The trade-off between scope and precision in sustainability assessments of food systems

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Abstract

With sustainability becoming an increasingly important issue, several tools have been developed, promising to assess sustainability of farms and farming systems. However, looking closer at the scope, the level of assessment and the precision of indicators used for impact assessment we discern considerable differences between the sustainability impact assessment tools at hand. The aim of this paper is therefore to classify and analyse six different sustainability impact assessment tools with respect to the assessment level, the scope and the precision. From our analysis we can conclude that there is a trade-off between scope and precision of these tools. Thus one-size-fits-all solutions with respect to tool selection are rarely feasible. Furthermore, as the indicator selection determines the assessment results, different and inconsistent indicators could lead to contradicting and not comparable assessment results. To overcome this shortcoming, sustainability impact assessments should disclose the methodological approach as well as the indictor sets use and aim for harmonisation of assumptions.

Introduction

Food production, in particular its agricultural stages, has substantial impacts on different environmental realms such as biodiversity, climate change, water, soil and air (Rockström *et al.*, 2009; Steinfeld, 2006). Furthermore, socio-economic impacts of food production play an important role as social and economic conditions on farms are often unfavourable and agriculture is often one of few economic activities in rural areas (European Commission, 2004).

During the last years, a variety of different tools has been developed for assessing aspects of sustainability in the food sector (Bockstaller et al., 2006; Grimm, 2009; Zapf et al., 2009). However, depending on the objective the tool has been designed for, they vary in scope (geographic area, thematic scope), assessment level (product, farm, agricultural sector) and precision. As a consequence, tools designed for different purposes and objectives may arrive for the same assessment issue at different assessment results. The main reasons for such differing sustainability assessment results for the same assessment issue are on the one hand that sustainability assessment tools in the food sector take an inconsistent perspective on the notion "sustainability" and that vary in the depth of analysis. The aim of this paper is a) to classify different sustainability assessment tools that can be used for evaluating farms and farming systems according to their main characteristics, including their perspective on sustainability and b) to assess the scope and precision of these tools in order to identify areas where trade-offs between these two characteristics of sustainability tools occur.

Methods

For this study, six sustainability assessment tools have been selected which represent different approaches: agricultural life cycle assessment (SALCA), environmental Management Systems

(REPRO), farm advisory (RISE), farm-level impact assessment (COSA), public monitoring systems (AUI), and policy impact assessment (FARMIS). The selected tools are taken as examples of tools for the different purposes; there are other tools with similar features.

Scope and precision of the six tools were assessed on the basis of publicly available tool documentations and / or publications. The scope was characterised by the geographical area (focus on specific country or globally applicable), the level of assessment (product, farm, sector) the sustainability dimensions covered (environmental, social and economic), and the categories/indicators covered in each dimension (Table 2). Precision was assessed qualitatively by analysing data needs and the validity of results based on the information available. The overall data needs were evaluated as a function of the sustainability dimensions, categories and indicators covered, the level of assessment and the intended precision of analysis which is given by the primary purpose of the tool (research, advisory, monitoring, certification).

Classification of tools and methods

The primary purpose of the selected tools and methods is either scientific assessment in research, for farm extension, policy advice, or as part of monitoring or certification schemes (Table 1). The tools address different target groups (researchers, farmers, policy makers and business partners). In the context of sustainable food production, tools can be applied either at farm, product, supply chain or even agricultural sector level. Depending on the assessment level and target group, the tools and methods face different needs to make assumptions transparent. While the scientific assessment tools SALCA and REPRO publish assumptions in scientific literature, the farm advisory and assessment tools (COSA, RISE) make their assumptions and calculation procedures not fully available to a broader audience. Usually, assumptions are shared among users via user manuals or upon request. Monitoring and certification tools follow much simpler procedures and need to guarantee full transparency of the calculation procedures. Finally, for the policy impact assessment model FARMIS, calculation procedures are published in detail in scientific literature and project reports.

