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Diverging and Converging Pathways

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Workshop Theme 2: Methodology and frameworks of farming systems transformation

Workshop 2.2: Sustainability assessments at farm level for catalysing practical change

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Despite the large body of literature on how to develop and select sustainability indicators there is still a serious lack of technically and practically feasible methods for conducting a sustainability assessement over a wide diversity of farming systems and of climate and soil conditions. Sustainability assessments hold the promise of assisting farmers in their transitions towards sustainable practice. They facilitate gathering of sustainability indicators, raise warnings or affirm improvements, and can incentivise transformation either by themselves or by benchmarking a farmer's practice against their earlier performance, or against how well their colleagues are doing. They can also support local dynamics by connecting farmers to each other, their industry peers, policy makers, marketers, local communities and consumers to drive change for resilience and sustainability. The workshop focused on the development of assessement methods considering potential trade-offs between scientific rigour of the assessment and the practical constraints of its application at a farm level (e.g.material, social and cognitive). Papers were invited dealing with either challenges in the development or in the use of the assessment. They could focus on the entire process or on one specific stage (from data acquisition to communication of results and their use to inform farm management). The workshop mixed presentations of classical sustainability methods (based on the three pilar model – economic, social, environmental) and of emerging ones as life-cycle assessments. A special focus was placed on the following aspects which are highly relevant to agriculture and that can be managed at the farm level: (i) ecotoxicity, biodiversity and soil quality, (ii) social sustainability, including animal welfare, physical and mental workload, and the aesthetic value of the agricultural landscape, and (iii) long-term economic viability of farms. Based on the submissions, other topics linked with sustainability of farms were included in the workshop (e.g. non-renewable energy demand, climate change). Practical aspects such as the development and selection of indicators, data acquisition and communication of results were discussed alongside. These steps are critical in the uptake of sustainability assessments as they impact simultaneously the workload of the farmers, and the accuracy and security of the process. Aggregation beyond the farm level was discussed in parallel in the TempAg workshop.

Lessons learned from a qualitative sustainability assessment method "Farm Talks"

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Abstract: This paper presents a qualitative peer review "Farm Talks" method which stimulates farmers' learning beyond existing quantitative sustainability assessment tools. Farm Talks were started in 2008 by the biodynamic farming association and the Demeter organisation in the Netherlands as a qualitative alternative to support learning and awareness on sustainability and biodynamic principles. In each Farm Talk, a farm is visited by a small group of colleagues and a facilitator to discuss farming practices and to explore how the farm could develop its sustainability performance. The Farm Talks method presents a novel approach to sustainability assessments in agriculture and enables farmers to define what they consider important for sustainable and biodynamic farming. The development of the method went through several phases of readjustments based on feedback from farmers and facilitators, and experiences from practice. The initial combination of learning and performance functions in Farm Talks caused tensions. Given the focus on individual farm development, the method continued as a learning and process-oriented method. A precondition for such an approach is the willingness of farmers to participate and actively engage. The method enables farmers to define actions for improvement based on their intrinsic motivation.

Keywords: Sustainable development, farm level, peer review, qualitative, biodynamic agriculture, sustainability assessment tools

Introduction

The need for a sustainable development of agriculture is widely acknowledged and should encompass economic, environmental and social dimensions (OECD, 2001; FAO, 2013). A large number of indicator-based sustainability assessment tools has been developed to gain insight into the sustainability performance of farming systems (Schader et al., 2014). Such tools could facilitate farmers and politicians in their decision making towards more sustainable farming systems (Lebacq et al., 2013).

The development of tools involves a wide array of decisions including the selection of themes, indicators and reference values, system boundary, and scoring and aggregation method (Binder et al., 2010; Bockstaller et al., 2015). These decisions are based on value judgements of the tool developers on what is relevant to assess sustainability and can vary widely between experts (Gasparatos & Scolobig, 2012; Thorsøe et al., 2014). A recent study by de Olde et al. (2016a) showed a lack of consensus amongst experts about what matters most in selecting indicators to measure agricultural sustainability. This lack of consensus reflects divergent agendas and differences in context, priorities and value judgements (de Olde et al., 2016a). The different perspectives on how to assess sustainability results in differences in tools, for example in data, time and budget requirements, output accuracy, transparency, and complexity (Marchand et al., 2014). Based on these characteristics, Marchand et al. (2014) distinguishes two types of tools: rapid and full sustainability assessment tools. Rapid tools use farmers' knowledge and require a limited input of time and budget whereas full assessment tools require a visit of an auditor or expert and make use of detailed data. Full assessment tools are characterised by a scientifically underpinned output accuracy and high complexity compared to rapid tools. Rapid assessment tools are characterised by a high user-friendliness, high transparency, high compatibility and limited data demand (i.e. high data availability) compared to full assessment tools (Marchand et al., 2014). This makes rapid assessment tools particularly suitable for larger groups of farmers to enhance learning, interest and awareness on sustainability. Farmers committed to monitor their performance more closely can continue learning by adopting full sustainability assessment tools with a more scientifically underpinned overview of the sustainability performance of a farm (Marchand et al., 2014).

Although both types of tools are aimed at improving decision making by farmers in line with the outcome of assessment, adoption of sustainability assessment tools in farming practice is challenging (Lynch et al., 2000; Triste et al., 2014). General aspects such as budget and time requirements, data availability, user-friendliness, language use, and tool accessibility are factors affecting the adoption of tools (Van Meensel et al., 2012; de Olde et al., 2016b). Another important factor for tool adoption, however, is the relevance as perceived by users (Van Meensel et al., 2012). A mismatch between value judgements (e.g. what are relevant sustainability indicators) of tool developers and users affects the perceived relevance of the tool and its results (De Mey et al., 2011; de Olde et al., 2016b). When value judgements embedded in a tool do not reflect those of farmers, results may become irrelevant to a farmer and left unused (Vatn 2005; Gasparatos & Scolobig 2012; de Olde et al., 2016b). This may be one aspect of why the implementation of assessment results in practice is a challenge for current sustainability assessments (Binder et al., 2010; Alrøe & Noe 2016). Sustainability assessment tools are generally developed by experts for whom comparative data results can be interesting in themselves. For integration into farm practices, however, proper attention needs to be given to translation from indicator outcome to a meaningful decision for change within a web of options and constraints in a farm system. A possible solution is involving stakeholders in the development of sustainability assessment tools (Reed et al., 2006; De Mey et al., 2011). Stakeholder participation in tool development can contribute to learning, increase awareness, and increase support for assessment results and measures (De Mey et al., 2011; Triste et al., 2014). But also, approaches in which farmers can incorporate their perspectives and values into the sustainability assessment process, and are supported in implementing assessment results, are needed (Binder et al., 2010; Alrøe et al., 2016; de Olde et al., 2016b). These approaches are necessary to facilitate a transition towards sustainable farming systems.

The aim of this study was to describe experiences in the development of a qualitative sustainability assessment method "Farm Talks". This method was selected as it presents an alternative approach to sustainability assessment compared to methods described in the literature so far and it has not been scientifically analysed before. Hence, this paper is the first of its kind, in which we analyse how this relatively long-running method that has been forced to adapt over the years deals with the above-mentioned challenges. We start by introducing our research method and case study. Then, we elaborate on the development of the method and the method in its current form. Finally, we reflect on the findings and discuss the importance of distinguishing learning and performance functions of sustainability assessment tools.

Farm Talks – a case study of a qualitative sustainability assessment method

Method

We used a case study approach to gain insight into the Farm Talks method. We focused on the method as applied in the Netherlands, where it was founded[1]. Case studies provide in-depth context-dependent insight and can present a valuable learning experience (Flyvbjerg, 2006). The case study research included an analysis of documents (i.e. minutes of the organisations involved, annual reports, evaluation reports, magazine articles and method documentation), scientific literature, and knowledge and experiences of the second author who has been involved in the development of the method since 2013. Triangulation of the findings was established by combining different sources of information which enhanced the reliability of the results (O'Donoghue & Punch 2003).

Farm Talks

Farm Talks are a form of peer review in which farmers evaluate each other's farm development. The Farm Talks are organised by the Demeter organization and the biodynamic association for all Demeter licensed farmers in the Netherlands. In each Farm Talk, a farmer is visited by a small group of 4 to 5 colleagues from different agricultural sectors, and a facilitator from the biodynamic farming association to facilitate the process. The host discusses strengths and challenges present on the farm and, together with colleagues, explores opportunities for farm development. Through discussion, participants explore what biodynamic farming and sustainability means to them.

Box 1. Biodynamic agriculture

In search of more sustainable practices, research and farming interest in alternative approaches such as biodynamic farming, is increasing (Turinek et al., 2009; Chalker-Scott 2013; Demeter, 2016b). Biodynamic farming is a unique form of organic agriculture, which includes the use of preparations for soil and crop quality, cosmic influences, animal manures, diverse crop rotation, and encourages local production and distribution systems (Turinek et al., 2009). Biodynamic agriculture is based on a series of lectures given by the philosopher Rudolf Steiner in 1924. Approximately 5,000 biodynamic farms, with over 160,000 hectares in more than 50 countries, are certified according to Demeter standards (Demeter, 2016b). Although biodynamic farming has been studied with scepticism and considered as dogmatic by part of the scientific community, the use of a holistic approach towards farming and the value of knowledge exchange and experiences in the biodynamic network of farmers and researchers have been acknowledged (Kirchmann, 1994; Turinek et al., 2009). As stated by Turinek et al. (2009): *'A worldwide network of farmers, researchers, advisors, teachers and others interested in BD farming could contribute toward naming and addressing questions from everyday practice in order to make important steps toward a more sustainable, healthy, prosperous and secure future.'*

[1] *The method is also used in Germany and on a smaller scale in the US.*

Farm Talks method

The development of the method

Farm Talks were started in 2008 by the biodynamic farming association and the Demeter organization. One of the key founders of the method is Jan Diek van Mansvelt; it was, therefore, initially called “Mansveltscore” (Demeter, 2016a). The initiative started in response to discomfort felt around the use of impersonal checklists as the basis for Demeter certification. Instead of rigid certification control, the process of peer review by means of Farm Talks would present a more development oriented alternative to the existing certification system. Certification would be dependent on the outcome of a Farm Talk and open to consider context specific situations at farms. The assumption was that if the results of a Farm Talk could be formulated specifically enough, and the development report could be evaluated by the certification committee, the method could partly, or completely, replace the external inspection of the Demeter certification process.

From 2008 onwards, a small section of the farmers participated voluntarily in Farm Talks to help develop the method (Figure 1). The Farm Talk method was regularly evaluated and adjustments were made based on the experiences and feedback of farmers and facilitators (e.g. description of themes, forms and structure of the meetings). Although the Farm Talks were evaluated by farmers as valuable, informative and relevant, the method was increasingly confronted with resistance from both farmers and facilitators. Facilitators feared they could be forced to signal problems (to function as a kind of inspector) and farmers were unsure how “the office” would evaluate their performance, downplaying the ambition of their self-chosen development actions just to be sure to reach the results of their commitment. Hence, integrating the results of the Farm Talks (development and learning focus) into the certification process (control and performance focus) was increasingly considered as a contradiction. Openness and trust as a basis for honest reflection and critical discussion of on-farm challenges were key values in the development oriented approach of Farm Talks. The idea of an external certification committee evaluating all that happened by means of an impersonal report was felt as a breach of trust. A focus on control or performance and use of checklists had negative connotations and was perceived as counterproductive. It led not only to pressure on the farmers to evaluate their colleagues positively but also reduced the ambition level of development actions, to make sure the actions were “fulfilled” at the next evaluation round. Moreover, uncertainty about how the results would be used in the certification process caused discomfort. The committee responsible for certifications shared this unease and decided in 2013 that the results of the Farm Talks were not suitable to be included in the accreditation for Demeter certification. Consequently, the role of Farm Talks for certification purposes had to be reconsidered but the method itself was accepted, now with all Demeter farmers participating.

2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Design method									
	Voluntary participation in Farm Talks and continuous development of the method								
			Expand Farm Talks to all Demeter farmers and prepare method as part of certification						
						Decision certification and evaluation			
							Farm Talks as a learning method		

Figure 1. Timeline of the development of Farm Talks

The current method

An evaluation of the method in 2014 concluded that Farm Talks contributes to learning and capacity building in biodynamic agriculture (Derkzen, 2014). Consequently, Farm Talks are continued as a form of schooling and development for biodynamic farmers. Farm Talks is part of an agreement between the Demeter foundation and each farm (licence contract), aimed to encourage lifelong learning. Although Farm Talks does not replace certification, it contributes in its own way to secure the quality of the Demeter brand (Derkzen, 2014).

Currently, approximately 130 Dutch biodynamic farmers are participating in the Farm Talks. Each farm is reviewed once in a two year period at which it is characterised and evaluated from its biodynamic aspects. Farm Talks' groups consist of farmers from different sectors to support innovative ideas and insights to develop, and to prevent very specific professional discussions between farmers from the same sector (e.g. on the right seed spacing of a seeding machine). The role of the facilitator is to structure the meeting, create a positive atmosphere, prevent too technical discussions, and to raise aspects that have not yet been discussed.

