Environmental Impact Assessment Review 32 (2012) 170–180

Contents lists available at SciVerse ScienceDirect

Environmental Impact Assessment Review

journal homepage: www.elsevier.com/locate/eiar

Multilevel and multi-user sustainability assessment of farming systems

Steven Van Passel [a,c,*], Marijke Meul [b]

[a] Hasselt University, Faculty of Business Economics, Centre for Environmental Sciences, Agoralaan, Building D, 3590, Diepenbeek, Belgium
[b] University College Ghent, Department of Biosciences and Landscape Architecture, Campus Schoonmeersen, Building C, Schoonmeersstraat 52, 9000, Gent, Belgium
[c] University of Antwerp, Department Bioscience Engineering, Groenenborgerlaan 171, 2020 Antwerp, Belgium

ARTICLE INFO

Article history:
Received 14 September 2010
Received in revised form 24 July 2011
Accepted 22 August 2011
Available online 21 September 2011

Keywords:
Sustainability assessment
Multilevel
Sustainable value
MOTIFS
Farming systems
End-user groups

ABSTRACT

Sustainability assessment is needed to build sustainable farming systems. A broad range of sustainability concepts, methodologies and applications already exists. They differ in level, focus, orientation, measurement, scale, presentation and intended end-users. In this paper we illustrate that a smart combination of existing methods with different levels of application can make sustainability assessment more profound, and that it can broaden the insights of different end-user groups. An overview of sustainability assessment tools on different levels and for different end-users shows the complementarities and the opportunities of using different methods. In a case-study, a combination of the sustainable value approach (SVA) and MOTIFS is used to perform a sustainability evaluation of farming systems in Flanders. SVA is used to evaluate sustainability at sector level, and is especially useful to support policy makers, while MOTIFS is used to support and guide farmers towards sustainability at farm level. The combined use of the two methods with complementary goals can widen the insights of both farmers and policy makers, without losing the particularities of the different approaches. To stimulate and support further research and applications, we propose guidelines for multilevel and multi-user sustainability assessments.

1. Introduction

Sustainability assessment is viewed as an important and necessary step to aid in the shift towards sustainability (Poppe et al., 2004). We need to consider which trajectories are equitable, economically and ecologically desirable and achievable (Moffatt, 2000), hence the measurement of sustainability is a daunting task. Very different sustainability evaluation tools already exist such as monetary tools, biophysical models and sustainability indicators. Examples of monetary tools are Cost Benefit Analysis (e.g. Costanza et al., 1997), the Index of Sustainable Economic Welfare (Daly and Cobb, 1989) and the Genuine Savings (Pearce and Atkinson, 1993). Examples of biophysical models are Emergy (Odum, 1996), Exergy (Bastianoni et al., 2005; Hoang and Rao, 2010) and the Ecological Footprint (Wackernagel and Rees, 1997). Well-known examples of sustainability indicator sets are developed by the UN (United Nations, 2001), OECD (OECD, 2006) and the EU (European Commission, 2005). Note that certain monetary and biophysical tools (e.g. the ecological footprint) can be identified as a kind of composite index of sustainability indicators. Furthermore, also combinations of physical indicators with monetary valuation can be identified (Neumayer, 2003). An example of such a hybrid approach is the sustainability gaps approach (Ekins and Simon, 1999). Interesting reviews of approaches for assessing the progress towards sustainability can be found in Neumayer (2003) and Gasparatos et al. (2008).

These different ways of measurement have been proposed regarding the monitoring and evaluation of sustainability based on different spatial, temporal and theoretical concerns (Kondyli, 2010). Many sustainability assessment approaches are designed for assessments at a specific level (e.g. firm level) and are not suited to be applied at a different level (e.g. sector level) (Dantsis et al., 2010). Hence, a plurality of methods is required for obtaining a sound, implementable, case- and system-specific sustainability assessment at different levels (Binder et al., 2010; Gasparatos et al., 2008; Hacking and Guthrie, 2008).

The concept of scale is of major importance with regard to sustainability assessment. The term scale refers to the spatial, temporal, quantitative or analytical dimensions used by scientists to measure and analyze objects and processes (Gibson et al., 2000). Levels refer to locations along a scale, as discussed by Gibson et al. (2000). In most cases, sustainability assessment takes place at a specific level (e.g. firm level) to support decision making by a specific end-user group (e.g. firm managers). A possible shortcoming of these one-level evaluations is that the multilevel hierarchy is not considered. For example, a production unit (e.g. a firm) is always part of a production chain, so measures taken to improve the sustainability at the level of the firm will have an effect on the whole chain. A firm also belongs to an economic sector, for example a dairy farm belongs to the dairy sector, so (policy) decisions made at sector level have an effect on the actions that can or have to be taken at firm level. Hence, performing a sustainability evaluation at the same time at different levels for different end-users could broaden the insights of these different end-users and provide a better support in decision making at each of the considered levels. That way, current or intended actions at for example the firm level most likely also contribute to the sustainability of the larger system, production chain,

* Corresponding author at: Hasselt University, Agoralaan, Building D, 3590 Diepenbeek, Belgium. Tel.: +32 472 93 00 23.
E-mail address: Steven.vanpassel@uhasselt.be (S. Van Passel).

