A REVIEW OF FARM SUSTAINABILITY ASSESSMENT METHODS. ARE THEY APPLICABLE TO THE BEEKEEPING SECTOR?

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ABSTRACT

The beneficial contributions of pollinators to the ecosystem and not only have been recognized for a while now. Still, the number of pollinators is decreasing, which is affecting the productivity of the agricultural sector. Sustainability addresses this issue and analysts have worked on developing frameworks to assess sustainability at farm levels. However, because of the heterogeneity of farm systems, such tools are difficult to apply. Therefore, researchers still face issues related to methodology because of the complexity of the sustainability concept. The present paper focuses on retrieving some of the most discussed but also some of the most recent methods of farm sustainability assessment and argue their applicability to the beekeeping sector following a literature review. The conducted analysis revealed that there is a way forward towards achieving sustainability and sustainable development through the development of more exhaustive sustainability evaluation tools both in agriculture, in general, and apiculture, in particular.

KEYWORDS: *agricultural sustainability, farm sustainability, sustainability assessment.*

1. INTRODUCTION

Sustainability and Sustainable Development are complex concepts which have been studied for decades now but still lack a common ground. Agriculture plays a major role in achieving Sustainable Development and the Sustainable Development Goals proposed by the United Nations (United Nations, 2015). Due to a growing population, there is a pressure on agriculture to respond to it (Dobermann & Nelson, 2013). Lately, efforts have been headed into assessing sustainability at farm level, as well as monitoring it. Although multiple studies and assessments were proposed over the past 30 years, efforts are still required, due to a deficiency of well grounded methodologies. Apiculture, also known as beekeeping, is an essential sector in food and agribusiness, especially since pollinators are key elements of agriculture diversity (Potts et al., 2010). Because of the varied agricultural systems, the range of sustainability themes increases, which makes it difficult to homogenize all elements into one single approach and to also apply it in an unique manner. Methodologically speaking, developing sustainability assessment tools in general, and in agriculture and apiculture in particular, is nowadays a key issue (Demartini et al., 2015) which requires further attention from literature.

2. SUSTAINABILITY IN FOOD AND AGRIBUSINESS

Sustainable agriculture is often referred to as the answer on how to produce more food by using fewer resources, reduce poverty or ensure food safety (Latawiec & Agol, 2016).
Thus, sustainable agriculture has become a global challenge and also a key to inclusive growth and development for the long-term, particularly in developing countries, where agriculture remains the main support of the economy. According to Food and Agricultural Organisation of the United

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Nations, sustainable systems of food production should be ensured by 2030 along with implementing agricultural practices that maintain ecosystems and increase production and productivity (United Nations, 2015), raising more attention on the matter.

The notion of sustainable agriculture gained grounds during the 1980s and with regard to it more than 70 definitions are found in the literature. Although similar in various aspects, sustainable agriculture definitions differ slightly in ways of prioritising different values or goals (Zhen & Routray, 2002).

Even though the concept of sustainable agriculture has been extensively studied up to date, there is little common ground in terms of its application on farms which leaves it open to several interpretations.

Going back to when the concept of sustainability emerged, it was first considered an environmental concept by the majority of people and organisations, but it later became clear that this is a misconception and sustainability is now defined as economically viable, environmentally liveable and socially equitable (Parent et al., 2010). Also Parent et al. (2010) noted that defining the concept of sustainability is different than the concept of sustainable agriculture, in which the farm must be liveable (in terms of life quality of the farmers and their families on the farm and in their communities), viable (in terms of economic performance of the farm, where the farm must be able to obtain income in the long run), ecologically reproducible (in terms of agricultural practices that imply the use of natural resources) and transmissible (in terms of next generation's ability to take over the farm). In other words, by defining the sustainable farm, Parent et al. established the basic premises of the sustainable agriculture.

2.1 International Organisations Recognition

Defining sustainable agriculture is essential, but so is the evaluation of different systems of farming (Sachs et al., 2010). Although there have been attempts to globally agree on a series of indicators on sustainable agriculture, results remain inconclusive (Latawiec & Agol, 2016). Still, different indicators and frameworks to evaluate sustainable agriculture were elaborated by various organisations, including United Nations (UN), Organisation for Economic Co-operation and Development (OECD), European Union (EU) or Food and Agriculture Organisation of the United Nations (FAO).

To further raise awareness of Sustainability and Sustainable Development at global level, United Nations adopted in 2015 a set of 17 Sustainable Development Goals (SDGs) (United Nations, 2015) that relate to sustainable agriculture and food security, climate change reduction, biodiversity and ecosystems protection. Closest to sustainable agriculture are goal 2 (food security and sustainable agriculture) and 12 (sustainable production and consumption).

