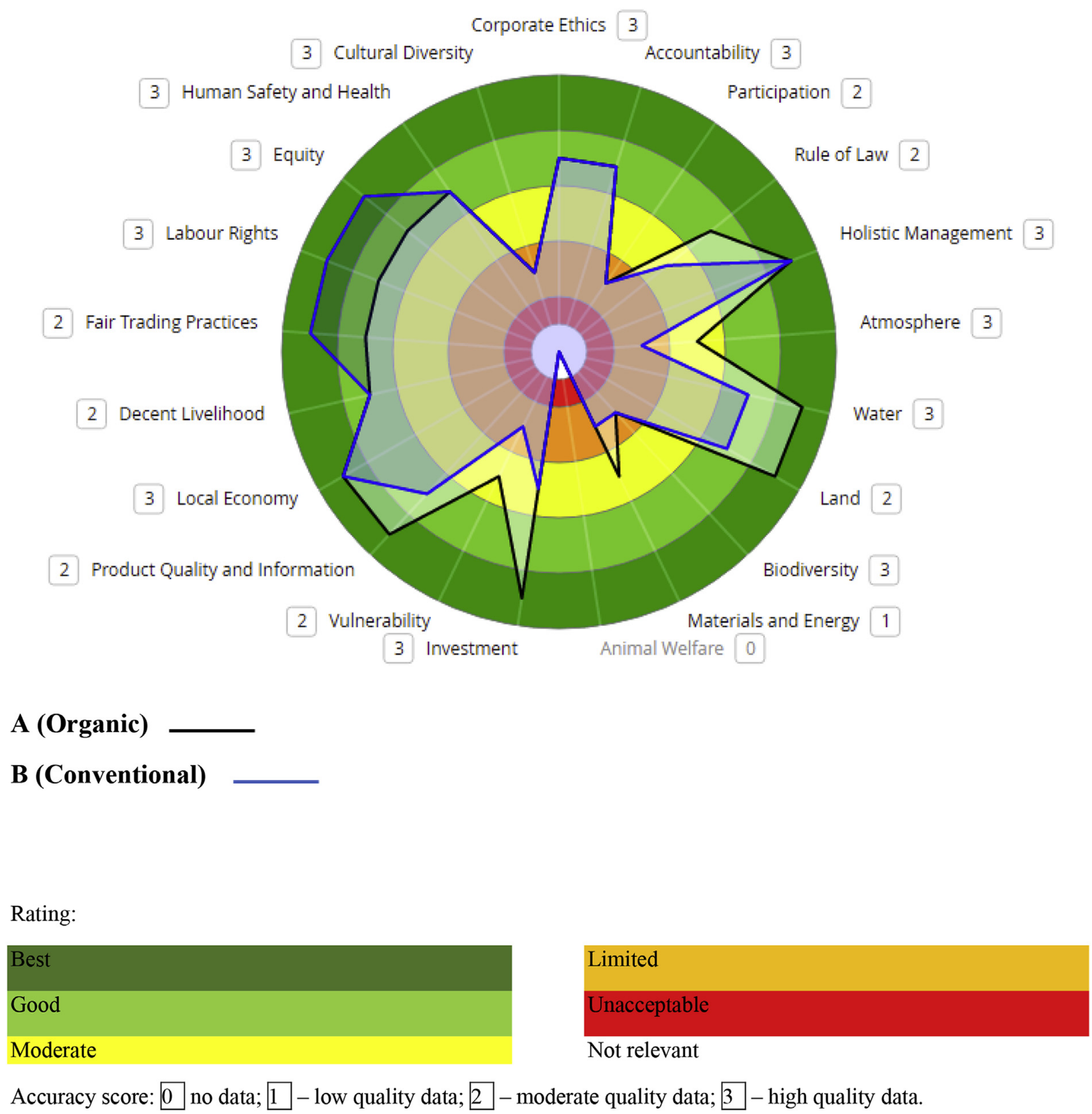

Fig. 6. Overall SAFA results

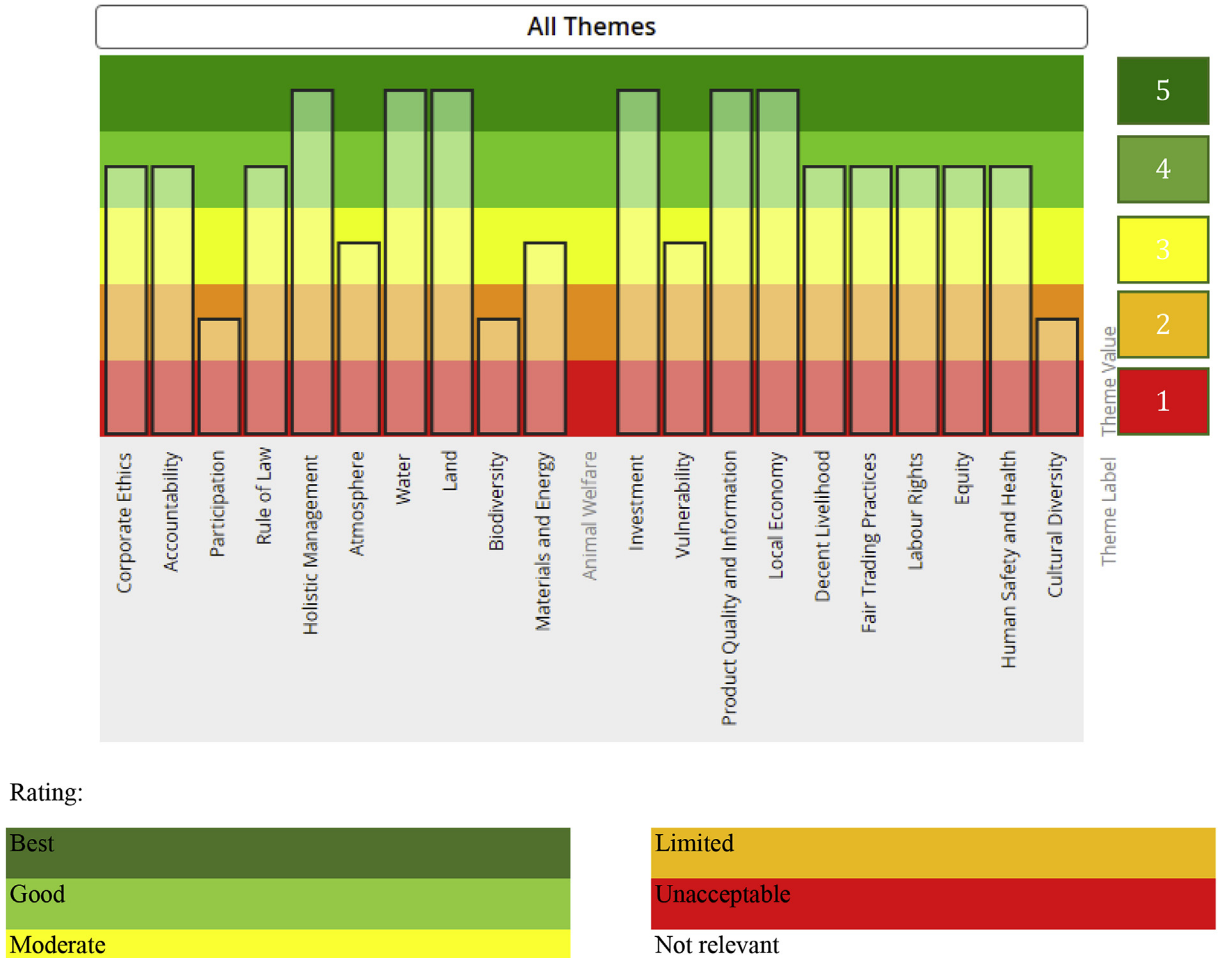

Fig. 7. *A* scores per themes.

Finally, the attitude of farms towards using raw non-renewable material and energy from non-renewable sources weakens the performance in the last theme since both organisations have planned to substitute the use of diesel with electricity as the primary source of energy. The difference in results is due to some infractions of certifiers' regulations, which took place during on-site visits to *B* (such as the use of fire to dispose of waste).

