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Innovation for Sustainable Sheep and Goat Production in Europe

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Abstract

This document describes the activities undertaken in _Task 1.2_: the process of reviewing and selecting sustainability assessment tools and indicators in preparation for developing a sustainability assessment tool specifically adapted for sheep and goat farming systems to be used within iSAGE project (Task 1.3).

First, a comprehensive **review** of the available tools and indicators was undertaken (_subtask 1.2.1_). This resulted in the identification of >100 tools and the detailed analysis of 21 of them. The indicators contained in these tools were identified and the extensiveness of the tools' coverage assessed. This was conducted using the framework proposed in the FAO's SAFA (Sustainability Assessment of Food and Agriculture systems) guidelines (FAO, 2012). Indicator quality is assessed based on whether it looks at a target set, a practice implemented or a measure of farm performance, and this approach was also replicated in the review. For the indicators, special emphasis was given to socioeconomic (_subtask 1.2.2_) as well as animal health and welfare (_subtask 1.2.3_) indicators in the context of sheep and goat production systems.

The overall aim was to select or create a rapid, but effective, assessment tool that would not compromise the scientific rigour of farm evaluation. Hence, a series of tools were assessed based on criteria that included: i) the ease of tool use, ii) the coverage of the sustainability criteria defined by the SAFA framework, and iii) the possibility and easiness of the tool's adaptation to include new indicators (**Appendix 1**, **Appendix 2**). Because of the review and analysis of tools, it was concluded that the Public Goods Tool (PG Tool) provides a rapid and comprehensive framework for assessing the sustainability of sheep and goat enterprises. The advantage of the PG Tool in comparison to other tools is its flexibility for adaptation to incorporate new indicators (as it was originally developed by ORC). The tool was also known within the iSAGE consortium and was ranked as the tool that the highest number of industry partners were familiar with in an industry partner survey (described below).

After the review two main activities were undertaken as part of _subtask 1.2.4_ to complement the review of tools: i) an online **survey** was conducted with iSAGE partners to identify the most relevant indicators for each of themes of SAFA and any existing familiarity with any of the identified tools and ii) two stakeholder's **workshops** were held to get feedback from stakeholders on the most appropriate indicators. The results of these activities (**Appendix 3**) were used to make a first selection of indicators that should be included within the final sustainability assessment tool.

The outcome form survey, feedback from workshops, expert analysis (with special focus on socio-economic and animal, welfare) and the existing indicators in PG Tool, a selection of 110 indicators were incorporated into a modified version of the PG Tool (**Appendix 4**). Finally, after deciding the scoring criteria to apply it was decided to conduct on-farm tests in four different countries (UK, Spain Greece and France), followed with **structured interviews** to collect feedback. The four farms covered the most representative sheep and goat systems in Europe. In those tests a target of three hours duration was set to balance rigour and practicality.

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1. Introduction

Sheep and goat production in Europe is characterised by great diversity in terms of production aims, farm size, breeds kept, and levels of intensification resulting in several different farm types. The latter include also organic, Protected Designation of Origin (PDO), Protected Geographical Indication (PGI), pluriactive farms or breed specific farms (see Deliverable 1.1 of the iSAGE; Theodoridis et al 2016). These farm types are specific to a wide range of environmental and socio-economic conditions with local, regional, national or intra-national importance and can vary in sustainability and their needs for innovation. Furthermore, the link of certain production systems to tradition and territory, their role in maintaining the vegetation and social activities provided are assets in less favoured areas, especially in the Mediterranean Basin.

Historically, goat production in Europe experienced a major development in the second part of the 20th century (Morand-Fehr et al., 2004, Devendra, 2010), while development of sheep farming systems happened earlier (de Rancourt et al., 2006). Nowadays, both the sheep and goat production systems in Europe depend deeply on common policies and subsidies; their sustainability in the long term is linked to their impact on the environment, their aptitude to adapt to changing environmental, economic or social conditions and their support of social and economic development (Dyrmundsson, 2006). It should be noted, however, that the evaluation of such potentials goes beyond the classical technical-economic evaluation (Toussaint et al., 2006) and requires a broader (i.e. beyond the limits of the technical system) and deeper (in the long term) analysis (Gibon et al., 1999).

Scientific evidence on farm sustainability assessments, as well as the sustainability assessment tools available to support decision-making, are ever-expanding (Binder et al., 2010; Bockstaller and Guichard, 2009; Carof et al., 2013; Gasparatos and Scolobig, 2012; Marchand et al., 2014; Ness et al., 2007; Schindler et al., 2015). These assessment tools can vary enormously in their scope and approach. To bring consensus amongst sustainability assessment of food production systems, the FAO in 2012 developed the Sustainability Assessment of Food and Agriculture systems (SAFA) framework (FAO, 2012), which defines sustainability in four "domains". These comprise the three traditional pillars – "environmental integrity", "economic resilience" and "social wellbeing" (Gibson et al., 2001), but now underpinned by the more recently suggested "good governance". The framework is widely accepted in the field of sustainability, already underlying many of the most recent sustainability assessment tools (Olde et al., 2016).

Many diverse processes are described as sustainability assessment due to its broad definition (Pope et al., 2004), and questions arise on how to navigate between these tools, what their key characteristics are and how can one select the most appropriate tool for one's specific purpose. To this respect there is scarce literature and guidance regarding optimal tool choice and the effective and practical use of such tools and methodologies – especially when it comes to evaluation of the sustainability of livestock production systems with focus on small ruminants, which often requires physical visits to farms and collection of data of different nature (De Ridder et al., 2007; Bernués et al., 2011; Gasparatos & Scolobig, 2012). Yet assessing the sustainability of small ruminant systems is crucial to ensure their long-term viability, to identify potential areas of improvement and efficiencies, to uncover trade-offs between different aspects of performance and to, potentially, demonstrate benefits of particular types of management strategies and the sector as a whole.

It is within this scope that Task 1.2 is situated. The task aims to identify, with involvement of stakeholders, suitable indicators and tools for assessing the sustainability of sheep and goat production systems in Europe. This is used to develop an assessment tool with which sustainability assessments of small ruminant production systems across Europe will be conducted (Task 1.3). To do this, it first conducts a thorough review, based on their attributes, sustainability assessment tools and frameworks that could potentially be used in sustainability assessment of sheep and goat production systems and evaluates the suitability of these tools in view of the specific objectives of the iSAGE project (subtask 1.2.1 – Section 3 of this report). Concurrent to this, specific indicators of sustainability of particular relevance to sheep and goat systems, focusing on the often under-represented social, economic and animal health and welfare aspects (e.g. Schader et al., 2014), are identified (subtask 1.2.2, 1.2.3). Finally, in consultation with stakeholders from both industry and research, the information collected in these tasks is analysed to establish a final tool to use for the assessments and the indicators that should either be contained within it, or added prior to use. The review of tools and indicators was conducted at Organic Research Center and it is described in detail in the following section.

2. Sustainability assessments for sheep and goat farming

Sustainability assessment can be defined as an evaluation exercise that directs decision-making to ensure ongoing feasibility of the production system in the future (Bond et al., 2012; Hugé et al., 2013; Pope, 2006). Indicator-based sustainability assessment tools and frameworks can either guide or conduct sustainability assessments (Coteur et al., in press, derived from Gasparatos and Scolobig, 2012 and Ness et al., 2007) and vary widely in their scope (geographical and sector), target group (e.g. farmers or policy makers), selection of indicators, aggregation and weighting method and time required for execution (Binder et al., 2010; Marchand et al., 2014; Schader et al., 2014). Although many highlight the importance of integrating environmental, economic and social themes in sustainability assessment tools, environmental themes and tools generally have received more attention (Binder et al., 2010; Finkbeiner et al., 2010; Lebacq et al., 2013; Marta-Costa and Silva, 2013; Schader et al., 2014).