Also liaised with the United Nations is the Sustainable Agriculture and Rural Development Initiative (SARD), which emerged in the 1990s and is supported by Governments and Intergovernmental Organisation, being led by FAO (FAO, n.d.). The objective of the initiative is to preserve, improve and restore social, environmental and social well-being and among its priorities are fairer conditions of employment in agriculture, improved access to resources and better sustainable agriculture practices through frameworks and tools.

More recently, in 2013, FAO developed the Sustainability Assessment of Food and Agricultural Systems (SAFA) which represents a set of Voluntary Guidelines. Its goal is to contribute to an improved sustainable performance in the food and agriculture sectors (FAO, 2013). SAFA also provides a benchmark to what sustainable food production means together with a template for agriculture and food sustainability assessment.

SAFA's aim is to encourage effective sustainability management and improvement towards economic resilience, social well-being, environmental integrity and good governance both at the production site or in the value chain. SAFA applies basic principles and encompasses four sustainability dimensions: Environmental Integrity, Economic Resilience, Social Well-being and Good Governance.
OECD has also recognized the impacts of agriculture, especially on the environment and developed a set of environmental indicators (AEIs) to monitor these impacts. Still, the indicators target benchmarking among countries and are not designed to be used at farm level (OECD, n.d.).
At EU level, the Common Agricultural Policy (CAP) enables periodic evaluations that take place within the Community.
Since its emergence, in 1960s, CAP has undergone a series of reforms now focusing on viable food production, climate change mitigation, the sustainable use of natural resources and balanced territorial development (European Commission, 2018). As of 2013, the latest CAP reform addresses commitments to social, economic and environmental sustainability, orientedness towards the sustainable management of natural resources, balanced territorial development and climate action (European Commission, 2018). Also, to help in evaluating the impact of CAP, the Farm Accountancy Data Network (FADN) instrument was developed by the EU (European Commission, 2018).

2.2 Understanding Sustainability Evaluation in Agriculture

Over the last two decades numerous indicators intended to measure and evaluate the dimensions of sustainability emerged due to the growing concern, especially for the environmental issues (Bockstaller et al., 2008). In matters of environmental sustainability, themes concerning it include pesticides, land management, emissions of greenhouse gases, non-renewable resources, soil quality and biodiversity (Latruffe et al., 2016). Still, some farm types including apiaries, are to some degree sustainable by default and only have a minimum negative impact on the environment, which is why some components are not applicable to all farms.
Porter (2008) noted that sustainability involves a holistic approach by framing the firm together with its environment as a whole, and that it should be managed in an explicit manner. Still, there has been little integration of all three dimensions of sustainability into a whole farm assessment, with the environmental dimension receiving most attention (Latruffe et al., 2016).
Economic sustainability in agriculture consists in economic viability and in the farm prosperity on the long-term in a changing economic landscape, yielding prosperity also to the farming community (van Cauwenbergh et al., 2007). Economic viability involves the measurement of profitability, stability, liquidity and productivity, although some (Bossel, 1999) also propose autonomy as an indicator, which measures the non-dependency and freedom of the farm. Long term implies either the duration of the professional life of the farmer or the takeover of the farm by the next generations, while changes in the economic landscape involve variability in input and/or output prices, yields, regulation or public support (Latruffe, 2016). In matters of inputs, the less a farm relies on external inputs, the less sensitive it is to price fluctuations, subsidies, input availability and terms of financing.
The social pillar of sustainability relates to people, and in agriculture it refers to the well-being of farmers and families and to the society as a whole (Lebacq et al., 2013). Lebacq et al. (2013) identified three categories of indicators for the social pillar at the farm level and they refer to quality of life, working conditions and education. The social sustainability at the society level is focused on values and concerns and Lebacq et al. (2013) distinguished three categories of indicators for it: multi-functionality (contribution to the ecosystem service and employment), acceptable agricultural practices (minimal negative environmental impact and animal welfare) and quality of products (food security and quality processes). Contribution to rural economy as another factor was also considered by van Calker et al. (2007).

The downside of social indicators in the measurement process is that various indicators are qualitative which makes it difficult to quantify them since they are mainly subjective.
The indicators which relate to the farm community mostly take the form of self-evaluations, surveys or interviews.