5.3. Economic resilience (C) dimension results

Organic banana reaches a higher price than conventional and FT certification implies extra cash for social and production investment. Consequently, the organic sector is more profitable than the conventional sector. This situation is reflected in the results of the economic dimension (see Fig. 4).

A proves to be sustainable in three out of four themes. In C1, the Fairtrade premium is USD 1.00 per banana box and accounts for USD 0.5 m per year to be spent on technological or social improvements. Thanks to this aid, *A* implemented several improvements such as the introduction of new machinery (e.g. water recycling, bunch transportation) and implementation of social services (e.g. farmers health service). In addition, *A* bought a 20has farm to manage directly.

C2 shows the common situation of high vulnerability. The main reason is the dependence on one single crop. Monoculture is the basis of the entire banana sector and only agri-forest farms grow a consistent percentage of other crops along with banana trees. Other points of vulnerability include the scarce number of customers, which in the case of *B* are only two big retailers, the lack of financial risk analysis and a product scarcity prevention plan. However, *A* is less vulnerable than *B* as it has access to a financial net (provided by the *Banco de Crédito*) and a more reliable cash flow trend in the last five years.

Slight differences emerged in theme C3, in fact, both certifiers and customers require measures that ensure food quality and contamination prevention. The gap in the results is due to the fully organic process implemented by *A* that does not use any chemical product.

Results in C4 are totally identical; both organisations pay all taxes due and hire only local workforce. Regarding this last point, it is important to underline that in the last decade some farms hire immigrant workers at lower wages; nevertheless, this practice resulted in a drop in productivity and product quality since banana plantations require an expert workforce and tacit knowledge that was impossible to find in unskilled workers. For this reason, at present, no farm hires foreign workers.

5.4. Social (S) well-being dimension results

If in the previous dimensions *A* equals or exceeds *B*'s results, in the Social Well-being dimension the results of *B* reveal a more sustainable scenario than that represented by *A*'s performance. In