While increasing interest has been devoted to incorporate environmental and social elements into what has historically been purely productivity analyses of food production systems (Marie, 2011), holistic assessment of sustainability simultaneously covering all aspects (social wellbeing, economic resilience, environmental integrity and governance) are, in the small ruminant sector in Europe, scarce (Bossis, 2004; Nahed et al., 2006; Bernués et al., 2011; Ripoll-Bosch et al., 2012). One study from Spain, (Nahed et al. 2006), in which the sustainability of 25 dairy goat systems in the Sierra de Cádiz was determined by the MESMIS (Framework for evaluation of management of natural resources incorporating sustainability indicators) methodology, compared three different types of production systems in terms of the degree of intensification (i.e. semi-extensive, semi-intensive, or intensive). The total sustainability score was found to decrease with increasing intensification (semi-extensive: 57.3%, semi-intensive: 55.7%, intensive: 53.1%). Adaptability was higher in intensive systems due to investment and external inputs, self-management was better in semi-extensive systems and equity better in semi-intensive systems. All systems had low scores for owned area per goat, goat mortality, somatic cells in milk and diversity in animal species. The aptitude of the indicators used to evaluate sustainability in this work, however, is questionable, as the indicators used were mainly of economic or biotechnical nature and gave only indirect information related to environmental or social issues.

In another study conducted in the West of France (Poitou-Charentes and Pays de Loire), Bossis (2004) analysed milk goat systems with the IDEA method. Covering intensive no-grazing and semi-intensive mixed crop-livestock systems, the IDEA approach was used without major difficulties, relying on well-established references. Environmental, social and economic mean scores obtained were 68%, 56% and 47% respectively, with large differences between types of production. The low economic scores are explained by a high specialisation of production and low incomes ◎ particularly in the case of systems producing exclusively milk ◎ and by a dependence on subsidies and inputs. The social performance of specialised systems was hampered by the heavy workload, but reinforced by the provision of employment. The environmental performance was good, particularly for mixed crop-livestock systems where forage was provided on-farm, or for pasture-based systems.

The iSAGE project comprises a strong and multi-lateral consortium consisting of 33 partners from six EU countries and Turkey. Five EU countries involved in the project – Greece, France, Italy, Spain and the UK – collectively account for 74% and 87% of the European sheep and goat populations respectively. Included in the consortium are 19 industry representatives from various production systems and socio-economic contexts, 13 research institutions and one international organisation.

One of the unique aspects of the project is the number of industry partners involved. With 19 partners, industry makes up 58% of all partners in the consortium. The 19 industry partners in iSAGE represent approximately 16 000 sheep and goat farmers with approximately 5.5 million sheep and goats. Through direct involvement of the industry partners in developing a sustainability assessment tool, iSAGE outcomes will potentially lead to increases in efficiency and production in a substantial proportion of the sheep and goat sector in Europe. The potential for societal impacts on nearly 16 000 farm households and reduced ecological impacts will further represent a significant benefit. A successful farm level exchange network that permeates the supply chain will increase the impact beyond these industry partners as iSAGE sustainability outcomes are used to develop and implement industry best practice.

3. Review of sustainability tools and indicators (*subtask 1.2.1*)

Different terms are used in the literature to describe sustainability assessments, such as methods, methodological approaches, frameworks, and tools (Marchand et al., 2014; Schader et al., 2014; Schindler et al., 2015). In this review, we focused on those sustainability assessments that have been developed into tools aimed at conducting ex-post assessments of the sustainability performance of farms using indicators. These are called indicator-based sustainability assessment tools. The following list of reviews and scientific papers relating to sustainability assessments applicable to agricultural systems was identified through a literature study (Alroe et al, 2016; Alroe and Noe, 2016;

de Olde et al., 2016; Dumanski et al., 1998; FAO, 1993; Knight et al., 2014, Lewis et al., 2010; Marchand et al., 2014; Padel et al., 2015; Schader et al., 2014; Schader et al., 2016; Smith and Little, 2013). This review resulted in a comprehensive, yet not exhaustive, list of 103 tools.

The characteristics of these identified tools were mapped out based on:

- Functional units (i.e. the quantification of sustainability used – currency, carbon footprint, standardised units etc.)
- Spatial scale (i.e. farm, product or sector level)
- Transferability (i.e. whether the tool was designed for a specific country/region or is more widely applicable),
- Sector scope (i.e. all farm types or specific to dairy/crops/etc.)
- Time taken to complete (where available; see Appendix 1)
- Assessment/software provider
- Any associated costs

Following this exercise, 21 tools were identified and subsequently were prioritised based on their coverage of the FAO's SAFA (Sustainability Assessment of Food and Agriculture systems) framework guidelines (FAO, 2012) (see **Appendix 2**). The FAO's SAFA guidelines define sustainability in four "domains": a) environmental integrity b) economic resilience c) social wellbeing and d) good governance. Each domain is subdivided into themes and then sub-themes. Indicator quality is assessed in SAFA based on whether it is outcome-based (e.g. actual measures of performances such as soil nitrogen surplus), related to individual farm practices or simply a farm target. This approach is also replicated in this literature review. Being a well-founded and widely accepted approach in the sector, SAFA provided a sensible framework to use as basis for the conduction of our own review for iSAGE and was hence adopted at the offset. Any indicators additional to those suggested in the SAFA framework were identified and where these indicators did not fit within an existing theme or sub-theme, new classes were proposed.

A similar review exercise was conducted by Olde et al. (2016) for four of the tools included in our analysis (RISE, SAFA Tool[1], PG Tool and IDEA). Their results are shown below, in Tables 1 and 2.

Table 1. Minimum (Min) and maximum (Max) time requirements (minutes) of the selected tools (Olde et al. 2016).

[1] The FAO did not just develop guidelines for sustainability assessment of agricultural systems. They also developed a separate tool – the SAFA Tool – and a corresponding, shorter SAFA app (predominantly aimed at smallholders in developing countries).

Task	RISE		SAFA		PG		IDEA	
	Min	Max	Min	Max	Min	Max	Min	Max
Preparation	105	180	10	25	30	60	60	75
Assessment	120	165	105	140	75	120	45	90
Calculation and reporting	105	180	15	15	30	60	45	60
Total	330	525	125	185	135	240	150	225

Table 2. General characteristics of the tools that complied with six selection criteria (Olde et al. 2016)

Tool	Full name	Target group	Reference	Origin
RISE	Response Inducing Sustainability Evaluation	Farmers	Häni et al. (2003)	Switzerland (Bern University of Applied Sciences
SAFA	Sustainability Assessment of Food and Agriculture Systems	Food and agricultural enterprises, organizations, governments	FAO (2013)	Multiple countries and institutes
PG	Public Goods Tool	Farmers, policy-makers	Gerrard et al. (2012)	UK (The Organic Research Centre)
IDEA	Indicateurs de Durabilité des Exploitations Agricoles	Farmers, policy-makers, education	Zahm et al. (2008)	France (multiple institutes)

3.1. Industry partners survey on identifying appropriate indicators and sustainability tool

In addition to the review of the tools and indicators for the sustainability assessments (Section 3, subtask 1.2.1), two other main activities were run in parallel. These were to develop specific indicators to cover the socio-economic aspects of sustainability (subtask 1.2.2) and to develop indicators to cover aspects related to animal health & welfare (subtask 1.2.3). These subtasks built on subtask 1.2.1, with special focus on sheep and goat systems. An initial draft of indicators was presented at the first iSAGE stakeholder workshop held in Zaragoza (June 2016) to get first feedback from project partners on understanding of the presented indicators and identify any key indicators that were missing. Following feedback from the stakeholder meeting, a list of the potential indicators for inclusion in the sustainability assessments was then presented to all the partners of the project by means of an on-line survey. The partners, in view of their experience and knowledge were asked to rank the indicators in order to select the final indicators for the sustainability assessments on the basis of the most “appropriate” and farmer/industry “commonly used” indicators (subtask 1.2.4). In addition, the survey asked partners to rank and give details of any sustainability assessment tools that they had used in the past or heard details of (see Table 4).

The survey was developed by ORC, CSIC and IDELE using the Qualtrics survey platform (Qualtrics, 2016), which was kindly offered for this purpose by the UNIVMP. The survey was web-based and was sent (in the form of a URL link) to all the partners in the consortium for participation. Some elected to spread it further to their wider stakeholder list, with the result that 69 individuals were eventually contacted.

