Review of current metrics, indicators and tools for monitoring the socio-economic performance of FAB solutions

Deliverable DT1.2.3 and DT1.2.4

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Project partners:

Title	Review of current metrics, indicators and tools for monitoring the socio-economic performance of FAB solutions
Date	28/2/2020
Contracted Client	EU Interreg
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How to cite this document	Wustenberghs H., Thielen M., Messely L. (2020) Review of current metrics, indicators and tools for monitoring the socio-economic performance of FAB solutions. Interreg North-West Europe FABulous Farmers, Deliverable DT1.2.4, Flanders Research Institute for Agriculture, Fisheries and Food (ILVO), Merelbeke, Belgium, 26 p.

Content

1 Introduction

1.1 Project background

The agricultural sector, the basis for the agro-food sector in North West Europe, is today heavily dependent on external inputs (fertilizers, pesticides, etc.) and creates a number of negative effects on the quality of natural resources (soil, water, biodiversity). Functional Agrobiodiversity (FAB) (targeted stimulation of biodiversity to deliver ecosystem services such as pest and disease control, pollination, soil and water quality) offers opportunities to drastically reduce the dependence on inputs, but the knowledge in this area is still highly fragmented and insufficiently embedded in agricultural practice, policy and society. The FABulous Farmers project aims to accelerate the implementation of FAB by farmers and other land managers in NWE, by collecting, deepening and sharing knowledge and practical experiences about FAB between farmers, scientists, citizens and policy makers in 12 pilot regions in NWE over 5 countries (FR, NL, UK, BE and LUX). 10 FAB solutions are developed in a region-oriented manner, tested and demonstrated across 315 farms and evaluated for ecological performance and economic profitability, with the aim of reducing the dependence on external inputs. In each pilot region, a FAB learning network is set up, in which farmers exchange knowledge and experiences and draw up a FAB action plan. In addition, we collaborate with local actors, citizens, policy makers and value chain partners to embed FAB more widely in society, policy and market, through the design and implementation of FAB landscape integration plans and the rollout of citizen science tools; development of policy papers (at EU and national / regional level), and 12 business cases for valorisation of FAB via the market. Finally, a long-term development plan is drawn up for the continuation and expansion of the FAB learning networks after the end of the project.

1.1.1 Position of this report in the project context

The work described in this report is part of work package 1 (WPT1) - task AT1.2 that identifies user-friendly tools and methods to measure the environmental and socio-economic performance of FAB solutions. These tools, methods and indicators should balance the need for on-farm efficiency, with the need for scientific robustness to measure change and provide regional project partners with aids for on-farm assessment.

1.1.2 Indicators in FABulous Farmers

In the FABulous Farmers project four types of indicators and tools are distinguished:

1. Performance indicators: measuring the effect of the implemented FAB measures
    - Economic performance - profitability: cost/benefit (yields)
    - Ecological/environmental performance: external input use (pesticides, fertilizers) and effects on natural resources (water, soil & biodiversity)
2. Tools to support farmers' learning processes: indicator sets that provide insight into overall farm sustainability and the positive impact of FAB.
3. Decision support tools: practical on-the-farm tools to assist farmers in their decision-making for implementation of FAB in their farming activities
4. Citizen science tools: community engagement tools and methodologies.

This report focusses on the second type of indicators: tools to support the farmers' learning process about overall farm sustainability and the positive impact of FAB. This introduction goes on to define some key concepts, while the following sections describe tool selection.

1.2 Integrated sustainability assessment tools (ISATs)

1.2.1 Sustainable agriculture

FABulous FArmers aims to result in a positive impact on sustainable development of farming and farming regions by enlarging knowledge and accelerating the implementation of FAB.

Brundtland defined sustainability as: "Development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs" (WCED, 1987). The FAO elaborated on that and defined sustainable agriculture as "the management and conservation of the natural resource base, and the orientation of technological change in such a manner as to ensure the attainment of continued satisfaction of human needs for present and future generations. Sustainable agriculture conserves land, water, and plant and animal genetic resources, is environmentally non-degrading, technically appropriate, economically viable and socially acceptable" (FAO, 1988). Sustainability thus integrates multiple dimensions.

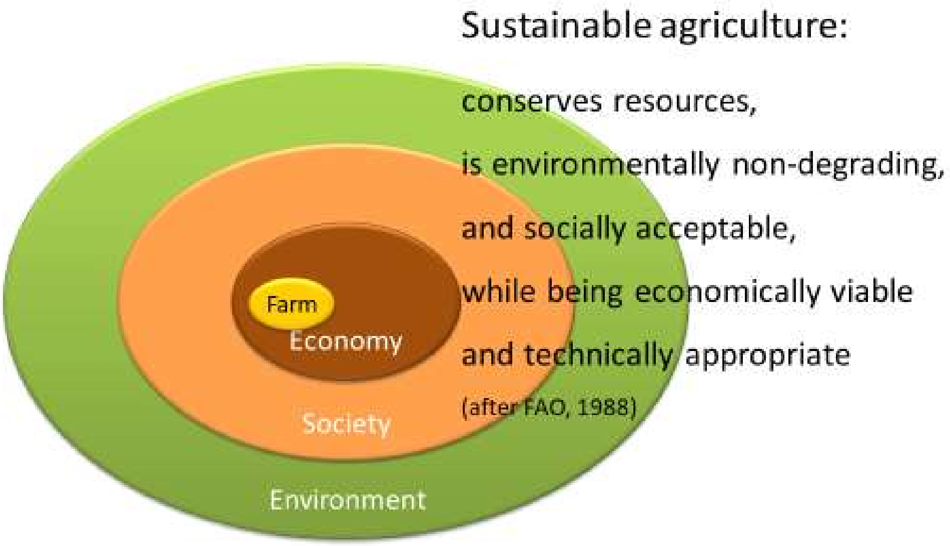

Figure 1 Sustainable agriculture definition and dimensions (definition following FAO, 2013)

1.2.2 Integrated sustainability assessment tools (ISATs)

From the definition of sustainable farming it follows that a farm sustainability assessment should integrate at least three dimensions: environmental integrity, economic resilience and social well-being. In its framework for Sustainability Assessment of Food and Agriculture systems (SAFA), the FAO (2013) introduced a fourth dimension: good governance. In sustainability assessment frameworks, the main sustainability dimensions are further broken down into themes and subthemes. For example, in SAFA the environmental dimension covers six themes: atmosphere, water, land, biodiversity, materials and energy, and animal welfare. The atmosphere theme split into greenhouse gases and air quality.

Conceptual frameworks, such as SAFA, need to be made concrete by a sustainability assessment tool, i.e. an analytical technique that can facilitate the assessment by measuring and monitoring sustainability (Gasparatos and Scolobig, 2012). Such tools integrate multiple dimensions and themes and assess multiple criteria, they are thus called multi-criteria assessment tools or integrated sustainability assessment tools (ISATs).

1.2.3 Sustainability indicators

ISATs can be sets of models and/or indicators, structured within a software or application. Indicators are variables, which points to, provide information about, or describe the state of phenomena, which are difficult to measure directly. Indicators measure performance or reflect changes in activities, projects or programs. Indicators are considered easy-to-use tools for farmers, because they simplify the complex system, inform and encourage decision-making (Girardin *et al.*, 1999; Hák *et al.*, 2007; UNAIDS, 2010). Even if often simplifications, indicators do need to point towards increased sustainability: *"an indicator is like a lighthouse, if we don't pay attention, we'll end up crashing on the rocks"* (Armen and Hänninnen, 2015: v).

