Participatory tuning agricultural sustainability assessment tools to Flemish farmer and sector needs

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Abstract

Many tools to analyse and support sustainable development exist, but their use in the agricultural sector remains obstructed by the sector's complexity and diversity. The objective of this research was to analyse, with a participatory action-research approach, various aspects of the design and use of sustainability assessment tools. The research originated from a Flemish farmers' union request to develop a sector-specific sustainability assessment tool (SAT). This request allowed action research by combining: (i) stakeholder involvement to clarify needs regarding sustainability assessment; (ii) the link between SAT and strategic decision-making and (iii) a supra-farm coordination or governance. The research, applied to four Flemish agricultural sub-sectors resulted in a context-specific SAT for each sector. They differed in complexity; procedural differences are described for two sub-sectors, in particular the links of SATs with strategic decision-making and the importance of supra-farm governance. We concluded with key attention points for future SAT development: (i) tuning sustainability assessment to stakeholders' needs, in particular with respect to strategic decision-making, (ii) the development context of a SAT, in particular with respect to governance and continuity in the envisioning process.

1. Introduction

Sustainable development stays high on the agenda of many actors in society. Decision-making units, such as governmental organizations, firms and NGOs increasingly try to incorporate sustainability into their management strategies. Incorporation is driven by numerous motives, such as corporate social responsibility, consumer demands or policy measures. Also the agricultural sector feels the urge to move towards more sustainable farming practices (Nevens et al., 2008). To achieve sustainable development, knowledge and actions at distinct levels (firm, sectoral, regional, chain or national) are required. Many tools to analyse sustainability have already been developed and described at firm or farm level (e.g. Alaphilippe et al., 2013; Ehrmann & Kleinhanss, 2008; Gerrard et al., 2012; Grenz et al., 2011; Meul et al., 2008; Van Cauwenbergh et al., 2007; Zahm et al., 2008), chain level (e.g. FAO, 2013; Peano et al., 2015; van Asselt et al., 2014) or regional level (e.g. Van Cauwenbergh et al., 2007; Sauvenier et al., 2005), but their implementation remains challenging (Bélanger et al., 2012; Alroe & Noe, 2016).

The implementation challenge is rather diverse and consists of many forms: indicators and tools focus on only one sustainability aspect; they are not developed for specific production systems; they are rather complex; or, they do not take into account the importance of communicating results towards other stakeholders (Bélanger et al., 2012; Binder et al., 2010). More, actual use of assessment results and adoption of sustainable practices is obstructed because the sector's structure prevents individual farmers to exert power on sustainable development. Many small farms are interacting in an atomistic competition (Stiglitz, 1987), selling homogeneous products at the market,

1 which enables customers to easily compare prices and makes farmers to be price takers.
2 The sector's structure gives rise to many non-point-source externalities difficult to
3 monitor and internalise (Field, 1994). Farms function in an agri-food chain with high
4 transaction costs (Santos & Eisenhardt, 2005) and difficult communication because of
5 chain length. Due to this atomistic and complex structure of the sector and the length
6 of the agro-food chain, sustainability efforts at farm level are not always visible at
7 market level and rewarded in higher prices. This means that farmers are reticent to
8 implement sustainable practices because of unexpected costs, risk or uncertainty about
9 price premiums (Lubell et al., 2011; Gocsik et al., 2015).

10
11 Following aspects may help to tackle the issues with implementing assessment tools and
12 adopting sustainable practices. First, a more direct stakeholder involvement seems
13 essential to clarify stakeholders' needs regarding sustainability assessment (Hermans et
14 al., 2011; Neef & Neubert, 2010; Triste et al., 2014). Active stakeholder involvement
15 during the design of a sustainability assessment tool includes different opinions and
16 sources of knowledge and increases the support base for implementation. These factors
17 are indispensable to raise the success of an assessment (Lang et al., 2012; van de
18 Kerkhof, 2006; Stringer et al., 2006; Bond et al., 2012; Bernet et al., 2001; Marchand et
19 al., 2010). However, combining different opinions is time-consuming (Hubeau et al.,
20 2017) and transparency, trust, equity and communication become crucial (Reed, 2008).
21 Second, linking sustainability assessment tools with strategic decision making and using
22 them as guiding instruments for sustainability choices, may facilitate their
23 implementation (Coteur et al., 2016). Sustainability assessment then serves to link
24 farmer's motivation to concrete actions, which creates an extra incentive for
25 implementation. Third, a supra-farm coordination or governance, which implies
26 structures run by a relatively small group of individuals representing (and in support
27 of) a larger group of individuals, may offer support because it relies on existing values
28 or relationships to stimulate its stakeholders in taking action. Working with a supra-farm
29 coordination, however, faces challenges such as the heterogeneity between sub-sectors
30 in terms of sustainability issues at stake, motivations of farmers and advisors to deal
31 with sustainability or the innovation level of the sub-sector.

32
33 The opportunity emerged in Flanders to study the complexity of the design and
34 implementation issue: the largest farmers' union (FU), Boerenbond, requested the
35 researchers to develop a sector-specific and practical sustainability assessment tool
36 (SAT). Although using the concept of tool in SAT and thus throughout this paper, we
37 focus on the assessment method and rationale and not on for instance the software or
38 technical interface of the tool. The concrete research request from the FU allowed us to
39 take into account the aforementioned aspects of involving stakeholders, linking the SAT
40 with strategic-decision making and foreseeing supra-farm coordination or governance.