When responding to the survey, partners were asked to select their three preferred indicators and rank them in order of "appropriateness" based on their own experience and perspective. "Appropriateness" was defined as:

a) How well the indicator represented the particular theme within sustainability;

b) How relevant the indicator was to the partners' production systems (i.e. whether it related to a major issue faced by their farmers);

c) How easily and reliably the indicator could be measured or quantified; and

d) Whether the data required to measure the indicator was already available.

The indicators the partners were asked to evaluate were divided into the SAFA themes (see Table 5), with themes split where necessary to ensure manageable numbers of indicators. Throughout the survey, appropriate space was given the participants to insert comments and/or to suggest indicators that were not on the list.

Table 3. Distribution of participants in online-survey by 'type of organization' and 'European climatic region'. Total number of respondents = 35 (for tools received no votes see Appendix 5)

Type organisation	Count	Climatic conditions	Count
Cooperative/producer group	8	Nordic/ Northern European	2
Trade organization	2	Eastern/ Continental	8
Levy body/board	3	Temperate maritime	10
Government/public sector	5	Mediterranean	15
Processor	0		
Wholesaler/distributor	1		
Retailer	2		
Academic	3		
Other	11		

A total of 35 responses were received from 69 potential participants. The 35 responses covered 95 % industry partners within iSAGE. The distribution of participants by 'type of organisation' and 'European climatic region' is provided in Table 4. The average suitable time that participants considered appropriate to conduct the assessment in a farm was between two and three hours (2.32 ◎ 0.75). The results of the survey are presented in Appendix 3 and the three most preferred indicators in each category are presented in Table 5. The results of the survey were analysed in view of the industry type i.e. sheep vs. goat organisations and were compared. In addition, preferences of research vs. industry partners were also evaluated. Interestingly, there was a high level of agreement between different stakeholder groups. This can be seen in the detailed information provided in

Appendix 3. The results from the survey were used to help compile a final list of sustainability indicators and identify a suitable assessment tool for the purposes of iSAGE (Section 4).

Table 4: Results from industry partner survey on experience of sustainability assessment tools currently available (tools presented, but receiving no votes, are shown below). Total number of respondents = 35 (for tools received no votes see Appendix 5).

Tool name	**% of respondents with experience of tool**
PG-Tool	11.4
CALM (Carbon Accounting for Land Managers)	8.57
IDEA (Indicateurs de Agricoles)	8.57
LEAF	8.57
SAFA	8.57
AssureWel	5.71
Cool Farm	5.71
Farm Carbon Calculator	5.71
MESMIS (Framework for Assessing Natural Resource Management Systems)	5.71
SimaPro	5.71
Water Footprint	5.71
Agroscope (see SALCA)	2.86
APSIM (agricultural production simulator)	2.86
CAPRI (Common Agricultural Policy Regionalised Impact)	2.86
COSA (Committee on Sustainability Assessment)	2.86
CPLAN	2.86
DIALECTE (DIAgnostic LiantEnvironnement etContrat Territorialdâ€™ExploitationFarm)	2.86
EAgRET	2.86
E-CO2 Project Carbon Assessments	2.86
EF (ecological footprint)	2.86
Farm Scale Resource Use Efficiency Calculator	2.86
FARMIS (Farm Modeling Information System)	2.86
Footprints4food	2.86
Teagsac National Farm Survey of Sustainability	2.86
Managing energy and carbon	2.86
openLCA	2.86
OSCAR	2.86
RISE	2.86
SMART (Sustainability Monitoring and Assessment Routine) farm tool	2.86

Table 5. List of the 3 most preferred options (all participants) in online survey as appropriate indicators in different SAFA themes and domains.

GOOD GOVERNANCE	
Corporate Ethics	**Accountability**
-Appropriate food and workplace safety protocols in use and able to be ident...	-Participation in agri-environment scheme(s)
-Risk management tool in place and regularly updated	-Staff training on sustainability issues
-Consideration of external impacts before implementation of policies and pro...	-Transparency: transparency policy is used and information available to stakeholders
Participation	**Rule of law**
-Professional network: cooperation between stakeholders	-Compliance with national laws and international agreements
-Availability of advisory services and organisations for stakeholders	-Working conditions of workers: liability regulations
-Effective stakeholder participation: feedback affects decision making	-Property/tenure rights
Holistic management	
-Farm owner education	
-Farmer education/environmental awareness	
-Full cost accounting: incorporating economic	
ENVIRONMENTAL INTEGRITY	
Atmosphere	**Water**
-Air pollution prevention and reduction practices	-Eutrophication
-Carbon sequestration	-Water use efficiency
-Feed conversion ratio	-Drought/desertification prevention measures
Landscape (part of 'Land' in SAFA)	**Soil quality (part of 'Land' in SAFA)**
-Landscape diversity	-Soil quality improvement practices
-Livestock density	-Soil erosion
-Land conservation and rehabilitation practices	-Soil nutrient balances
Materials and energy	**Biodiversity (1) -**
-Fossil fuel use	-Grazing/mowing regime
-Grazing	-Ecosystem enhancing practices
-Feed conversion index of livestock	-Ecosystems protection - Safeguarding protected threatened representative
Biodiversity(2) -	**Freedom from stress**
-Biodiversity index - cultivated species	-Stocking density
Table 5. (continued)	-Queuing at feeding

-Landscape - diversity -Genetic diversity - ecosystem	 -Water availability
Animal health -Somatic cell count -Lamb/kid mortality rate -Severe lameness	
ECONOMIC RESILIANCE	
Investment -Animal productivity -Cost of production -Gross margin/unit	**Vulnerability** -Sales agreement between the farmer and the purchaser for the quantity and t... -Dependence on CAP subsidies or external funding sources -Product diversification/ specialisation
Product quality/information -Production with quality label/ certification -Traceability systems -Meat and milk quality control measures	**Local economy** -Sale of the products (milk/lamb) to local enterprises -Use of local procurement -Direct farm sales
SOCIAL WELLBEING	
Fair Trading Practices -Quality of worklife -Wage level -Likely continuity of the farm for the 10 next years	**Labour rights** -Employment relations and contracts -Child labour (under 16 years old) -Forced labour
Equity/Cultural Diversity -Indigenous knowledge -Gender equality -Non-discrimination	**Human health and safety** -Safety of workplace operations and facilities -Health and safety training -Health coverage and access to medical care

4. Selection of sustainability tool and indicators (*subtask 1.2.2 - 1.2.4*)

As part of *subtask 1.2.4* i.e. development of assessment approach and by using the information and data collected through the industry partner survey, workshop discussions and literature review, the following procedure was put forward:

1. To identify the most appropriate **indicators** in all dimensions (i.e. social, economic, environmental, governance)

2. To select the best sustainability assessment **tool** for iSAGE purposes (analysis in a range of typologies for sheep and goats farms)

3. To ensure that all the key indicators identified in step (1) were included in the tool selected in step (2) and if not, an additional list of indicators would be built to be incorporated in the selected tool.

4.1. Selection of the indicators

It was perceived that the sustainability assessments to be carried out in the iSAGE project should cover a range of environmental, economic, social and governance indicators, in accordance with the FAO SAFA guidelines. The decision on the most appropriate indicators (with starting point on survey results) was discussed and approved by participating partners through on-line meetings and e-mail discussions. The most preferred indicators in the stakeholders survey, overall and by stakeholder categories (sheep/goat, milk/meat) were included. Also, discussions held over the two stakeholders' meetings (Zaragoza, June 2016 and Rome, December 2016), helped to identify other indicators that are particularly relevant in more specialist types of production systems. These were applied following the general criteria to the selection of indicators within the following three categories of indicators.

4.1.1. Animal health, welfare and livestock management indicators

The final selection of the specific animal welfare indicators to be included in the PG tool considered the particularities of sheep and goat farming systems, given their farm-type variation (e.g. intensive, extensive, PDO, organic etc.; for full details please refer to Deliverable No: 1.1 "Report on new farm typologies for sheep and goat systems within the EU) and ensured that all types of production systems (e.g. meat, milk, dual purpose etc.) are fully covered (Theodoridis et al., 2016). The selection built upon task 1.2.1 (Section 4), recommendations from the AWIN project (AWIN, 2015) and DairyCare COST Action and SOLID project experience, as well as latest EFSA recommendations (2014). The addition of new indicators was based on a multi-dimensional concept (mental and physical health in harmony with environment and the ability to cope with likely changes in the environment due to climate change) following four principles (good feeding, good housing, good health and appropriate behaviour), and considers extensive systems as well as animals kept indoors.