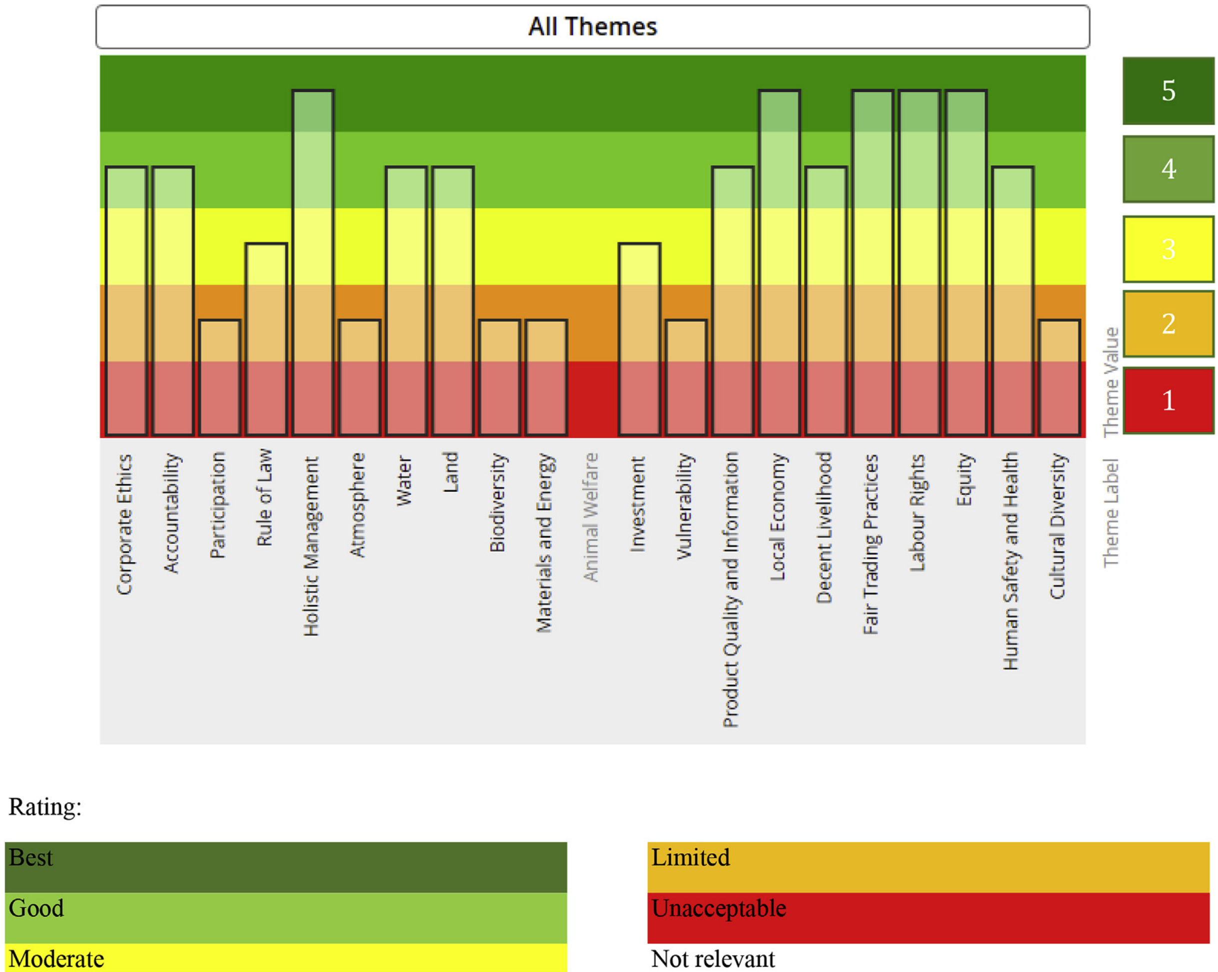

Fig. 8. *B* scores per themes.

particular, *B* surpasses *A* in four out of six themes (see Fig. 5).

Theme S1 addresses life conditions of workers and farmers. Since *B*'s producers are bigger, it comes as no surprise that their workers are also better off than *A*'s. Also, *B*'s workers declare a higher income, as 77% of them declare they can satisfy the needs of their families with their wages versus 39% of *A*'s.

Theme S2 addresses fair trade with customers. Even though, in general, *A* enjoys fair relationships with customers and prices are established by the government, there is evidence of the unofficial price arrangement once or twice a year when buyers expect sellers to return part of the regular price "under the table". This happens when small farms sell to big exporters, but there is no evidence that this arrangement occurs with big farms too, thus *B* is probably immune to this practice.

Theme S3 is linked to labour rights. In this case, the difference in size is the source of the difference in the results. In fact, big farms are more likely to be subject to workers' rights inspections than small-holder farms, because the latter are usually located far from villages and personal arrangements between employers and workers are preferred to formal regulation. For this reason, the analysis reveals 25% illegally contracted workers in the farms of *A* and the presence of child labour, in particular among employers' family members.

Theme S4 is related to equity with respect to minorities, women and disabled individuals. The difference is the fact that not all *A*'s farmers claimed to respect women's right to maternity leave, but a third of them prefer to hire a man rather than a woman to avoid this situation. Similarly, *A*'s farmers did less to reduce the gap in hiring disabled people than *B*'s farmers did.

Theme S5 relates to health and safety. Although both organisations supposedly provide training courses in first aid and safety, a higher rate of accidents was found in *A*. This fact is probably related to the less strict observance of safety regulations of small farms. Nevertheless, *A* performs better than *B* as it possesses, according to FT standards, a formal plan aimed at not contaminating the surrounding environment, even though in both *A* and *B*, there is no evidence of surrounding contamination.

As for theme S6, which is related to indigenous knowledge and local species, it is rather interesting that both *A* and *B* obtained the same results. In both cases, records show very poor outcomes as no plans or contracts take into account indigenous intellectual property and plant species respond to market demand rather than local needs.

5.5. Overview

However, SAFA is a tool that allows different levels of depth. In fact, the analysts may refer to very high-quality data or simply personal estimations. The accuracy of the score is reported on a 3-point scale for each theme in the spider graph (Fig. 6).

The way SAFA calculates the score for each theme is through arithmetic mean. The present analysis kept one decimal digit. In contrast, SAFA rounded the score to the next integer so that, for example, 3.1 and 3.9 both score 4. The scores are displayed below as they appear in the SAFA tool.