The objective of this research was thus to implement a participatory action-research approach to develop an on-demand SAT tuned to farmer and sector needs in support of strategic farm and sector decision making. To do so, our research built on and combined published frameworks of Binder et al. (2010) and Coteur et al. (2016), it was implemented in four sub-sectors (fruit production sector, beef production sector, greenhouse production sector and arable farming sector) and could rely on existing governance structures within these sectors. This paper aims at describing outcomes of this action research focussing on two Flemish sub-sectors that differ in context and complexity, in particular on the links of the SATs with strategic decision making and the importance of a supra-farm governance (section 3). Furthermore, key attention points for future SAT development are addressed (section 4).

2. Research approach

2.1 An on-demand precursor for action research

In 2012, the main farmers' union in Flanders (Belgium), Boerenbond, came up with a demand to develop a SAT. At that time, the request fitted in a road-map for concrete actions towards sustainable farming, based on an extensive envisioning process within the FU. As Boerenbond believes that sustainability at agricultural industry level starts with improving sustainability of farms, the main strategic goal was to pro-actively tackle sustainability demands with sub-sector-specific tools at farm level. A SAT must then be able to highlight weak and strong points of the farm and stimulate the farmer to take action.

To contribute to the research objective, following a participatory action-research approach, two important prior choices are made: first on the type of assessment tool and second on the framework to design the tool.

With respect to the first choice, we faced the large variety of tools to assess sustainable development. Many authors have categorized them (e.g. Binder et al., 2013; Binder et al., 2010; Bockstaller et al., 2009; De Ridder et al., 2007; Gasparatos & Scolobig, 2012; Gasparatos et al., 2008; Ness et al., 2007; Schindler et al., 2015; Singh et al., 2012). Categories vary from monetary tools, model tools, bio-physical tools, indicator tools to multi-criteria analysis tools. Given the purpose of the intended SAT, we chose to develop an integrated indicator-based assessment tool using a set of indicators: an integrated assessment because we wanted to include the multi-dimensionality of sustainability; a set of both effect- and means-based indicators because we wanted to be able to point out weak and strong points of a farm. Although both aggregated and non-aggregated indicators can be used together at different stages of an assessment, the former to

1 compare and conclude, the latter to analyse (Bockstaller et al., 2008); we chose not to
2 use one aggregative composite indicator, because a single index hides those weak and
3 strong points. Furthermore, aggregating the various dimensions of sustainability is often
4 not meaningful (Kulig et al., 2010). Gasparatos and Scolobig (2012) confirm that
5 indicator-based tools are best suited to give a broad view on sustainability, to
6 incorporate multiple sustainability perspectives and to include stakeholder participation
7 during their development.

8
9 Regarding the second choice, literature describes various frameworks for constructing,
10 conducting or evaluating sustainability assessment tools and developing or selecting
11 indicators (e.g. Alkan Olsson et al., 2009; Bélanger et al., 2012; Binder et al., 2010; Pülzl
12 et al., 2012; Sala et al., 2015; van Asselt et al., 2014; Van Cauwenbergh et al., 2007;
13 Veleva & Ellenbecker, 2001; Von Wirén-Lehr, 2001; Wiek & Binder, 2005). These
14 frameworks show many similarities, but often lack a clear section on the importance of
15 stakeholder involvement. Sala et al. (2015) and Binder et al. (2010) both developed a
16 framework that explicitly incorporates stakeholder involvement. After considering both
17 frameworks, we decided to use the framework of Binder et al. (2010), because it was
18 based on the development of an indicator-based tool and used for a review of seven
19 indicator-based sustainability assessments tools in agriculture. This theoretical
20 framework, visualized in Figure 1, comprises a normative, systemic and procedural
21 dimension, which are all interlinked (Binder et al., 2010). The main dimension is the
22 procedural one, which describes the design of the assessment tool. The normative
23 dimension focusses on what to assess when dealing with the sustainability of a system
24 and the systemic dimension looks at the system representation. Based on the
25 framework (Figure 1), the participatory action-research approach was conceived in six
26 different phases, with a cyclical process of action, reflection and validation and a number
27 of meetings per phase depending on stakeholders' needs.

Figure 1: Participatory research approach - development process of assessment tools (based on Binder et al. (2010))

2.2 Phase 1: Determining user group, design stakeholder involvement (Procedural dimension)

The first research phase is procedural and coincides with the preparatory phase of the Binder et al. (2010) framework, in which the system, scale of analysis and user group are defined. Decisions on how and when stakeholders are involved are also made during this phase. As such, this phase determines the project outline. The system under study is the Flemish agricultural system and analysis will be done at farm level. The FU requested an assessment tool for four different sub-sectors: fruit production, beef production, greenhouse production and arable farming. To ensure close cooperation with the FU during the full project duration, the participatory research approach involved farmers, advisors and experts through several focus groups and individual meetings. Farmers were FU members and depending on the sub-sector, one or more FU advisors were involved. Experts were invited based on their expertise in the specific sub-sector. In particular during the subsequent phases 2a, 2b and 3, stakeholders participated in an interactive way according to the typology of participation proposed by Pretty (1995), meaning that stakeholders participate in joint analysis to define the sustainability of a specific sub-sector and to select and verify indicators. Doing this, participation is seen as a right, not just a way to achieve project goal. During the phases 4, 5 and 6, the participation typology was more functional, which means that stakeholders are actively involved to solve specific questions regarding the content of the tool, although major decisions were already made during previous phases (Pretty, 1995).

2.3 Phase 2a: Determining sustainability themes that define sustainability at farm level (Normative dimension)

Binder et al. (2010) described the normative dimension as a translation of sustainability concepts into different sustainability themes. Furthermore, goal setting and assessment type have to be taken into account.