In the selected indicators, resource-based and management-based indicators have been combined with questions associated with direct observations of animals (see Appendix 4).

4.1.2. Socioeconomic indicators

As previously, the identification of socioeconomic indicators considered the specificities of sheep and goat farming systems across Europe (Theodoridis et al., 2016). For the economic indicators, preference was given to the "gross margin" approach (goat or sheep income, less variable costs), which is already used by several partners in the iSAGE project and requires less time to evaluate the economic efficiency of livestock enterprises than the "costs of production" approach used, for example, by Agribenchmark or the French livestock farms networks. Beyond that, we have expanded the scope of the economic assessment with indicators about product quality (food safety, quality, and product certification), integration in the local economy (use of local procurement, regional purchases), vulnerability (sales agreements, dependence on CAP subsidies, farm specialisation) and long-term profitability (investments, farm succession) (see Appendix 4).

For the social indicators, we considered two classes of indicators: a) "internal" indicators, which refer to aspects related to the on-farm working conditions that farmer(s) are usually exposed to, number of staff employed by the farm business, farmers' and workers' skills and training and health and safety aspects; and b) "external" indicators, which cover aspects related to the relationship and interaction of the farm with the wider social environment, such as community engagement or fair trading practices.

4.1.3. Environmental indicators

Although the focus of WP1 was on the identification and selection of new indicators relating to social sustainability and animal health and welfare, environmental indicators missing from the PG tool were identified and incorporated within the assessment framework. Indicators were selected within the SAFA themes of atmosphere, water, landscape, soil quality, biodiversity, and materials and energy. Individual indicators associated with each area were drawn from a range of sources including Government guidelines and codes of best practice (e.g. Defra, 2006, Environment Agency, 2007, Natural England, 2007), industry-facing guidelines (e.g. ADAS and The Organic Research Centre, 2002) and the SAFA framework itself (FAO, 2012). New indicators were selected in relation to the use of supplementary feed, on-farm energy efficiency, management of on-farm fires (e.g. burning scrub), water pollution prevention and biodiversity management (Appendix 4).

4.2. Selection of the sustainability tool

As with the selection of the indicators described above, the decision on the most appropriate tool was based in principle on its compliance with the FAO SAFA guidelines. Therefore, a comprehensive sustainability assessment tool was considered more suitable for the project. It was apparent that, to fulfil the objective of WP 1, the sustainability tool should also be capable of assessing the sustainability of sheep and goat farm systems and supply chains across a range of typologies (Task 1.3), but also to help develop a toolbox of assessment tools and indicators that can be used in the future to assess the sustainability of sheep and goat production systems (Task 1.4). The fact that the sustainably assessments will be aimed at, and will be carried out on, sheep and goat farms, indicated the need for selecting a rapid, yet effective, assessment tool that would not compromise the scientific rigour of the farm assessment process. Specific selection criteria therefore included:

- Ease of tool use. This refers to the expertise and time taken to carry out the assessment. It was considered that a farm assessment should be completed ideally within three hours but in less than four hours. However, in view of competing demands for a famer's time and the continuous interaction foreseen with farmers over the life time of the project, survey feedback indicating 2–3 hours as the ideal assessment length and the trade-off usually seen between time required to complete and quality of results.

- The coverage of a range of sustainability criteria as defined within the SAFA framework (good balance).

- The possibility and ease to adapt the tool to include new indicators identified through the process outlined above and in Section 4.4.

Characterisation of tools according to these criteria took place in subtask 1.2.1, as described in Section 3 above. This was supplemented with the outcomes from the online partner survey related to tool familiarity and assessment duration (Table 4; survey described in Section 4.1 and shown in Appendix 3).

The list of the potential sustainably tools was discussed and approved by participating partners (ORC, CSIC and IDELE) through on-line meetings and e-mail discussions. The PG Tool was the approach that marginally showed highest percentage of partners that had used it (four out of 35), although there was a high number of other tools with similar proportion of users (four tools with three out of 35). Two tools received specific positive recommendations in the comments – the PG Tool and EAgRET – and four additional tools were identified (RAT, GEROKO, NAIA and Diagnosti), only one of which received specific positive comments (GEROKO). It was, however, concluded that the Public Goods Tool (PG Tool) provides the best option in this project for a rapid yet comprehensive framework for assessing the sustainability of the sheep and goat sector. The specific criteria that showed a clear advantage of the Public Goods Tool in comparison to the other tools are:

- The PG Tool can be readily adapted to incorporate new indicators but, unlike the framework-style tools (e.g. the SAFA tool), already contains many of the required indicators and benchmarking. Both indicators and benchmarks can be extremely time intensive to add from scratch. The tool has furthermore been developed by ORC, which makes its adaptation easier than other tools. The number of new indicators to add that are specifically relevant to the sheep and goat sector and that have emphasis on economic performance and animal welfare is rather high (see Section 4.4) and a flexible tool is thus required.

- The modular structure of the tool made it easy to modify to follow FAO's SAFA framework, covering environmental, economic, social and governance domains.

- The tool has been peer-reviewed by multiple experts in the UK and across Europe as part of the development process (Gerrard et al., 2011; Unwin, 2011; Leach et al., 2013; Defra, 2014).

- It has been used successfully in multi-national sustainability assessments within the FP7 project Sustainable Organic and Low Input Dairying (SOLID), in which 70 organic and 32 low input dairy farms were assessed across nine countries, including dairy oats in Spain and Greece (Leach et al., 2012; www.solidairy.eu). In addition it has been used successfully national (UK) or international research projects (five in total), generally receiving positive feedback from farmers, researchers and advisors (Defra, 2014), and has been tried and tested within similar tasks involving multiple industry and academic partners. Therefore, we could be confident that, following its adaptation, it would be able to provide a comprehensive evaluation of sustainability in a limited timeframe (i.e. 3-4 hours per farm).

- It was one of only three tools to receive positive recommendation from the survey.

- The outputs from the tool can be used for life cycle assessment purposes (see Olde et al. 2016 and Hietala et al. 2015), which will allow for application of the data within the Task 1.3.3 of iSAGE: Assessment of innovation strategies.

5. Development of the PG tool for iSAGE

The development of the PG Tool for use in iSAGE project involved a) the inclusion of the indicators identified as described above and b) a comprehensive approach and analysis with regards to the formulation of the questions to asked, which will be the potential options for responses, and how each response will be scored (from 1 to 5). Some questions required five different answers, given scores 1 to 5, while others required only three and the scores assigned were 1, 3 and 5. Scores were attributed based on recommendations for best practice included within guideline documents (e.g. CALU, and ADAS, 2007) with the higher score representing the best sustainable practice. Some indicators required more than one question in order to be addressed. This process of elaborating the questions and the answers was carried out first by ORC, IDELE and CSIC separately for environmental, socioeconomic and animal health/welfare, respectively. Then, once included in the tool, they were analysed by the three groups and discussions held on line to finalise scoring criteria.

A significant proportion of the new indicators added to the PG tool (Table 6) related to animal health and welfare, farm livestock management, social sustainability and governance (the latter area was previously missing from the PG tool). The dominance of these previously under-represented areas reflects the focus of WP1 and the research reviews that took place at earlier stages. Animal welfare and social sustainability also tend to be under-represented in sustainability assessments in general and were therefore given a greater emphasis within this Work Package. The indicators identified in the project survey that are not listed here, were already present in the PG Tool.

Table 6. Number of indicators included in original PG Tool and new ones included in iSAGE.

Spur name:	Original PG tool	ISAGE PG Tool
Soil management	9	9
Agri-environmental management	25	25
Landscape and heritage	9	12
Water management	15	15
Fertiliser management and nutrients	21	22
Energy and carbon	9	21
Food security	6	12
Agricultural systems diversity	6	8
Social capital	18	37
Farm Business Resilience	8	30
Animal Health Management*	24	23
Animal Welfare Management*		17
Governance	not included	18

*Health and welfare management were combined in the original PG tool

Following incorporation of the new indicators, the PG tool was tested on five farms. These farms were two sheep meat farms (one organic) in the UK, one dairy goat farm in Spain, one dairy sheep farm in France and one meat goat farm in Greece. These farms cover most of the farm types (semi-intensive sheep in the UK, intensive goat production in Spain and semi-intensive dairy sheep production in France).