In preparation of a Farm Talk, the host prepares the visit by self-evaluating the farm against eight qualities and related themes for sustainable and biodynamic farming. A self-evaluation manual lists each of the qualities with detailed subchapters and sets of questions. Each subchapter asks for the vision of the farmer on this theme, thereby stimulating not just a performance check but also thinking about the "why". Asking "why" questions are important to connect the results on the indicators to the intrinsic motivation in order to change practices. Figure 2 shows examples of themes within each quality; a farmer can also define his own themes. Next to the self-evaluation, a farmer defines possible development actions for the farm.

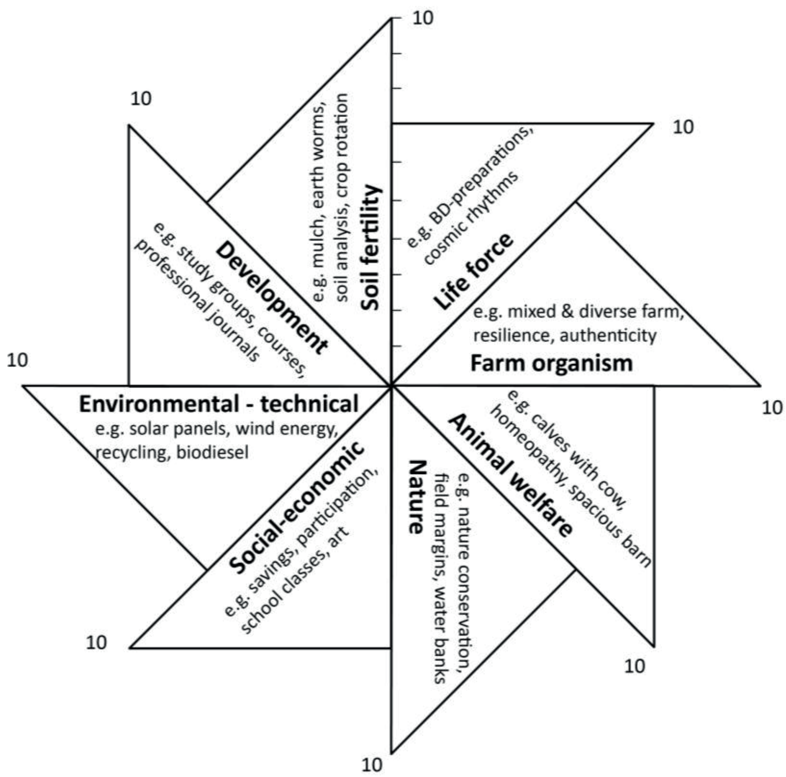

Figure 2. Diagram with eight qualities and examples of themes for self-evaluation. The host self-evaluates his or her own performance (maximum score of 10) on this diagram.

The design of the Farm Talks process is based on the method of appreciative inquiry in which the focus is on a positive approach to what is possible rather than what is wrong (Cooperrider & Srivastva 1987; Grant & Humphries 2006). In addition, Theory U (a theory of learning and management) and the concept of “presencing” formed an inspiration for the design of the method (Scharmer, 2009; Seifter et al., 2010). Both aspects are integrated in the second phase to include not only rational aspects but also what can be sensed. The farm visit is generally structured in four phases.

1. **Farm tour.** The visit starts with a short tour on the farm in which the farmer introduces the farm and describes the characteristics and challenges while showing different aspects and locations of the farm.

2. **Characterising.** In this phase, the visiting farmers and facilitator take a moment in silence to ‘characterise’ the farm by visualising an image, word, or picture representing the essence of the farm and farmer in its current manifestation. This is done before all aspects of the farm are discussed systematically, to let the creative, imaginative side of everyone speak. The images are often very different, yet with a similar message.

Box 2. Example characterisation

"During a farm visit at a care farm images such as a "Rubik's cube" or a "magician juggling to keep many plates in the air" and "octopus" came to the minds of the farmers present. Everyone was impressed by how the farmer of the care farm organised the farm around people with special needs, taking the person's liking and capability as his starting point while also trying to deliver orders on time to retailers and dealing with several different care institutions, various tasks in vegetable and livestock production and, naturally, considering the weather. Although said with admiration, there is a downside to such an image, a possible tension which shows even more strongly when all images seem to point to a similar underlying message. Follow up questions could be; "Do you feel such a situation as Rubik's cube is sustainable for your personal health?" or "Is the complex organisation influencing the quality of the produce you deliver?" Not easy questions, but within a setting where the group has just shared images, it shows through those images that this tension was already felt and understood. Hence, the farmer feels "seen" by his peers, which opens up the conversation and helps the peer review."

3. **Peer review.** After the characterisation, the colleagues score the performance of the farm on meta-level, using the eight qualities shown in Figure 3. The host discusses his or her own evaluation in comparison to those of colleagues. The discussion can focus on each quality, or on only those qualities on which the evaluations differ. Differences in the evaluations often form the basis for new insights. The discussion should result in issues to be developed in the future and should be linked to the farmer's motivation. In the discussion the following aspects are discussed:

   a. What has been observed?
   b. How do you evaluate what has been observed?
   c. How did the farmer evaluate him/herself compared to colleagues?
   d. What are the issues the farmer wants to develop?

Experience with the method indicates that a farmer often tends to score him or herself lower compared to colleagues. Discussion on why this occurs reveals that even though performance on a particular issue is high, the ambition of the farmer is also an important factor. A farmer may not be satisfied with his or her own performance on a certain theme, while the peers evaluated the performance as high. The idea of the Farm Talks method is that development can be reached on topics where focus, energy and enthusiasm are present. If working on a certain theme is not supported by the motivation of a farmer, results may be low and expectations not met.

4. **Decisions.** Based on the discussion, the farmer decides what to work on and formulates actions as specific as possible. The plan is written down on a form and signed by the visiting farmers. A financial contribution of 75 euro made by the farmer is returned to the farmer after the form with signatures is submitted to Demeter.

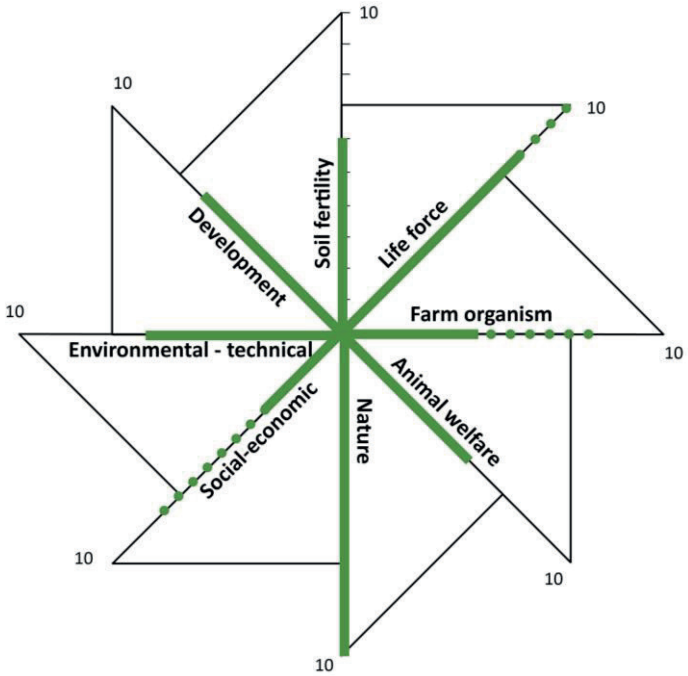

Figure 3. Example of an evaluation and aspects to develop. The solid lines represent the current performance of the farm on the qualities, based on peer review. The dotted lines indicate the intended development of the farm.

Farm Talks as a rapid sustainability assessment tool

We compared the characteristics of Farm Talks with critical success factors defined by De Mey et al. (2011) and Marchand et al. (2014) for the implementation of sustainability assessment tools (Table 1). The data is predominantly derived from farmers' knowledge and has a high data availability and compatibility (Table 1). The qualitative approach of Farm Talks does not include calculations and is high in user-friendliness and transparency. The output accuracy and data correctness is, however, subjective and not scientifically underpinned (Marchand et al., 2014). The characteristics of Farm Talks are in line with those of rapid sustainability assessment tools (Marchand et al., 2014), except for the method of data gathering which is not based only on a self-evaluation by the farmer but also includes a peer review by colleagues.

Table 1. Critical success factors for the implementation of sustainability assessment tools, and how these factors are addressed in Farm Talks. *(The critical success factors and their descriptions are adjusted from De Mey et al. (2011) and Marchand et al. (2014)).*

Critical success factor	Description	Farm Talks
Attitude of model user	Values and beliefs of users regarding sustainability issues	Values and perspectives on eight qualities are discussed during the farm visit.
Compatibility	Compatible with data systems and accountancy	High, no quantitative data input required
Data availability	Availability of data for calculation	High, based on farmer's knowledge and experience

Data correctness	Correctness of data used to calculate indicators	Subjective
Complexity	Degree of complexity of the tool (i.e. complex indicators, calculations and interpretation of results)	Low
User-friendliness	Flexible and easy to use and calculate	High
Transparency	Tool and data are transparent on uncertainty of results	High
Communication aid	Support and use in discussion sessions with farmers	High, the tool is based on discussion among farmers
Organization of discussion sessions	Practical organisation of discussion session with farmers	Described in the text. Key elements: discussion based on openness and trust; facilitator; transparency in how the results are used
Effectiveness	Relevant to use and implement	Considered relevant for learning and farm development

Rapid sustainability assessment tools like Farm Talks can contribute to dialogue, learning and awareness on sustainability among farmers (Marchand et al., 2014; Triste et al., 2014). This strength was also recognised in the evaluation of the Farm Talks method in 2014. Attempts to integrate a performance function (as part of the certification procedure) in the method had a negative effect on the quality of the process. The Farm Talks method in its current form, therefore, focuses on the learning function. Such a process-oriented focus requires good facilitation, trust and transparency (Ansell & Gash 2008; Triste et al., 2014).

Discussion

Although sustainability assessment tools are aimed at learning and supporting decision making, tool adoption in farming practice has been challenging (Triste et al., 2014). Rigby et al. (2000) state: *“Much of the measurement of indicators has, at the end of the day, largely resulted just in the measurement of indicators. The actual operationalisation of indicators to influence or lead to change, for instance in policy, is still in its infancy.”* The perceived relevance by users, in this case farmers, of sustainability assessments is an important factor in the implementation of tool results and requires alignment of values between tool developers and users (Gasparatos 2010; de Olde et al., 2016b). Even when a tool is perceived as relevant, however, the assessment results are not necessarily implemented in practice (de Olde et al., 2016b). An important reason is neglect of the process after the results: the translation process into meaningful practices and other farm decisions. The Farm Talks method addresses these challenges by involving farmers to share their values and perspectives and defining actions for improvement based on their intrinsic motivation.

The Farm Talks method is an example of a bottom-up sustainability assessment tool (Binder et al., 2010). In Farm Talks, the majority of decisions related to tool development (e.g.

definition of sustainability and selection of themes, indicators, reference values, weights) are made by the farmers during a farm visit. In other tools these decisions are often made by external experts (Binder et al., 2010; Alrøe & Noe 2016). The Farm Talk method provides a structure for the assessment process (preparation and visit) and eight pre-defined qualities for sustainability of biodynamic farming to focus on. During peer review, farmers discuss these eight qualities and develop a joint and context-specific understanding of each quality and the performance of the farm at that moment. In an implicit manner, they decide what is important in sustainability and biodynamic farming and discuss how this should be evaluated. This active involvement of farmers in the development of the tool can contribute to mutual learning and a sense of ownership (Triste et al., 2014). Farm Talks thus reduces the risk of a mismatch of value judgements between tool developers and users. Critical success factors for the adoption of tools are also addressed in Farm Talks (Table 1) including the availability of data, limited input of time and budget, user-friendliness as well as language use, tool accessibility and a context-specific approach (Lynch et al., 2000; Van Meensel et al., 2012; Marchand et al., 2014; de Olde et al., 2016b). By jointly formulating actions for improvement during the assessment process, the method supports farmers to apply assessment results in their decision making and turn the assessment into transformation.

Whereas the ability to incorporate farmers' perspectives and values in sustainability assessments is a strength of the method in terms of joint learning, and a possible solution to the problem of tool adoption, it also presents a weakness as the method is highly malleable and hence not suitable for performance benchmarking. The qualitative and implicit method enables farmers to define what is important for sustainability of biodynamic farming, however, it is highly subjective and not scientifically underpinned. Assessment results cannot, or only to a very limited extent, be used in comparative analysis of the sector. Here, again, it is important to acknowledge what function the tool is aimed at since unacknowledged tensions between functions may lead to situations in which neither the one nor the other function is fulfilled (neither performance measurement nor learning). Benchmarking in order to rank performance for a general public requires externally validated data whereas tools aimed at learning benefit from a design aimed at "sense making" of outcomes in very specific contexts. Indeed, function confusion was also part the decision to change the method of Farm Talk at a certain point in the method development to focus on learning only.

