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Stakeholders' perceptions of sustainability measurement at farm level

Increased attention for sustainability in agricultural production within the food sector has enhanced the need for farm-level information. This article aims to explore stakeholders' perceptions of sustainability measurement at farm level in an established monitoring system. Qualitative research, including discussion groups and semi-structured interviews in nine European countries, identifies existing divergences in perceptions, especially for those indicators not expected to be used for farm-level decision making. The perception of feasibility and usefulness of an indicator is determined by (a) indicators' intrinsic attributes, (b) the measurement system in which it is inserted, (c) farm characteristics and (d) farmers' attitudes toward the measurement. Identifying stakeholders' perceptions could help to improve the discussion between researchers and users in the selection, communication and use of sustainability information along the agricultural sector.

Keywords: stakeholder involvement, farm level sustainability indicators, qualitative research

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Introduction

As a response to the multiple pressures of climate change, natural resource degradation, societal demands and global markets, the food sector is facing the challenge of moving toward more sustainable ways of production, driven by regulatory frameworks and changes occurring along the agricultural supply chain (Higgins *et al*., 2010). Operationalising the concept of sustainability is believed to be necessary to define goals, track performance, induce behavioural changes and help to solve disputes (Bosch *et al*., 2015).

Owing to the multiple functions of indicators as a scientific unit, measurement unit and policy element (Joumard and Gudmundsson, 2010), the selection of a set of indicators has been argued to be both a scientifically and politically iterative process (Mccool and Stankey, 2004), located in a fuzzy area between the production and use of scientific knowledge (Turnhout *et al*., 2007). While considering users' perspectives in the selection of indicators helps to achieve transparency, relevance, ownership and public legitimacy (Moxey *et al*., 1998), it requires a dialogue between designers and users. This dialogue is considered an 'untamed problem', where multiple values are in conflict, outcomes are uncertain and there exists significant scientific disagreement (Batie, 2008). The aim of this study is to explore stakeholders' perceptions regarding the feasibility and usefulness of the introduction of sustainability indicators in an existing farm level monitoring system. Using the definition of stakeholders of Freeman (1984), we consider the perceptions of those individuals or groups who affect, or are affected, by the introduction of sustainability indicators. This research is part of the European Union (EU) Framework 7 project FLINT (Farm Level Indicators for New Topics in Policy Evaluation), the objective of which is to test the feasibility of establishing a common standard set of farm-level indicators for policy evaluation in nine EU Member States, ideally linked with the Farm Accountancy Data Network (FADN). This paper describes the methods used to collect stakeholders' perceptions, the main results and the conclusions.

Theoretical background

Agricultural information systems include both the production of data and the transformation of these data into information that is useful for a policy decision or a problem solution (Bonnen, 1975). Those systems rely on the measurement process, in which a concept is linked to one or more latent variables, and these are linked to observed empirical variables (Bollen, 1989). If the concept is complex or has different meanings for several actors – such as sustainability along the food chain – we can expect that the concepts and information derived from those systems have different values for the different actors. The values and perceptions of stakeholders can be divergent in conflicting ways, turning a complex problem into a 'wicked' one that cannot be solved, only managed (Peterson, 2013). Stakeholder involvement has been considered as a way to increase the likelihood of evaluation utilisation (Taut, 2008), a missing step in indicator validation (Cloquell-Ballester *et al*., 2006) and an important input while dealing with complexity, uncertainty and ambiguity (Renn, 2015).

Sustainability is identified as an untamed problem because of the complex and dynamic nature of the problem definition and radically different understandings (Batie, 2008). Nevertheless, in order to be measured, analysed and communicated, the sustainability concept is reduced to a limited number of indicators (Schindler *et al*., 2015). Indicators are defined as a *quantitative or qualitative factor or variable that provides a simple and reliable means to measure achievement, in order to reflect the changes connected to an intervention, or to help assess the performance of a development actor* (DAC-OECD, 2002, p.25). The assessment of indicator quality is made through a list of criteria. The more frequently used criteria are those developed by OECD (2001): policy relevance, responsiveness, analytical soundness and data availability. However, in general, there is no universal set of criteria to judge indicators, and there is no common understanding regarding the definitions of the criteria. Selection approaches such as rating, standardisation, weighting and combining (Rice and Rochet, 2005) have until now been a science-led process where the political or managerial context in which indicators are used is not fully

Table 1: Indicators of sustainability at farm level by dimension of sustainability.