Feedback from farmers was recorded on the applicability and usefulness of the tool and the time it took to assessment. Results from these assessments suggest the tool provides a useful framework and identifies areas of poor/good performance. Following farmers' feedback, considerable attention was paid on the time that the assessment is taking to be completed. The sustainability assessment using the final version of the tool takes about 2 to 3 h and the final version of the tool is ready to be circulated to iSAGE partners.

Conclusions

The work conducted in this task showed that, despite the growing interest in livestock sustainability assessments, no specific tools that cover all sustainability domains and types of production systems are developed with focus on the small ruminant sector.

The assessment approach for the selection of the indicators and the sustainability tool we developed in this Task was effective and systematic; it consolidated information and data collected through the industry partner survey, workshop discussions and literature review. Thus, the most appropriate indicators in all dimensions (i.e. social, economic, environmental, governance) were identified in addition to the best tool for assessing sustainability of farms in the iSAGE project ensuring analysis in a range of farm types. It was decided that the Public Goods Tool (PG Tool) was the most appropriate for the project as it was the first to fulfil all the key selection criteria (i.e. ease of tool use; the coverage of a range of sustainability criteria as defined within the SAFA framework and; the possibility and ease of adapting the tool to include new indicators).

During the adaptation of the tool we ensured that all the key indicators identified were included in the tool paying considerable attention to the time that the assessment is going to take on farm. Following its adaptation, the PG-Tool underwent systematic tests in UK, Spain, Greece, France and Italy as part of the WP1, assessing in sheep or goat farms in these counties, in order to identify possible flaws or errors. The final version of the tool is ready and it takes about 2 to 3 h to complete and it is about to be circulated to iSAGE partners for the sustainability assessments (Task 1.3). It should be noted that in this case we work collaboratively with the Task 2.2 (Farmer Survey) in order to address both tasks 1.3 and 2.2 in one farm visit, when possible and minimise the total time required for the two.

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APPENDIX 1

Table summarising the review of Sustainability Assessment tools and principal attributes (subtask 1.2.1)

Tool	Functional units	Spatial scale	Geographic transferability	Time	Primary purpose	Reference
Tools fully assessed						
APOIA-NOVORURAL	standardised index	Farm	Global			Rodrigues et al. (2010)
FESLM (Framework for the evaluation of sustainable land management)	standardised index	Landscape/ Regional	Global		Landscape planning	Smyth and Dumanski (1995)
FSA tool (sustainable agriculture initiative platform)	standardised index	Farm	Global		Farm advice/ monitoring/certification	SAI 2013
Healthy Farm Index	standardised index	Farm	Global			Quinn et al 2013
IDEA (Indicateurs de Durabilité des Exploitations Agricoles)	standardised index	Farm	France	3-6h	Farm assessment	Zahm et al. (2008); Vilain 2008 (manual)
InVEST (Integrated Valuation of Environmental Services and Tradeoffs)	monetary units	Landscape	Global		Policy advice/farm advice	natural capital project
MASC (multi-attribute assessment of the sustainability of cropping systems)	standardised index	Farm	Western Europe			Meul et al. (2008) - <hal-00886415>
MESMIS (Framework for Assessing Natural Resource Management Systems)	standardised index	farm	Global			
MOTIFS (Monitoring Tool for Integrated Farm Sustainability)	standardised index	Farm	EU	days	Assessment/monitoring	Meul et al 2008; Van Passel and Meul, 2012
OCIS PG-Tool	standardised index	Farm	EU	2-4h	Farm advice	Gerrard et al (2011); Lillywhite et al. (2012)
RAD (diagnostic de durabilite du Reseau de l'Agruculture Durable)	standardised indexz	Farm	Global			López-Ridaura (2002)
REPRO (REPROduction of soil fertility) (incorporated into DLG-Zertifikat certification)	standardised index	Farm/ product	DE and surrounding countries	5h	Research/policy advice	Hülsbergen (2003)
RISE	standardised index	Farm	Global	3-6h	Farm advice	

SAFA	standardised index	Farm	Global	2-3h	Farm advice	FAO 2014
SALCA (Swiss agricultural life cycle assessment) (aka. Agroscope)	GWP/ha; GWP/t	Farm/product/field/crop	Central Europe	4h	Research	Nemecek et al. (2011); (Rossier and Gaillard, 2004); http://www.agroscope.admin.ch/
SimaPro	Multiple damage categories incl. GWP, ecosystems (quality, extinction rate etc), human health, resources…	Farm	Europe (also some N Am. Methods)			http://www.simapro.co.uk/
SMART (Sustainability Monitoring and Assessment Routine) farm tool	standardised index	Farm	Global	2h	Farm monitoring	Jawtusch et al. (2013)
Sustainable Agriculture Steering Group (Unilever)	standardised index	Farm	Local (each crop different)		Farm monitoring	Pretty et al, 2008a/b; https://www.unilever.com/Images/sust_ag_sust_life_tcm244-424310_en.pdf
Agri-environment footprint index	self defined	Farm	Global	x	Policy advice	purvis et al, 2009
SSP (sustainability solution space for Decision Making)	self defined	Farm/landscape/Regional	Global	x	Policy advice/farm advice/landscape planning	Binder and Wiek (2001)
MMF (Multiscale Methodological Framework)	self defined	Farm/landscape/Regional	Global	x	Research	López-Ridaura et al. (2005)

APPENDIX 2

Table summarising the indicators coverage of the reviewed Sustainability Assessment tools (subtask 1.2.1)

Tool	**Indicators included**							
	Economic Resilience		**Environmental Integrity**		**Social Wellbeing**		**Good Governance**	
	SAFA indicators	**Additional indicators**	**SAFA indicators**	**Additional indicators**	**SAFA indicators**	**Additional indicators**	**SAFA indicators**	**Additional indicators**
APOIA-NOVORURAL	9	0	25	1	9	3	2	0
FESLM (Framework for the evaluation of sustainable land management)	9	4	10	1	5	0	6	0
FSA tool (sustainable agriculture initiative platform)	13	1	20	1	14	1	5	2
Healthy Farm Index	1	0	6	0	0	0	0	0
IDEA (Indicateurs de Durabilité des Exploitations Agricoles)	12	0	33	0	4	2	2	2
InVEST (Integrated Valuation of Environmental Services and Tradeoffs)	0	0	10	0	0	0	0	0
MASC (multi-attribute assessment of the sustainability of cropping systems)	4	2	10	1	1	1	0	0
MESMIS (Framework for Assessing Natural Resource Management Systems)	7	3	11	1	2	0	1	4
MOTIFS (Monitoring Tool for Integrated Farm Sustainability)	5	0	26	0	9	0	5	0
OCIS PG-Tool	11	0	28	0	5	0	2	0
RAD (diagnostic de durabilite du Reseau de l'Agruculture Durable)	7	1	11	0	3	3	0	0
REPRO (REPROduction of soil fertility) (incorporated into DLG-Zertifikat certification)	8	0	14	0	4	0	4	0
RISE	13	0	33	0	14	0	10	0
SAFA	27	0	43	0	19	0	19	0
SALCA (Swiss agricultural life cycle assessment) (aka. Agroscope)	1	0	9	0	0	0	0	0

SimaPro	1	0	15	1	-2	3	0	0
SMART (Sustainability Monitoring and Assessment Routine)	22	0	41	0	19	0	15	0
Sustainable Agriculture Steering Group (Unilever)	11	0	20	0	0	0	0	1
Agri-environment footprint index	THIS IS A FRAMEWORK; INDICATORS ARE SELF-DEFINED							
SSP (sustainability solution space for Decision Making)	THIS IS A FRAMEWORK; INDICATORS ARE SELF-DEFINED							
MMF (Multiscale Methodological Framework)	THIS IS A FRAMEWORK; INDICATORS ARE SELF-DEFINED							

APPENDIX 3

Ranking of indicators by goats/sheep and industry/research organizations through on line iSAGE survey (subtask 1.2.4). The 3 most preferred are highlighted in green (only 2 in sections with 5 or less indicators). Number in the columns shows order of preference within each group.