Each Farm Talk is different as it reflects the frame of reference (knowledge, norms, values, interest and convictions) of the host and visiting farmers (Te Velde et al., 2002). The diverse, qualitative and context-specific results of Farm Talks are not suitable for comparison between farms, benchmarking or certification, as was recognised in 2013. This may present a weakness for more quantitative oriented stakeholders such as food industries, municipalities and banks (Bell & Morse, 2001). This issue, the lack of formal recognition at institutional level, was also recognised as a challenge in participatory certification in organic agriculture as introduced by IFOAM (Nelson et al., 2010). At the same time, both quantitative and qualitative approaches to sustainability are inherently subjective and connected to value judgements and diverse perspectives. Transparency in sustainability assessment tools (e.g. on value judgements, assumptions, function and objectives) is important to prevent a mismatch of expectations among those involved.

Experiences with Farm Talks indicate that a combination of a qualitative learning function and a performance-oriented focus (i.e. certification) results in pressure on the dialogue process of the Farm Talk itself which can affect the quality of both the assessment process and its outcomes. Similarly, Nelson et al., (2010) discussed the risk of social and personal conflict resulting from the dependency on peer assessment outcomes as a challenge in participatory certification. This indicates that the functions (learning and performance) involve different priorities and requirements. Separating functions, as suggested by Triste et al., (2014), is therefore needed to reduce the risk of tensions. Moreover, in a learning and process-oriented tool, like Farm Talks, the willingness of farmers to participate and actively engage is a precondition. Although it is self-evident that this willingness is a critical factor for the adoption of the tool, where and on what aspects willingness is present can be seen and strengthened through appreciative inquiry during the assessment process itself, while in more top-down, expert-based tools unaltered and unspecified willingness is often assumed to be there. Linking assessments to the intrinsic motivation and willingness might be critical for the implementation of the results from other tools which have less focus on the process of translation. Evaluation of how Farm Talks, and other sustainability assessment tools, bring about change is urgently needed.

Conclusion

Limited adoption of sustainability assessment tools is seen as a challenge in the transition towards more sustainable farming systems. The Farm Talks method presents a novel approach to sustainability assessments in agriculture by using peer review and enabling farmers to define what they consider important for sustainability and biodynamic farming. It can be categorised as a rapid sustainability assessment tool, and we showed its advantages (i.e. limited investment of time and budget, high data availability, high user friendliness and limited complexity) and disadvantages (i.e. subjective output accuracy and data correctness). The Farm Talks method presents a qualitative and implicit approach to stimulate learning, reflection and awareness among farmers. As the initial combination of learning and performance functions in the method caused tensions, Farm Talks continued as a learning-oriented method. The method enables farmers to define actions for improvement based on their intrinsic motivation, and could therefore support the implementation of assessment results.

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Animal pain assessment as an innovative and sustainable approach for livestock production

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Abstract: Sustainable assessment seems to be quite complex to do because there are different ideas of what exactly should be 'sustained' in terms of degraded natural resources (soil and water insecurity) and/or socioeconomic challenges (economic growth, threatened rural livelihoods, social injustice). Even if sustainable development lacks clarity, it supports the common wish of welfare and wellbeing for all, now and in the future. As the development of assessment methods towards sustainability often aims to design more productive, sustainable production systems that are less harmful to the environment, we propose in our contribution to focus on social sustainability such as animal welfare which directly impacts on wellbeing of humans and animals but also on the efficiency of farm production. In fact, animal welfare is here assessed through animal pain indicators which mix animal welfare concerns, animal health issues and animal breeding efficiency (animal pain inducing more work time for farmers and a lower growth rate for animals). But animal pain seems hard to objectify depending both on self-sensibility of humans and on the status of animal species considered. It also depends on the breeding experience of farmers and social interactions they have with various experts such as veterinarians or researchers. This is why we have considered in our contribution the case of bovine and pig breeding in which both the status of animal sensibility and the organisation of expertise between farmers and their advisors differs. We have used two different ways to study how the stakeholders deal with animal pain. First we have gathered breeders, veterinarians, farm advisors and trainers in two focus groups (FC): the first one has been focused on empirical pain assessment, the second one on appraising procedures experimented with by scientists and engineers in order to better manage animal pain on farms. We have then conducted two qualitative surveys: one on farm and one to grasp how farmers, veterinarians and technicians interact to share information and knowledge about animal pain assessment in order to better manage farm animals.The first FC led us to clarify the dimensions of a practical assessment of pain combining variability of perception, problem detection and qualification of pain. The second FC highlights the delicate division of roles between stakeholders and the practical constraints and resources of a better management of animal pain. The first qualitative survey shows the relative absence of animal assessment by farmers, except when it is connected with an illness. The second qualitative survey describes the condition of mutual learning between farmers and advisors for catalysing practical change in animal pain management.

Keywords: Animal pain assessment, animal pain management, sustainable animal breeding, innovative farm practices

Introduction

Sustainable assessment seems to be quite complex to do because there are different ideas of what exactly should be 'sustained' in terms of degraded natural resources (soil and water insecurity) and/or socioeconomic challenges (economic growth, threatened rural livelihoods, social injustice). Even if sustainable development lacks clarity, it supports the common wish of welfare and wellbeing for all, now and in the future. As the development of assessment methods towards sustainability often aim to design more productive, sustainable production systems that are less harmful to the environment, we propose in our contribution to focus on social sustainability such as animal welfare which directly impacts on wellbeing of humans and animals but also on the efficiency of farm production.

Measuring "animal quality of life" as a key element of sustainable farming

Livestock systems are generally designed to optimise production costs while ensuring food safety (by minimising biological and chemical risks) and preventing animal health issues. According to an AFSSA survey (Lafay, 2009), such designs are accompanied by an intensification of livestock production systems within an increasingly controlled environment, affecting the living conditions and welfare of farm animals (Fraser, 2008). This leads to a rise in animal welfare concerns, initially expressed by animal rights advocates but gradually becoming a mainstream social issue (Dantzer, 2002). This is one of the main reasons animal welfare now forms part of the European agricultural policy agenda (Bourdon, 2003). This led to the financing of a scientific research project Welfare Quality (2004-2009)[1] to develop a methodology for animal welfare assessment including health, food, behaviour and housing. Such an assessment fits well within a systems-oriented approach to quality of life in farming both for farmers and farm animals, since improved animal behaviour facilitates handling and consequently reduces working time for humans. It is also a good indicator of sustainable farming characterised less by intensification and more by an efficiency of interactions. More recently, an Animal and Society meeting in France has focused on animal pain as a major societal issue[2]. One of the outcomes of these meetings was to call for a multidisciplinary scientific assessment of animal pain, in order to identify, understand and minimise pain in farm animals[3].

Management of animal pain in livestock production systems

Animal pain is obviously an important factor within animal welfare (Phillips, 2009); it also has the specific advantage – as illustrated in the case of lameness – of closely articulating health, wellbeing and productivity in both dairy production (Green et al., 2002) and breeding sows (Willgert, 2011). The measurement of animal pain, moreover, is highly context dependent, varying according to farmers' experiences and the human-animal relationship. Pain assessment in animals presupposes a strong knowledge of animal behaviour in order to correctly interpret signs of pain, particularly as such signs may be masked by animals' atavistic behaviour, seeking to conceal weaknesses so as not to appear vulnerable to predators. Pain assessment seems then to be an on-the-ground sustainable farming indicator because animal pain detection implies that farmers will react quickly to solve problems and improve their management practices. Animal pain management is therefore both a local and a global challenge, with social pressure to reduce animal pain becoming increasingly important (Coleman, 2009). The challenge then is to objectify pain measurement so it may serve (i) as information about a dysfunction, (ii) as a risk-assessment for livestock losses, and (iii) as a

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[1] *http://www.animalwelfareplatform.eu/Welfare-Quality-project.php*
[2] *http://agriculture.gouv.fr/sites/minagri/files/documents/pdf/Animal_Societe_Reu_cloture_Doss_Presse.pdf*
[3] *https://www6.paris.inra.fr/depe/Media/Fichier/Expertises/Douleurs-animales/Synthese-Douleurs-Animales-version-anglaise*

basis for decision-making on the farm. Such a measurement may then function as a sustainability standard.

Pain assessment in generic and singular terms

The extension of such a standard to the farm level, however, raises questions about farmers' training in the use of analgesics, about the supervision of analgesics by veterinarians (who normally have sole authority for the medical treatment of pain), about the feasibility of analgesic use on the farm, and of course about the cost of such treatments (Mellor, 2009). Even for veterinary staff, it can be difficult to assess the benefits of analgesic use, particularly since common criteria cannot be used to evaluate all types of pain (acute or superficial, punctual or chronic, neuropathic, etc.) for all species (Gaynor & Muir, 2008). The limitation of an objective pain assessment lies in the fact that there is no established 'gold standard' or generic means of comparing different measurements. This means animal pain assessment will be based on subjective interpretations of animal behaviour by a variety of observers who may be farmers, veterinarians, or technical advisors. It is around these issues of pain measurement, definition of an appropriate analgesic treatment, and support for farmers in animal pain management that a multidisciplinary project called AccEC[4] was set up three years ago.

For the purposes of the project, a multi-actor approach was developed gathering together researchers, technical institute engineers, technical advisors or trainers, and farmers' representatives from two livestock sectors (dairy cows and pigs). Two qualitative investigations were conducted: the first with dairy and pig farmers to understand how they manage animal pain on their own; the second with veterinarian-technician-farmer trios to understand how they inform one another about animal pain, how they assess it, and what decisions are taken. This qualitative approach was coupled with experimental protocols evaluating pain from dehorning (cattle) and tail docking (pigs) within the context of animal behaviour assessments, in order to study whether a standard pain assessment is applicable at ground level. The results of these protocols were discussed in two focus groups (cattle and pigs) bringing together different actors (farmers, veterinarians, technical advisors, trainers) from each sector. The advantage of considering two animal species (cattle and pigs) is that human perceptions of animal pain should be different (Phillips & McCullough, 2005; Heleski & Zanella, 2006).

Livestock management that relies on knowledge of animal behaviour

The objective measurement of animal pain implies both attentiveness to animal sensibility and a high level of concern for the detection and resolution of animal-based signals of potential livestock problems. The livestock systems (dairy cattle, pigs) considered here are both characterised by a continuous use of monitoring indicators and an awareness of the impact poor animal welfare (or animal pain) can have. Thus in pig farming, monitoring is everywhere:

> "*When I enter the livestock building, I detect right away if there is a heavy atmosphere, bad temperature or ventilation, or other technical alerts that may affect the living condition of animals. Then I visit each pig box to look at the overall appearance of pigs: How are they distributed in the box, are they grouped or not?*

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[4] *Accompagner la prise en charge des douleurs animales à l'**é**cornage et la **c**audectomie, financed by CASDAR fund of French Agriculture Department*

Are they lying in a bad area? Have they eaten? Have all animals eaten or not? Then we come to the individual level to observe if some animals look different, have an abnormal gait, isolate themselves…" (Pig farmer).

In dairy farming, livestock monitoring likewise relies on technical indicators, primarily milk production but also on observations of the cows' behaviour during milking, feeding, housing or locomotion. Farmers organise their work around the need to be a good animal keeper.

"*What is difficult in our business is ... you need to have a good eye on animals. If you handle them too fast, you will miss a lot of things like coming into heat, which impacts reproduction, or the development of an illness, which may affect herd health overall. Sometimes you hear coughing, you say oh it's okay, but the next morning you come back and your animal is dying*" (Dairy farmer).

There is a similar attitude in pig handling:

"*We need to spend more time with our swine to get to know them. Farmers or employees who are not familiar with animals can't see when an animal is sick. They look at them without seeing them.*" "*A good pig farmer, when he moves behind the sows, he knows immediately if they are coming into heat again. In the same way, he can see before everybody else when an animal is declining. It's a question of feeling with the animals. Personally I don't have it, it's my wife who see things earlier*" (Pig farmer).

Similarly, the livestock breeders we interviewed say they must "*keep an eye*" on their animals as the best way of preventing problems among the livestock. But they must also "*keep an eye on farm performance, because everything is connected: you have to check that the two (animals and farm) go together, it's the most interesting and the most complicated part of the job*" (Dairy farmer). Livestock management is then a delicate balance between animal performance and animal welfare.

An attention to animal behaviour at different life stages

Animal behaviour is not just what an animal does, but also when, where and why it does what it does. Assessments of animal welfare will thus take a different form according to the animal species and its life phase. In the pig sector, monitoring during the fattening stage (finishing pigs) and the gestational stage (pregnant sows) is primarily delegated to automated systems. Monitoring consists of checking that the automatic distribution of feed is working properly and that the building conditions are correct (temperature, ventilation). Basically, "*everything is under alarm, and if there is a problem, it sounds*". The situation is quite different, however at certain risky phases of the animals' life (such as birth, weaning, or pregnancy).

"*During the piglets' birth, for weeks say, I do day-and-night monitoring, it's 15-16 hours per day for 2 days. You have to prevent the crushing of the young by the sows, who are uncomfortable with them. You have to check that they're not cold, that they're not shivering, in order to save them from death. It's a lot of work*" (Pig farmer).

Taking care of young animals also brings a lot of feeling to the work of farming: "*I like the birth, when I can save many young. That's rewarding, although sometimes it fails: last night, I lost three piglets; it bothers me a lot*" (Pig breeder). In fact, the time spent with the piglets enables breeders to improve their farm output. Likewise, the careful monitoring of pregnant cows or sows provides a return on investment, because it guarantees the capital which makes the farm sustainable. "*Losing a sow is more annoying than losing a piglet, we spend more time with her, and the sow has a zootechnical history so we know all of its performance*" (Pig breeder).