Environmental	Economic and innovation*	Social
E1 Permanent grassland	***EI1*** Innovation	***S1*** Advisory services
E2 Ecological Focus Areas	***EI2*** Producing under a label or brand	***S2*** Education and training
E3 Semi-natural farmland areas	***EI3*** Types of market outlet	***S3*** Ownership-management
E4 Pesticide usage	***EI4*** Past/future duration in farming	***S4*** Social engagement/participation
E5 Nutrient balance (N, P)	***EI5*** Efficiency field parcel	***S5*** Employment and working conditions
E6 Soil organic matter in arable land	***EI6*** Modernisation of the farm investment	***S6*** Quality of life/decision making
E7 Indirect energy usage	***EI7*** Insurance: production, personal and farm (building structure)	***S7*** Social diversification: image of farmers/ agriculture in local communities
E8 Direct energy usage		
E9 On-farm renewable energy production	***EI8*** Share of output under contract with fixed price delivery contracts	
E10 Farm management to reduce nitrate leaching		
E11 Farm management to reduce soil erosion	***EI9*** Non-agricultural activities	
E12 Use of legumes		
E13 GHG emissions per ha		
E14 GHG emissions per product		
E15 Carbon sequestering land uses		
E16 Water usage and storage		
E17 Irrigation practices		

* Indicators that form part of the current FADN Farm Return are not included in this list
Source: own compilation

recognised (Turnhout *et al*., 2007; Rametsteiner *et al*., 2011).

Considering the increasing availability of data and the different users of information (Pannell and Glenn, 2000), the value of sustainability indicators is argued to rely on the relevance of data for optimising farm efficiency (Fountas *et al*., 2006) or the use of the information in the supply chain for creating competitive advantages through transparency and innovation (Beske-Janssen *et al*., 2015). An appropriate combination of methods to involve stakeholders would lead to the integration of scientific expertise, rational decision making and public values (Renn, 2015).

Methodology

To explore stakeholders' perceptions, a mixed-methods research approach was used, simultaneously collecting both quantitative and qualitative data in a concurrent embedded strategy within a qualitative predominant method (Creswell, 2009). Qualitative approaches are appropriate when it is necessary to involve participants with a specific interest and personal experience (Bitsch and Olynk, 2007), the results do not need to be generalised to a population (Patton, 2015) and the results could be used for evaluation and the development of policy recommendations as well as in action research (Bitsch, 2005). Four steps were conducted in order to involve stakeholders, of which steps 1 to 3 were conducted by project partners in each country.

The list of indicators (Table 1) was selected after an extensive literature review, analysis of information gaps and discussions within the project team. Stakeholders were identified based on who is involved in collecting, storing, analysing, reporting and using the information generated. Considering the expected level of availability of stakeholders and the list of preselected sustainability indicators, visualised group discussion tools and semi-structured interviews were designed and pilot-tested with farmers and farm advisors.

Sixteen group discussions and 42 individual interviews were conducted between September 2014 and January 2015. In total, 174 stakeholders were consulted through discussion groups, face-to-face individual interviews, group interviews, interviews by telephone and interviews by email. The discussion groups and semi-structured interviews tools consisted of two parts. Firstly, stakeholders answered three open-ended questions related to their experience about the collection of sustainability data (*Q1: How is farming being influenced by changes and demands coming from society, consumers, policy, trade partners? Q2: What kind of data are requested from you/do you request? Q3: What is your experience collecting and/or using those data?*). Secondly, stakeholders scored the feasibility and usefulness of each of the 33 indicators using a two-pole scale (--, -, +/-, + and ++) and giving their reasons for the assessment.

Eight stakeholder groups can be identified among the participants (Table 2). Farmers and farm data collectors of the FADN system account for 33 and 26 per cent respec-

Table 2: Stakeholder groups consulted about their perceptions of sustainability.

Group	Description
Farmers (58)	Diary, beef, arable and mixed crops farmers.
Farm advisors (13)	Technical experts or specialists, extension agents, and advisory and accountancy services whose work is realised at farm level.
Farm data collectors (46)	Professional data collectors and farm advisors who are involved in FADN data collection.
FADN representatives (9)	Contact persons of FADN liaison institutes, statistical offices, national representatives, coordinator or contact persons of national FADN systems.
Policy makers and / or policy evaluators (9)	Experts and head of units of agricultural authorities, directorates for agricultural ministries sections, policy evaluators and planners, rural development experts.
Scientists and academics (11)	Professors of universities, scientists of research institutes.
Farmers representatives (3)	Policy expert of a chamber of agriculture, a research director of farmers' union and a farmers' union representative.
Value chain actors (14)	Sustainability manager, farm service director and representative of dairy processors' and milk cooperative, director of a sugar company, director of a trade company, representative of a federation of agri-food industry, members of institutes for organic food associations and food chain quality, an organic bakery, marketing personnel of a food company.