Goal setting was done by both the project leaders from the FU and stakeholders from the specific sub-sectors. As a starting point, the FU determined the concept of sustainability. As stakeholders' goals needed to be incorporated in the assessment tools, it was necessary to reveal specific sustainability themes and sub-themes (as described in De Olde et al. (2016)) for each sub-sector. During a first focus group with farmers, experts and advisors, stakeholders were asked to think about the sustainability of their sub-sector and how it is shaped, keeping in mind the economic, environmental and social dimensions of sustainability. This initial brainstorm yielded a list of topics at stake within each sub-sector, afterwards, we structured these topics using a framework developed during the SVAPPAS project (www.svappas.ugent.be) (Table 1). This SVAPPAS framework divides each sustainability dimension into sustainability themes. After structuring the topics at stake, they were (re)clustered to make a final set of relevant sustainability themes for each sub-sector.

Table 1: Framework for structuring topics which define sustainability for each sub-sector (Source: www.svappas.ugent.be)

Environmental	Economic	Social
Nutrients	Profitability	Internal social sustainability
Crop protection	Stability	External social sustainability
Waste	Efficiency/productivity	
Soil	Social-economic	
Water		
Air		
Energy		
Biodiversity		

According to the Binder et al. (2010) framework, the normative dimension is also determined by the assessment type, which entails (i) the type of benchmarking methods, (ii) whether the indicators are effect- or means-oriented and (iii) the aggregation level of indicators. Effect-oriented indicators are more suitable for monitoring, while means-oriented indicators (causal indicators) can highlight changes in management (Bockstaller et al., 2015). To develop the assessment tools, we mostly used existing indicators. Since the assessment type strongly depends on the chosen indicators, this normative dimension is highly influenced by the choices made within the procedural dimension which encompasses the selection of indicators.

2.4 Phase 2b: Determining the complexity of the assessment (Systemic dimension)

The systemic dimension or system representation is characterized by parsimony (as much simplicity as possible), sufficiency (as much complexity as needed) and indicator interaction (Binder et al., 2010). During this phase, the link is made with the Coteur et al. (2016) framework, which combines two dimensions (Figure 2).

Figure 2: Two-dimensional framework which combines the time and complexity dimension of sustainability assessment with the strategic decision making of a farmer (Coteur et al., 2016)

The first dimension relates to the SAT complexity, encompassing three levels: basic, moderate and full. The basic complexity level, level 1, encompasses tools that consist of means-based indicators. These tools allow for a very basic way of qualitative assessment because only readily available data or knowledge of a farmer are needed. At level 2, the assessment becomes more complex because more insight into the sustainability of a farm is necessary to develop improvement strategies. The focus lies on learning and both quantitative and qualitative indicators are used. Level 3 focusses on more thorough assessments, for example Life Cycle Assessment. This full level requires intensive data collection and is more time and budget consuming. Level 3 is also the level at which indicator interaction is taken into account.

The second dimension of the framework is the time aspect of strategic decision-making and includes 5 steps: assessment tool use, interpretation of results, developing improvement strategies, implementation of strategies, monitoring and benchmarking. As a result, a farmer can choose a given complexity of a SAT depending on his needs related to the steps in his strategic decision-making process. Hereby, the farmer creates a farm-specific trajectory of SAT adoption. Coteur et al. (2016) elaborate on this using different examples of such trajectories.

The systemic dimension of Binder et al. (2010) is reflected in the complexity dimension of the Coteur et al. (2016) framework. The first complexity level mainly focuses on

1 parsimony, while the other two levels mainly focus on sufficiency. Stakeholders were
2 consulted to determine which level is preferred within their sub-sector, since they have
3 a very clear view on their sector needs and on their willingness to use a tool at one of
4 these levels. Whether or not to consider indicator interaction results from the chosen
5 complexity level.

7 *2.5 Phase 3: Selecting and verifying indicators (Procedural dimension)*

8 Indicator selection is the next main step in the procedural dimension of the Binder et al.
9 (2010) framework and is linked to both the normative and systemic dimensions.
10 Selected indicators need to characterize the farms within a sub-sector and choices on
11 indicator interaction are made.

12
13 Indicator sets from 60 different peer-reviewed published assessment tools - of which 10
14 were discussed in detail - were listed within a toolbox and resulted in a set of 320 well-
15 described indicators. For each sub-sector, sustainability themes were defined by a set
16 of indicators selected from this toolbox. Indicators were selected based on their
17 applicability to a specific sub-sector, their level of assessment (farm level) and their
18 measurability related to the timeframe of an indicator and the data at hand. If
19 necessary, an additional literature review was done to find more appropriate indicators.
20 After this first selection by the researchers, the indicators were presented to the
21 stakeholders in a second focus group. The goal of this workshop was to verify the
22 selected indicators and discuss their applicability, including calculation and scoring
23 methods within a specific sub-sector.

24 *2.6 Phase 4 – 5 – 6 : Developing - Consulting – Validating (Procedural dimension)*

25 The following three steps of the procedural dimension of the Binder et al. (2010)
26 framework were organized in an iterative way, depending on the needs and the
27 remaining questions of the stakeholders.

28
29 In the fourth phase, the indicators were adapted and refined by the researchers based
30 on the discussions during the second focus group and on the specific needs of every sub-
31 sector. Per sub-sector, indicators were brought together in an Excel file using tabs to
32 distinguish the various sustainability themes. Only some indicators needed adjustments,
33 because most indicators were selected from a toolbox based on scientific literature and
34 containing already well-developed indicators. When necessary, we consulted experts
35 with knowledge on a specific theme or indicator to contextualize and to focus on scoring
36 and weighting when this was lacking in literature.