Three types of indicators can be distinguished:

(1) target-based indicators assess whether plans or policies are in place;

(2) practice-based indicators, also called means-based, refer to indicators that assess farm practices or technical means;

(3) performance-based indicators, also called effect-based or result-oriented, are used to assess the impact of practices (FAO, 2013: 56-59).

From (1) to (3) the indicators usually come closer to the reality of the impact they aim to assess, while the feasibility of measurement decreases (Payraudeau and Van der Werf, 2005) (Figure 2). The indicator type used, is thus an important determinant for the complexity of an ISAT (Coteur *et al.*, 2018).

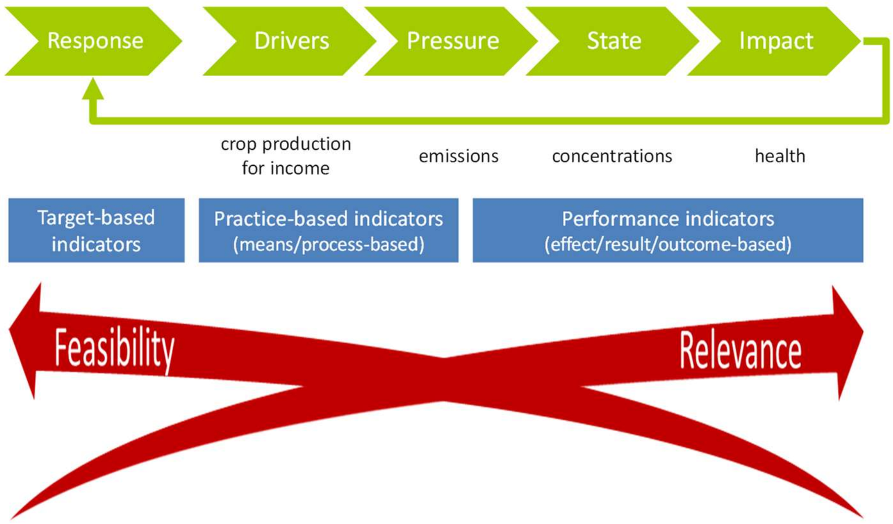

Figure 2 Indicator types and their relevance and feasibility (After Payraudeau & Van der Werf, 2005 and FAO, 2013)

1.3 Selecting an appropriate ISAT for FABulous Farmers

The selection of an appropriate ISAT to support farmers' learning process about sustainability in the FABulous Farmers project, was done in three phases:

1. In the first phase six ISATS, that were estimated to support farmers' learning process were selected from a larger pool of ISATs previously studied at ILVO.
2. In the second phase the thematic coverage of these six ISATs was studied in-depth, which allowed to reduce the selection to two ISATs that fitted closest to the FABulous Farmers themes.
3. In the third phase the two most appropriate ISATs were tested in practice and a final decision was reached.

2 Phase 1: Selection of integrated sustainability assessment tools able to raise farmer awareness and support learning processes

2.1 Criteria for sustainability assessment in FABulous Farmers

Sustainability assessment, in general, is "conducted for supporting decision-making and policy in a broad environmental, economic and social context, and transcends a purely technical/scientific evaluation" (Sala *et al.*, 2015). It is a process that aims to direct decision-making towards sustainability (Pope *et al.*, 2017). In FABulous Farmers, specifically, the focus is on decision-making by farmers and directing their farm management towards increasing sustainability.

Coteur *et al.* (2016) argued that in order to guide farmers' strategic decision making, sustainability assessment tools should be used in a flexible way. Different tools, of different complexity, can thus be used in different steps of farmers' pathway towards sustainability. As their business evolves towards more sustainability, farmers need tools with different functions. In the first instance, the ISAT in FABulous Farmers should be suitable to raise farmers' awareness about sustainability and support their leaning process. Triste *et al.* (2014) and Coteur *et al.* (2016) both emphasise that farmers in such a case first need a quick assessment that is communicative to raise their interest and awareness, before they require a decision support tool that may be more complex.

Criteria to select potential ISATs for FABulous Farmers thus were:

- Farm level assessment;
- Quick assessment tool;
- ISAT's primary purpose is farmer learning, farm development (not just certification);
- ISAT can be used in North West Europe and in all countries therein;
- ISAT can be transposed to the project context without further research.

2.2 Selection procedure for potential ISATs for FABulous Farmers

To select potential ISATs for FABulous Farmers we could build on previous work by ILVO's Social Sciences Unit.

A first source was our previous research for the OECD TempAg research collaboration (Wustenberghs *et al.*, 2015). There, an inventory of 170 sustainability frameworks, metrics and tools was compiled from a scan of peer reviewed and grey literature and internet sources. From this inventory, ISATs were selected that are

(i) suited for agriculture (regardless of the assessment level);
(ii) applicable in temperate climates;
(iii) designed to assess sustainability in an integrated way based on at least three dimensions – economic, environmental and social.

Furthermore, in this previous research an in-depth literature study was performed on how to discern ISATs and the characteristics used to do so. These characteristics were questioned in an online survey with the ISAT developers/users, which resulted in a database of 37 ISATs x 25 characteristics.

A second source was a part of Ine Coteur's PhD research (Coteur *et al.*, 2018). She used the TempAg database as a starting point, but while that included all types of ISATs, the PhD research focussed on ISATs that may support farmers' strategic decision making (making it an excellent source for FABulous Farmers). With this farmer focus, the initial database was narrowed down, using four key criteria:

(i) (one of the) primary purpose(s) stated in the TempAg survey was farm development (discarding ISATs that only focus on reporting, research, or certification);

(ii) the assessment level is the farm or field level (discarding ISATs with larger spatial scales, such as farming industry, national/regional and product level assessments);

(iii) the potential end-user(s) of the ISAT results are farmers or farmers in discussion groups (discarding ISATs exclusively aiming at policy makers or researchers);

(iv) the SATs should already be implemented on farms.

The selection yielded 18 ISATs, which were analysed in-depth using a focussed literature study and interviews with the tool developers. This allowed to place the ISATs in the management-complexity framework, proposed by Coteur *et al.* (2016), as is shown in Figure 3.