Source: own compilation

tively of the persons consulted, and more than 50 per cent of them came from Spain and Poland. FADN representatives and actors involved in national policy evaluation initiatives make up 10 per cent of the respondents. Other stakeholders not directly involved in the current FADN measurement system, but potential users of the information (such as farmers' representatives, researchers and value chain actors), represent 28 per cent of the participants.

The quantitative scores assigned by stakeholders were used to generate the average numeric assessment of indicators. The analysis of the answers of the open-ended questions and qualitative comments on the indicators was made with the help of the 'ATLAS.ti7' software for qualitative analysis (ATLAS.ti Scientific Software Development GmbH, Germany). The coding was conducted in two steps: (a) an initial open coding of the qualitative answers, aiming to delimit categories, commonalities and differences; and (b) a second coding based on the categories established in the first stage, searching for patterns and generalised relations following grounded theory analysis principles.

Results and discussion

Here, the results of the coding process are presented, as are the quantitative scales that were used to classify indicators.

Identification of current sustainability monitoring systems

Stakeholders consulted identify three types of farm-related measurement systems: (a) regulations-based measurement; (b) market-led measurements; and (c) own farm measurement system. Regulations-based monitoring systems have as a purpose compliance with government rules or policy evaluation, for example cross-compliance mechanisms. Market-led measurement initiatives request information based on the commercial arrangements between farmers and their customers, for example information that is requested by traders, retailers or consumers. Farm monitoring systems include all the data and information management (digitalised or not) managed within the farm (Figure 1). According to the interviews, those systems have their own incentives and characteristics, being complementary or even 'redundant', depending on the features and requirements of the supply chain and the national contexts.

Interviewees agreed that the management of data and exchange of information is a time-consuming and costly process, with a high level of variability among farmers on the willingness to participate. Three factors affecting the exchange of information about sustainability were identified: (a) alignment of the farm system information with the required information and with the objectives behind the indicator; (b) expectations of the information exchange, including trust among actors, expected benefits and expected risks; and (c) cooperation of users beyond the farm level with regard to the calculation, analysis and the availability of information.

Alignment of required information with own farm management information system and farm objectives. Information exchange is determined by the availability of the information at the farm level. The current state of bookkeeping and use of digitalised information tools at this level is highly variable, according to the type of farming and the region. Gathering of variables that requires additional investments, time or knowledge from the farmers' side adds difficulties to the collection. Closely related is the compatibility of the objectives of the external actor to the farm's objectives: interviewees stated that information provision makes more sense if the information can be used for farm-level planning and decision making regarding business strategies or production factors use. Nutrient balance, for example, "can be used as part of a nutrient management plan".

Expected outcome of the information exchange. Farm advisors and other non-farm stakeholders mentioned that data gathering is not a one-sided data provision, but an exchange of knowledge, even in the short term. The level of trust between actors is identified as extremely important: the provision of accurate information can be highly influenced if the data are linked to an incentive or penalty. Also, a data collector should be a reliable agent, trained about the information to be collected and knowledgeable of the area and local farms in order to validate the data during the collection phase. Three main perceived benefits of information exchange were mentioned: professional support to the farmer, a farm-level customised report and the possibility of benchmarking.

Beyond farm level: cooperation among sustainability information users. Data gathering is the first step of knowledge generation. The conversion of the data into usable information includes calculating, interpreting, inferring, communicating and influencing decisions. During this process, issues arise outside of the farm level: (a) calculation of indicators is not standardised; (b) interpretation and inference of indicators can be misled without the necessary control variables and knowledge of the context; (c) indicators should be communicated back to the farmers, society or consumers in an understandable and complete way; and (d) conflicts between sustainability goals among actors requiring information. For all these issues, cooperation between stakeholders is needed. Potential conflicts between databases could be avoided with "collective databases that can be accessed by different parties" or the implementation of "unique data codes for indicators". Both solutions imply the creation of norms that are not yet developed.