1 In the fifth phase, also the FU advisors were consulted on these matters and questions
2 were asked about the representation of the sustainability theme (content of indicator)
3 or the importance that was given to a specific question or aspect of the indicator (scoring
4 system).

5
6 These two phases were repeated several times before the assessment tool was tested
7 and validated with farmers in a sixth step. During a farm visit, we tested the assessment
8 tools together with the farmer using his data. During the test, farmers had the
9 opportunity to comment on the design of the questions, data availability and the results
10 of the tool. This sixth phase enabled us to look for gaps in the tool and make important
11 improvements.

12
13 Figure 3 gives an overview of the stakeholder consultations per sub-sector. Research
14 activities are presented by a rhombus shape. Researchers were involved in each of the
15 meetings with advisors, experts and farmers and they analysed and processed data
16 input in between the meetings. Focus groups are presented by an oval shape, individual
17 meetings by a round shape. The number of meetings varies between the sub-sectors
18 because of different stakeholders' needs and the amount of specific knowledge that was
19 needed from advisors of the farmers' union.

Figure 3: Overview of the participatory research trajectory for fruit production sector, arable farming sector, greenhouse production sector and the beef production sector (based on Kerselaers et al., 2015).

3. Results

The participatory research approach resulted in a sub-sector-specific SAT for each of the considered sub-sectors. A first section (3.1) describes the normative dimension of the SATs by elaborating on the farm sustainability concept. Next, the systemic dimension, related to the complexity of the SATs, is described in section 3.2. Section 3.3 describes the procedural dimension by illustrating the beef and fruit production sector in depth.

3.1. Normative dimension: Farm sustainability concept

The normative dimension translates sustainability concepts into various sustainability themes. In our case, the FU determined the overall sustainability concept and opined that economic sustainability is crucial, but that anchorage in society (social sustainability) should be achieved to realize economic sustainability of the Flemish agriculture. Ecological sustainability is seen as a requirement for economic sustainability, which means that resources must not be depleted so that future generations are able to continue resource use. Stakeholders wanted to integrate the three dimensions of sustainability into their daily operations, but each sub-sector pointed out specific issues of concern: for example, animal welfare in beef production sector, visual impact of greenhouses or permanent crops in the fruit production sector. This means that the operationalization of sustainability differed according to the sub-sector. The context-specificity of the results is presented in Table 2. At this stage, themes are still described in a general way, which kept the option to determine more concrete indicators in a later phase. This means that two sub-sectors may consider the same theme as important for their sustainability, but that the content of those themes finally differed. Differences between sub-sectors are then more explicit at indicator level.

Table 2: Normative dimension: context-specific sustainability themes for the four sub-sectors (presence (✓) or absence (✗) of sustainability theme in the SAT)

Themes	Fruit production sector	Arable farming sector	Beef production sector	Greenhouse production sector	Examples of sub-themes
Nutrients	✓	✓	✓	✓	Nutrient management and efficiency
Crop protection	✓	✓	✓	✓	Usage of crop protection products and management
Waste	✓	✓	✓	✓	Waste management
Soil	✓	✓	✓	✓	Soil quality and erosion
Water	✓	✓	✓	✓	Water use and source of water
Air	✗	✗	✓	✓	Air quality and emissions
Energy	✓	✓	✓	✓	Energy use and source of energy
Biodiversity	✓	✓	✓	✓	Diversity of crops and animals near the farm
Landscape	✓	✗	✗	✗	Landscape architecture, visual nuisance,...
Visual and auditive impact	✗	✗	✗	✓	Visual and auditive impact of greenhouses
Society and image	✓	✓	✓	✓	Involvement in the community or relation with recreants
Cooperation	✓	✗	✗	✓	Cooperation between farmers
Labor	✓	✓	✓	✓	Intensity of labor, working conditions, education of employees,...
Productivity	✓	✓	✓	✓	Productivity of labor, capital or land
Profitability	✓	✓	✓	✓	Labor income or return on assets
Stability	✓	✓	✓	✓	Cash flow, solvency, dependency on subsidies...
Family and income	✗	✓	✓	✓	Acceptable family income
Average selling price	✓	✗	✗	✗	Average selling price per unit of product
Succession	✗	✗	✓	✗	Presence of successor
Livestock	✗	✗	✓	✗	Sustainable livestock: selection criteria for livestock, heritability
Animal welfare	✗	✗	✓	✗	Welfare of animals
Animal health	✗	✗	✓	✗	Health of animals
Product quality	✗	✗	✗	✓	No subthemes

3.2 Systemic dimension

In phase 2b, the needs of the different sub-sectors were determined through regularly asking information during workshops and meetings about their interests and goals of using the tool within their sub-sector. This yielded data sets on overall needs (based on De Mey et al., 2011; De Olde et al., 2016; Marchand et al., 2014), integrated by Coteur et al. (2016). In particular, the beef production and greenhouse sector were interested in communicating their progress towards sustainability without time consuming and intensive data collection. On the other hand, fruit production and arable farming advisors focused more on learning between farmers through comparing their results. Linking these needs to the complexity level of the Coteur et al. (2016) framework (Figure 2), two SAT designs remained at complexity level 1 (beef production, greenhouse sector) and two others reached complexity level 2 (fruit production and arable farming).

The necessity of taking into account the interaction among indicators is part of the systemic dimension and depends on the complexity level. For instance, at complexity level 1, the goal was not yet to fully understand the system in detail, but to create awareness on sustainability and possible sector communication. As a result, including trade-offs would ask too much data and time requirements related to these goals. Also for the level 2 tools, we decided not to incorporate indicator interaction as this would complicate the assessment and hamper the discussion of the results with farmers. Binder et al. (2010) point out that this also implies a decrease in system representation and that trade-offs cannot be analysed. We acknowledge this shortcoming, but by using the level 2 results in discussions groups with farmers and linking them with strategic decision making (see section 3.3), trade-offs are discussed qualitatively but also thoroughly.