But taming animals remains a central challenge for breeders:

> "*We try to spend a lot of time with new sows in quarantine, so they will be quiet in the maternity room. All this time spent will be recovered in breeding performance, with animals that are less fearful and easier to manage" (Pig breeder).*

Since cattle breeding is less intensive than pig breeding, with fewer animals and a lower reproductive rate[5], dairy farmers tend to have a more individualised approach to their animals. As one farmer with both cows and pigs put it: "*We become less attached to a pig than to a cow. It depends on the species, on the way of breeding… With cattle, we work more at an individual level while with sows, we always manage a group of animals.*" This attitude likewise reflects the greater economic value of a cow relative to a pig. "*With cattle, you must save the cow first, it's your main means of production. With pigs, the sows cost less and can be replaced more easily. A sow, it's not big capital, but a cow is*" (Cattle and Pig breeder). This attachment to cows is also linked to the fact that they spend much longer on the farm than pigs or sows. So the capital is not only economic but also relational.

An animal pain assessment both clear and ambiguous

These qualitative investigations show that farmers rarely evoke pain spontaneously; they associate it with injuries (lameness), with specific life phases (birth, weaning, etc.), or, more often, with disease. This is partly due to the difficulty of identifying signs of animal pain:

> "*Cows' behaviour it is not easy to grasp because they express pain poorly*" (Cow breeder). "*Sometimes, when you look at a sow, you don't see any trouble, but the day after the animal could be in a completely bad way. It's something underlying that was there, but very hard to see. Something in its eyes, you have to grasp…*" (Pig breeder).

The scientific assessment of animal pain has detailed three kinds of behaviours (Weary et al. 2006): *behaviours directly related to pain*, such as increased vocalisation or specific attitudes (posture, facial expression); *alterations to normal behaviour* such as reduced locomotive activity (walking, running, stretching, etc.), loss of appetite; *incongruous choices* made by animals. These indicators are concrete and relevant for people in contact with animals, but they can also be generic to a lot of farms. A pig farmer sums it up: "*I listen when all is calm, without any groan or scream. Then I look at each pig box, if some animals stay alone, if they are eating regularly, if they move comfortably or stay in a cold or dirty place, which is abnormal.*"

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[5] *In 2010, the average size of a cattle farm was 60 cows, versus an average of 200 sows in pig farming. A cow calves every two years, while a sow gives birth to 12 piglets every six months.*

The primary indicator could be a change in animal posture or appearance or a behaviour which is "unusual." The two most important warning signs are a drop in animal production or anorexia, as explained by a dairy farmer:

> "*A cow that doesn't eat and/or produces a low quantity of milk is probably in very bad health, but such a state can also be linked to its walking, how it holds its head, if it's breathing is difficult or if it's coughing ... there are many signs that show you that an animal is really bad*."

But although these signs are apparently easy to recognise, it is difficult for the breeder to assess the severity of the pain they express. Most breeders report observing silent pains they cannot explain: "*Lameness is very visual, we see that the cow is having trouble walking when it walks but it's not so serious. But in other cases you feel the cow is wrong without being able to explain or solve it. Moreover, different cows can express the same pain differently (according to temperament), which makes it confusing as to the seriousness of the pain*" (Cattle breeder).

Despite these differences, the best way to recognise pain lies in a good awareness of animal behaviour as it relates to animal production, which remains an indicator of poor animal welfare:

> "*Depending on where an animal is injured: if it's a limp - falling production will be gradual because the animal will eat less; if it's something strange eaten by the cow - it will be more sudden; if the animal is lanky without rumination - it's a big pain in the paunch and then it's very dangerous.*" (Cattle breeder).

Detection is much more complicated in pigs, first of all because observation of animals is more collective, often at the farm level. It is also difficult to distinguish an individual behaviour among a large number of animals kept in boxes at a high density.

> "*A sow ... when it doesn't get up or doesn't eat, we take its temperature, but it's hard to specify the problem, so we will administer a general medical treatment (antibiotic, anti-inflammatory, and so on…). With cows, it seems to me easier to target the problem, but with sows it is quite difficult*" (Pig and Cow breeder).

Various relationship between breeders and vets in assessing animal pain

Faced with an unknown pain, farmers generally call their vet whose intervention depends on animal-human relationships (more individual in cattle breeding; more collective in pig barns). Cattle vets are likewise more focused on individual pathologies, as one explains: "*I'm generally called for a particular case. So I will not scan the herd unless I'm seeking the cause or the spread of an individual pathology by looking at the rest of herd. I don't look for it in particular, but I remain open to everything.*" In the pig barn, therapeutic intervention is more collective, and tends to rely on monitoring systems as diagnostic aides because of the difficulty of identifying individual animal behaviour problems. The veterinarian's intervention is thus both curative to treat the suffering animal and preventive to reduce the risk of the problem spreading to other animals on the farm. Besides pig vets work in close interaction with farm technical advisors, both belonging to the same hog processor groups. So the porcine veterinarian's intervention is thus part of an overall monitoring system for the pig operation including both animal health and animal performance.

However, veterinarians and farmers have different methods for assessing animal pain. Veterinarians focus more on clinical signs, using their knowledge of key indicators of pain levels and medical risks for animals. They can also measure pain using specific tests: "*With the clinical assessment, we are able to quantify blood glucose with CPK, to quantify lactic acid with a bit of biochemistry.*" (Bovine vet). Farmers are more attentive to chronic or recurrent pain affecting animals over longer periods of time.

> "*I mean, lameness in cattle is the most painful for me because of its duration. It is more subtle than pathologies such as mastitis or digestive diseases, which are more sudden and intense but also shorter because we intervene quickly. It's more difficult to cure something latent, you can't fix something when you can't precisely identify the cause and the impact.*" (Cattle Breeder)

In the pig sector, farmers, veterinarians, and technical advisors are continually challenged to assess animal pain according to pigs' behaviour.

> "*It is not easy to assess pain. When a pig has a prolapsed rectum, he doesn't express much pain. But it may be a false impression!! On the other hand, pigs can squeal a lot in non-painful situations, like when they're being caught by the farmer.*" (Pig Vet).
> "*It's hard to know if there is pain or not, because in fact the pigs are always squealing. Maybe they're just squealing because they've been picked up, but maybe too we have to consider that stress induces pain*." (Technical Advisor).

Assisting farmers in the management of animal pain
In pig rearing as in dairying, farmers typically do not make use of the concept of animal pain as such in their work; they are more concerned with animal welfare or health as an aspect of housing or rearing conditions for animals on the farm. As noted above, the AccEC project focused on livestock production practices which clearly appear to be painful for animals (dehorning, tail-docking, castration). But for many farmers, they have specific advantages:

- These practices protect animals against the risk of injury, particularly in situations of high animal density. This is the case with dehorning for cattle and tail-docking[6] for pigs.
- These practices make it easier and/or safer to handle the animals (dehorning, castration);
- These practices improve meat quality (elimination of foul odours for male swine; reduction of 'slash' on cattle carcasses).

Farmers also argue that although dehorning for cattle and castration and tail-docking for pigs are painful, the pain is temporary and has no permanent effect on the animals. Similarly, pig farmers note that in the nursery pens the piglets return quickly to the sow's teats after the procedure and that these supposedly painful practices have no impact on pigs' growth or performance:

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[6] The natural behaviour of pigs is to forage in search of bugs, seeds and roots. Even when pigs are not hungry, they still look for food by rooting in the soil and gnawing all sorts of things. It is therefore important for them that the pigsty contains something for them to play with. Otherwise, as in the case of many pig buildings with concrete floors, natural pig behaviour can escalate into problems like tail biting. Although many farmers try to enrich the pig box environment with toys, chains, or even just straw, it is not always enough to stop tail biting, which can cause serious injury or even death. Hence the longstanding practice of tail docking, which greatly reduces tail-biting behaviour.

> "*You castrate a piglet, then lay it down on the ground, it will quickly go back to suck. So you presume that it's painful, but it isn't really clear. If you just pick up a piglet, it will squeal; you manipulate it without doing anything, it squeals. For sure when you castrate it, it squeals, but no more than if you do nothing. People say, ouch, castration, the poor thing, well ... you can see they are a little shaken, but they recover very fast and the following day it is as if nothing has happened, the healing is impressive…*" (Pig breeder)

If cattle breeders recognise that dehorning is painful, they also consider it "*a blessing in disguise, because it enables them to be quiet all their lives.*" To handle animal pain by administering analgesics can be very restrictive for farmers in terms of work organisation, drug action time, and management of the animals afterwards. On the other hand, they recognise that having less-stressed animals can facilitate their work.

> "*At first, I dehorned without anesthesia. Now I use analgesics and it will be better because the calves go back to eat without apprehension. It's better for the animal and it's better for us because the calf doesn't move around when we dehorn, so it's easier*." (Cattle Breeder).

In this way, farmers' management of animal pain seems to be governed by a cost-benefit analysis (Mellor et al., 2009). Through experimental dehorning trainings (including those initiated by AccEC project), farmers can reconsider the cost-benefit balance of different dehorning practices. First, they are made aware of the main issue involved, through an explanation of the calf's anatomy, showing that the horn is easily removed at a young age. Technical training can then develop a better dehorning gesture and the use of tools to make the job simpler and effective even with a very small horn bud.

> "*Since the training, I use a gas dehorner. It's very convenient and faster. Before, we burned the horns at two or three months, it was hard to do with strong animals. Today I do it with calves that are 15 days old. Following the trainer's advice, I bought small electric clippers to cut the hairs just around the horns, so I can see them better. Next, I simply place the iron and turn it well around. It's almost an instantaneous pain and the calves go back to eat quietly after being dehorned*." (Cattle Breeder).

In other words, the pain reduction was first registered more on a technical level than on a therapeutic one. In fact, one of the major constraints to dehorning encountered by farmers lies in animal handling. Training can present the interest of administering a sedative to the animals to facilitate the farmers' work. This practice, however, raises the question of farmers' ability to administer the correct dose of such drugs. Faced with this requirement and also because of the drug action time, most farmers prefer to use a mechanical restraint on calves. Nevertheless, the practice of sedation is easier to do on dairy cattle, and tends to be more widely used in the dairy sector because it improves welfare for both animals and farmers.

For pig farmers the issue is quite different because it is much more difficult to assess pigs during castration and/or tail docking than calves during dehorning. The analgesic protocols used during the AccEC project experiments confirmed this. Even where some light pain reactions were detected, they were insufficient to prove the advantage of analgesics. The advantage of animal pain management in this case is less in terms of farming practices and more on the social level, as a way of improving the social acceptability of the pig sector. For this reason, the focus group concentrated on debates surrounding the integration of all piglet processing, such as castration and tail docking, under only one drug administration, thereby reducing the impact of the management of animal pain on farmers' practices. All stakeholders, however, argued that tail docking, teeth grinding, and castration should be carried out at different ages for practical and health reasons. As in the case of dehorning, then, the challenge was less to suppress pain with analgesics than to reduce it through better farming practices. The AccEC project is thus attempting to develop better guidelines for tail docking in order to prevent improper healing of the tail. But the main factor driving this practice remains the fact that not doing it can have dramatic outcomes for pig rearing.

> "*I stopped tail docking once because the piglets had arthritis in their tails. But quickly I was confronted with cannibalism among the fattening pigs. It can degenerate in six hours, you can come in in the morning and see nothing, but then go back in the afternoon and find a pig so eaten by the others that you have to euthanise it… blood everywhere*!" (Pig breeder).

An outcome of the AccEC project in the pig sector was to construct a self-assessment grid for farmers regarding tail-biting risks. Here again, the challenge with animal welfare application is to find a good balance between animal sensibility and farm efficiency as a guarantee of sustainable farming.

Concluding Remarks

The goal of our proposal was to describe the issues surrounding better management of animal welfare as a benchmark for sustainable farming. Animal welfare is understood by farmers to be a central dimension of their breeding practices, but its implementation in agricultural policy is perceived as a top-down standard which ignores basic on-the-ground realities. Taking animal pain into account thus leads one to mix subjective and objective assessments of the living conditions of animals in farms. In this way, pain assessment expresses a tension between generic and singular approaches to measurement. In our study, we first sought to better understand what can be described as an animal alert on the farm according to the farmer's sensory appraisal of animal behaviour. But this subjective assessment has to be objectivised by comparisons among animals' performance to grasp the nature of the alerts which differ between cattle and pigs. Even if signs of discomfort among animals are apparently easy to recognise, it seems difficult for breeders to assess the nature and severity of the pain. It leads individual assessments to become collective through interactions between farmers and veterinarians or technical advisors in order to discuss with others and justify the measure which has to be taken face to pain. This exchange also leads to the differentiation of acute and chronic pain according to the impact on herd performance. In this way, painful practices such as dehorning or tail docking are considered less problematic than diseases or lameness because of their brief nature, although the second may affect breeding on a long-term basis. This induces a cost-benefit assessment of animal pain in farms. Therefore, the costs of pain management in dehorning practice balances drug costs and much more time spent on dehorning on one side with easier dehorning work and better animal recovering after surgery. But in tail docking the cost-benefit analysis will be disadvantageous: the brief and invisible pain of tail docking is also confronted with intense and long pain (tail biting) when the latter is not practised.