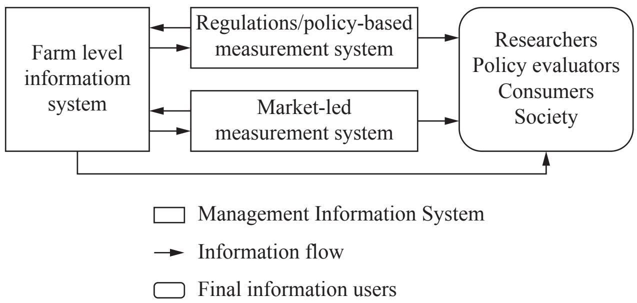

Figure 1: Schema of current sustainability information measurement systems and flows identified by stakeholders.
Source: own construction

Assessment of feasibility and usefulness of sustainability indicators

Across the whole group of surveyed stakeholders, on average, all indicators were considered useful and, with the exception of greenhouse gas (GHG) emissions, all the indicators were considered feasible. Nevertheless, few indicators are considered as being very useful (Figure 2).

The reasons for the differences in assessment of indicators are identified by grouping the concepts derived from the perceptions toward the indicators into categories.

Factors that determine perceived feasibility

The assessment of the feasibility of an indicator would not only depend on the characteristics of the indicator itself (type of data and evidence, level of measurement and allocation) but also on the characteristics of the measurement system in which it is embedded (availability of matching information), the farm characteristics (type, size, fragmentation) and the attitude of the farmer towards the measurement (Table 3).

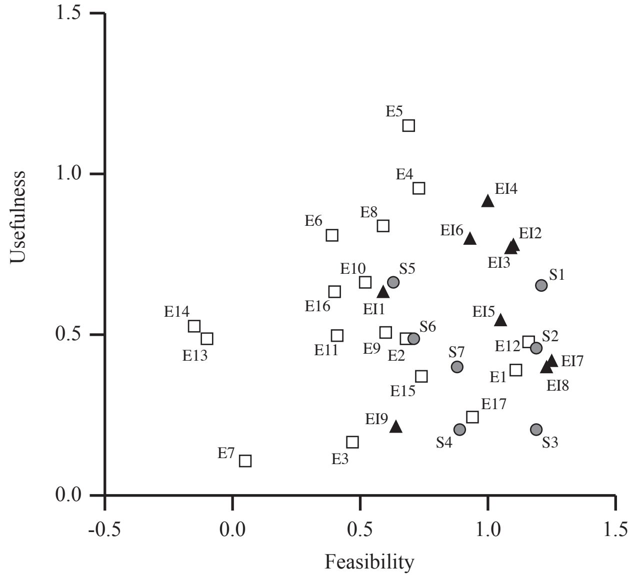

Figure 2: Stakeholders assessment of indicators according to perceived feasibility and usefulness**.**
Scale: 2=++; 1=+; 0=+/-; -1=--; -2=--
See Table 1 for names of indicators
Source: own composition

Table 3: Factors that determine the perceived feasibility of indicators of sustainability.

	Categories and coded attributes	Description and examples
Indicator's attributes	***Type of data***	
	Evidence-based data	Data that are measured with an established instrument and which is ascertainable, e.g. invoices, soil organic matter content.
	Best-estimated data	Data that are estimated or approximated according to the knowledge of the farmer, e.g. manure usage, farm practices, water usage, innovation, advisory services.
	Calculation	Information that is deducted using normative scales or standard coefficients, e.g. GHG emissions.
	Perceptions	Subjective opinions which are not possible to measure physically, e.g. quality of life perceptions.
	Level of data breakdown in collection and calculation	
	Household level	Level at which the measurement or collection of variables of the indicators take place, e.g. soil organic matter is measured in sampling plots; pesticide usage can be measured at crop, parcel or farm level; emissions can be calculated by hectare or product.
	Farmer level	
	Farm level	
	Plot /parcel/crop/field level	
	Product level	
Measurement system	***Availability of data***	
	Part of the recording system of the farm	Data and information are kept in different types of recording systems within the farm: books, software, databases and sheets. In some cases, they are digitalised. Example: farmers keep registers about pesticide usage, fertilisation, cattle movements, investments, contracts, and financial bookkeeping.
	Part of existing external and accessible databases	Farm level information that is collected and stored in databases outside the farm, e.g. Land Parcel Identification System, projects' databases.
	Agent requesting it	
	Regulations: mandatory at farm level	Information that is requested for compliance with regulatory issues, e.g. pesticide usage for regulations, cross compliance checks.
	Requested by clients: desirable or mandatory at supply chain level	Information that is required by traders or consumers, e.g. antibiotics usage, quality assurance per product, certification schemes labelling.
	Special programmes: optional	Information that is requested by special programmes, e.g. certification schemes, research projects, rural development programmes.
Farm	***Farm characteristics***	
	Size	Size of the farm: small/big farms.
	Type	Type of agricultural system, e.g. livestock, horticulture, orchards.
	Fragmentation	Dispersion of the fields and parcels.
	Region	Region, context in which the farm is located.
Farmer	***Farmer attitude toward information provision***	
	Sensitivity of the information	Information which provision can be seen as potentially harmful for the farmer, e.g. personal/private information, part of their business strategy.
	Trust in researchers and policy makers	Degree of trust on the use of information, e.g. doubts about how the information will be used: new taxes, regulations, new requirements.