3.3 Procedural dimension: in-depth illustration of the beef and fruit production sector

The remainder of the procedural dimension will be illustrated and discussed for two examples in each complexity level: the beef production sector for level 1 and the fruit production sector for level 2. These two-subsectors differ to a high extent in terms of expressed needs regarding the assessment tool and mindset within the sub-sector.

3.3.1 The beef production sector

Each sustainability theme was divided into sub-themes and a list of means-based indicators was selected in phase 3 of the development process. The means-based indicators consist of management options for farmers. This long list of management options was shortened during subsequent phases in the process. Table 3 presents the sub-themes and the total number of management options a farmer can implement per

1 sub-theme. Examples of these options are the use of renewable energy such as solar
2 panels or a wind mill, the presence of hedgerows, or the presence of natural light in the
3 stables. A farmer needs to indicate the management options implemented at his farm.
4 The total sum of the implemented management options are listed per sub-theme and
5 theme (Table 3). The questions were built as yes-no questions to indicate the presence
6 or absence of a management option on the farm, which eased the summing of
7 implemented management options. No overall sustainability score is calculated for this
8 complexity level and no weighting between management options or themes is applied.
9 The results of a farm are thus presented as in Table 3, however instead of the total
10 number of management options, the number of implemented management options per
11 sub-theme is indicated.

Table 3: Themes and sub-themes addressed at level 1 for the beef production sector, together with the total number of management options used at each sub-theme

Theme/Sub-theme	Total number of management options	Theme/Sub-theme	Total number of management options
1. Nutrients		Use of electricity	2
Production and storage of manure	2	Alternative energy sources	6
Nutrient cycle, origin and efficient use of feed	5	Saving of fuel	16
Fertilization	11	8. Biodiversity	
2. Crop protection		Genetic diversity of stock	2
Prevention	8	Associated biodiversity in animal production	9
Monitoring	6	Botanic management	4
Usage and reduction	17	Meadow bird management	5
3. Waste	8	Farmland management	6
4. Soil		Associated biodiversity in feed production	3
Erosion	14	9. Livestock	2
Soil structure	5	10. Society and image	13
Organic matter	3	11. Animal welfare	
Soil biodiversity	2	General	1
Chemical soil quality	2	Feed and water supply	7
5. Water		Housing	15
General	1	Pain	4
Drinking water and feed	4	12. Animal health	
Cleaning	2	General	4
Quality, purification and re-use of water	6	Introduction and transfer of diseases	11
Alternative water sources	2	Fire safety	3
Irrigation	6	13. Labour	
Re-use of water from feed production	2	Safe working conditions and health in animal production	22
6. Air		Entrepreneurship and succession	9
General	3	Education	1
Reduction of ammonia emission	5	Labour intensity and efficiency	1
Reduction of odour emission	1	Safe working conditions and health in feed production	9
Reduction of methane emission	4	14 Succession	/
7. Energy		15. Income/Productivity/profitability/Stability	4
General	2		

3.3.2 The fruit production sector

In phase 3, an initial selection of 84 indicators was presented to a panel of diverse experts during individual meetings. These discussions resulted in a list of 52 indicators. This list was further reduced by combining indicators within the same theme, resulting in a list of 35 indicators (Demeyer et al., 2012). During phase 4 and phase 5, these indicators were refined or removed to match the context-specificity of the FU's fruit production sector. The final SAT consists of 32 indicators. Each sustainability theme has one or more indicators, which are effect-based, means-based or a combination of both.

An indicator is scored between 0 (least sustainable) and 100 (most sustainable). This means that the score of each indicator is rescaled to increase the comparability between indicators and to enhance the visualization of the results. Different scoring methods are used to score the indicators. Where possible, we used indicator values from a reference group of farmers as a benchmark value (e.g. water efficiency, source of energy) or pre-defined scores from literature (sustainable crop protection or income stability). When no literature was available or benchmarking with a reference group was not possible (e.g. specialization of the farm and safety of the working environment), benchmarks were based on the input of experts and advisors. To compose the reference group for calculating the benchmarks, we used farms of which the area of apple, pear and cherry exceeded 80% of the total area. The benchmark values were calculated by means of deciles and the results of the reference farms were divided into 10 deciles. A minimum, 9 deciles and a maximum were calculated with each decile representing a score between 0 and 100. An overview of the selected indicators is presented in Table 4. Per indicator, a description, the type of indicator and the scoring method is shown.

Before testing the SAT, we held a meeting with farmers to introduce the SAT and to receive valuable feedback. The SAT was first tested by four farmers to improve the design of the assessment tool. Farmers gave feedback on the questioning, the results generated by the SAT and its practical use. Although yet limited as test, upscaling seemed reasonable: next step would be the implementation or use of the SAT by a larger group of farmers. Such a large scale implementation would enable to check and improve the practical use of the assessment tool and improve benchmarks. The current status of the SAT allows for continuous improvement while upscaling. As Figure 3 shows, phase 4-5-6 were repeated to enhance the content of the assessment tool.