2.3 Sustainability in Apiculture

At global level, the apiculture market is estimated to grow from US$8.378 billion in 2017 to US$10.074 billion by 2023 (Knowledge Sourcing Intelligence, 2018). The growth is linked to an increase in demand of bee products especially due to their diversity of use and quality. However, in a number of countries, such as US, beekeeping is seriously affected by seasonal disturbances and not only. Still, the value of the sector has received attention and recognition from institutions and organisations such as European Union, which supports apiculture across its Member States through a series of measures including applied research and market monitoring among others.
Most aspects regarding sustainability are followed in the apiculture activity (Mogni et al., 2009). Beekeeping is characterised by low negative ecological impact and is seen as an integrating activity that has low entry barriers. From an economic point of view, beekeeping is a sector with significant potential to generate value.
In relation to the apiculture sector, Fritz and Scheifer (2008) developed a methodological framework. It is, however, based on qualitative assessment. The framework proposes a model of sustainable food and agribusinesses, with an assessment of the sector. The main elements are given by environmental, social and economic aspects. The environmental component comprises: the consumption of fresh water and energy for production, waste (in terms of packaging and food waste), greenhouse emissions from transportation and food production, biodiversity and soil quality. The social component encompasses indicators that relate to: health and nutrition, food safety, food networks, fair and ethical trade, animals and social and ethical conditions in companies. As for the economic scale, affordability for consumers, food quality and food chain performance and competitiveness were involved.

3. SUSTAINABILITY ASSESSMENT FRAMEWORKS FOR AGRICULTURE

Farm sustainability description involves a series of complex parameters. This leads to a complex evaluation based on an aggregative structure, and up to date there have been various works (Fritz & Scheifer, 2008; Parent et al., 2010; Latawiec & Agol, 2016) on developing appropriate tools and methodologies. Since for the beekeeping sector no framework to assess sustainability quantitatively has been developed so far, four methods that assess sustainability at farm level, in general, have been reviewed. Out of the four chosen methods, IDEA, RISE and SAFE are among the most well known, while the 4Agro method is one of the newest methods for agricultural sustainability assessment, being developed in 2016.

3.1 IDEA Method

IDEA method is one of the frameworks that has been used in assessing sustainability, mainly in French farms, among other places (Kelly et al., 2018). Its name stands for Indicateurs de Durabilité des Exploitations Agricoles and it assigns sustainability scores thorough 41 sustainability indicators that relate to environmental, social and economic aspects (Vilain, 2008). The aim of the IDEA method is to provide sustainability assessment of farms though an operational tool. The target group of users is given by farmers, researchers, policy-makers and farmer organisations (Binder & Feola, 2013). The method defines sustainable agriculture through three pillars, namely Economic Viability, Environmental Reproducibility and Social Liveability. Sustainability of different types of farms is measured by using sustainability scales containing components, which in turn are made up of indicators (Parent et al., 2010). Each indicator assigns a variable to be assessed.

The environmental scale comprises most indicators, 19, while the economic scale has 6 indicators and the social one has 16. All scales have the same weight and data is gathered by assigning scores to farmers' behaviour and practice (Parent et al. 2010). The environmental scale components include diversity (degree of biodiversity of farms), organisation of spaces (use of land related to soil erosion and parasites reduction), agricultural practices (use of agrochemicals and fertilisers), natural resources (impact of agronomic activities on water use and soil quality) and energy (energy input). The social scale components are made up of quality (of farm products), short supply chain (support for the local economies), work (quality of life, family labour, innovation and research) and ethical and social developments. In measuring the economic state of a farm thorough IDEA, among the parameters considered by the economic scale are given independence component (economic autonomy) and diversification (capacity to diversity farm activities) (Gaviglio et al., 2017). IDEA method is used, in general, in specific studies (Kelly et al., 2018). A problematic issue in applying the framework is the assessment of social sustainability, since many indicators are qualitative and difficult to calculate. Another particularity of the method is that indicators interaction is not considered (Binder & Feola, 2013). Also, a lot of data is required in calculating the scores (Parent et al., 2010).
The advantages of using the IDEA method include that data analysis follows a clear and structured methodological procedure, results can easily be communicated to farmers, it allows monitoring and to some degree benchmarking (Binder & Feola, 2013).