That the analysis of the management of pain enlightens us is the necessary conjugation between synchrony and diachrony of pain assessment from a perspective of sustainable breeding. Pain management is also conditioned by the future consequences of potential pain. This appears especially in animal births, where too much pain for mother could affect the health of the young (Mellor & Stafford, 2004)

> "*Calving, all that is surgery. This can be very painful. Now I think more how to assist more calving, to make it go as well as possible for the cow.*" (Cattle Breeder)

> "*We always take into account animal pain during birth. When sows have pain, it makes them aggressive, so we give a painkiller to them.*" (Pig Breeder).

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Assessing family farm sustainability using the IDEA method in the Saïs Plain (Morocco)

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Abstract: The increase of irrigated crops in Saïs Plain has led to an alarming aquifer over-exploitation and has contributed indisputably to price volatility related to the saturation of local and national markets. Consequently, these dynamics put the sustainability of farms at risk. To better evaluate how farmers consider the sustainability issue, responses were collected from a survey (covering 40 farms) related to farmers' perceptions and attitudes towards the sustainability concept. The environmental issues, taking into consideration that they are the responsibility of public bodies and policies, did not feature prominently as a key priority for farmers. In fact, to bring into focus the inherent weaknesses of farmers' agricultural practices, the IDEA method was adapted to evaluate the sustainability of 14 farms. Methodological changes concerned: (i) score weighting, in order to highlight local issues; (ii) removal of irrelevant indicators; and (iii) addition of major local issues. The method enables each single type of farmer to better identify weaknesses that they can improve. Also, it arouses reflections regarding the technical reasoning as well as the value systems on the origin of the farmers' decisions. However, most farmers were not individually concerned by environmental issues addressed by IDEA. They were mostly concerned about economic aspects as key drivers for their decision-making processes and their perception of sustainability. The discussions of the IDEA results yielded two main reactions: (i) farmers' intent to secure on-farm income through diversification of productions; and (ii) farmers' willingness to take economic risks, especially in speculative horticulture value chains.

Keywords: Sustainable development, assessment methodology, farming system, farmer's perception

Introduction

Since the emergence of the concept of sustainable development, local and international organisations have called for methodologies aimed at assessing sustainability (ONU, 1992). This call had led to an expansion of assessment methods based on different tools such as indicators, multi-criteria analysis or assessment-based modelling. These three methods are applicable to different scales (Ness et al., 2007). Several authors have stressed the relevance of the farm scale, which takes into account all the practices (Thivierge et al., 2014), to assess agricultural sustainability (Häni et al., 2003; Pacini et al., 2003; Van Cauwenbergh et al., 2007). The farm overall perspective provides opportunities to improve sustainability and give useful tools helping: (i) farmers to assess sustainability of their farms in order to identify weaknesses and areas for improvement in managing their future operations (Rodrigues et al., 2010); (ii) advisors to identify new skills and tools for addressing sustainability issues at farm level (Zahm et al., 2008); (iii) researchers to design innovations that can enhance agricultural sustainability in local contexts while supporting farmers in their evolution (Dogliotti et al., 2014; Ryschawy et al., 2014); and (iv) policy-makers to maintain and encourage environmentally-friendly systems through appropriate financial support (Van Calker et al., 2008).

Most of the evaluation methods of sustainability do not provide a transdisciplinary approach to farming and sustainability issues; they are principally assessing a ‘‘snapshot’’ state of agricultural systems (Duru & Therond, 2015) or discarding farmers' decision-making (Darnhofer et al., 2010). However, the farm in a systemic approach must be considered a unit composed of different subsystems: farmers, including their personalities, skills, long-term goals, values and lifestyles (Gafsi & Brossier, 1997); and manifold subsystems including cropping and livestock systems (Fairweather & Campbell, 2003; Schmitzberger et al., 2005). Indeed, farm management is influenced by the farmer perceptions, preferences and risk aversion (Burton & Wilson, 2006) as well as by his/her economic framework, social norms, local agro-ecosystem and the farm structure (Slee et al., 2006).

Methods of sustainability evaluation have mostly been developed in northern agricultural contexts, for instance AGRO*ECO (Bockstaller et al., 1997; Girardin et al. 2000), MOTIFS (Meul et al., 2008), IDEA (Zahm et al., 2008) or EVAD (Rey-Valette et al., 2008). Only some of these methods have been adapted and used in southern countries where there is a need for greater assessment of the farming systems’ sustainability (Fadul-Pacheco et al., 2013). Moreover, works that combine ecological, social and economic sustainability with farmers’ perceptions of sustainability, are still lacking (Darnhofer et al., 2010). Based on a study involving 40 farmers in the Saïs Plain (Morocco), this paper aims to evaluate farmers' perceptions of the sustainability concept by using and adapting a formal evaluation tool called IDEA (Farm sustainability indicators). We outline how we approached the adaptation of the IDEA method, a tool based on a selection of indicators and originally designed for the French context. Also, we discuss the relevance of this method to the community of farmers by benchmarking their perceptions of sustainability and decision-making before and after IDEA was carried out.

Context and methodology

The Saïs Plain context

Prior to the drought of 1980, Saïs' farming systems were dominated by rainfed agriculture (cereals, legumes, olive and almond trees) associated with small herd livestock (sheep and cattle). Following this period, farmers progressively turned to the use of groundwater through individual wells and irrigated crops, enabling the emergence of horticulture (onions and potatoes) followed by orchards (peach, plum, and grapes). Today, Saïs displays a huge diversification of farms depending on resource availability and individual farmer’s strategies. Three types of farms have been identified based on a 40 farms survey. T1 farms are close to the initial traditional system farms combining rainfed crops and livestock on land without water access. T2 farms have access to irrigation while maintaining production diversity based on rainfed crops, irrigated crops and livestock. T3 farms are specialised in various orientations (irrigated vegetables, irrigated fruit trees or milk production). Furthermore, the extension of irrigated crops had led to over-exploitation of the aquifer (Quarouch et al., 2014). The increase in production (vegetables and recently fruits) and the lack of farmer associations and low long-term storage capacities led to price volatility and saturated local and national markets (Lejars & Courilleau, 2014). This situation threatens not only the sustainability of the aquifer but also the viability of farmers' activities (Bekkar et al., 2009). Moreover, in other countries, the adoption of irrigated crops showed an intensification process causing irreversible negative impacts on the environment. These issues make Saïs Plain, as an open-air laboratory, an interesting case study of the sustainability concept that can be exported to other regions of Morocco or southern countries where sustainability is threatened.

The assessment methodology

This assessment study is a continuum of a previous study analysing the dynamics leading to the regional diversity of family farms. It was applied to a limited sample of 40 cases reflecting the diverse production systems in the studied area. To evaluate how farmers consider their farm sustainability, we started by collecting farmers' perceptions of the sustainability concept on the 40-farms sample; we asked an open-ended question to farmers about the meaning of farm sustainability. The word sustainability in Arabic is "*daymouma, al estidama*" which refers to a wide sense. Thus, for a more accurate sense of farm sustainability, we have embedded these words in a question (What does "sustainable farm" mean to you, in the sense that your farm continues to produce in the long run?). Since the study is still in progress, we started by assessing the sustainability of 14 farms. The IDEA *(Indicateurs de Durabilité des Exploitations Agricoles)* methodology was applied to assess the sustainability of family farms (Vilain et al., 2008; Zahm et al., 2008). This method was developed in France and used in countries such as Tunisia (M'Hamdi et al., 2009) and Mexico (Salas-Reyes et al., 2015). Since it provides a holistic and integrated view of farm sustainability, IDEA takes into account the three dimensions of sustainable development represented by agroecological, socioterritorial and economic dimensions (Table 1). The sustainability value is given by the lowest score of the three dimensions (Hansen, 1996). The score of each dimension is obtained by summing up components' scores that can be up to 100 points. In the same manner, the score of each component is obtained by adding up indicators' scores. A theoretical framework can be found in Vilain et al. (2008) and Zahm et al (2008) or by consulting the IDEA website (http://www.idea.chlorofil.fr/).

Table 1. Dimensions, components and indicators of the IDEA method

Dimensions (3)	**Components (10)**	**Indicators (42)**
Agroecological	Diversity	Diversity of annual and temporary crops (A1), diversity of perennial crops (A2), animal diversity (A3) and animal biodiversity (A4)
	Organisation of space	Crop rotation (A5), dimension of fields (A6), management of organic waste (A7), ecological buffer zones (A8), contribution to environmental challenge of the territory (A9), improvement of the space (A10) and fodder area management (A11)
	Farming practices	Fertilisation (A12), manure management (A13), pesticides (A14), veterinary products (A15), soil protection (A16), water management (A 17), energy dependency (A18)
Socioterritorial	Quality of products and the land	Quality process (B1), valorization of the building patrimony and landscape (B2), non-organic waste management (B3), access to the property (B4), social involvement (B5)

	Employment and services	Short trade value chains (B6), autonomy and enhancement of local resources (B7), services and multiple activities (B8), contribution to employment (B9), collective work (B10), probable farm sustainability (B11)
	Ethics and human development	Dependence on commercial concentrates (B12), animal welfare (B13), training-education (B14), labour intensity (B15), quality of life (B16), isolation (B17), quality of buildings (B18)
Economic	Viability	Economic viability (C1), economic specialisation rate (C2)
	Independence	Financial autonomy (C3), sensibility to government subsidies (C4)
	Transferability	Transferability (C5)
	Efficiency	Efficiency of the productive process (C6)

The original method was adapted to the Moroccan context through incorporating context elements and modifications highlighting issues pointed out by farmers and key resource persons. Methodological changes concern: (i) Score changing, respecting the principle of scoring attribution linked to the original method. This means that the weight of indicators is organised by priority. Indeed, the most fundamental and general are those having more weight than the most specific ones. For instance, the water management score (A17) was increased to benefit farmers who preserve water resources; (ii) Deleting items or indicators, due to the absence of some settings in Saïs such as “permanent grassland” that appears in the diversity of perennial crops (A2) and fodder area management (A11), or the absence of standards and regulations such as "approved spreading effluents plan" linked to manure management (A13); (iii) Addition items, in order to emphasise the specific setting in Saïs such as share-farming (collective work (B10)), which allowed many farmers with resource constraints to produce and to value family manpower, or to implement some logics such as the balance between transmissibility and attractiveness of farm needed for a future buyer (which led us to add the ‘potential income’ item to transferability (C5)); (iv) Modification items or indicators, to adjust threshold values according to the standards prevalent in the study area such as crop rotation (A5) indicator, or to replace non-existing elements with others having the same scope. For example, quality labels and standards (B1) indicator was changed by the valorization of products having a value linked to the territory (onions).

Afterward, adjusted minimum and maximum ratings were made based on tests that allow maximum distinction between farms. After the assessment, the outputs of IDEA were discussed with the farmers in order to understand their strategic choices and their perception of farm sustainability.

Table 2. Adaptations made to IDEA indicators to meet Saïs context

Indicators	Adaptations
Diversity of annual and temporary crops (A1), diversity of perennial crops (A2), animal diversity (A3), and animal biodiversity (A4), quality process (B1), valorization of the building patrimony and landscape (B2), non-organic waste management (B3), access to the property (B4), social involvement (B5), autonomy and enhancement of local resources (B7), services and multiple activities (B8), economic viability (C1), economic specialisation rate (C2)	Score changed
Diversity of perennial crops (A2), fodder area management (A11)	Item linked to permanent grassland removed
Contribution to environmental challenge of the territory (A9)	Deleted
Crop rotation (A5); dimension of fields (A6), economic viability (C1), transferability (C5)	Threshold values adjusted
Sensibility to government subsidies (C4)	Indicator modified to "possibility of financing investments"
Transferability (C5)	Item linked to income potential added
Efficiency of the productive process (C6)	Item linked to ability to generate value added by MWU added

Results

Initial farmers' perceptions of sustainability

According to farmer's perception of sustainability, environmental issues do not represent a top priority for them, whatever their production system is .This does not mean that they are not aware of local environmental issues; for instance, 75% of farmers are aware of the over-exploitation of the aquifer. But only farmers affected by this problem (2 answers) or by soil fertility degradation (6 answers) link sustainability to environmental issues (Figure 1). However, their main position is characterised by the economic aspects of sustainability linked to the economic viability of the farm expressed by "an adequate income" (13 answers). This position is directly related to their own specific context. For instance, 30% of farmers state that they would be unable to continue farming if the volatility of vegetable prices persists. Environmental issues are considered to be the responsibility of public bodies and policies. Indeed, some farmers consider that environmental issues are not the unique responsibility of the farmer but of all the community. Others wonder why farmers would care about the environment as long as the government itself does not care about the over exploitation and depletion of the groundwater reserves. As a matter of fact, the government subsidises irrigation water access and grants licences for even more well-digging in the area.

For farmers, sustainability also depends on their own personal values. Thus answers such as motivation and labour (6 answers), preparing sons to succeed (6 answers) or building a legacy (7 answers) reflect the social values of the farmers. Answers linked to good quality of life (3 answers) or to reducing drudgery (3 answers) reflect farmers' preferences, while answers linked to technical know-how (2 answers) reflect farmers' expertise.