Table 4: Definitions and methodological facets of the selected indicators for the fruit production sector

Sustainability theme	Indicator	Description	Type of indicator	Scoring method
Nutrients	Nutrient management	Risk of environmental impact by improper nutrient management	M	L
	Nitrogen efficiency	Amount of nitrogen produced per unit consumed nitrogen	E	RG
	Phosphor efficiency	Amount of phosphor produced per unit consumed phosphor	E	RG
Crop protection	Sustainable crop protection	Risk of environmental impact by improper crop protection management	M	L
Waste	Waste management	Risk of environmental impact by improper waste management	M	L
Soil	Soil quality	Soil quality based on organic matter content, chemical and physical soil quality	E	L
Water	Water efficiency	Unit of water produced per unit consumed water	E	RG
	Water intensity	Amount of water consumed per unit of land	E	RG
	Source of water	Share of alternative water resources (rain water, surface water and shallow ground water)	M	L
	Water quality	Risk of surface water pollution by waste water	M	L
Energy	Energy efficiency	Unit of energy produced per unit consumed energy	E	RG
	Energy intensity	Amount of energy consumed per unit of land	E	RG
	Source of energy	Share of renewable energy used	M	RG
Biodiversity	Associated biodiversity	Diversity of crops and animals near the farm	M	L;E
Landscape	Landscape	Awareness for visual nuisance, landscape architecture and maintaining cultural heritage	M	L
Society and image	Society and image	Relation with tourists and recreants, involvement in and services for the community	M	L
Cooperation	Cooperation	Cooperation between farmers within the fruit production sector	M	L

Labour	Labour intensity	Indicates the stress level of farmers in one year	M	L
	Employment	Staff turnover both for seasonal and permanent workers	M	L
	Entrepreneurship	Degree of the farmer's entrepreneurship	M	L
	Safety of working environment	Indicates the safety of the working environment and the amount of safety measures taken	M	L;E
	Education of employees	Opportunity an employee to follow education	M	L
Productivity	Productivity	Labour, capital and land productivity	E	RG
Profitability	Profitability	Return on assets and labour income	E	RG
Average selling price	Average selling price	The average selling price per unit of product	E	RG
Stability	Solvency	Solvency ratio and its evolution relative to the previous financial year	E	RG;E
	Dependency on subsidies	Share of subsidies in gross margin (totale revenues minus direct costs in euro)	E	RG
	Cash flow	Cash flow of farm business	E	RG
	Specialization of farm	Indicates the specialization rate based on the income of a specific cultivar and the number of ha per cultivar	E	L;E
	Income stability	Stability of the income and how a farm is protected against unforeseen circumstances	M	L

Indicator type: E = Effect-based; M = means-based

Scoring method: RG = benchmark based on reference group; L = indicator score from literature; E = indicator score based on input from experts

1 Scores are presented per sustainability theme by taking the average of the individual
2 indicator scores, without using weights. They are visually integrated in a radar graph to
3 give a clear overview of the scores and give an accurate insight in the performance of
4 the farm on every sustainability theme (Albo et al., 2016). The radar graph information
5 is complemented by a bar chart, indicating the individual indicator scores to discover
6 the reason behind low or high results for a theme. We advise users to use the bar chart
7 when identifying weak and strong points and not only base the interpretation of the
8 results on the sustainability scores of the themes. The radar graph and bar chart are
9 presented in Figure 4 and 5, showing a fictive example.

10
11 **Figure 4:** Fictive example of results for the fruit production sector. Indicator scores are
12 visually integrated in radar graph at sustainability theme level. Sustainability score
13 between 0 (least sustainable) and 100 (most sustainable).

Figure 5: Results of indicator scores from fictive example (figure 4) presented in a bar chart. Sustainability score between 0 (least sustainable) and 100 (most sustainable).

4 Discussion

4.1 Link with strategic farm and sector development

Given the atomistic farm structure within a (sub)-sector and the sector-specific differences resulting in different SAT design complexities, much attention needed to be paid to align farm and sector development. We used two lenses, both issuing from the Coteur et al. (2016) framework: first, the functional view, second the time dimension.

First, with respect to the functional view, it was important to focus on one tool function instead of trying to combine more than one within the assessment tools. Common tool functions are communication, monitoring, farm development and reporting. Combination of different tool functions within one tool often restricts tool use (Triste et al., 2014; Marchand et al., 2014). By using the Coteur et al. (2016) framework during the development of the assessment tools and uncovering the needs and the context in which each farmer, group of farmers, or even sub-sector operate, we were able to focus

on one function at a time. Many authors state that taking into account the context, the addressed function and end-user is important during the development process of an assessment tool. (Bockstaller et al., 2009; Cerf et al., 2012; Dahl, 2012; van de Fliert & Braun, 2002; Triste et al., 2014). Although context-specific assessment approaches can be time- and resource-consuming and despite some disadvantages such as reducing the possibility of standardization or neglecting more global sustainability issues (Binder et al., 2010; Mascarenhas et al., 2010), Gasso et al. (2015) confirm that a high level of specificity within the assessment tools can stimulate farmers in taking action to improve the sustainability of on their specific farm.

Second, the use of the assessment tools was linked to the strategic decision-making process, which relates to the time-dimension of the Coteur et al. (2016) framework. The first step of the framework, using the SAT, can be done within the daily operations of the FU. This offers a possible larger scale implementation or use of the tool with the goal to make farmers aware on the sustainability issues in their sector. Based on the results of this first step, advisors, farmers or farmer groups can choose their specific trajectory. As a result, the following 4 steps will be different for the different sub-sectors and even for the specific advisor, farmer or farmer groups using the SAT within a sub-sector. The use of this framework gives the end-user the opportunity to deliberately link the use of the SAT to his strategic decision making.