An important distinction between the tools needs to be made with respect to their perspective on sustainability. There are two prevalent perspectives of the notion ‘sustainability’: Either, sustainability is interpreted from a farmer’s perspective. In this case, sustainability describes whether the farm is able to sustain for a longer period of time. This interpretation focuses on whether the farm, as an economic entity, is resilient enough a) to use its resources (natural, social and economic resources) without depleting them and b) to cope with possible upcoming changes in the societal, economic and environmental framework. Or, sustainability is interpreted from a societal perspective. In this case, the subject of the assessment is whether the farm contributes to a sustainable development of society (WCED, 1987). This means that the assessments focus on the impacts of farm management on the economic, social and environmental resources of society. These impacts can be either positive (services delivered) or negative (damages or costs induced). The latter perspective is often employed in the context of the concept of multifunctional agriculture (OECD, 2001).

Among the tools analysed SALCA (life cycle assessment), AUI (monitoring) and FARMIS (sector level impact assessment) pursue primarily a societal perspective while the farm-level advisory (RISE) or assessment (COSA) tools have primarily a farm level view on sustainability (Table 1). The perspective on sustainability is primarily determined by the indicators chosen to assess the economic dimension. This difference will be clarified in the following section.

Table 1: Classification of sustainability assessment

Tool / Method	Type of approach	Developer	Primary purpose	Primary target groups	Transparency of assumptions	Perspective on sustainability	Reference
SALCA	Agricultural life-cycle assessment	Agroscope Reckenholz-Tänikon (ART)	Research	Researchers	a large number of assumptions has been published in ecoinvent reports and publications on the web	societal	Nemecek et al. (2010)
REPRO	Environmental Management System	University Halle-Wittenberg	Research, Certification	Researchers, Business partners	a large number of assumptions has been published in scientific publications	farm / (societal)	Hülsbergen (2003)
RISE	Tool for farm advisory	Bern University of Applied Sciences HAFL	Extension	Farmers	manual and guest account available upon request	farm	Grenz et al. (2011; 2009)
COSA	Tool for farm-level assessment	Committee on Sustainability Assessment (COSA)	Extension	Farmers	indicator list available online	farm	http://sustainablecommodities.org/cosa
AUI	Monitoring tool	FOAG, Switzerland	Monitoring	Different stakeholders	description not yet available	societal	http://www.blw.admin.ch
FARMIS	Economic policy impact assessment model	Johann Heinrich von Thünen Institut (vTI), Research Institute of Organic Agriculture (FiBL)	Research, policy advice	Policy makers	a large number of assumptions has been published in scientific publications, including 5 PhD theses	societal	Sanders et al. (2008) Schader (2009)

Evaluation of scope and precision of approaches

The geographical area covered of the tools is predominantly determined by data availability. With respect to the geographical area, tools are either a) globally applicable (RISE), b) in principal adaptable to a global scale, however datasets focus on certain countries or for certain crops or farm types (SALCA, REPRO, COSA) or c) designed to be applied in specific countries (AUI, FARMIS).

With respect to the level of assessment, the tools can be classified into those working a) at product level (SALCA, REPRO), b) at farm level (RISE and COSA) and c) at sector level, or with representative farms, respectively (FARMIS, AUI). Several tools are able to assess both product and farm level (SALCA, REPRO) or sector and farm level (FARMIS).

All tools analysed cover environmental aspects of sustainability, but to a varying extent. Mostly, biodiversity, energy use, GHG emissions and nutrient balances for nitrogen and phosphorus are covered. Management of soil and water is included in RISE, COSA and AUI while SALCA and REPRO only soil is only take soil management into account. Among the six selected tools, animal welfare is only assessed by RISE.

The precision of the assessments by the different tools is difficult to judge, as detailed assumptions are often not publically available. Furthermore, tools like RISE and REPRO are to some extent generic; i.e. they allow for an adaptation of data collection and calculations to different situations. This results in variable levels of precision of the same tool applied in different circumstances.