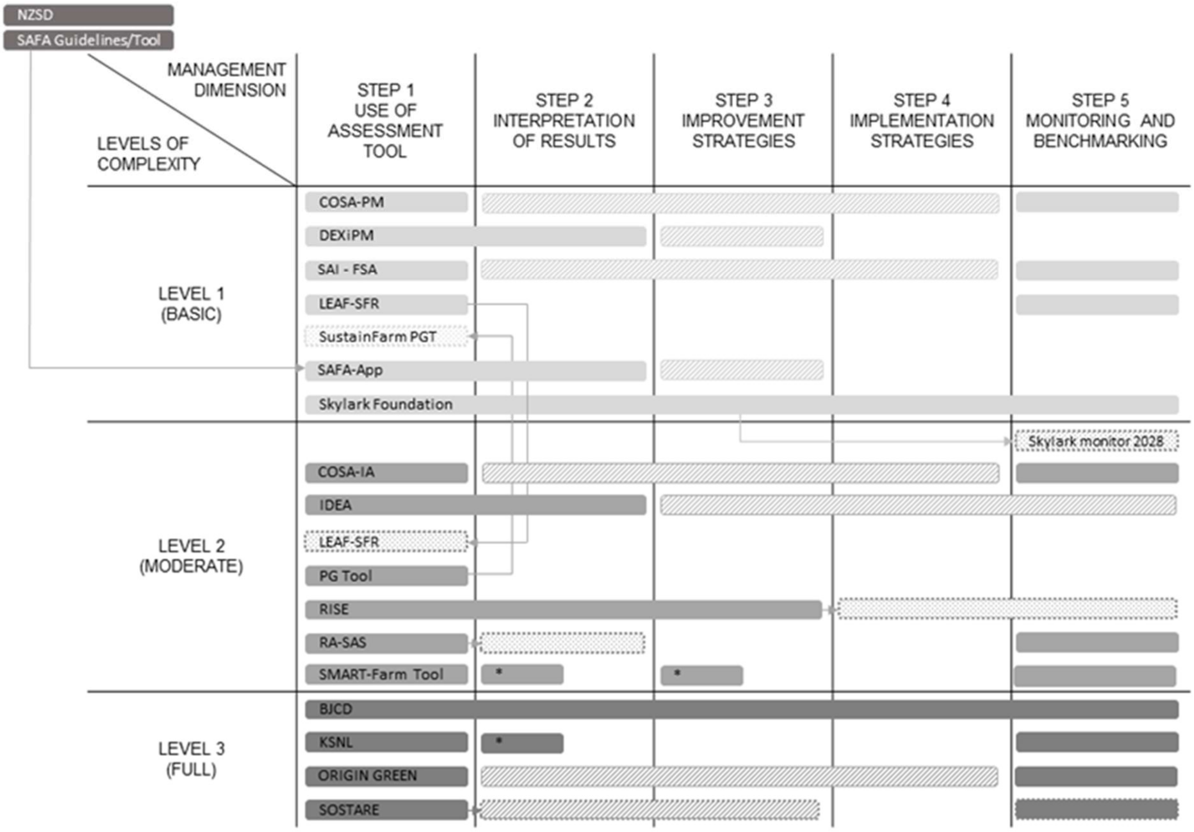

Figure 3 *SATs classification according to their complexity level and the steps in the farmer's strategic decision making (sustainability management)*
*(solid bars = position of SAT in management-complexity framework; dotted bars = the future ambitions of the SAT developers, indicating the direction in which they want these tools to evolve; hatched bars = steps dependent on external parties; * = only non-personal information via report)*

In the management-complexity framework of Coteur *et al.* (2016), complexity levels are distinguished based on the characteristics of the tool itself, i.e. use of qualitative or quantitative indicators, data collection methods or the time requirement. First level "basic" ISATs are a very quick and easy way to assess a farm using farmer's knowledge and readily available data. Indicators are very simple and consist mainly of target or practice-based indicators. Second level "moderate" ISATs, can be quantitative or qualitative, simple or complex, but the data collection itself stays rather simple. Level three "full-scan" ISATs provide detailed information on the sustainability themes and often use performance indicators.

The management dimension of the framework reflects the steps in the farmer's decision-making process in sustainability management. We looked at the number of steps an ISAT incorporates or supports.

- step 1: the actual use of an assessment tool;
- step 2: interpretation of the results and gaining insights into the sustainability of multiple farm aspects;
- step 3: finding options, i.e. developing improvement strategies;
- step 4: implementing the new strategies on the own farm;
- step 5: monitoring and benchmarking, i.e. follow-up of and reflection on the outcomes.

The ISAT classification in Figure 3 was used as a basis for selection of potential ISATs for FABulous Farmers. In a meeting with the FABulous Farmers management board on March 26th, 2019, Ine Coteur and Hilde Wustenberghs discussed ISAT properties, using the criteria in section 2.1. They concluded to further evaluate six ISATs:

1. DEXiPM
2. LEAF-SFR
3. PG Tool
4. SustainFarm PG Tool
5. SAFA-App
6. SMART Farm Tool

Table 1 shows an overview of these ISAT's full names, primary purposes, origins, literature sources and scopes. The characteristics used by Coteur et al. (2018) to classify the ISAT's in the management-complexity framework (Figure 3) are listed in Annex 1.

This choice of potential ISAT's to support the FABulous Farmers' learning process was confirmed at the SCT meeting of April 11th, 2019, with the assignment for ILVO to look closer into the details of the tools. It was stated there that the more "basic" ISATs are more fit for farmer learning and raising awareness, e.g. in farmer discussion groups, but they are less suited for baseline and performance measurement, as the assessments in these ISATs are mostly qualitative (e.g. low/moderate/high), meant to provide a holistic picture of sustainability, and thus rather general (as opposed to a specific, quantitative effect measurement).

Table 1 Overview of ISATs selected for in-depth analysis

	Abbreviation	Full name of the ISAT	Primary purpose	Origin	Literature	Sector scope	Regional scope
1	DEXiPM	DEXi Pest Management (Multi-Attribute Decision Making in integrated pest management)	Support the design of innovative cropping systems and give advice	INRA, France	Pelzer *et al*. (2012), Vasileiadis *et al*. (2013), Angevin *et al*. (2017)	crop production	Europe
2	LEAF-SFR	Linking Environment and Farming - Sustainable Farming Review	Management tool that helps farmers to farm more sustainably	LEAF, UK	LEAF-SFR and LEAF-IFM websites	general	international
3	PG Tool	Public Goods Tool	Assess the provision of "public goods" by a farm Aim is to create awareness and give an overview of strong and weak points	Organic Research Centre, UK	Gerrard et al. (2011, 2012), ORC (2014), PG tool website	general	Europe
4	SustainFarm PG Tool	SustainFARM Public Goods Tool	Assess farming system sustainability and decision support tool for farmers and land managers	ORC, SustainFarm project	ORC (2019)	general	Europe
5	SAFA-App	Sustainability Assess-ment of Food and Agriculture systems - Smallholders App	Capacity building, collective learning and raising awareness	FAO	FAO (2015), SAFA website	general	international
6	SMART-Farm Tool	Sustainability Monitoring and Assessment Routine – Farm Tool	Giving a broad and diverse picture of the farm sustainability and monitoring. Benchmarking farms worldwide.	FiBL, Switserland	Schader *et al*. (2016), SMART website	general	international

3 Phase 2: Evaluation of ISATs thematic content

In the second phase of the FABulous Farmers ISAT selection, DEXiPM, LEAF-SFR, both versions of the PG Tool, the SAFA-App and the SMART Farm Tool were studied in detail for their thematic content.

3.1 Selection criteria for the learning tool in FABulous Farmers

A preliminary version of this study was presented at the FABulous Farmers partner meeting in Hoekse Waard, the Netherlands, on June 25th, 2019. There the selection criteria for the learning process support ISAT were fixed:

1. The ISAT should at least cover all the themes of the FABulous Farmers performance indicators;
2. The assessment cost (in terms of staff time or external expertise) should be low, as little budget is foreseen for a learning tool;
3. Any necessary data should be readily available;
4. The assessment should be do-able in every pilot region;
5. The assessment should not ask too much effort from the farmers, as different kinds of tools will be used in the project that each will demand an effort/data from the farmers.

3.2 Method for evaluating ISATs thematic content

The thematic scope of the 6 ISAT on the FABulous Farmers shortlist was studied using two lenses.

First, a sustainability assessment should be based on a solid conceptual framework (Sala et al., 2015). For FABulous Farmers, the potential ISATs' themes were set off against the SAFA framework, the Sustainability Assessment of Food and Agriculture systems, proposed by the FAO (2013). SAFA offers a holistic framework, with the guiding vision that food and agriculture systems worldwide are characterized by four dimensions of sustainability, i.e. the three that are traditionally considered: environmental integrity, economic resilience and social well-being, plus the newly introduced "good governance". SAFA outlines the essential elements of these dimensions in 21 themes, e.g. for the environmental dimension: atmosphere, water, land, biodiversity, materials and energy, and animal welfare. The themes are further divided into 58 sub-themes, e.g. for atmosphere: greenhouse gases and air quality. An overview is given in Figure 4.