These lenses and their interaction are reported here in detail for two sub-sectors, again the beef and fruit production sectors are chosen because of their difference in obtained complexity level. The beef production sector specified its needs in terms of communicating the sustainable development of their sub-sector to the broader public in a straightforward way. The SAT was therefore developed at complexity level 1 with communication of the sub-sectors' sustainable development as the main objective of the tool. However, to meet this objective the SAT needs to be used at a larger scale during the first step of the Coteur et al. (2016) framework. The results of the SAT then lead to an overview of implemented management options at sectoral level. By repeating the assessment over time and evaluating the progress, the FU can identify weak and strong points at sectoral level and develop improvement strategies. The results show for instance how many famers implement a water audit or how many farms were care farming. Over time, the sub-sector's sustainability is reflected in the total sum of implemented management options, which will be communicated towards farmers and external actors. The SAT's result focuses on the progress of a sub-sector and does not aim to indicate a good or bad sustainability performance because the management options are not scored based on their impact on sustainability. The drawback of this basic assessment is the superficial view on the sustainability of a farm or sub-sector because it is not capable of giving detailed information about the weak and strong points of the farm itself. By communicating the progress on sustainability to external actors, and thus by raising the consumer awareness of sustainability, FU advisors wanted to

1 trigger the farmers to implement more sustainable farm practices. Furthermore, by
2 giving farmers an accessible tool at complexity level 1, rather than a more complex and
3 time-consuming tool at level 2 or 3, their interest in sustainable breeding and learning
4 about sustainable farm practices could be triggered. Looking into a list of management
5 options and thinking about their implementation can raise awareness on the subject of
6 sustainability. The latter is rather a side effect of using the SAT than the main focus of
7 the assessment tool.

8 The fruit production sector requested a SAT with a farm focus. This sector already has a
9 long history with integrated production, the awareness within this sector is already high
10 and many farmers are willing to adopt sustainable practices, also visible in the use of
11 production standards, e.g. Global G.A.P or IPM production standards (Damos et al.,
12 2015; Sansavini, 1997). Despite the fact that production standards focus mostly on
13 ecological aspects (Demeyer et al., 2012), it shows that the fruit production sector is
14 engaged in sustainable fruit production. Therefore, the main function of the fruit
15 production sector's SAT is farm development, with a focus on learning between farmers
16 by comparing their SAT's results. In the first step of the Coteur et al. (2016) framework
17 the level 2 SAT can be completed by an advisor from the FU together with farmers as
18 calculations are based on readily available data. Because of the close cooperation with
19 the FU, we used mainly their accountancy system to collect data for the SAT in the fruit
20 production sector. Indicators of the SAT are adapted to the data provided by this system.
21 This, however, implies that the compatibility of the assessment tool with other
22 accountancy systems might be rather low, as the data gathering might not be in line
23 with that from different accountancy systems.

24
25 The assessment tool at complexity level 2 visually highlights weak and strong points by
26 means of a radar graph. The radar graph offers a benchmark when farmers discuss their
27 results during discussions groups in step 2 of the framework. They can quickly compare
28 their results and discuss strategies for the improvement of their farm (step 3 of the
29 Coteur et al. (2016) framework). They are able to make strategic choices based on the
30 SAT output and related discussions. Furthermore, they can decide whether further in-
31 depth monitoring on some urgent specific issues is necessary and thus decide if making
32 the step to level 3 tools is worthwhile. Such radar graphs are also used by other tools
33 such as the SAFA, RISE, MOTIFS or IDEA tools (FAO, 2013; Grenz et al., 2011; Meul et al.,
34 2008; Zahm et al., 2008) and literature confirms that these graphics are useful in
35 supporting discussions (De Mey et al., 2011; Meul et al., 2008; Sala et al., 2015).

36
37 Of major importance during the discussion groups is the validity of the chosen
38 indicators, the accuracy of the SAT's output and related the interpretation of the results.
39 The SAT of the fruit production sector consists of effect- and means-based indicators or
40 a combination of both. Although van der Werf & Petit (2002) and Bockstaller et al. (2008)
41 argue that the use of effect-based indicators is preferred to means-based indicators as

the latter do not indicate the actual impact on sustainability, we experienced that means-based indicators are valuable when focusing on learning within discussion groups. Means-based indicators proved to be an important base for discussion, without the need for understanding the calculation method behind the effect-based indicators thoroughly. Furthermore, the data availability and the accuracy of the output varied among the indicators. For instance, data input for the indicator source of energy is reliable because the total amount of used energy and the amount of produced energy was listed in the accountancy of the farmer. Other indicators were derived from questionnaires or based on well-known literature. However, some indicators provided less accurate results due to a lack of data or calculation methods. For instance, results defined by the indicator water efficiency were found to be inaccurate due to a lack of accountancy data. Farmers were seldomly aware of the amount of surface or rain water they have used. The interpretation of the results can be affected by the use of means-based indicators and by the varying accuracy of the SAT's output. Therefore, transparency about the data correctness and accuracy of the results were already addressed during the SAT development. Transparency was provided by a manual for each of the tools, including the structure and content of the tool, the scoring method and a section about the interpretation of the results.

4.2 Reflection on the importance of an existing governance structure

Finally, we discuss the influence an existing governance structure, such as the FU, has on the entire process and eventually future governance. The fact that the FU management decided to take action, to develop a road map towards sustainable farming and to initiate the development of sub-sector specific SATs must be seen as a top-down action within the FU. This top-down decision was considered as necessary to effectively start the discussion about sustainable farming within the organization. We experienced some major advantages of working with a large FU as Boerenbond, such as the leverage it offered to organize meetings and workshops, the ability to use their knowledge about the agricultural sector and their large network. The FU was a central actor in our SAT development process and implementation. Furthermore, being leader in a sustainability development initiative gave credibility to the FU, which may lead to an increased market power at sector level and allow better negotiations with other agro-food chain actors on sustainability requests, and thus finally could end up with a higher financial return at farm level. Next to the advantages, working with a relatively small group of individuals within the FU yielded the following attention point: do they have the same values or priorities as the larger group of farmers they represent? For a researcher it is important to be aware of this and to continuously reflect on the choices that have been made, having in mind this larger group of farmers.