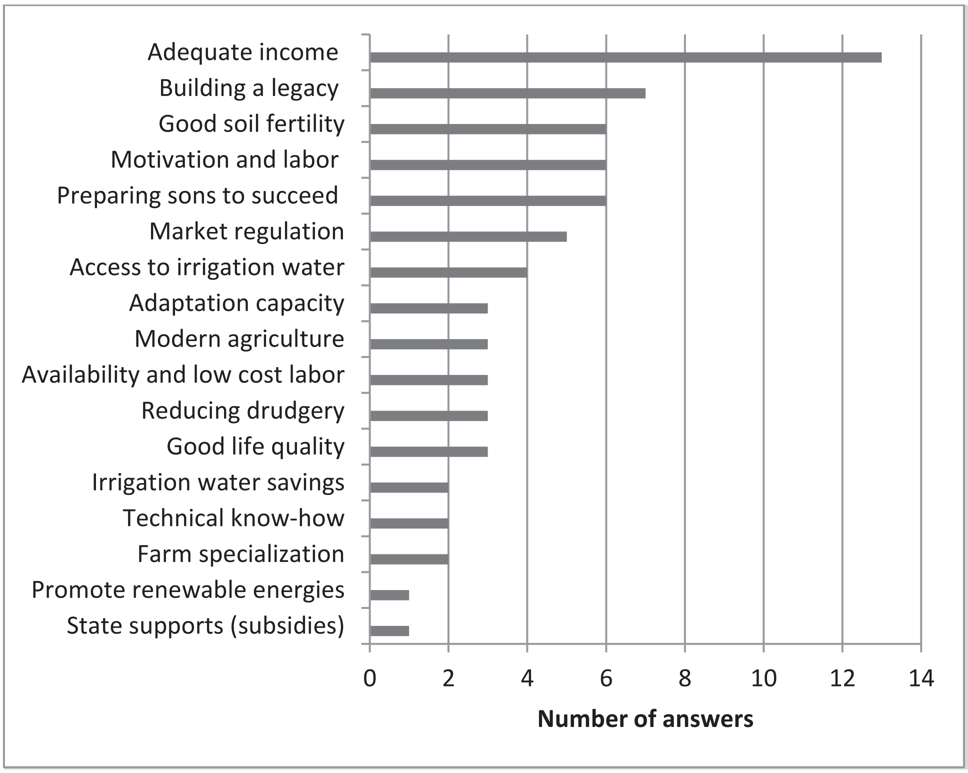

Figure 1. Meanings of sustainability perceived by the 40 farmers surveyed in the Saïs Plain

Enriching farmers' and researchers' perspective by using IDEA

The IDEA method favours diversified farms as the absence of diversification leads to technical weaknesses (preservation of soil fertility, dependence on purchased inputs and on markets), which may result in environmental and economic concerns in the long term. Hence, diversified farms are considered more sustainable than specialised ones. The three types of farm show that sustainability and weaknesses differ from one to another (Figure 2). For example, T2 has poor agricultural practices relating to high nitrogen balance due to strong fertiliser and high pesticides use. T1 on the other hand has extensive practices but a space mismanagement related to the large acreage of land. Lack of diversification of T3 and the low score of agricultural practices gives it a low agroecological sustainability but better economic sustainability corresponding to the good viability of this system. The socioterritorial dimension does not depend on the farm type. As a matter of fact, this score depends on several parameters related to the personality of the farmer and his/her preferences. Thus, using the IDEA method has allowed us to comprehend farmers' sustainability position by refocusing the discussion on the concrete weaknesses of agricultural practices (nitrogen balance, lack of diversity or space mismanagement) and their impact on the environment.

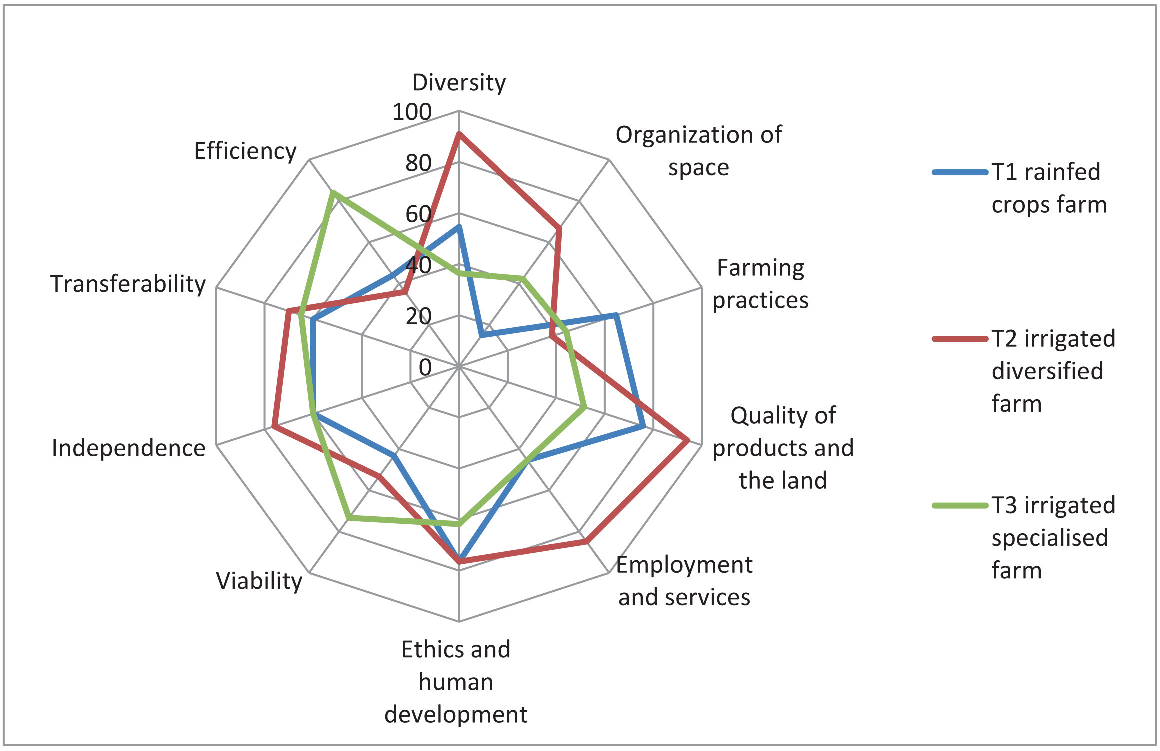

Figure 2. Three farm assessment results (one of each type) representing the elements discussed with farmers

Although the method did not raise any new issues that farmers were not already aware of, as they mentioned, it stimulated reflections regarding the technical reasoning as well as the value systems underlying farmers' decisions. The 14 farmers attest that in their decision-making only economic aspects are taken into account. Actually, environmental concerns are minimised regardless of their expected future impacts. Faced with their sustainability scores, (10/14) farmers acknowledged the environmental limitations of their farms and justified their stand on economic grounds. Indeed, they aim to maximise their income and sustain their family, which implies the use of intensive farming practices in a context of constrained sale prices. Thus, intensification is implemented regardless of its eventual environmental impacts.

> Mohamed, farmer (March 2016) *"Farming is my only source of income, I have no other alternative. I have neither a retirement pension scheme nor a health care insurance. So I have to think about several things at the same time, such as meeting my family's basic needs, coping with diseases and health risks, the hazards of everyday life (...) I find myself forced to enhance productivity to earn more. If I engage in preserving the environment (...), what I might earn, will not even allow me to meet the basic needs of my children."*

(4/10) farmers ignore the impact of their practices on the environment, but their purely economic motivations lead to a significantly increased use of inputs.

> Abdelali, farmer, (May 2016) *"we do not know exactly the crop needs, but the lack of fertilisers is easily noticeable on crop conditions (...) if I increase the input of fertilisers, the crop grows faster, allowing me to shorten its production cycle and sell more quickly (...). Based on my personal experience, the more fertilisers you give to a crop, the more important is crop performance (...) but I don't really think that this could affect groundwater or soil quality."*

Aiming to ensure greater productivity, farmers seek to maximise the factors they are able to harness (chemical inputs and irrigation), then aspire to a good market cash crop. This is the case for instance with onion production, which uses many chemicals and water irrigation in order to get a high yield that will provide insurance in a context of unstable market prices. With rainfed productions however, where prices remain more or less stable in the market, farmers are pushed to engage in tinkering depending on climate variations. Tinkering refers to the capacity to find the best combination between rainfall and inputs that will allow a large increase of the yield. For example, subsequent to the drought recorded in the first quarter of 2016, several farmers neither treated nor applied fertilisers to cereals and legumes, given the low expected yield due to the drought.

> Rachid, farmer (May 2016) *"The reduction in production costs related to a reduction of inputs for the onion crop is insignificant compared to the earnings in production (...) If I decide to reduce inputs, this individual change will be negligible since other farmers will continue intensive practices (...) to preserve the environment, we need alternatives such as those taken by developed countries, whereby states encourage adoption of environment- friendly practices through payments extended to farmers. But here, as long as there are no safeguards to ensure a good income, we are obliged to support our family by all means."*

Several farmers however, who are aware of their intensive practices, consider that environmental issues must be supported by the state. They think that the sociopolitical context in which they operate encourages the adoption of intensive practices. The public bodies aim to increase production, so they promote directly (by irrigation subsidy) or indirectly (by importing and manufacturing of fertilisers and crop protection products) the intensive practices. According to farmers, the State is responsible for the effects on the environment and thus it is felt that only they can act on environmental issues. This could begin by making farmers aware of the negative effects of their practices and, thereafter, by adopting appropriate policies.

Moreover, the discussion with the farmers concerning the IDEA method and its relevance resulted in two main reactions: (i) farmers secure their income through diversification of productions (4/14 of farmers), although this has a primarily economic aim it provides other benefits not targeted at priority but appreciated by farmers, such as synergies between productions, food security and livestock as savings. Besides, these farmers see themselves as sustainable and aligned with the principle of sustainability expressed by IDEA; (ii) farmers are ready to take an economic risk (5/14), especially in speculative horticulture value chains. The success story of precursors in orchards and the preconceptions motivate strongly farmers' decisions to develop horticulture. Moving forwards tree fruits' farming represents to these farmers a qualitative evolution; an emancipation from agricultural hard labour and an aspiration for better living. They have a project to plant orchards without consideration for the current and future issues of fruits' prices and water availability. These threats seem to be a long way off for some of them, who believe in finding adequate solutions at the moment when the actual threat happens. Faced with these threats, a number of farmers think of leaving the tree fruit cultivation adventure and going back to vegetables. In contrast, other farmers are more reactive and think of developing product valorization strategies (spreading productions in time, transformable fruits, selling in short circuit), or water resource security strategies (security drill, basin).

Furthermore, only farmers already embedded in the adventure of fruit growing, ask for greater state intervention in order to regulate the prices. They felt that avoiding over-production must be managed by the State by imposing crop areas for these speculative productions. However, in opposition with the IDEA outputs, these farmers consider themselves more sustainable according to their own criteria; such as the better viability of the farm, the higher quality of life and the reduction of working time. These farmers state that the lack of diversity of productions and the weak agroecological sustainability do not worry them.

Discussion

IDEA and assessment

The method has achieved its purpose; it allowed each type of farmer to better identify weaknesses on which they can act if they engage in a process of evolution towards sustainable agriculture. However, some aspects of the farmers' perceptions of sustainability have not been integrated into the adaptation of the IDEA method in order to respect its principles and generic design, although that would have been more compatible with the concept of sustainability as perceived by farmers. For example, fluctuations in market prices are a factor that can impact the long-term sustainability of farms according to several farmers. This is not represented in the economic dimension. Besides, score calibration by expert makes the method closely related to the local context. Giving maximum scores to salient aspects, reflects the importance of the given aspects in this context. Some difficulties related to the scoring were mitigated through the weights in the tests of 14 farm cases. The tests also showed that the method allowed productive exchanges with farmers, which led to an experimental validation of its use value. The case of Saïs confirmed the effectiveness of the method in warning users about the weaknesses of farms as has been shown in Tunisia (M'Hamdi et al., 2009), Mexico (Fadul-Pacheco et al., 2013; Salas-Reyes et al., 2015) and France (Zahm et al., 2008). However, the processes towards sustainability at the farm level considered by the method (organic farming, alternative agriculture, conservation agriculture) were not measured in this case study due to their absence.

To a certain degree the farmers can develop appropriate management strategies by themselves, considering their own priorities and conditions and based on the provided indicator descriptions or calculation methods (Meul et al., 2008). In addition, a number of cognitive difficulties such as illiteracy or language may push farmers to be reticent of approaching the method. The need to be assisted by a professional is a condition for these farmers. Contrary to this, other farmers claim they don't need any method to evaluate their farms because they acknowledge their strengths and weaknesses.

In addition, the method does not prescribe a specific change but rather gives indications for improvement, which encourages a) farmers to discuss with professionals the different ways of improving their situation and b) the advisory professional to suggest improvements or changes. For this reason focus groups show interesting results for this method; farmers can discuss the background of their indicator results with other farmers and experts. As a result, farm experiences and management practices, together with expert opinions, motivate and stimulate farmers to improve their sustainability (Van Passel & Meul, 2012).