Second, it was checked whether and how the six ISATs cover the themes of the FABulous Farmers performance themes, i.e.

- Economic performance - profitability: cost/benefit (yields);
- Ecological/environmental performance: external input use (pesticides, fertilizers) and effects on natural resources (water, soil & biodiversity).

Both lenses were made explicit in an Excel file, in which themes and subthemes were listed for each of the six ISATs and then summarised on two overview sheets, one using the lens of the SAFA framework, the other using the FABulous Farmers themes lens. The overviews can be found in Annex 2 and Annex 3 respectively.

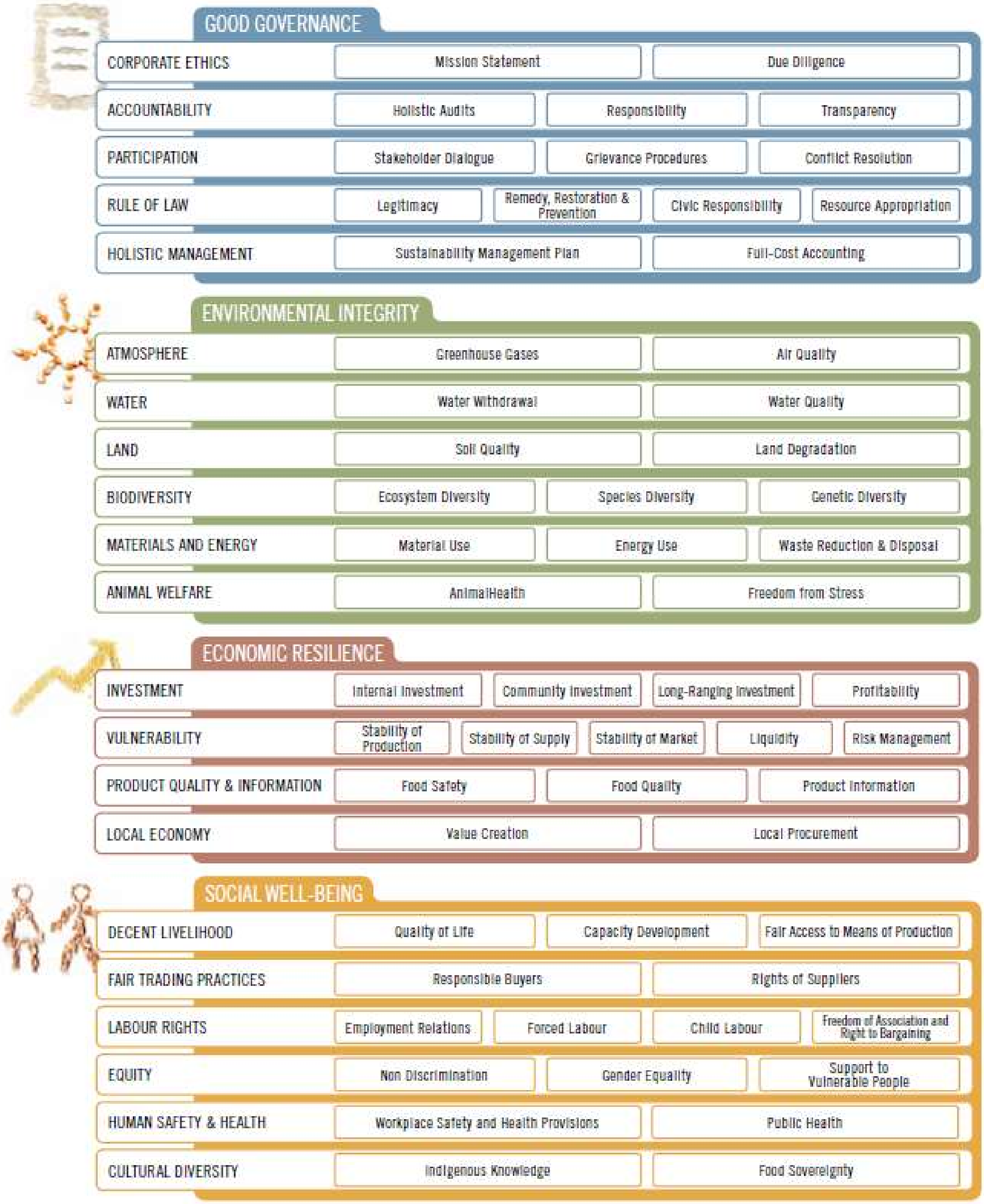

Figure 4 The SAFA framework with the four dimensions of sustainability and the themes and subthemes in each dimension

3.3 Result from the SAFA based evaluation

The overview sheet using the lens of the SAFA framework showed very well where there are gap in the ISATs thematic coverage or not.

- The environmental themes are covered rather good in all ISATs.
- Even if a SAFA subtheme is covered in a given ISAT, the correspondence is not always complete. For example, the PG Tool only considers carbon emissions, not all greenhouse gas emissions.
- Indicators related to crop protection and fertilisation need to be inserted in the water, soil or air quality themes and the working conditions theme in case of protective clothing. This may complicate SAFA-based tools, such as SMART, in which for example the pesticide indicators are attributed to several SAFA themes (and thus need to be weighted).
- The economic dimension of sustainability is not assessed by the LEAF Sutainable Farming Review (LEAF-SFR).
- "Landscape & Heritage" and "Social Value of Landscape", which are themes in the PG Tool, DEXiPM and LEAF-SFR, cannot be found in the SAFA framework.
- The Governance dimension of sustainability was introduced by SAFA. It is covered in the SAFA-based tools, i.e. SAFA App and SMART, and in the recent SustainFarm PGTool, but not in the somewhat older tools, i.e. the "standard" PGTool and DEXiPM.

3.4 Results from the FABulous Farmers themes evaluation

By using the FABulous Farmers themes lens, a number of issues were found, which are explained below and summarised in Table 2.

1. Yield – gross margin – productivity

- Only DEXiPM, PG Tool and SMART Farm Tool take yield into account.
- Gross margin:
  - The PG Tool and SMART Farm Tool assess farm product prices, but not input cost;
  - Only DEXiPM assesses production cost (inputs: pesticides, fertilizer, fuel, seed, irrigation)
- SAFA App & SMART assess stability of farm profitability, not the yield, producer prices or input cost.
- The SustainFarm PGTool assesses farm business resilience, not economic themes considered in FABulous Farmers.
- LEAF-SFR does not cover the economic dimension at all.

2. Pesticides

- DEXiPM and SMART cover pesticide related issues in the most complete way.
- In LEAF-SFR and SustainFarm PGTool the coverage is insufficient.
- The "standard" PG Tool and SAFA App show moderate coverage.
- It needs to be noted that the SAFA App contains questions with "no go" answers. These are answer options that can cause a whole indicator to be rated as red or "unacceptable", even if other questions are green ("good"/"best"). One of these questions is "48. Do you ever mix pesticides?" in the Hazardous Pesticides subtheme of Product quality and information. If this question is answered with "Yes" this is a "no go" (No = green). In NW-Europe, probably not many farmers can answer this question

with "No", especially since it isn't specified for "synthetic pesticides", contrary to some other questions.