1 However, the implementation of the assessment tools was obstructed because not all
2 of the members of the FU supported the top-down decision to develop SATs (Coteur et
3 al., 2014). The dominant reasons not to support the approach and to use these SATs
4 within a context or sub-sector-specific discussion groups were very diverse. First and
5 foremost, as stated by Coteur et al. (2014), there was a gap between the viewpoints of
6 the project initiators, the actual members of the FU and their advisors on the strategic
7 focus related to sustainable farming. Although of major importance, there was a lack in
8 communication and transparency about the top-down decisions related to such
9 strategic issues. In addition, a change in leadership/management with new priorities
10 occurred, which again obstructed the development of a continued vision on the
11 implementation of the SATs. Kotter (1996) confirms that changes or decisions will not
12 occur when they are not anchored in the organization. Due to insufficient envisioning
13 continuity, the capacity of the farmers' union to support mutual action and to
14 implement sustainable practices eroded. Also at the level of the advisors, we
15 experienced obstructions to implement the SATs. First, the current evaluation system of
16 the advisors within the FU is based on individual farm visits and consultancy moments,
17 the organization of discussion groups we suggested in the framework are not included.
18 As a result, some advisors of the FU experienced this as an extra not rewarded work
19 load. Second, they already experienced a lack of time within their daily work program,
20 and current management did not intend to appoint staff to support, guide or organize
21 such discussion groups using the SATs. Finally, many advisors were still focusing on
22 efficiency and did not want to reinforce the concept of sustainability that such
23 trajectories aim at. Also here we experienced differences between sub-sectors, the
24 advisors of the fruit production sector were more interested in implementing the SAT
25 than for instance the advisors of the arable farming sector, mainly because of the history
26 of integrated pest management in the sector and thus their open-minded viewpoints
27 towards sustainability issues. Also the more direct link of the fruit production sector with
28 the market and consumers could play a role in this difference as sustainability efforts
29 can be made more visible to consumers.

30
31 Finally, the importance of continuing the envisioning process is illustrated with the
32 current shift within the FU strategic focus towards climate smart agriculture. As such,
33 future collaborations with the FU will direct the implementation of the SATs and the
34 trajectory approach to the current strategic focus of climate smart agriculture. The SATs
35 will be re-examined and adapted to this focus, but the vision of sustainable farming
36 incorporated now is definitely coherent with the vision of climate smart agriculture.
37 Although the SATs and trajectory approach was (i) designed to the sub-sector and
38 stakeholders needs at a specific moment and (ii) linked with the strategic focus of the
39 organisation (FU) at that time, we experienced a continuous need to adapt to ongoing
40 dynamics and visions and an appropriate anchoring within the institutions. Therefore, a
41 recurrent evaluation throughout the process of tool development and implementation

is recommended (Coteur et al., 2014), and thus the need of flexible tools and approaches still stands.

5. Conclusion

The analysis in this paper allowed us to elucidate crucial aspects for developing and implementing sustainability assessment tools in agriculture. Although the research issued from a concrete demand and was action-research based, we derived two key attention points for future tool development processes. The first concerns the necessity of tuning sustainability assessments to stakeholder needs. Appropriate tuning not only implies stakeholder involvement right from the start while taking context specificity into account, but also supposes continuous monitoring of underlying issues or motivation of stakeholders. The second attention point relates to the nature of the development context, such as the structure of the agricultural sub-sector in which the assessment is developed and implemented, the strategic issues at stake and the role of a supra-farm governance structure inducing the process.

The first attention point is supported by the fact that our participatory research approach and stakeholder involvement led to a variety in tools and trajectories for the four sub-sectors considered. Dependent on the context of the sub-sector, the implementation of the tools occurred with different methods and intensities, resulting in context-specific tools that differed in goals, themes, complexity and indicators. Although this is very important for enabling farmers to follow a farm-specific trajectory and implement improvement strategies (Coteur et al., 2016), the intrinsic differences between the sub-sectors are a major reason for a difficult implementation of the assessment tools. The farmers' union advisors from the fruit production sector, for instance, were more interested to put the tools into practice than the arable farming sector.

The second attention point relates to the developmental context of the sustainability assessment. Although the tool development included many stakeholders, the original decision to develop tools was made top-down. Having the farmers' union as a central actor in the tool development process and implementation has some advantages, such as the leverage effect of the organization or their extensive knowledge and network. But the inevitable top-down nature of such an envisioning process also entails that not all members of the FU involved in the project were in favour of a sustainability assessment (Coteur et al., 2014). This could have influenced the lack of implementation within some sub-sectors. Finally, top-down envisioning will be sensitive to changes in leading positions within the organization. Events in our action research illustrated that such changes may alter the strategic focus of the organization and thus the choice to use

1 budget for other strategic issues rather than investing in the implementation of the
2 SATs. Therefore, evaluating the differences in motivations and vision within the supra-
3 farm governance is of major importance throughout both the development and
4 implementation process.

5
6 The research finally shows that combining existing research approaches, such as the
7 Binder et al. (2010) and the Coteur et al. (2016) frameworks, proved valuable to
8 reconcile the stakeholder involment with context-specificity and governance. However,
9 we strongly recommend to organise recurrent evaluation moments to align motivations
10 and visions within the supra-farm governance structures. In addition, future research
11 should focus even more on the implementation of “flexible” assessment tools, the role
12 of stakeholders, the existing governance structures, and the link with strategic issues at
13 stake.

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