Source: own compilation

Factors that determine perceived usefulness

Indicator usefulness depends mostly on the relevance for the stakeholders of the objective behind the indicator (Table 4). In two farmers' discussion groups, however, it was stated that is meaningful to collect some indicators even when they are not usable at farm level: a difference in the value for the farmer and the public value was highlighted.

For the interviewees, an indicator is a simplified metric of a complex reality expected to change; therefore, how well the indicator represents this reality is the second factor influencing the usefulness criterion. To infer and make valid conclusions, the adequate judgment would need to use contextual factors and control variables. As one consulted researcher pointed out: "There are facts, lies and statistics. It is not difficult to collect data; it is much more difficult to understand the data".

Perceptions toward indicators according to sustainability dimension

Crossing indicator assessment and using the schemes presented in Tables 3 and 4, this section discusses the stakeholders' perceptions of the indicators categorised in the three dimensions of sustainability.

About *environmental indicators*, stakeholders pointed out the importance of explaining the rationale and links between indicators, taking into account the 'cycles' in agriculture. National sustainability objectives could be translated at a farm level only if information could be consolidated or aggregated using a farm-level balance. Evidence-based data (soil organic matter, water use, energy production, energy consumption) is perceived as costlier and difficult to measure accurately; however, much significant information is already available from farm records (e.g. fertilisers, pesticide usage). Many variables of the indicators are best estimates: farm practices, percentages of allocation (between crops, activities or at the farm/household level) or calculations (water usage, manure usage). Those indicators that measure changes in quality of production factors were identified as usable for farm planning and management to reduce costs, increase productivity and foresee future demand (E5, E12, E10, E8, E9, E6, E16). Those related with greening were linked with access to subsidies (E1, E2, E3). The pesticide usage indicator was associated with complying with regulations and customers' requirements. GHG emissions, on the contrary, is an 'important' indicator used 'to inform', not usable at farm level, and important for the consumer; therefore, highly valued by the value chain actors and policy makers and poorly valued by farmers. Most of the stakeholders – except for value chain actors – considered measuring it as difficult. Indicators related to pesticide usage and nutrient balance were considered as possible sensitive indicators. The link between farm practice and impact was also stressed: there is the need to collect enough information to make the causality link possible; however, the complexity in some environmental indicators to establish this link was also identified: "some activities will lead to measurable changes over 20 years". The need for match information sources and methods using multiple databases, or measurement ini-

Table 4: Factors that determine the perceived usefulness of indicators at farm level.

	Categories and coded attributes	Description and examples
Indicator's attributes	***Relationship of the indicator with sustainability objectives***	
	Causality	Clear causality relationship between variables collected and objectives measured. From the scientific point of view, if the indicator is a valid representation of the expected problem to be measured.
	Interpretation	Existence of sufficient knowledge to interpret the indicator properly and link with management actions.
	Context variables	Availability of knowledge of 'context variables' that make it possible to infer valid conclusions and compare across time, farmers, countries and regions.
	Level of breakdown in reporting	
	Farmer level Farm level Plot /parcel/crop/field level Product level	Level at which the data is transformed into information that can be used for decision making, e.g. pesticide usage can be reported at crop, parcel or farm level; emissions can be calculated by hectare or product or reported by farm.
Measurement system	***Perceived relevance of problem measured with the indicator***	
	Farmer Farm advisors Policy makers Consumers Society	Relevance of the objective measured through the indicator for the stakeholder, e.g. farm advisors are interested in to know overall performance of the farm; consumers and society are interested in pesticide usage and emissions.
	Perceived potential use of the indicator	
	Decision making	Potential to use the indicators for planning and management at farm level, advisor level, sector level, national level, policy level.
	Inform or communicate	Indicator main use is to inform other actors: researchers, policy makers, consumers, community.
Farm	***Farm characteristics***	
	Size	Size of the farm: small/big farms.
	Type	Type of agricultural system, e.g. livestock, horticulture, orchards.
	Region	Region, context in which the farm is located.
Farmer	***Farmer objectives***	
	Farmer objectives	Objectives, e.g. profit maximisation, organic agriculture, protect the environment.