An overall view of the evaluation results shows how no theme is rated “unacceptable”, so it is possible to conclude that certification and government effort succeeded in guaranteeing a minimum level of sustainability.

At the same time, it is important to observe that 9 out of 20 themes report the same score for both organisations; 8 themes reveal progress for *A* over *B*, and 3 themes display an advantage of *B* over *A* (see Table 7).

In addition, *A* achieves the “Best” scores 6 times, while in 3 themes it scores the lowest rate of “Limited” (see Fig. 7). However, *B* scores “Best” 5 times and “Limited” 6 times (see Fig. 8).

6. Discussion

These results generate the need for an in-depth analysis of three main aspects: firstly, the main objective of this study, i.e. the effect of certification on banana agri-system sustainability; secondly, the actual situation of the banana agri-system; and, finally, the effectiveness of SAFA.

6.1. Certifications

The positive effect of certification on sustainability is indubitable: both organisations would have scored considerably worse if they had not respected certifiers standards. Furthermore, the difference between the two organisations is generally ascribable to better standards implemented by *A*.

In particular, if in the Environment dimension, the organic process of *A* results in better performance in atmosphere, water land and energy themes, FT standards generate better achievements in Economic and Governance dimensions.

Interestingly, *B* surpasses *A* in three social well-being themes. The fact that FT is stricter than private standards seems not automatically lead to a better level of sustainability. There may be different explanations for this outcome, but two seem the most probable: the first is that FT standards are matched by private standards; the second is that the cause of this result is more likely to be found in other aspects, for example, in the size and processes of the single farm rather than in the certification standards. The latter is precisely the line of study in Clercx and Huyghe (2013), who remark how certifications are more concerned with the product than land and thus underrate complex social dynamics at, for instance, workforce level.

Nevertheless, to investigate this situation more in depth, it is necessary to conduct another study focused on social sustainability at worker level, since this group represents the weakest participants in the system.

6.2. The banana agri-system

The analysis reveals some interesting aspects of the agri-system. First of all, sustainability is an issue that has only received attention from stakeholders in recent years as a consequence of consumers' interest and requirements. A deep interest in the sustainability of local agriculture from producers and key stakeholders appears to be far from being achieved.

Specifically, the weakest points in the evaluation were shown to depend more on the situation of the agri-system rather than on a single organisation. In fact, in three themes both *A* and *B* have the lowest mark: the lack of performance in Participation, Biodiversity and Cultural diversity reflects backwardness of the entire system and the use of land in the past (Clercx et al., 2015).

In the last decade, the government has developed policies focused on sustainable development (Santos et al., 2016; SENPLADES, 2013) that are more the result of from-above planning rather than the product of a collective stakeholders' agreement.

Hence, the implementation of a bottom-up sustainability programme is once again a solution recommended by the present study.

6.3. Sustainability assessment tools

SAFA demonstrates its capacity to represent an agri-system. The 114 indicators applied in this study (the five indicators of theme E6 were not applied as the farms do not grow livestock) cover a wide spectrum of aspects, so all relevant factors were analysed. Hence, SAFA fully demonstrates its capacity to evaluate in depth a specific agri-system and its approach allows for a sound evaluation that is easily understood by both researchers and, more important, farmers. In fact, the visual representation of scores leads farmers to ask for the reason why a specific indicator scored badly and the

Table 7
Results comparison.

Comparison *A* (Organic) vs *B* (Conventional)	Code	Theme name
A is more sustainable than B	G4	Rule of law
	E1	Atmosphere
	E2	Water
	E3	Land
	E5	Materials and energy
	C1	Investment
	C2	Vulnerability
	C3	Product quality and information
A and B are equally sustainable	G1	Corporate Ethics
	G2	Accountability
	G3	Participation
	G5	Holistic management
	E4	Biodiversity
	C4	Local economy
	S1	Decent livelihood
	S5	Human safety and health
	S6	Cultural diversity
B is more sustainable than A	S2	Fair trading practices
	S3	Labour rights
	S4	Equity

possible way to improve the performance and raise the mark.