3. Fertilisers
- Best covered in DEXiPM, PGTool and SMART.
- The PG Tool even has a quantitative assessment of this theme. The farm's N-, P-, K-balance is calculated based on content of inputs & outputs (the farm's inputs (seed, feed, fertiliser, etc. and outputs (tonnes of crops and numbers of animals) need to be listed in an Initial Data Collection sheet).
- The SAFA App moderately covers this theme.

4. Water quality
- LEAF-SFR and SustainFarm PGTool rather focus on water use than on the protection of surface/groundwater.
- Best coverage in SMART.
- Moderate coverage in PGTool and SAFA App.

5. Soil quality and land degradation
- Best coverage in DEXiPM and SMART.
- Moderate coverage in all other ISATs.

6. Biodiversity

Relatively good coverage in all ISATs.

Table 2 Summary of ISATs coverage of FABulous Farmers themes

Theme	DEXiPM	LEAF-SFR	PG Tool	SustainFARM PG Tool	SAFA-App	SMART Farm Tool
Yield	++	no	++	no	no	++
Cost/benefit	cost	no	sales price	no	no	sales price
Profitability	++	no	farm business resilience	farm business resilience	+	++
Pesticides	+++	insufficient	+	insufficient	+	+++
Fertilisers	+++	++	+++	+++	++	+++
Water quality	+	water use	+	water use	+	+++
Soil quality	+++	++	++	++	++	+++
Biodiverity	++	++	++	++	++	++

The content of this summary table is based on the exhaustive table in Annex 3.

3.5 Conclusion from the thematic evaluation

Following conclusions were drawn from the results shown in the previous sections:
- SMART Farm Tool and DEXiPM are the most complete ISATs;
- PG Tool and SAFA App show reasonable thematic coverage;
- The PG Tool is partly quantitative, all other assessments are qualitative;
- The LEAF-SFR and the SustainFarm PG Tool show insufficient thematic coverage and therefore do not meet the first FABulous Farmers selection criterion (section 3.1).

3.6 Conclusions for further ISAT testing

The above results and conclusions were presented at the October 1st, 2019, SCT meeting. There the conclusions were also set off against the other FABulous Farmers selection criteria (section 3.1).

1. SMART Farm Tool
   This is the most complete tool of the six ISATs studied. Moreover, its qualitative assessment is partly based on quantitative data. However, the SMART Farm Tool does not meet the second FABulous Farmers selection criterion: using this ISAT would be too expensive for this project. An assessment by trained external analyst, including the farm report would cost ± 1500 € per farm. Also the alternative of training SMART analysts within FABulous Farmers would be infeasible due to the training time needed.

2. SAFA App
   This is a very simple tool, that still covers many (sub)themes in simple questions. It is a self-assessment, which would not ask too much effort from the farmers (criterion 5). Many of the FABulous Farmers partners, who attended a presentation on SAFA[1], were enthusiastic about it. However, at the time of the SCT meeting, the tool was no longer supported by the FAO (surveys not available on server).

3. DEXiPM and PG Tool
   These are the other ISATs that showed respectively good and reasonable thematic coverage. It was decided to test these two ISATs in practice before making a final decision on the learning tool to use for FABulous Farmers.

4 Phase 3: Evaluation of 2 ISATs in practice

Following the conclusion from the previous section, Hilde Wustenberghs (ILVO) and Michel Thielen (LTA) both tried using DEXiPM and the PG Tool for a specific farm. They found advantages and disadvantages for both ISATs, which are summarised in Table 3.

These results were presented at the November 25th-27th, 2019, FABulous Farmers partner meeting, together with following recommendations:

- Using DEXiPM would require time and efforts from the FABulous Farmers assessors, as software training is recommended and an agreement would need to be reached on thresholds for the qualitative assessment categories across the project regions and cases.
- Using the PG Tool seems most feasible for inexperienced assessors, as the Excel software is quite intuitive. However, as the thematic coverage of crop protection related issues is insufficient, using an extra tool for this theme is recommended.

The partners follow these recommendations and it was decided to use the PG Tool as a tool for raising farmers' awareness about sustainability and support their learning process.

[1] Several FABulous Farmers partners attended the Workshop on Sustainability and Resilience Assessment Methods, organised by the SusCrop ERA-net on September 10th, 2019, at the Flanders Research Institute for Agriculture, Fisheries and Food (ILVO) in Melle, Belgium (www.suscrop.eu).

Table 3 Advantages and disadvantages of DEXiPM and PG Tool found in a comparison in practice

	Advantages	Disadvantages
DEXiPM	• Together with SMART, the most complete ISAT in the thematic evaluation of 6 ISATs (section 3.5) • Assessment feasible at system/plot level (comparison between plot with/without FAB measures feasible) • Clear tree structure, reflecting dimension, themes, subthemes and indicators • Different types of result graphs can be built by the software	• The tool is designed in DEXi software on a Java platform. It's use is not intuitive and carefully studying the manual and/or training are prerequisites for the assessors. • Qualitative assessment of themes and subthemes (low/medium high): what at first seems an advantage, is in practice a disadvantage. It is not clear what the definitions of the categories are. In FABulous Farmers, thresholds for the categories would need to be established. • Language issue: in the "English" version, the commands are in English, but the themes and subthemes to be evaluated are still in French.
PG Tool	• The tool is an Excel file, with an initial data collection sheet and sheets per theme that need to be filled out. It's use is quite intuitive and would not require much training for the assessors. • Partly qualitative assessment: N-, P-, K- and energy balances are calculated based on quantitative data (areas of crops; import/export of seeds, forage, etc.; whole farm use of organic and inorganic fertilisers; numbers of animals on the farm; etc.) • Qualitative assessments are clearly defined: many yes/no questions or predefined answer categories. • Results (summary spider graph and bar chart with subtheme scores) are built as the sheets are filled out	• Less complete ISAT • The assessment of crop protection related issues is definitely insufficient. There are only 9 questions on herbicide and other pesticide use in the "agri-environmental management" theme. • Only available in English.

5 Conclusion

The Public Goods Tool (PG Tool) will be used in the FABulous Farmers project as a tool for raising farmers' awareness about sustainability and support their learning process. Gérard Conter and his colleagues at LTA adapted it to a "FAB-PG-Tool", by removing all external links and adapting UK-specific issues to the European context of all pilot regions. A training on the tool will be organised on March 2nd, 2020.

A working group will be created in the FABulous Farmers project to discuss the issue of an appropriate pesticides indicator (and potentially give advice to European decision makers about this issue).