CATEGORY / INDICATOR	TYPE ORGANIZATIONS				
	SHEEP	GOATS		INDUSTRY	RESEARCH
Ethics					
Appropriate food and workplace safety protocols in use and able to be ident...	1	2		4	2
Consideration of external impacts before implementation of policies and pro...	2	5		1	4
Regular assessment of views and priorities of stakeholders (preferences and...	4	4		2	6
Risk management tool in place and regularly updated	2	1		3	1
Sustainability 'mission statement' present in enterprisesâ€™ planning and rep...	3	4		3	5
Influence of enterprises' sustainability commitments in key decisions and p...	5	5		5	7
Percentage of staff or people who can identify and explain the enterpriseâ€™s...	3	3		4	3
Accountability					
Holistic audits: recognised sustainability audit tool used &amp					
Leakage effects: exporting of enterprises' environmental/social impact	7	5		7	6
Participation in agri-environment scheme(s)	1	1		1	1
Stakeholder consultation employed to ensure the views of vulnerable stakeho...	3	5		4	6
Staff training on sustainability issues	2	2		2	2

Transparency: transparency policy in place	4	5		7	3
Transparency: documents and webpages have clear pathways for accessing info...	5	4		5	7
Transparency: information needs of stakeholders are assessed and met.	6	3		6	5
Transparency: transparency policy is used and information available to stak...	5	3		3	4
Participation businesses.					
Community participation	6	5		6	7
Ability to identify and resolve stakeholder conflicts	5	4		5	4
Professional network: cooperation between stakeholders	1	1		1	1
Effective stakeholder participation: feedback affects decision making	3	2		2	3
Strategies put in place to overcome barriers to stakeholder engagement	6	4		7	5
Satisfactory stakeholder grievance procedures	7	6		8	7
Availability of advisory services and organisations for stakeholders	2	3		3	2
Information/ learning exchange in relation to 'good governance'	6	5		7	7
Self-determination of stakeholders	8	6		10	7
Diversity/strength/structure of social afflilations	8	6		9	6
Diversity/variety of stakeholder engagement approaches	4	4		4	8
Rule of law					
Compliance with national laws and international agreements	1	1		1	1
Fiscal responsibility	3	4		3	4
Property/tenure rights	4	3		4	3
Working conditions of workers: liability regulations	2	2		2	2

Holistic management					
Application of recognised conservation methods	5	4		5	6
Compatability with national policy goals	8	8		6	10
Employee environmental training	11	6		9	8
Environmental checklist on employee training waste management etc.	10	6		9	7
Farm owner education	1	2		1	1
Farmer education/environmental awareness	4	1		3	2
Full cost accounting: incorporating economic	3	5		3	3
Monitoring of performance criteria	2	8		2	8
Reproductive management plan for livestock	6	3		3	7
Research and development programme in place	9	7		7	8
Sustainable forest management	11	7		9	9
Use of 'best available farming technology/techniques' to improve performanc...	7	8		4	5
Use of internal management systems to improve performance	9	8		8	4
Atmosphere					
Air pollution prevention and reduction practices	1	1		1	2
Carbon sequestration	2	2		2	1
GHG emissions	4	3		4	4
Feed conversion ratio	3	1		3	3
Water					
Acidification	7	4		6	8
Drought/desertification prevention measures	3	3		3	3

Eutrophication	1	2		2	2
Groundwater reserves	6	6		6	4
Sedimentation	2	7		4	9
Surface roots/deep roots of plants	5	5		5	7
Water footprint	4	5		8	5
Water use efficiency	1	1		1	1
Change in flood risk	5	7		7	7
Landscape					
Annual harvest/annual sustained yield	7	3		6	8
Land conservation and rehabilitation practices	3	6		1	6
Areas of high natural value under cultivation	8	6		8	10
Biotechnology managed in an environmentally sound way	9	8		9	12
Environmental management improved locally	4	7		3	9
Farming intensity	10	8		4	4
Incidence of fires	8	6		8	6
Grazed woodland	5	1		5	5
Land conservantion and rehabilition plans	10	8		7	6
Land use change	6	4		7	3
Landscape diversity	1	2		4	1
Pasture profit index	7	6		10	7
Use of renewable/recurrent raw materials: natural regeneration of forests e...	7	6		7	10
Rooting depth	10	8		8	11
Slope stability	10	8		11	12

Use of genetically modified organisms: risk to other land uses	10	8		11	12
Livestock density	2	5		2	2
Soil quality					
Soil biota index	6	4		7	4
Soil C/N ratio	8	4		12	3
Soil bulk density	9	6		12	9
Soil compaction	7	6		10	5
Soil chemical quality	9	6		6	7
Soil depth	7	4		10	6
Soil dehydrogenase activity	9	6		12	9
Soil nutrient balances	2	3		3	4
Soil erosion	3	2		2	2
Soil physical structure	5	3		5	8
Soil pH	4	6		4	9
Soil productivity	7	5		6	5
Soil pollutant concentrations	5	5		6	5
Soil quality improvement practices	1	1		1	1
Soil temperature	9	4		10	9
Soil water holding capacity	8	3		8	6
Soil texture	9	6		9	9
Soil water status	7	6		11	7
Biodiversity(1)					

Disease spread prevention	6	4		7	6
Ecosystem enhancing practices	3	3		1	8
Ecosystems protection - Safeguarding protected threatened representative	2	4		3	4
Farming intensity	7	5		7	8
Grazing/mowing regime	1	2		2	1
Livestock density	4	1		4	2
Saving of seeds and breeds	9	6		6	9
Shade - Protection from weather	9	6		11	11
Species conservation practices	5	3		5	5
Genetic diversity - Use of 'wild' gene pools for domesticates	10	6		11	10
Use of companion plants and animals	9	6		12	9
Land available for activities other than food production	8	6		10	7
Genetic diversity - cultivated species	4	6		9	3
In-situ conservation	7	6		8	11
Biodiversity(2)					
Accumulated leaf litter layer	8	6		9	8
Age distribution of trees	4	5		5	6
Biodiversity index - cultivated species	1	1		1	1
Biodiversity - farmland bird index	2	4		4	5
Biodiversity index - incidental species	5	6		7	7
Age or DBH (diameter at breast height) distribution of trees	7	6		9	7
Dead/decaying wood availability	8	6		9	8
Hedge density	5	3		6	6

Hedge length	2	5		5	4
Landscape - connectivity	7	5		8	7
Landscape - diversity	3	2		2	2
Leaf area index	8	6		9	6
Naturalness index	8	6		9	8
Soil biota index	6	5		8	5
Genetic diversity - ecosystem	5	5		3	3
Materials and energy .					
Fuel use efficiency	8	3		6	3
Grazing	4	1		2	1
Raw material use intensity	7	2		5	6
Renewable energy use targets	5	6		3	5
Total resource use	7	6		7	3
Waste proportion recycled	3	6		4	7
Waste production	8	5		8	6
Waste reduction targets	9	6		8	9
Fossil fuel use	1	2		1	2
Feed conversion ratio	8	6		8	4
Feed conversion index of livestock	2	4		2	5
Farming intensity/livestock density	6	4		4	8
Energy use	8	2		7	4
Cumulative energy consumption	4	5		6	4

Animal health					
BCS	1	1		3	3
Lamb/kid mortality rate	2	2		2	2
severe lameness	3	2		7	5
Abscesses	4	3		9	4
Faecal soiling score	4	3		8	6
hair condition	4	3		7	4
nasal discharge	4	3		9	6
Udder assimetry	4	3		9	7
Average lactations/reporductive cycles	4	3		2	3
Age of goats/sheep first kidding/lambing	4	3		4	7
Mortality rate adults and kids/lambs	4	3		1	1
Cullins trategy	4	3		7	5
Fertility rate	4	3		4	4
spending on antibipotics	4	3		5	6
Mastitis incidence	4	3		7	5
Somatic cell count	4	3		6	4
Freedom from stress					
Queuing at feeding	1	2		2	2
Water availability	3	2		1	3
Queuing at drinking	5	6		6	6
Bedding	7	5		4	6
Temperature in facilities	4	6		5	4