Nonetheless, the high variety of themes is the main obstacle to its application since the analysis of the four dimensions requires a process where several steps are necessary to plan the analysis and different instruments must be applied simultaneously. In this study, a novel approach for the operationalisation of SAFA was applied. It consists of set structured interviews with seven managers and employees of both organisations, inspections of farms to control the application of rules and procedures and two surveys of farmers and workers. The process took a total of nine months; thus, the instrument cannot be considered as quick and agile as it seemed initially. However, since a relevant part of the time was spent designing the operational approach, practitioners applying the same approach could conduct the analysis more rapidly.

Moreover, the framework reflects the limitations of the top-down approach. In particular, since farmers are not involved in the process of defining indicators, they could not understand the logic and relevance of some indicators.

For example, indicator S6.1 refers to indigenous communities and asks if farmers respect indigenous rights and intellectual property. In this case, farmers state that they have no contact with indigenous people since those communities are present in other parts of the country and not in the province. However, in particular in the case of small farmers, although they do not belong to the native community, they may consider themselves as indigenous, since their ancestors were the first to cultivate those lends. Thus, the indicator proved difficult for researchers to manage and irrelevant to farmers.

For this reason, as recommended by Bonisoli et al. (2018), a solution could be a combination of SAFA and a bottom-up approach, MESMIS for instance, so that SAFA indicators could be the basis for a participative process involving key stakeholders in indicators recognition.

7. Conclusions

The present study presents an analysis of the sustainability of certified agri-food produce. This analysis contributes to the academic debate concerning the comparison between certified and conventional agri-systems in three key ways: it develops an exhaustive evaluation that comprehends the four sustainability dimensions, employs an original approach that operationalises SAFA, and delivers a detailed evaluation whose results can be transformed into actions to improve the sustainability of a system that strongly depends on market demand.

The study utilised SAFA as an instrument to assess and compare the sustainability of the certified and conventional banana agri-systems because of the wide spectrum of sustainability themes considered in the evaluation, it can be easily implemented and understood by producers and decision makers, and the consequential possibility to identify precise measures to enhance sustainability in the short term.

The results demonstrate that the certified banana system performs at a higher level of sustainability in the governance, environmental and economic dimensions, yet it leads to lower sustainability outcomes in the social dimension. This finding is particularly important since it calls into question whether certification schemes actually achieve one of their two main objectives, i.e. the improvement of stakeholder's well-being.

Nevertheless, SAFA reveals that the agri-system displays certain flaws regardless of the type of production. For instance, with the sole exclusion of agri-forest farms, all producers are growing a monoculture, and intercropping is not considered an option since the introduction of a second crop would mean a drop of revenues. This fact increases vulnerability and jeopardises soil quality. Moreover, there is no evidence of any air contamination control or air contamination awareness among farmers and workers as the vast majority of farms still use fuel-based energy generators rather than renewable-based ones. Finally, most of the material utilised is raw and non-renewable, and a satisfactory waste recycling scheme is a target still far from being reached.

The present study has the limitation that it analyses a specific sector of Ecuadorian agriculture. However, the depth and set of factors analysed offers a methodology that can be extended to the assessment of sustainability in other agri-systems, particularly in those where there may be controversy between different certifications. Furthermore, this paper applies an original approach for the operationalisation of SAFA, which could possibly be implemented by other practitioners, although its detailed presentation is beyond the scope of this analysis.

Additionally, this study discloses, on one hand, a general higher level of sustainability of certified farms and, on the other hand, the need for ensuring demand for certified products in destination markets. Hence, further studies could target at least three possible subjects. Since certified producers obtain lower results in social sustainability, an initial issue to address could be the analysis of reasons and the identification of possible measures that might improve performance in this dimension. Secondly, due to the high scores in environmental and economic sustainability, future research should consider the most suitable marketing tools aimed at enhancing demand for certified products in both local and foreign markets. Finally, since the decisive performance in all sustainability dimension of agri-forest farms, an in-depth inquiry targeting decision-makers is required, one which contemplates large-scale financial and operational aid for a possible conversion of conventional farms to agri-forest. In the three cases, SAFA could provide a reliable basis for carrying out said research.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jclepro.2019.07.054.

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