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SMART:	https://www.sustainable-food-systems.com/en/smart/

Annex 1: General, complexity and management characteristics of ISATs

Extract from Annex 3 to Coteur *et al*. (2018)

		1. DEXiPM	2. LEAF-SFR	3. PG Tool	5. SAFA-App	6. SMART-Farm Tool
GENERAL CHARACTERISTICS	**Stated goal** **Primary purpose**	Support the design of innovative cropping systems and give advice	Management tool that helps farmers to farm more sustainably	Assess the provision of “public goods” by a farm. Aim is to create awareness and give overview of weak and strong points farm.	Capacity building, collective learning, raising awareness	Giving a broad and diverse picture of the sustainability of the farm and monitoring. Benchmarking farms worldwide.
	Sector scope	crop production	general	Intitial focus on organic was broadened to include all farms	general	general
	Regional scope	Europe	UK, international	Europe	international	international
	Level of assessment	Field	Farm	Farm	Farm	Farm
	Applying user	Researcher and advisor	Farmer	Advisor or researcher + farmer The advisor does the evaluation.	Farmer or advisor	Trained analyst
	End-user	Researchers and advisors Farmer	Farmer + LEAF-Marque certification	Farmer	Farmer, advisor	farmer and downstream agri-food chain actors

		1. DEXiPM	2. LEAF-SFR	3. PG Tool	5. SAFA-App	6. SMART-Farm Tool
COMPLEXITY DIMENSION	**Method data collection**	Combination of a questionnaire based interview and field visit	Online self-assessment	Interview to fill out Excel file, with a worksheet per theme and an initial general data collection sheet.	Self-assessment via app	Standardized interview procedure, by trained auditor
	Time for data collection	1-2h	2-4h on average	2-4h	1h	2-3h
	Total assessment time	1,5-4h	2-4h on average			
	Data intensity	low	low	medium-low	low	rather low
	Data type	qualitative judgement (high/medium/low), partly based on quantitative data	qualitative data *In future, LEAF would like to make the SFR more quantitative.*	Mainly qualitative and some quantitative data *A more quantitative self-assessment App is being developed.*	qualitative data	qualitative and quantitative data
	Assessment type	qualitative	qualitative assessment (answer options range from fully achieved, considerable progress, some progress, not started or not applicable)	Mainly qualitative assessment, quantitative for nutrients and energy. Each question is marked with a score between 1 (no benefit) and 5 (highest score).	Qualitative assessment (green - yellow - red)	Quantitative score (0-100%), based on qualitative assessment (1-5 score) of positive and negative aspects per theme Complex calculation algorithm
	Type of indicator	Practice-based indicators	Mainly target- and practice-based indicators, few performance-based	Mainly practice-based, some target- or performance-based	Practice- and target-based indicators	Target-, practice- and performance-based indicators
	Number of indicators	Depends on the use in practice	90 questions	54 indicators 183 questions (V2)	40 indicators (100 questions)	Number of indicators depends on relevance check, i.e. an automatic selection of a subset from a pool of 327 indicators

		1. DEXiPM	2. LEAF-SFR	3. PG Tool	5. SAFA-App	6. SMART-Farm Tool
MANAGEMENT DIMENSION	**Step 1 - Assessment**	Describe and analyse the existing system. Dashboard is built automatically and various types of tables can be drawn by the software.	Automated result graphs build as the data are entered. Bar charts per dimension compare the farm's performance with the previous year (if available) and with the average of all users in the previous year.	The assessment is carried out by an advisor or researcher, together with the farmer. In the Excel results sheet a graphical report is built as the interview progresses (radar diagram overview + bar charts per theme)	Automated report: 21 themes histogram	Automated 60 page report, including the overall results and the results per theme in a radar diagram, …
	Step 2 - Interpretation of results	Results are discussed in groups	The self-assessment is accompanied by guidance and signposting to extra material that explains the meaning of the question. Results are presented in a report without support.	Results are presented without support (occasionally explanation about lay-out or use of report, but no recommendations).	Default SMSs /voice mail messages support interpretation	… guidance on how to read it, and per subtheme a table of positive and negative aspects. So farmers can see where they are doing well where they could improve.
	Step 3 - Improvement strategies	Adjust: design a new cropping system	/	/	Default SMSs /voice mail recommendations are sent for indicators rated "unacceptable". Advisors may customize these messages.	The report provides automated suggestions for improvement measures. Sometimes results are discussed in farmers' workshops (mainly in developing countries).

		1. DEXiPM	2. LEAF-SFR	3. PG Tool	5. SAFA-App	6. SMART-Farm Tool
MANAGEMENT DIMENSION	**Step 4 - Implementation strategies**	Accompany implementation of new cropping system	/	/	/	The SMART-Farm Tool is not intended to provide extension services to individual farms.
	Step 5 - Monitoring and benchmarking	Evaluate new cropping system	Regular use of the LEAF-SFR is mandatory for LEAF-Marque certification. Monitoring may also be done voluntary.	/	/	Monitoring is recommended either every third year or after a substantial change in farm management. Benchmarking = goal. The tool is intended to "support the comparability between farms that are completely different".

Annex 2: SAFA themes in 6 ISATs

dimension	Theme		Subtheme		DEXiPM	assessment (yes/no)	LEAF-SFR	assessment (yes/no)	PG Tool	assessment (yes/no)	SustainFarm PG Tool	assessment (yes/no)	SAFA-App	assessment (yes/no)	SMART assessment (yes/no)
Environmental integrity	E1	Atmosphere	E 1.1	Greenhouse Gases	greenhouse gas emission	1	Greenhouse Gas Emissions + Carbon Footprint	1	carbon emissions	1	carbon emissions	1	GHG mitigation practices	1	1
			E 1.2	Air Quality	NH3-emission + pesticide volatilisation	1	Pollution Risk Assessment + Action Plan	1	/	0	/	0	Air pollution prevention practices	1	1
	E2	Water	E 2.1	Water Withdrawal	water use	1	Water Management Water Use Efficiency	1	water management: irrigation, water harvesting	1	/	0	Water conservation practices	1	1
			E 2.2	Water Quality	eutrophication potential (surface water quality)		Nutrient management - N-use - Fertiliser Application		manure management		NPK balance	1	Water pollution prevention practices	1	1
					groundwater quality	1	SOM % + Synthetic Nitrogen Use Efficiency	1	water management: reducing pollution	1					
					aquatic toxicity pesticides + heavy metals		Drainage land + built areas		crop protection and pesticides: prevention measures						
							Crop Health and Protection	1	Biodiversity: Crop protection & pesticides	1				0	
	E3	Land	E 3.1	Soil Quality	chemical + physical + biological	1	Soil Management Plan + Soil quality	1	Soil management	1	Soil management	1	Soil improvement practices	1	1
			E 3.2	Land Degradation	fysical soil quality	1	Soil Erosion + cultivation & drilling method	1	Soil management: erosion	1		1	Land conservation and rehabilitation practices	1	1
	E4	Biodiversity	E 4.1	Ecosystem Diversity	flora field margins + weed diversity & abundancy	1	Landscape and Nature Conservation	1	Biodiversity: habitats, AES, etc,	1	Management of boundaries	1	Ecosystem diversity	1	1
			E 4.2	Species Diversity	natural enemies & pollinators	1	Monitor Flora and Fauna	1	Biodiversity: rare species	1	Cropland & Livestock diversity,		Species conservation practices	1	1
			E 4.3	Genetic Diversity	/	0	/	0	Ag system div.: livestock & cropland diversity	1	woody perennials + genetic heritage	1	Saving seeds and breeds	1	1
	E5	Materials and Energy	E 5.1	Material Use	mineral fertiliser use	1	N-use	1	NPK balance	1	NPK balance	1	Nutrient balance	1	1
			E 5.2	Energy Use	consumtion (direct + indirect) & efficiency	1	Energy-efficiency	1	Energy & Carbon	1	fuel use & contractor work	1	Energy Use	1	1
			E 5.3	Waste Reduction and Disposal	/	0	Reduce-reuse-recycle	1	Farm wast disposal	1	/	0	Food loss and waste reduction	1	1
	E6	Animal welfare	E 6.1	Animal Health	/	0	Animal Husbandry		Animal health	1	Animal health, health plan, staff resources, biosecurity	1	Animal Health and welfare	1	1
			E 6.2	Freedom from Stress	/	0	/	0	Animal welfare	1	Ability to perform natural behaviours + housing	1	/	0	1
Economic Resilience	C1	Investment	C 1.1	Internal Investment	investment capacity	1		0	Farm resilience: investment	1	Farm resilience: investment	1	/	0	1
			C 1.2	Community Investment	/	0		0	/	0	/	0	Community investment	1	1
			C 1.3	Long Ranging Investment	/	0		0	/	0	/	0	/	0	1
			C 1.4	Profitability	gross margin, subsidies, labour cost	1	**LEAF-SFR does not realy cover the economic dimension of farm sustainability**	0	Financial viability: prices	1	/	0	Profitability	1	1
	C2	Vulnerability	C 2.1	Stability of Production	Authonomy of the enterprice:	1		0	Farm resilience: still in business	1	Farm resilience: still in business	1	Product diversification	1	1
			C 2.2	Stability of Supply	independency from subsidies	1		0	Renewable energy	1	/	0	/	0	1
			C 2.3	Stability of Market	economic efficiency pesticide dependency	0		0	Ag system fiv.: Marketing outlets & on-farm processing	1	Farm resilience: demand for non-food production	1	Stability of Market	1	1
			C 2.4	Liquidity	specialisation	0	Financial Planning	1	Financial viability: assets	1	Financial viability	1	Liquidity	1	1
			C 2.5	Risk Management		1		0	/	0	Farm resilience	1	Safety nets	1	1
	C3	Product Quality and Information	C 3.1	Food Safety	Acceptibility of the product	1		0	Food security: Food quality certification	1	/	0	**Hazardous pesticides**	1	1
			C 3.2	Food Quality	access to output market: product quality	1		0	Food security: 3rd party endorsement	1	/	0	Food quality	1	1
			C 3.3	Product Information	access to output market: sanitary demands	1		0	Food security: Food quality certification	1	/	0	Certified products	1	1
	C4	Local Economy	C 4.1	Value Creation	/	0		0	Food security: local food	1	Farm resilience: ≠ sources of income + Systems diversity: n° marketing outlets, on-farm processing	1	Regional workforce	1	1
			C 4.2	Local Procurement	Contribution to employment	1		0	Food security: off-farm feed	1	/	0	/	0	1
					Rural integration / social value of landscape	1	Community Engagement	1	Landscape & heritage: historic features, landscape management	1	Landscape & heritage: historic features, landscape management	1		0	0