3.2 RISE Method

RISE stands for Response-Inducing Sustainability Evaluation and is a framework for holistic assessment of farms (Gaviglio et al., 2017). Developed in Switzerland during the 1990s, the method has been applied in several countries (Schader et al., 2014). It views sustainable agriculture through productivity, efficiency, competitiveness and protection of the environment and local communities (Binder & Feola, 2013). The tool provides assessment on the three pillars of farm sustainability, and although there is no typical repartition between them, the indicators interact more than in the IDEA method (Binder & Feola, 2013). It encompasses 12 indicators and aims at identifying the strengths and weaknesses at farm level (Gaviglio et al., 2017). RISE looks to assess the level of sustainability at farm level, induce management feedback, and provide potential opportunities and failure visualisation. The method allows the calculation according to the Degree of Sustainability (DS=S-D) (Gaviglio et al., 2017), where S (State) and D (Driving Force) are evaluation values of each indicator. Similar to IDEA, interviews are used for indirect evaluation, however, there are few social indicators (Binder & Feola, 2013). The method is addressed to farmers and its themes include: pesticides and agrochemicals, fertilization, energy, soil, water, diversity and biodiversity, local economy, work, social inclusion, animal health and welfare and economic viability (Gaviglio et al., 2017). The drawbacks of the method include its limited capacity to answer research questions (Schader et al., 2014), the limited number of indicators for all three aspects of farm sustainability, the load on resources for each indicator (Parent et al., 2010). To these adds the general character of it and the fact that is not specific to one farm type, such as apiaries. On the other hand, among the benefits of RISE are identified the fact that it allows comparison in terms of sustainability between farms or agriculture systems, the balance between the complex reality and the comprehensible results (Binder & Feola, 2013) and the usefulness in farm management (de Olde et al., 2016).

3.3 SAFE Method

SAFE or Sustainability Assessment of the Farming and the Environment (van Cauwenbergh, 2007) is a holistic and hierarchical framework for evaluating the sustainability of the agricultural production systems and policies. It was developed in Belgium in 2006 (Gaviglio et al., 2017) and views sustainable agriculture through biological diversity, regeneration, vitality, capacity, productivity and ability to function (Binder & Feola, 2013).

The method aims to identify, further develop and evaluate the production, techniques and policies of agricultural systems. It targets researchers and policy makers and extends the analysis beyond farm level, to regional level (Binder & Feola, 2013). Thus, it is designed for multiple levels ranging from parcel and farm to region and state. A particularity of SAFE it that involves some stakeholder participation. SAFE covers all three pillars of sustainability, but there is no interrelationship between them (Binder & Feola, 2013). Its themes include ecological zones (habitat conservation), energy dependence, sustainability of employment, quality of products, added value, autonomy and CAP independence (Gaviglio et al., 2017).

3.4 AGRO Method

The 4Agro method is a new method of evaluation of the environmental, social and economic sustainability of agricultural systems (Bertocchi et al., 2016). Developed in Italy in 2016, it comprises 42 quantitative indicators under an aggregative structure. It allows benchmarking among homogeneous types of farms. For the environmental scale, its components include diversity, agricultural practices, space management, energy and natural resources.

The social scale comprises the categories of supply chain, products, work, society, culture and ecology and ethics and human development, while the economic scale consists in economic viability, independence, transmissibility, diversification and multi-functionality (Bertocchi et al., 2016). The developers of the method (Bertocchi et al., 2016) noted that it shows sensitivity to farms' characteristics.

Table 1. Farms assessment methods comparison

Method	Strengths	Weaknesses	Applicability to beekeeping sector
IDEA	Requires a lot of data; Follows a clear and structured methodological procedure; Provides comprehensible results; Allows monitoring; Allows benchmarking.	Used in specific studies; Many qualitative indicators (social scale); Requires a lot of data; No interaction among indicators.	Partly; Developed for farms, in general; would need adaptation for beekeeping sector.
RISE	Indicators interact; Provides comprehensible results; Allows benchmarking; Useful in farm management.	Few indicators; Limited capacity to answer research questions; Load on resources on each indicator.	Partly; Developed for farms, in general; would need adaptation for beekeeping sector.
SAFE	Allows analysis at extended spatial levels.	No interrelation between indicators; Stakeholder participation.	Partly; Developed for farms, in general; would need adaptation for beekeeping sector.
4Agro	Allows benchmarking; Comprises only quantitative indicators.	New method.	Partly; Developed for farms, in general; would need adaptation for beekeeping sector.

Source: Own adaptation

4. CONCLUSIONS

Agriculture systems are fundamental to achieving sustainable development and this was emphasized also by international organizations. The present paper addressed farm sustainability assessment with a particular approach to the apiary sector. The literature review of the retrieved methods revealed that there is no common ground regarding either conceptualization or methodological procedure. This highlights once more the need to further explore the complexity of the sustainability concept. It was also revealed the lack of a framework to quantitatively evaluate the sustainability of apiary farms and that the existing ones do not entirely apply to all farming systems. The comparison of farm assessment methods brings forward that the four investigated methods are only partly applicable to the beekeeping sector. The fact that some indicators or components are non-applicable is due to them not taking part in beekeeping activities, such as the use of pesticides and fertilizers or the use of land related to soil erosion reduction. However, the signals that agricultural sustainability is essential are clear.

To conclude, the purpose of this paper was to show that there is a way forward towards achieving sustainability and sustainable development through the development of more exhaustive sustainability evaluation tools both in agriculture and apiculture.

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