Acces to shade	6	4		4	4
Wind/rain protection	3	5		3	6
Hoof overgrowth	10	5		8	8
Stocking density	2	1		1	1
Improper disbudding	10	4		9	6
Stereotypy	10	6		9	7
Itching	10	6		9	8
Management around milking	9	3		6	5
Dry period length	7	4		5	7
Familiar human approach test	8	6		7	6
Investment					
Animal productivity	1	1		1	1
Gross margin/unit	2	2		3	3
Net income	5	4		4	2
Cost of production	4	3		2	3
Business Plan	8	2		6	4
Long-term profitability	3	3		2	5
Community investment	9	5		8	6
Internal investment	6	6		7	5
Price determination: break-even point considered when negotiating	7	4		5	4
Vulnerability					
Sales agreement between the farmer and the purchaser for the quantity and t...	1	1		1	1

Dependence on CAP subsidies or external funding sources	2	3		2	1
Liquidity	6	5		5	5
Guarantee/security of production levels	5	5		4	3
Product diversification/ specialisation	4	2		4	2
Procurement channels: mechanisms to ensure stable supply	7	6		6	4
Stability of supplier relationships	3	4		3	3
Risk management plan	7	6		7	3
Product quality/info					
Meat and milk quality control measures	2	1		2	1
Traceability systems	3	2		3	2
Production with quality label/ certification	1	3		1	3
Hazardous pesticides: handling &amp	6	6		6	6
Food contamination	5	5		5	5
Product labelling	4	4		4	4
Local economy					
Structure of farm labour force	4	3		4	3
Use of local procurement	2	2		1	3
Sale of the products (milk/lamb) to local enterprises	1	1		2	1
Direct farm sales	3	4		3	2
Fiscal commitment: taxes paid in country of operation	5	5		5	4
Decent livelihood - Decent Livelihood comprises the capabilities					

Wage level	1	1		2	1
Labour productivity	5	3		6	4
Quality of worklife	2	3		1	2
Days off	3	4		4	3
Likely continuity of the farm for the 10 next years	4	5		4	5
Fair pricing and transparent contracts	6	2		3	6
Rights of suppliers	7	6		6	7
Labour rights					
Employment relations and contracts	1	1		1	1
Forced labour	4	4		3	4
Child labour (under 16 years old)	3	3		4	3
Freedom of association and right to bargaining with employer	2	2		2	2
Equity					
Non-discrimination	1	2		1	2
Gender equality	2	1		2	1
Support to vulnerable people	3	4		4	4
Indigenous knowledge	4	4		4	3
impact on food sovereignty	5	3		3	4
Human safety					
Health and safety training	3	1		2	1
Safety of workplace operations and facilities	1	2		1	1

Health coverage and access to medical care	2	4		3	2
Impact on public health	4	3		4	3

APPENDIX 4

New sustainability indicators added to PG Tool (subtask 1.2.4)

SAFA domain and Indicators included	Which information to collect ?
ECONOMIC RESILIENCE	
Animal productivity	Average number of lambs (or kids) sold /ewe (or goat)
	Milk yield
Economic result	Gross margin / ewe or goat
Sales agreement between the farmer and the purchaser for the quantity and the price of milk or lambs	Do you have a sale agreement with your purchaser for the quantity of milk or lambs (or kids): yes, no
Dependence on CAP subsidies or external funding sources	CAP or government subsidies / gross farm product
Product diversification/ specialisation	Proportion of total income from goat or sheep unit
Liquidity	
Diversity of supply channels	Number of supply chanels
	Lamb or kid meat is sold with a quality label: Organic agriculture, Protected Designation of Origin, Protected Geographical Indication…
Production with quality label/ certification	Milk or cheese is sold with a quality label: Organic agriculture, Protected Designation of Origin, Protected Geographical Indication…
	Product clearly labelled with information about producer as well as product info : yes, no
Product packaging	The animals are correctly identified and products traceability is ensured : yes, no
Traceability systems	Carcass quality controls are regularly done to meet the expected food quality levels: yes, no

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Use of local procurement	Do you apply a procurement policy that prioritizes the purchase of inputs from local suppliers : yes, no
Direct farm sales	Do you sell your milk (or cheese) or your lambs (or kids) directly on the farm: yes, no
Structure of farm labour force	Total workforce (detail for family, hired and volonteer workforce)
Sale of the products (milk/lamb) to local enterprises	Do you sell your milk or your lambs (or kids) to local enterprises: yes, no
SOCIAL WELLBEING	
Traceability systems	The animals are correctly identified and products traceability is ensured : yes, no
Meat and milk quality control measures	Carcass quality controls are regularly done to meet the expected food quality levels: yes, no
	Milk (and cheese) quality controls are regularly done to meet the expected food quality levels: yes, no
Quality of worklife	Can you estimate the workload on your farm: very height, height, medium, low, very low
	Can you estimate the work onerousness on your farm: very height, height, medium, low, very low
	Do you do some works with neighbours farmers: yes, no
Days off	Average number of days off per year
volunteers/apprentices taken on farm	Number of volunteers/apprentices
farmer engages in training in new BATs	mechanisms by which the farmer stays aware of current Best Available Technologies/Techniques
Rights of suppliers	Does the farm place any restrictions on the suppliers and if so, what?: yes, no; if YES specify which restriction
Fair pricing	sale price of farm products compared to industry average (and justification if higher/lower)
Employment relations and contracts	Do you have a written agreement with your employee(s) that meet national and international labour treaties including social security: yes, no
Family workers statute	family members work under no formal or informal agreement (for example, a promise of the farm when the farmer retires): yes, no
Forced labour	Procedure for finding and employing labour

Child labour (under 16 years old)	Under 16's involved in farm work? If YES: ask about hours per week, mitigation of any effect on schooling, whether they are involved in ALL farm activities (considering safety aspects - them and others)
Freedom of association and right to bargaining with employer	Employees members of associations/unions? Yes, No; IF NOT - could they be if they wanted?
Non-discrimination	Do you actively avoid discrimination against any employee or prospective employee? yes no
Gender equality	Female labour force / total labour force
Support to vulnerable people	Presence of vulnerable people on farm (disabled/retired/migrants): yes, no If YES policies in place to facilitate their work? ; If NOT: are opportunities where support could be offered considered and expressed when looking for new labour, in order to widen the people meeting requirements?
Indigenous knowledge	Do you make use of any techniques/breeds/cultivars that originated from an indigenous community or traditional cultural heritage?: yes, no If YES: do you know whether these people have been, or are being, remunerated for this knowledge if desired?
Human health	Is there a known procedure for accessing emergency medical care?: yes, no
Human health	Harvest practices in relation to use of above chemicals. Compare to recommended safe practices (use a single legal standard across ALL countries)
Human health	procedures in place to avoid contaminated products leaving farm
Human health	Instances of contaminated products leaving farm in last 5 years. IF >0, procedures put in place since
Human health	involvement in community healthy living work
Universal rights of indigenous communities	Do you make use of any techniques/breeds/cultivars that originated from an indigenous community or traditional cultural heritage? Yes, no If YES: do you know whether these people have been, or are being, remunerated for this knowledge if desired?
Local breeds and seed	Do you keep any local breed of sheep or goat: yes, no If YES, proportion of sheep, goats