Source: own compilation

tiatives with the same indicators were concepts particularly claimed by policy makers, FADN representatives and data collectors.

Indicators of social sustainability at farm level are perceived by stakeholders as best estimated data and perceptions. In general, they are not currently requested, except in specific rural development programmes or specific research surveys. Like the other indicators, the need for clearer definitions of variables was mentioned. Social indicators are perceived as indicators for informative purposes: they are information already known by the farmer, with low relevance for farm decision making, high usability for policy making and low importance in regard to informing consumers. Policy makers and researchers discussed the importance that social indicators have, and how they have been less present than economic and environmental indicators within the sustainability discussion, while farmers, farm advisors and value chain actors questioned to what extent their analyses will be effectively used. The indicator for employment and working conditions was assessed as the most useful one, despite the complexities of calculating seasonal labour and the number of working hours. Policy makers in particular found a link between social indicators and rural development programmes, even though the fact that having a common exhaustive list that could be relevant and applicable for all regions could be a challenging task.

The indicator based on subjective perceptions (S6) prompted divergent opinions from all stakeholder groups. Many stakeholders emphasised the importance of this measurement but, for others, personal perceptions were regarded as beyond the objectives of policy, and the subjective nature of the questions and the influence of multiple non-controllable factors make their analysis only useful for longitudinal research. Possible sensitive indicators identified were S1, S4, S6 and S7.

Most of the *economic indicators* presented to stakeholders are best estimates or are already accessible using existing bookkeeping on the farm, except for the innovation indicator EI1. This needed to be explained further; while some stakeholders mentioned its importance as part of the objectives of the EU's Common Agricultural Policy, there was a high level of divergence on the concept, the way to measure it, the objective behind its measurement and how it would be analysed. For some other indicators, the relationship with sustainability was not clear (EI2, EI, EI8). Market indicators such as labels and fixed contracts stimulated many different opinions: they have a value important for the farm, but they do not represent a sustainability objective in themselves. Possible sensitive indicators were also identified (EI8, EI9, EI6, EI4).

Conclusions

We have conducted a stakeholder analysis of the measurement of sustainability at farm level. Stakeholders acknowledge sustainability measurement as an important trend in the agricultural sector in which three information systems are identified: own farm system, regulation-based system and market-led system. Every system has its own institutional arrangements, goals and incentives. Information exchange within those systems is influenced by (a) the level of alignment between the farm and the agent requesting it: objectives, information requirements, trust, expected benefits and expected risks and (b) the cooperation of users of indicators beyond the farm level.

Stakeholders assessed 33 sustainability indicators based on feasibility and usefulness criteria. Overall, all indicators are perceived as useful and, except for GHG emissions, all are considered feasible to measure at the farm level. Environmental indicators are perceived as the most useful for all eight groups of stakeholders, especially those indicators expected to be related to farm productivity. Innovation and economic indicators (different from indicators already included in FADN) are perceived more feasible but less useful for sustainability measurement. Social indicators are perceived as important from the policy and research point of view but less useful from the farmers' and value chain actors' perspectives. In general, divergences between stakeholders' perceptions arise for those indicators that are not expected to be used for planning and management at the farm level. The differences in perceptions on how feasible and useful an indicator is could be explained not only by the intrinsic attributes of the indicators but also on the measurement system requiring it, the farm characteristics and the attitude of the farmer towards the measurement. This confirms the value of scientific but also societal criteria in the selection of indicators.

Although the testing of indicators in a monitoring system will be done in the subsequent steps of the FLINT project, stakeholders' consultation elicits the main arguments and different points of view that potentially could improve communication between researchers and users of information. Further assessment is needed of the influence of stakeholders' analysis in the process of introduction of a set of indicators of sustainability and its contribution to the current discussion about efficiency, trade-offs and sustainability development at farm, sector or supply chain level.

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