However, with respect to complexity of model algorithms and the level of details of communicated results, it seems that SALCA and REPRO are able to cover environmental impacts with the highest precision. The farm-level advisory tool RISE and the farm-level assessment tool COSA, judge some environmental impacts indirectly via farm management practices implemented on the farm. For instance, soil erosion is not quantified itself but the implementation of erosion prevention measures is assessed, or a simple risk assessment is combined with farmer observations of environmental damage (e.g. soil erosion, soil compaction). Among the farm level tools analysed, RISE appears more sophisticated in analysing environmental impacts than COSA. Due to its high aggregation level, the sector level impact assessment tools FARMIS can only work with limited farm-specific information. Therefore, their precision for farm-level assessments is low.

But even tools with a high precision in environmental questions may come to different conclusions, e.g. with respect to greenhouse gas balances. For instance, REPRO explicitly takes into account carbon sequestration differently than SALCA. As this factor has a critical impact on the greenhouse gas balance different farming practices are evaluated with different results.

The social dimension of sustainability is covered neither by SALCA nor by the sector-level assessments of AUI and FARMIS. The farm level advisory, assessment and certification tools RISE, COSA and REPRO cover social issues to a varying extent. While RISE takes into account working conditions (including gender issues, working hours etc.) and quality of life, COSA additionally assesses participation and transparency (and thus aspects of governance). REPRO primarily includes specific issues regarding working conditions that are straightforward to quantify and check (working hours, salaries, number of leave days), as the *DLG-Zertifikat*, which is a sustainability certification scheme for business-to-business communication, is based on a REPRO assessment, needs to be based on unambiguously verifiable information. On the contrary, COSA and RISE explicitly widen the focus to include “soft” indicators such as farmers’ perceptions.

Table 2: Comparison of level of assessment, scope and precision of sustainability impact assessment tools for farms and farming systems

Tool / Method	Level of assess ment	Geogra phical area	Environmental dimension		Social dimension		Economic dimension		Data needs
			Coverage of topics	Preci sion	Coverage of topics	Preci sion	Coverage of topics	Preci sion	
SALCA	product level farm level	Focus on Switzerl and	Non-renewable energy demand, Global warming potential, N and P eutrophication potential, eco-toxicity, human toxicity, ozone, Acidification potential, biodiversity, soil quality	High	Not covered	-	not covered	-	High
REPRO	farm level, product level	Focus on German y	N and P balance, humus balance, biodiversity, energy intensity, plant protection, soil compaction and erosion, greenhouse gas (GHG) emissions	High	Salaries, working hours, number of leave days, vocational training, participation, safety at work, integration in and commitment to region	High	Farm income/value added, profitability of production factors, change in equity capital net investments, profit rate	High	High
RISE	farm level	globally applica ble	Energy and climate, Water, Soil, Biodiversity and plant protection, Nutrient cycles, Animal welfare	Moder ate	Working conditions, Quality of life	Mod erate -high	Economic viability, Farm management	Mode rate	Moderate
COSA	farm level	globally applica ble	Water (Conservation, Quality), Resource management (Waste Management, Input management), Soil health, Biodiversity (flora, fauna), climate change, producer perception of changed environmental issues	Low	Labour conditions (health and safety, living conditions), basic human rights and equity (labour rights, education, gender, food security), community/participation, shared value (transparency, investing capacity), perception of social issues	Mod erate	Producer livelihood (revenue, costs, income), risk (diversification, information, credit, volatility, vulnerability), competitiveness (Business development, differentiation, efficiency), producer organization (governance, services), perception of economic circumstances	Mode rate	Moderate