Social Well-being	S1	Decent Livelihood	S 1.1	Quality of Life	job satisfaction	1	/	0	Employment: salary	1	workload non-food production	1	Quality of life + Wage level	1	1
					operational difficulties	1	/								
			S 1.2	Capacity Development	access to knowledge	0	Staff IFM Awareness	1	Skills & knowledge	1	Skills and knowledge	1	Capacity development	1	1
			S 1.3	Fair Access to Means of Production	access to inputs	1	/	0	/	0	/	0	/	0	1
	S2	Fair Trading Practices	S 2.1	Responsible Buyers	Profitability: sales price	1	Customer Relationships	1	/	0	/	0	Fair pricing	1	1
			S 2.2	Rights of Suppliers	access to output market	1	Supplier Relationships	1	/	0	/	0	/	0	1
	S3	Labour Rights	S 3.1	Employment Relations	/	0	/	0	Employment	1	/	0	Employment relations	1	1
			S 3.2	Forced Labour	/	0	/	0	/	0	/	0	Forced Labour	1	1
			S 3.3	Child Labour	/	0	/	0	/	0	/	0	Child Labour	1	1
			S 3.4	Freedom of Association and Right to Bargaining	/	0	/	0	/	0	/	0	Freedom of association and right to bargaining	1	1
	S4	Equity	S 4.1	Non Discrimination	/	0	/	0	/	0	/	0	Non-Discrimination	1	1
			S 4.2	Gender Equality	/	0	/	0	/	0	/	0	Gender Equality	1	1
			S 4.3	Support to Vulnerable People	/	0	/	0	/	0	/	0	/	0	1
	S5	Human Safety and Health	S 5.1	Workplace Safety and Health Provisions	farmer's / workers' health risk	1	Worker Safety & Welfare, Social Audit	1	Human health & wellbeing (incl. exposure to chemicals)	1	Human health & wellbeing	1	Workplace Safety and Health Provisions	1	1
			S 5.2	Public Health			Product Safety and Quality	1	Animal health: Biosecurity	1	Animal health: Biosecurity	1	/	0	1
	S6	Cultural Diversity	S 6.1	Indigenous Knowledge	/	0		0	/	0	/	0	Indigenous knowledge	1	1
			S 6.2	Food Sovereignty	/	0		0	/	0	/	0	Food Sovereignty	1	1
Good Governance	G1	Corporate Ethics	G1.1	Mission Statement	/	0	Business Direction, development,	1		0	Holistic management	1	Mission explicitness	1	1
			G 1.2	Due Diligence	Acceptability of the strategy to society	1		0		0	Ethics	1	/	0	1
	G2	Accountability	G 2.1	Holistic Audits	/	0		0		0	Accountibility: previous SA	1	Accountability: accuracy of records	1	1
			G 2.2	Responsibility	/	0		0		0	/	0	/	0	1
			G 2.3	Transparency	access to output market: sanitary demands	1	Records	0		0	/	0	/	0	1
	G3	Participation	G 3.1	Stakeholder Dialogue	/	0	Public access	1	Public access	1	Public access	1	Participation	1	1
			G 3.2	Grievance Procedures	/	0	Resolution of Farm Complaints	1		0	/	0	/	0	1
			G 3.3	Conflict Resolution	/	0		0		0	/	0	Conflict Resolution	1	1
	G4	Rule of Law	G 4.1	Legitimacy	/	0	Legislative Requirements	1		0	Ruke of law	1	Legitimacy: Compliance	1	1
			G 4.2	Remedy, Restoration and Prevention	/	0		0	The governance dimension was not included in the "classic" PG Tool V2, it is included in V3	0	/	0	/	0	1
			G 4.3	Civic Responsibility	/	0		0		0	/	0	/	0	1
			G 4.4	Resource Appropriation	/	0		0		0	/	0	Tenure rights	1	1
	G5	Holistic Management	G 5.1	Sustainability Management Plan	/	0	Farm Environmental Policy & Plan	1		0	Accountibility: sustainability management plan	1	Sustainability Management Plan	1	1
			G 5.2	Full-Cost Accounting	/	0		0		0	/	0	/	0	1
						28		24		32		27		42	58