Post-assessment

Farmers do not seem to be individually concerned by environmental issues addressed by IDEA. They are more concerned with the economic aspects which drive their decision-making processes and orient their perception of sustainability. They think that no agriculture is sustainable if it is not first and foremost a profitable agriculture. They consider the environmental impacts of their practices and their management to be the responsibility of the State. Indeed, in this context of market opening, sustainable practices are considered less profitable than those farmers currently adopt. This could be explained by the fact that environmental issues are not yet alarming farmers in the Saïs region and do not disturb the farmer or the State. Thus, the desire of farmers to maximise their income, whatever the effect on resources, could lead to a tragedy of the commons (Hardin, 1968). In contrast, environmental concerns have already become critical by strongly impacting the farm and the farmer decision-making processes in other regions (in European countries for instance). In these countries, governments encourage the agricultural change by influencing farmers directly or indirectly via policies and actions - such as trade policies, price supports, taxes, research and development, various forms of compensation, marketing boards, and land use incentives and controls. But even in these contexts, where these issues are socially recognised and accepted, farmers regularly face conflicts between economic and environmental issues, especially when market prices decrease or when public or private regulations push for more environmentally friendly practices (Dobbs & Pretty, 2008). Thus, it shows that sustainable farming is not only the problem of farmers but concerns also consumers and all society through public policies (Cembalo et al., 2013). Indeed, actions encouraging farmers to sustainable change must be effective to be adopted (Kheiri, 2015). They must be compatible with the sociopolitical environment within which farmers operate and consider their societal values. This study, showing the perceptions and preferences of farmers regarding sustainability, could be a good starting point for introducing such actions.

Using an evaluation method of sustainability such as IDEA, which promotes a production model based on the multifunctionality of agriculture, does not appear to be directly applied to farmers in emerging economy contexts such as Morocco, where there are specific issues and challenges. The use of IDEA helped to address environmental aspects that farmers did not mention during the first interviews and to better understand their strategies and decisions. The case of Saïs illustrates the contrast of sustainability apprehension between researchers and farmers. For the former it was illustrated by the method and for the latter by their perceptions of sustainability and their value systems. The concept of sustainability implies a way of thinking, consequently, people's beliefs and values will continue to mold public understanding of the concept and what sustainability means and how it can and should be achieved. Thus we return to the old affirmation of MacRae et al. (1990) - we cannot expect to have a sustainable agriculture unless all of us adopt a fundamentally different way of thinking about agriculture, which will require major changes in personal beliefs, values and lifestyles. Indeed, it proves to the state that there is no absolute definition of agricultural sustainability and that there is a need for contextualisation.

Although, to put these results into perspective, they relate to a small sample, they have allowed us to establish a “stocktaking” of farm sustainability and to understand the strategies of farmers in the context of market competition. The need to be competitive pushes farmers to adopt a perspective of "now" and not "forever."

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Implementation of sustainability assessment and reporting in horticulture: a case study of New Zealand's wine and kiwifruit sectors

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The AgriBusiness Group

Abstract: The wine and kiwifruit sectors are New Zealand's most valuable horticultural sectors, representing almost 60% of export value of all horticultural exports. A significant reason for this is that globally they are seen to provide high quality and safe products that are grown ethically and with minimum impact on the environment. This success in part is due to the market assurance programmes within each sector. The kiwifruit sector for example has been underpinned by programmes like GLOBALG.A.P. and an integrated pest management programme. Similarly, the wine sector has been supported by an integrated winegrowing programme which has evolved over 20 years into Sustainable Winegrowing New Zealand. However market expectations also continue to evolve and with it so must the sector's assurance programmes. If both sectors are to maintain and increase market value they must set new aspirational goals. To help achieve this, the NZ Sustainability Dashboard Project has been operating in both sectors to augment sustainability assessment and reporting. In the wine sector, the project has supported enhancements to the Sustainable Winegrowing NZ programme, development of new scorecard tools, and individualised benchmarking reports (with video tutorials on how to interpret them). In kiwifruit, unique online web-based dashboard tools that capture, report and benchmark sustainability-related information are currently being developed and piloted amongst different types of stakeholders e.g. growers and packhouse staff. This paper describes how these initiatives have come about, grower engagement, and the associated learnings.

Keywords: Participatory action research, primary industries, Zespri

Introduction

The primary sector dominates the New Zealand economy. Total primary sector export revenue was approximately NZ$38.3 billion for the year ended 30 June 2014, accounting for around three-quarters of the total merchandise export revenue (MPI, 2013). To help future proof this while at the same time maintaining, if not enhancing, social outcomes and environmental integrity, the New Zealand Sustainability Dashboard (NZSD) project was established in 2012. This project is helping primary industry partners to develop sustainability assessment, monitoring, reporting and learning tools that will empower New Zealand producers, processors and distributors of food and fibre to meet their market, regulatory, and business requirements, as well as societal expectations, while contributing to New Zealand's resilience and sustainability. This paper specifically focuses on the development and implementation of tools in NZ's two biggest horticultural export sectors of wine and kiwifruit.

The NZSD project

This is being led by The Agricultural Research Group on Sustainability (ARGOS) which has been studying sustainability within NZ's primary sector since 2003. ARGOS involves around 15 researcher partners from 10 local research organisations or companies, bringing together skills in economics, social science, ecology, Māori cultural science, engineering, agribusiness and software development. The research approach underlying the NZSD project involves Participatory Action Research (PAR) that has a concerted focus on the inclusion of end-users and experts from a range of disciplines working closely together.

Fundamentally, the NZSD project aims to deliver three main interlinked outputs. Firstly, a sustainability assessment framework which sets out the goals being addressed as well as the indicators and metrics used to evaluate movement towards these goals. Secondly it aims to help industries develop assessment and reporting systems either through the direct delivery of tools or through informing industries to develop their own tools. Thirdly, tools for learning that help growers and industry improve, for example decision support, risk assessment and statistical (e.g. power analysis) tools to assess trends in sustainability indicators. The goal here is to unify and streamline reporting for better benchmarking of performance and to turn sustainability auditing into a genuine opportunity for learning by growers.

Initially, sustainability assessment and reporting tools were developed for the New Zealand wine and kiwifruit sectors because these are well-managed industries with key stakeholders who wanted to participate. For wine, Sustainable Winegrowing New Zealand (SWNZ) is the main industry partner while for kiwifruit it is Zespri which is the sole exporter of kiwifruit from NZ. Tools are now being developed for other sectors including Māori agribusiness and forestry sectors.

The NZSD project is funded largely by the NZ Government, specifically The Ministry for Business, Innovation and Employment (MBIE). It is also funded and supported by each of the primary industries involved.

The NZSD framework

Globally, hundreds of sustainability, assessment and reporting frameworks exist and an important objective of the NZSD project was to bring elements of these together to form a unified framework that met the needs of local stakeholders but which was internationally relevant. Specifically, the NZSD framework has been developed to have an overarching goal across four pillars of sustainability – Good Governance, Economic Resilience, Agroenvironmental Integrity and Social Well-being. This closely mirrors the main sustainability dimensions identified by FAO's Sustainability Assessment of Food and Agriculture Systems (SAFA) (FAO, 2014). Within each pillar is a hierarchy of five levels. The first describes the goal for the pillar, which is broken into the outcomes if that goal is achieved. Each outcome is further divided into objectives, or the intent of these outcomes. The achievement or movement towards the objectives will be shown using indicators and measures (Hunt, 2014). This framework is summarised in Figure 1 with an example of the outcomes, objectives and indicators within a pillar (the social well-being one) shown in Figure 2. Within each of the sectors participating in the NZSD project, the framework elements are being developed by each end-user in consultation with the project team and other stakeholders. The NZSD framework is being used to inform that.

Figure 1. Outline of NZSD framework structure.

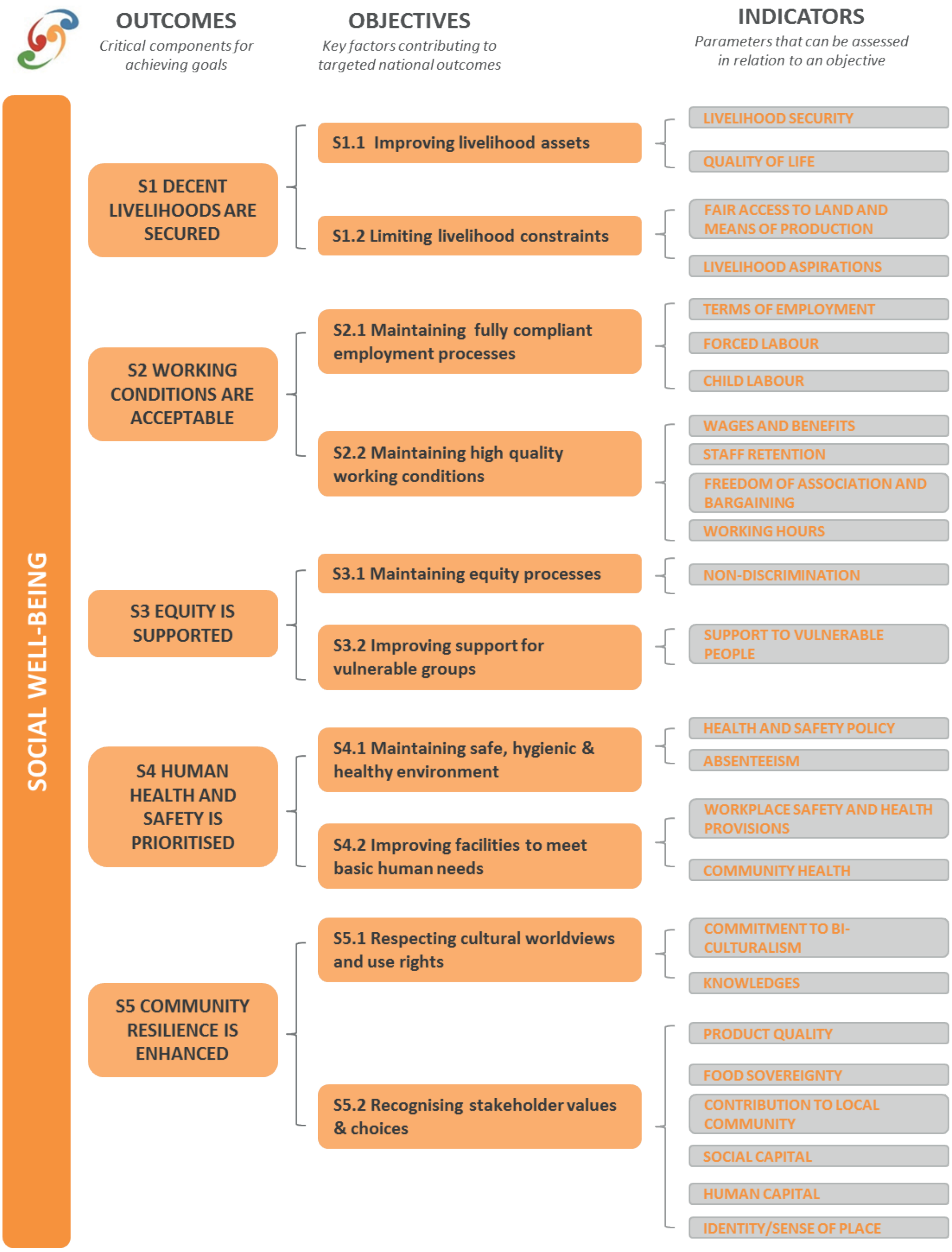

Figure 2. Social well-being framework developed by the NZ Sustainability Dashboard Project.

Sustainability assessment and reporting tools

Tool selection

Each sector involved in the project was identified to have different timeframes for development and implementation of sustainability assessment and reporting tools. The wine sector had an immediate requirement of industry roll-out within a year. For this reason an off-the-shelf software package (SoFi from PE International) was adapted to meet their needs. The advantage of this approach is faster implementation, however it offers less flexibility in design and development plus there is a subscription cost. In contrast, the kiwifruit sector had an expectation of four years or more for industry roll-out and so a bespoke solution was able to be developed. While slower, this affords great flexibility in design and development and while there may be on-going maintenance costs there is no subscription cost. The bespoke needs of the end-user are more likely to be catered for using this approach. For the kiwifruit solution, standard Microsoft technology was used with the view that this would make it more compatible with industry systems and therefore enable easier integration if required. Specifically, the dashboard was developed in ASP.NET 4 (C#) MVC using Microsoft Visual Studio 2012 with a Microsoft SQL Server 2012 Express database. Interactive charts were created using 'Highcharts' (a JavaScript solution). These different solutions are being evaluated as part of the project and will provide important learnings for other sectors interested in developing similar capabilities.

Development process

In the kiwifruit sector, where a customised solution is being built, an agile software development methodology called Scrum has been used. This is a project management framework that is suitable for projects with aggressive deadlines, complex requirements and a degree of uniqueness. In Scrum, projects move forward via a series of iterations called sprints. Each sprint consisted of a number of tasks that typically required one to two weeks to complete. Primarily the Scrum team has consisted of the software developer (tool builder), product owner (representing end-users) and scrum master (project manager). An online collaboration tool called 'Trello' was used to assign tasks and track progress. This process has been very successful for prioritising and development. Building of the dashboard tools has been overseen by a software development expert and mentor to ensure the best use of processes.