Tool	Level of assessment	Geographical area	Environmental dimension		Social dimension		Economic dimension		Data needs
AUI	sector-level	Switzerland	Nitrogen and phosphorus (balance and emissions), energy use and efficiency, water protection, soil protection, biodiversity and landscape	Moderate	Not covered	-	Not covered, assessed via different tool (*Zentrale Auswertung*)	-	Moderate
FARMIS	representative farm-level, sector-level	Germany, Switzerland	Energy use, biodiversity, N and P eutrophication, GHG-emissions	Low	Not covered	-	Farm income, profitability, labour use, costs of policies, policy-related transaction costs, cost-effectiveness of policies, etc.	Low	High

The economic sustainability dimension is addressed neither by SALCA nor by the monitoring tool AUI. The farm advisory tool RISE and the assessment tool COSA consider economic sustainability from a farmer's perspective. This means that the economic dimension is focused on the farm's economic stability, profitability and liquidity. However, from a societal perspective the primary aim with respect to sustainable food production is not to keep the farms profitable but to make the farms deliver public goods to society and contribute to rural development. Such services can be value creation and social commitment in rural areas, the delivery of cultural and educational activities and the cost-effective delivery of the aforementioned public goods. REPRO has an ambivalent perspective on economic sustainability, as primarily the farmer's but also elements of the societal perspective are employed.

None of the selected tools can be classified as having low data needs as all the tools are ambitious either in terms of level of assessment (AUI, FARMIS), sustainability dimensions covered (RISE, COSA, REPRO) or the precision of the assessment (SALCA, REPRO). However, if directly comparing the data requirements between these tools we evaluate RISE (see also Zapf et al., 2009) and COSA as less data-demanding although they cover all three dimensions of sustainability and a large variety of categories in each of the dimensions. REPRO (Zapf et al., 2009) and SALCA on the other hand have the highest data-demand.

Conclusion with respect to the research questions

From our analysis we can conclude that there are sustainability impact assessment tools with a high level of precision which are research oriented and designed for farm or product level impact assessment but which are limited with respect to the geographical are (validated only for one specific country) and the coverage of the sustainability dimensions (focus on environmental dimension). On the other hand, those sustainability impact assessment tools which are designed for extension show a lower level of precision but a wide coverage of both the geographical area (RISE aims at globally applicable) and the sustainability dimensions considered. Thus, it seems that there is a trade-off between precision, purpose (research or advice) and coverage of the geographical area and sustainability dimensions. REPRO is an exception as it also covers socio-economic aspects and thus tries to bridge this gap between scope and precision. This attempt, however, is made at the cost of practicability as the demand for data is very high, the cost of a sustainability certification based on REPRO is high.

Furthermore, an ambiguous perspective on sustainability, in particular economic sustainability, was found when assessing the tools and methods in this study. In fact, the tools RISE and COSA focus on farm-level sustainability, which rather translates into resilience of farms and is thus different from sustainability from a societal perspective, which is assessed by SALCA, AUI and FARMIS. REPRO has an ambivalent perspective on sustainability as they contain both elements of a societal and a farm-level economic perspective.

The trade-off between scope and precision and the different perspectives on sustainability lead to the conclusion that a one-size-fits-all solution for sustainability assessments is not applicable. Rather, the design of sustainability impact assessment tools should be tailored to the specific question or problem, its purpose and the geographical coverage. The indicator sets used in the sustainability impact assessment tools analysed are not consistent for the same impact category. This means that indicators with a high precision or scope do not necessarily lead to the same assessment result as indicators with low precision. This could lead to the situation that different sustainability impact assessment tools applied for e.g. the same farm could arrive at differing impact assessment results. Thus, to avoid contradictory impact assessment results, there is the need for harmonisation of the indicator selection in order to have consistent indicator sets. Furthermore, the differences between the perspectives on sustainability, the scope and the precision of different tools require to be disclosed. A promising approach in this respect is the SAFA (Sustainability Assessment of Food and Agriculture) - Guideline (FAO, 2012), which aims at harmonising sustainability assessments and making methods and results of sustainability assessments in the food sector more transparent and comparable.

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