0195-9255/$ – see front matter © 2011 Elsevier Inc. All rights reserved.
doi:10.1016/j.eiar.2011.08.005

sector or society as a whole. In that case, instead of striving for the construction of one complete sustainability assessment approach for all levels, we propose a smart combination of existing methods applied at different levels and for different end-users. Although multilevel and multi-user sustainability assessment is relevant for all kind of systems, the literature review and case-study in this paper will be restricted to farming systems.

Many methodological approaches regarding sustainability assessment in agriculture have been published with several advantages, disadvantages and limitations (Dantsis et al., 2010). The most common approach to assess the impact of environmental or policy changes on sustainability relates to the use of indicators (Bell and Morse, 1999; Diaz-Balteiro and Romero, 2004; Ewert et al., 2009). The value of a sustainability indicator is its potential to improve decision making, and so it is best thought of as a source of information (Pannell and Glenn, 2000). Hence, indicators describe (complex) phenomena in a quantitative way by simplifying them in such a way that communication is possible with specific target groups (Lenz et al., 2000). Furthermore, Shields et al. (2002) argue that indicators of sustainability will only be effective if they support social learning by providing users with information they need in a form they can understand and relate to. Sustainability indicators serve as performance indicators in the sense of saying to us that things are getting better or that things are getting worse (Patterson, 2006). This implies that a reference point or benchmark system is necessary. To give guidance towards sustainability, reference values are needed for each indicator, these can include policy targets, best available technologies, comparisons with other countries or firms.

For agriculture, several indicator-based monitoring tools already exist and are applied in practice. These indicators generally are used (i) individually, (ii) as part of a set, or (iii) combined into a composite index (Farrell and Hart, 1998). Since individual indicators are of limited use to adequately represent all essential aspects of a complex system's sustainability, a balanced set of indicators is preferred (Bossel, 1999). Although unconnected indicators encourage the fragmented view, combining several indicators can be seen as a significant first step to adequately assess the sustainability of an activity or firm (Farrell and Hart, 1998). The next important step is to analyze the links between social, environmental and economic aspects.

Table 1 gives an overview of common and recent indicator systems for sustainability measurement of agricultural systems, found through a literature search in scientific journals. The literature review shows that existing indicator tools can be categorized according to the intended level of application (farm level, sector level and regional level), and the intended end-user group (farmers and policy makers). Note that it only makes sense to compare different levels if these levels belong to the same scale (Gibson et al., 2000). The intended level of application belongs to two different scales: (i) a 'production' scale (with two levels: farm level and sector level) and (ii) a 'spatial' scale (with two levels: farm level and regional level). As a consequence, analysis on sector level and spatial level cannot be compared or should be compared very cautiously (as indicated in Table 1 with the dotted line).

With regard to end-user groups we categorized the tools based on the intended or most important end-users: farmers (including farm consultants) and policy makers. In certain cases, the authors claim that the analysis is useful for both farmers and policy makers (e.g. Langeveld et al. (2007)) but we tried to identify the most important target group (or end-user group). The end-user group 'researcher' is not added because we assume that all tools are also described for other researchers for further research. Certain assessment tools incorporate the perception of different stakeholders, notwithstanding the fact that these tools are used to support a certain user-group. For example Van Calker et al. (2004) take into account the perception of different stakeholders (producers, consumers, policy makers and farms) using different weights for sustainability aspects to compare dairy farming systems to support farmers as end-users.

Table 1 shows that for policy makers as the intended end-user group, several tools exist that are used to assess sustainability at different levels. Examples are Andreoli and Tellarini (2000), who perform a farm assessment and compare different production types (or subsectors) and Van Passel et al. (2009) who perform a farm assessment and evaluate basic policy options. Stoorvogel et al. (2004) compare different production systems and analyze their spatial variation and Azad and Ancev (2010) calculate the environmental performance index to compare production types and regions. Such comparisons cannot be considered as multilevel sustainability assessment due to the fact that different scales are considered (Gibson et al., 2000). Note that for the review in Table 1, we consider farm level including field level, sector level

Table 1
Integration tools to assess sustainability at different levels for different end-users.

	Farmers	Policy makers
Farm level	Lewis and Bardon (1998)[a] Girardin et al. (2000)[a] Ten Berge et al. (2000)[b] Rigby et al. (2001)[a] Lopez-Ridauro et al. (2002)[a] Häni et al. (2003)[a] Van Calker et al. (2004, 2006)[b] Langeveld et al. (2007)[a] Van Cauwenbergh et al. (2007)[a] Meul et al. (2008)[a] Rodrigues et al. (2010)[b]	Andreoli and Tellarini (2000)[b] Sands and Podmore (2000)[b] Reinhard et al. (2000)[b] De Koeijer et al. (2002)[b] Pacini et al. (2004)[b] Coelli et al. (2007)[b] Van Passel et al. (2007, 2009)[b]
Sector level		Andreoli and Tellarini (2000)[b] Stoorvogel et al. (2004)[b] Van Passel et al. (2009)[b] Azad and Ancev (2010)[b]
Regional level		Smith et al. (2000)[a] Schultink (2000)[a] Stoorvogel et al. (2004)[b] Ewert et al. (2009)[b] Azad and Ancev (2010)[b] Balana et al. (2010)[b] Dantsis et al. (2010)[b] Hoang and Rao (2010)[b]

[a] Refers to a visual integration approach.
[b] Refers to a numerical integration approach.