Annex 3: FABulous Farmers themes in 6 ISATs

	FABfarmers theme	DEXiPM	LEAF-SFR	PG Tool	SustainFARM PG Tool	SAFA-App	SAFA-Tool	SMART-Farm Tool
Economic performance	**Yield**	Production value (= yield * sales price)	LEAF-SFR does not cover the economic dimension of farm sustainability	Yield level	/			Yield
	Gross margin			Level sales prices	/			Producer price vs. market price (level, tendency, loss)
		Production cost (inputs: pesticides, fertilizer, fuel, seed, irrigation)		/	/			
	Profitability			/	/	Profitability: "During the last five years, how often were farm revenues greater than costs?"	C 1.4 Profitability	Profit stability
		Subsidies		/	/			
		Labour cost		/	/			
				Farm business resilience: investment capacity, farm longevity, etc.)	Farm business resilience: investment capacity, farm longevity, etc.)			
Environmental and ecological performance	**Pesticides**			dependent on version!	The biodiversity theme, with its subtheme Crop Protection and pesticides was dropped from the Sustainfarm PG Tool			Knowledge active subst.
						45. Synthetic pesticides (Y/N)		Use of PPPs
	D driving factor = use	Treatment Frequency Index (TFI)						
								N° act. subst. Use growth regulators
	P pressure = toxicity, risk	Air: drift, volatilization				46-48 hazardous pesticides		
		Water: - Leaching groundwater - Aquatic toxicity		prevent water contamination				Persistence in water None on riparian strips Toxic to aquatic organisms
		Soil: toxicity					C 3.1.2 Hazardous Pesticides: (handling highly hazardous pesticides & use of biological or mechanical pest management techniques)	Persistence in soil
		Fauna pressure - natural enemies - Pollinators	CP.CQ.11 Environmental risk	Questions on taking biodiversity into account when spraying				
		Flora pressure						
		Farmer & worker health risk			Human health and wellbeing: training of those handling pesticides	73 no vulnerable groups, only trained operators 74 Protective clothing		Protective clothing
		risk of residues					C 3.1.3 Food Contamination: No MRL exceeding	
	S state							Acute toxicity inhalation
	I impact							Correct waste disposal
	R response = measures		CP.CQ.1-10 questions on various response measures	general control method		51. Crop disease management = practices list (yes/no)		
				sprayer calibration		58. Sprayer cleaning		
		pesticide cost						

Fertilisers							
D driving factor = use	mineral N-, P-, K- fertilisation organic N-fertilisation organic amendements/fertilisation	SM.SQ.07 N-use SM.SD.02 Synthetic Nitrogen Use Efficiency	N-, P-, K- mineral & organic inputs	N-, P-, K- mineral & organic inputs	41. Fertiliser *type* used		322-324 Mineral N-, P-, K- usage 308 share farmyard manure
P pressure = toxicity, risk	N surplus P surplus eutrophication potential chemical soil quality		N-, P-, K- balance calculated based on content of inputs & outputs	N-, P-, K- balance calculated based on content of inputs & outputs			378-380 point sources of nutrients and pollutants
S state							
I impact							
R response = measures	stubble and straw management	Nutrient Management Plan	Soil analysis		43. Determination dose	E 3.1.3 Soil Chemical Quality	290 Determination dose < soil analysis
			Determination dose		42 Soil fertility measures: cover crops, N-fixation, intercropping, crop rotation		≠ analyses
		Fertiliser Storage	Manure storage		38. Manure management (storage, application, compost use)	E 2.1.2 & E2.2.2 Water Conservation & Pollution Prevention Practices > fertilisation measures	
		Fertiliser Application	Application methods				708 Precise fertilisation
	deep soil cultivation						
	mineral fertiliser cost						
Water quality							
D driving factor	pesticides & fertilisers: see above	CP.CQ.11 Environmental risk pesticides Fertilisers: see above	prevent water contamina-tion by pesitices (above) N-,P-, K-balance	/ N-,P-, K-balance	45. Synthetic pesticides (Y/N)		pesticides & fertilisers: see above
P pressure = toxicity, risk	erosion, runoff & leaching risk (see below)						700 erosion prevention measures
	heavy metal contamination			/			
S state						E. 2.2 Water Quality E 2.2.3 Concentration of Water Pollutants E 2.2.4 Wastewater Quality	
R response = measures			Measures to minimise water pollution and maximise water efficiency		58. Water pollution prevention measures (crop/animals directly next to water, sprayer cleaning, domestic wastewater)	E 2.2.2 Water Pollution Prevention Practices	Measures to minimise pollution e.g. 285 cover crops; 299 green cover; 605 riparian strips; 601-602 permanent grassland conversion/restorage; 743 % sealed area; 377,05 wastewater discharge; 327, 331,765 waste disposal
			Flood defence and runoff prevention + water use	/		E 2.2.1 Clean Water Target	
		Focus rather on water management (~use) than water quality		Focus rather on water management (~use) than water quality			

Soil quality & land degradation

P pressure	fysical soil quality: - erosion risk - compactation risk						300 Erosion sensitivity
	biological soil quality: - disturbance by pesticides - min. N-, P-, K- fertilisation						
S state			% land affected by ≠ types of erosion			E 3.1.2 Soil Physical Structure	
							296 % degraded land 298 % regenerated land 281 % soil compaction
	chemical soil quality: - organic matter - P-surplus	SM.SD.01 Organic Matter % SM.SD.02 Synthetic Nitrogen Use Efficiency SM.SQ.06 Nutrient Management Plan SM.SQ.07 Nitrogen Use	Soil analysis SOM ↑ / = / ↓	Soil analysis SOM ↑ / = / ↓		E 3.1.3 Soil Chemical Quality E 3.1.5 Soil Organic Matter E 3.1.4 Soil Biological Quality	 748 humus balance 294 heavy metals
R response		SM.SQ.01 Soil Management Pla SM.SQ.02 Soil Quality testing SM.SQ.03 Soil Erosion Prevention	Soil management (land use) Measures reducing erosion risk	Soil management (land use) Measures reducing erosion risk	Soil improvement practices: 41. Fertilizer type 42. Soil fertility	E 3.1.1 Soil Improvement Practices	288 & 700 Measures to prevent erosion 288 & 700 Measures to prevent erosion
	biological soil quality - physical stress: deep cultivation	SM.SQ.04 Cultivation Methods	Winter grazing	Winter grazing			286 % UAA with measures countering soil degradation; permanent grassland; 206&764 % legumes; 299 green cover; 225 % green cover; 237 % mulching; 207 % direct seeding; % undersown;229 % ecological compensation; 202 % agrofarestry; 208 % woodland; 619 % drained land; 287 compaction by heavy machinery
		SM.SQ.05 Drilling Methods			Land conservation and rehabilitation practices: 36. Tillage method 44. Soil management 49. Land use and land cover change	E 3.2.1 Land Conservation and Rehabilitation Plan E 3.2.2 Land Conservation and Rehabilitation Practices	

Biodiversity							
P pressure	on fauna: soil natural enemies flying natural enemies pollinators only FAB, no neutral fauna on flora: natural & semi-natural flora weeds						
S state		LN.MD.01 On-farm Habitats	cropland diversity livestock diversity rare native livestock breeds heritage varieties of crops	cropland diversity livestock diversity rare native livestock breeds heritage varieties of crops		E 4.1.3 Structural Diversity of Ecosystems E 4.1.4 Ecosystem Connectivity E 4.2.3 Diversity and Abundance of Key Species E 4.3.2 genetic diversity of domesticated plants and animals	
R response		Biodiversity measures: LN.LQ.01-09 Conservation Audit Conservation and Enhancement Plan Conservation Aims Staff Involvement in Conservation Range of Habitats Cropping Area Habitats Livestock Habitats Field Boundaries Monitor Flora and Fauna	presence small landscape elements management boundaries: presence high value boundaries, n° hedgerow trees, management actions	management boundaries: actions taken	Biodiversity measures: 49. Land use and land cover change 40. Burning fields 50. Species conservation 51. Crops disease management 52. Diversity of production 53. Locally-adapted varieties 54. Sourcing seeds and breeds	E 4.1.1 Landscape/Marine Habitat Conservation Plan E 4.1.2 Ecosystem Enhancing Practices E 4.2.1 Species Conservation Target E 4.2.2 Species Conservation Practices E 4.3.1 Wild Genetic Diver-sity Enhancing Practices	Biodiversity promoting measures: mostly already mentioned under previous themes On-farm biodiv. Promotion: beneficials 229, 711 Ecological compensation area