	Do you produce your seed for fodder crops or cereals: yes, no If YES, proportion of the seeds used during a year
GOOD GOVERNANCE	
Risk management tool in place and regularly updated	Evidence of risk management tool in use and up-to-date
Influence of enterprises' sustainability commitments in key decisions and processes	To what extent do sustainability commitments influence key decisions and processes
Holistic audits: recognised sustainability audit tool used & results regularly reviewed	Recognised sustainability tool already used
Leakage effects: exporting of enterprises' environmental/social impact	Indirect environmental, social and economic impact of management decisions is considered e.g. impact of suppliers
Transparency: documents and webpages have clear pathways for accessing information	Information on farm's sustainability measures is openly available
Transparency: transparency policy is used and information available to stakeholders	Information on farm is openly available (ideally with a policy on transparency)
Ability to identify and resolve stakeholder conflicts	Evidence of stakeholder identification and potential conflict resolution if required
Satisfactory stakeholder grievance procedures	Evidence of process in place to resolve stakeholder conflicts and grievances
Effective stakeholder participation: feedback affects decision making	Evidence of stakeholder feedback being incorporated into decision making e.g. consultation exercises
Fiscal responsibility	Any fines, prosecutions or disputes in relation to poor financial management
Working conditions of workers: liability regulations	Any fines, prosecutions or disputes in relation to labour rights
Compliance with national laws and international agreements (incl. human rights)	Any accidental breaches of national laws in the past
IF a breach of law has occurred, accidently or otherwise, have actions been taken to prevent it happening again? [or is there a procedure in place to do so should a breach occur in the future?].	Actions in place to avoid any fines, prosecutions or dispute occurring again
Property/tenure rights	Any fines, prosecutions or disputes in relation to property and tenure rights

Full cost accounting: incorporating economic, social and environmental performance and impacts	Evidence of full cost accounting system in use
Environmental checklist on employee training, waste management etc.	Employees are trained on environmental issues
Monitoring of performance criteria	Evidence of sustainability performance monitoring
Use of 'best available farming technology/techniques' to improve performance	Evidence of application of latest best farming practice and efforts to stay aware of changing BATs
ENVIRONMENTAL INTEGRITY	
Air pollution prevention and reduction practices	Machinery used and method of use (eco-driving, well maintained engines, EURO standards, etc.)
Air pollution prevention and reduction practices	management of burning/fire frequency
GHG emission prevention and reduction practices	Machinery used and method of use (eco-driving, well maintained engines, EURO standards, etc.)
GHG emission prevention and reduction practices	use of peat
GHG emission prevention and reduction practices	Burning practices (and fire incidence)
GHG emission prevention and reduction practices	Soil tillage/direct seeding
GHG emission prevention and reduction practices	Building insulation
Feed conversion ratio	How feed rations are decided
Eutrophication	Local water quality problems downstream of farm
Reduction of sedimentation practices	Tillage practices/direct drilling
Reduction of sedimentation practices	Presence of standing trees/woody species
Livestock density	Stocking density on field
Soil contamination with residues/heavy metals/other pollutants	Water used for irrigation - is the cleanliness/ph/salinity monitored and frequency
Soil quality improvement practices	Practices to increase soil OM/biodiversity/structure (tillage, pesticide use, etc)
Genetic diversity - Use of 'wild' gene pools for domesticates	Strains of crops used and factors influencing selection

Genetic diversity - Use of 'wild' gene pools for domesticates	Breeds used and factors looked at in bloodline
Genetic diversity - cultivated species	Factors influencing strain/breed selection (as above)
Genetic diversity - cultivated species	Factors considered when breeding (do they include hereditary lines/parentage?)
Soil biota index	Practices used aimed at improving soil biological quality (no till, pesticide practices, organic fertiliser etc.)
Grazing	Amount of supplementary feed given
Raw material use intensity	Practices to reduce material use
Raw material use intensity	Practices to switch from non-renewable/intensive/short term materials to renewable/recycled/long lasting materials
Feed conversion index of livestock	Feed given per animal (total feed; number of animals). For pasture, use literature values
Crops and livestock adapted to local biotic conditions	Breeds/cultivars and proportions
Waste production	Amount of waste produced in each of waste categories above
Animal Health	
Frequency of livestock inspection for signs of illness/injury	Ask farmer
Age of goats/sheep first kidding/lambing	Ask farmer
Longevity of sheep or goats	Ask farmer for absolute age and also whether they think it is longer/average/below average
Functional longevity	Age to which the farmer keeps the animals as productive livestock
Number of antibiotic treatments / ewe / goat	Number of antibiotic treatments
Sanitary status	Fulfillment of the higest sanitary status acording to legal regulations plus freedom of some extra diseases
Culling strategy	Different options (keep records and criteria to remove animals according to production , health/only those that get very ill….)
Disease prevention in breed/ breeding stock selection	Ask farmer
Mastitis and udeer asimetry incidence	Different % as options
Lameness incidence	Different % as options

Hair/fleece associated problems	Different % as options
Freedom from stress	
Water availability	In situ observation of animals following AWIN protocol on queuing at drinking
Wind/rain protection	In situ observation of facilities and environment
Stocking density	Number of animals per pen area
Livestock adapted to local biotic conditions	Breeds on farm and proportions
Adequate availability of feed (forage) ad libitum	Have the animals free access to food along the day? i.e. permanent disposal of low nutritive forage (straw, grass silage,…)
Use of local breeds more adapted to environment	Yes, mix, no
Building design to avoid thermal stress	In situ observation
Freedom from stress around milking	In situ observation
Appropriate handling equipment on farm	In situ observation
Incidence of feeding-associated disorders (acidosis, Ketosis, enterotoxemia…)	Range of %

APPENDIX 5

List of sustainability tools that received no vote in the industry partner survey (Refers to section 3.1)

ANCA (Annual Nutrient Cycle Assessment)
APOIA-NOVORURAL
ARBRE (Arbre de lâ€™Exploitation Agricole Durable)
AUI (Agrar-Umweltindikatoren; Agri-environmental indicators)
AVIBIO
Boone and Dolman (2010)
BROA (Biodiversity Risk and Opportunity Assessment)
CAPRI (Common Agricultural Policy Regionalised Impact)
CCalc
Coteur et al.(2014)
DairySAT
Dantsis et al.(2010)
DEXi-PM
DIAGE (DIAgnostic Global d'Exploitation)
DIALOGUE (Diagnosticagri-environnementalglobal dâ€™exploitation)
DLG (DLG â€“ ZertifikatNachhaltigeLandwirtschaft)
DRAM
DSI (Dairyman Sustainability Index)
DSR (Driving Force State Response)
DurabilitÃ© des eBalance
ecoinvent
EIME
EMA (environmental management for agriculture)

FARMSCOPER (FARM SCale Optimisation of Pollutant Emission Reductions)
FARMSMART
FCAT
FESLM (Framework for the evaluation of sustainable land management)
Fieldprint calculator
Footprints4food
FSA tool (sustainable agriculture initiative platform)
GaBi
GEMIS
Healthy Farm Index
Teagsac National Farm Survey of Sustainability
HGCA biofuel GHG calculator
HGCA carbon footprinting decision support
IFSC
IMPACCT (Integrated Management oPtions for Agricultural Climate Change miTigation)
INDIGO (INdicateurs de DIagnostic GlObal a la parcelle)
InVEST (Integrated Valuation of Environmental Services and Tradeoffs)
IRENA
ISAP (Indicator of Sustainable Agricultural Practice)

MEXALCA (Modular EXtrapolation of Agricultural LCA)
MMF (Multiscale Methodological Framework)
MODAM
MOTIFS (Monitoring Tool for Integrated Farm Sustainability)
openLCAOSCAR
PASMA
PLANETE (Pour l'analyse energetique de l'exploitation)
PROMAPA.G
PROSA
Quantis Suite
RAD (diagnostic de durabilite du Reseau de l'Agruculture Durable)
RAUMIS
REGIS
REPRO (REPROduction of soil fertility) (incorporated into DLG-Zertifikat certification)
RISE
SAEMETH
SAFE (sustainability assessment of the farming and the environment)
SALCA (Swiss agricultural life cycle assessment) (aka. Agroscope)
SDA

EP (Ecopoints)	KSNL (Kriteriensystem Nachhaltige Landwirtschaft)	SEEbalance
Exploitations	KUL/USL (Criteria and Standards for Sustainable Agriculture)	Sheep Carbon Footprint Tool
Farm Scale Resource Use Efficiency Calculator	Labelguide WWF	SILAS
FARMIS (Farm Modeling Information System)	L'arbe d'exploitation agricole durable	SOAAN
	Managing energy and carbon	SPA
	MASC (multi-attribute assessment of the sustainability of cropping systems)	SSP (sustainability solution space for Decision Making)
		Sustainable Agriculture Steering Group
		Team 5
		Umberto