Design and functionality

For kiwifruit, which is delivering a custom solution, a prototype was initially developed with its appearance and functionality largely determined by the dashboard project team with some input by industry partners. The solution has been designed to cater for three different types of stakeholders identified as important by our partners i.e. growers, postharvest operators, and Zespri staff. The design and functionality is consistent irrespective of which stakeholder type is using the application. However the content (i.e. metrics and indicators) differs reflecting the different end-user needs and systems. For example, a grower will have access to agrichemical indicators but this does not apply to a postharvest operator who instead will have access to indicators like energy use. An important design feature of the solution is benchmarking and the ability for users to customise this. Other key features are the ability of users to enter different levels of information (e.g. whole orchard vs individual cultivar information) and the integration of existing data already being collected by industry which is important to minimise manual data entry and duplication. These were identified through consultation with end-users as essential for ease of use and for maximising engagement. The importance of incorporating features like these is discussed further below.

Content

To date, the indicators and metrics of sustainability that have been included in the NZSD tools have been largely identified by the end-users to ensure their immediate needs have been met and to encourage participation. For the kiwifruit sector, these have mainly been production (i.e. number of trays, fruit size), revenue, cost and input (e.g. electricity, fertiliser, agrichemical) metrics. An example of a social indicator was included (i.e. community donations in dollars) but testing identified that this may not be a good measure of community support as some growers make contributions in non-financial ways (e.g. volunteering). For the wine sector, energy, water and agrichemical use metrics have initially been included. Within each dashboard these have been aligned with the appropriate pillars and objectives. As the tools are developed further, other relevant indicators and metrics will be added that align with the NZSD framework. Given the potentially large number of indicators and metrics required to provide information on all aspects of sustainability, aggregated indices of performance may be developed and sharp prioritisation undertaken to identify what measures are needed.

Evaluation

Early versions of the NZSD tools are being regularly evaluated by several end-users within each sector. Feedback from trialists is being obtained through semi-structured interviews conducted face-to-face. This iterative is being used to prioritise the development, content and functionality of the dashboard solutions.

Maximising participating and trust

One of the biggest challenges of this project will be obtaining enough engagement from end-users to provide the minimum amount of information needed to meet industry and market needs. This is particularly so for the kiwifruit industry whose growers are typically over 55 years old, have limited computer experience and may be sceptical of the value of such tools. Several strategies are being used to maximise uptake.

Firstly, a key driver for growers engaging with NZSD tools is that they enable them to meet compliance processes. In the wine sector, the NZSD tool (known as WiSE; *Wine Industry Sustainability Engine*) must be used and completed by growers for their products to be included in the Sustainable Winegrowing NZ programme and subsequently be eligible to enter NZ wine awards. For the kiwifruit sector, the NZSD tool has been identified for its potential to help with its existing compliance processes, like GLOBALG.A.P.; information already being collected by the NZSD could be automatically fed into the GLOBALG.A.P. process or vice versa, thereby simplifying the compliance process for growers.

Importantly, participation and trust in the tool is likely to increase if personalised, rapid and tuned benchmarks can be provided. Thus, the NZSD tools endeavour to provide instant benchmarking as soon as users upload their own data. Tuned benchmarks in the wine industry include regional and soil type benchmarks for water use, regional and catchment (5 or 10km radius) agrichemical use benchmarks (Figure 3), and operation size benchmarks for water and energy use by wineries. Similarly for kiwifruit, users can customise benchmarking i.e. using drop-down menus (shown in Figure 4) they can specify benchmarks for a particular region, growing method (e.g. conventional or organic) or cultivar. With wine, video tutorials are provided to help users interpret their reports and the benchmarking within. To date, feedback from growers has identified the benchmarking feature as particularly valuable and something that is likely to drive change.

2 Powdery Mildew Control - Number of Applications (spray passes)

Your Vineyard	Within 5 km*	Average number of applications (passes) per block	Otago	New Zealand
0.3	0.2	Lime Sulphur	0.2	0.2
8.9	10.0	All PM controls	10.2	10.2
8.5	9.8	Sulphur	8.3	7.3
1.0	0.7	DMI	0.8	0.9

*Grouped data to ensure confidentiality

Figure 3. Example of agrichemical use reporting and benchmarking for the NZ Wine Sector, produced by the NZSD project.

Minimising data capture and entry has been identified as important for good engagement. Where possible, information that is already being collected will be entered into the tools and preferably this will be done automatically by linking to existing databases. An example of this is electronic spray diaries held by some sectors. These spray diaries can be interrogated to provide information relating to not just agrichemical use but also a number of other sustainability-related issues like water use, greenhouse gas emissions, eco-toxicity, and pest and disease incidence. For kiwifruit, spray diaries held by industry are already successfully being imported, analysed and reported (Figure 4). It is hoped that the dashboard tools will also link to regional and national databases, maps or models (e.g. weather and soil maps) that will allow growers to better interpret their farming outcomes.

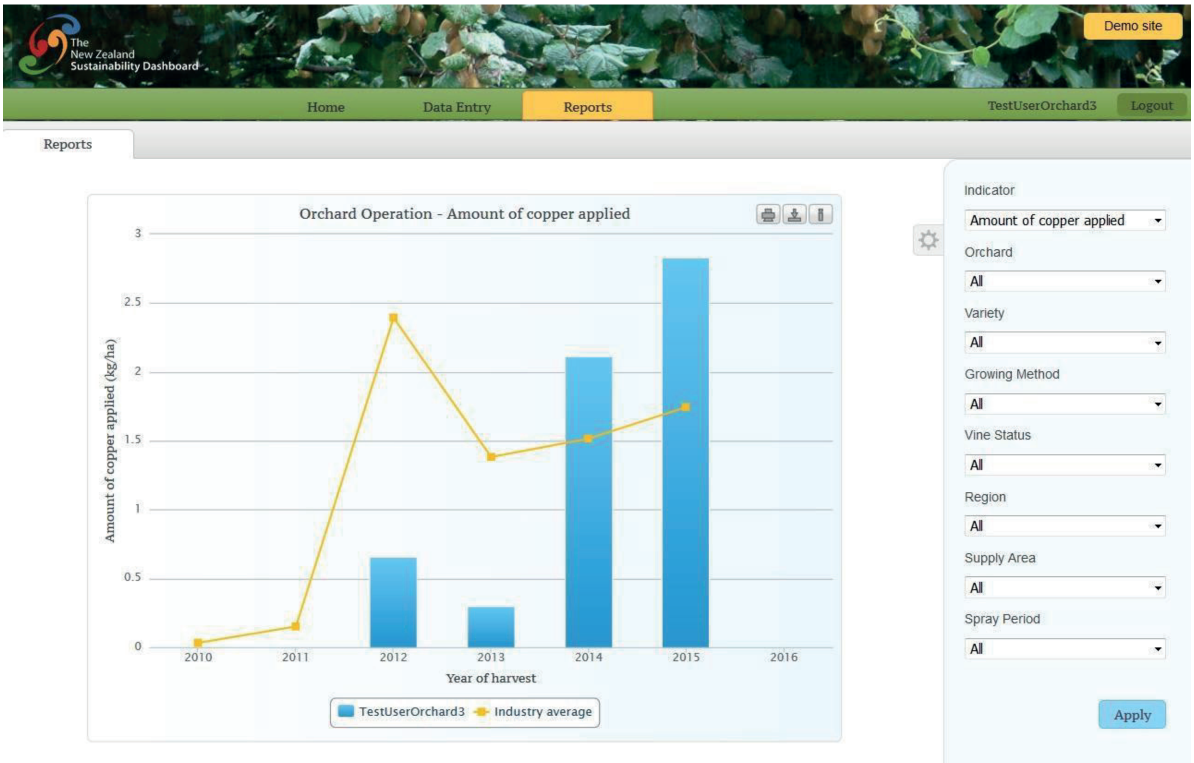

Figure 4. Example of reporting and benchmarking in the prototype NZSD kiwifruit tool for kiwifruit growers. Here, copper use is automatically derived from imported spray diaries collected by industry. A menu on the right allows fine-tuning of benchmarks.

It is anticipated that the tools can be used to interrogate and report relationships between management decisions, inputs and outcomes. For example, relationships between fertiliser use and environmental impacts (e.g. nitrate leaching) or production. This feature is likely to further drive participation.

Learning tools

In addition to helping industries undertake sustainability assessment and reporting, the NZSD project also hopes to provide learnings to become more sustainable. Benchmarking and providing feedback showing weak sustainability performance is probably not enough on its own to trigger change amongst growers or industry stakeholders. Thus, the project aims to provide best practice and decision support tools to aid management. In the wine sector for example, the project has led to the development of individualised reports that describe and benchmark the use of inputs on vineyards, but which also provide best practice recommendations to drive more sustainable outcomes. For example a new powdery mildew resistance management strategy has been developed by SWNZ. In line with this the NZSD project has developed an individualised one page report that highlights how, based on the previous seasons spray programme, the grower performed against the new strategy. Not only has this publicised the new strategy and provided targeted advice to the growers, but the industry gets an overview of which parts of the new strategy need the most focus. Consequently they are able to tailor their other forms of dissemination to address the largest issues.

Preliminary evidence indicates that reporting and benchmarking is helping to optimise practices. It was identified that about 40% of wine growers were applying sub-optimum levels of sulphur for efficacy against powdery mildew. Through individualised benchmarking and reporting this potential issue was highlighted. The following season this group of growers, when compared to the rest of the industry, statistically significantly increased their sulphur application rates by 25%.

In terms of assisting industries at a policy level, the research team is currently developing two tools: (i) a biodiversity risk assessment tool that can be used to help predict the effects of land use change on biodiversity within production landscapes and better inform land management policies, and; (ii) a power analysis module that can help optimise indicator sampling design criteria like the number and frequency of measures, optimum rotors of measures between years, and duration of sampling. For the latter, the goal is to ensure sufficient statistical power is achieved to provide an early alert of upcoming risk while minimising costs and impost on the growers themselves.

Industry implementation

In June 2014, the NZSD tool for the wine sector (WiSE) was rolled out to all growers and wineries. The NZ wine sector has taken ownership of the tool and embedded it within their existing processes, making it part of business-as-usual. The individualised reports and dashboards are evolving as members become familiar and comfortable with the system. The NZSD project is now working with SWNZ on delivering their new strategic plan by providing advice on global best practice in sustainability.

For kiwifruit, the tools have initially been developed as standalone (i.e. external to existing industry systems), with the expectation that the kiwifruit sector, in particular Zespri, would take ownership and incorporate it into their existing or future systems. This integration is seen as important for ensuring the solution continues to be used. However, future integration is uncertain given the industry is currently making significant changes to their existing information systems. It is therefore possible that the dashboard tools will not be adopted by industry. Given this, it is proposed that the NZSD project continues to develop the tools but less so i.e. the focus would be to demonstrate how information could be collected, analysed and reported, rather than developing a fully functional tool for the industry to use. For example, as has been done with wine, the kiwifruit dashboard could be modified to illustrate how agrichemical use could be reported with additional benchmarks like the average for all orchards within 5 km of the current orchard. It is expected that this would inspire the development of future industry systems for sustainability assessment and reporting. Also, the project will continue to provide information and knowledge to assist industry to strengthen its sustainability assessment and reporting. This change of tack highlights the challenge of working in a real-world situation with a dynamic industry like NZ’s kiwifruit sector.

Key to the successful adoption of tools and findings from the NZSD project to date has been a strong and respectful relationship between the project team and the main end-users. In particularly, this has been enabled by having dedicated NZSD project managers in each sector who have worked closely with their respective stakeholders for a number of years. This has been invaluable firstly for identify industry needs but also for meeting those needs as each manager has developed a deep understanding of their industries. End-user involvement from the beginning and throughout is essential for ensuring their sustainability assessment and reporting needs are met and to prevent unnecessary and unwanted development.

Conclusions

The NZ Sustainability Dashboard project is assisting NZ’s primary sector to undertake effective sustainability assessment and reporting. At a grass-roots level this will allow growers to lift performance, while at a sector and national level it will strengthen New Zealand’s ability to respond to customer and market demands for information relating to the economic, social and environment consequences associated with NZ’s food and fibre production. The project is already helping the NZ wine and kiwifruit sectors to undertake more effective sustainability assessment and reporting using quite different approaches. Central to this has been a strong and positive relationship between the project team and end-users.

Acknowledgements

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Comparing the sustainability performance of certified and non-certified coffee farms in Uganda: synergies and trade-offs between sustainability themes

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Abstract: The Sustainability Assessments of Food and Agriculture Systems (SAFA) framework published by the Food and Agriculture Organisation (FAO) aims at harmonising sustainability assessments and making methods and results more transparent and comparable. There is, however, limited understanding of the interactions between SAFA themes under different agricultural production contexts. Synergistic interactions may allow for simultaneous enhancement of more than one sustainability goal, while conflicts in some sustainability goals might result in trade-offs. In this article: (i) we assess the sustainability performance of certified (organic and fair trade) and non-certified smallholder farms in both Robusta and Arabica coffee production systems in Uganda, employing the indicator-based SAFA-consistent Sustainability Monitoring and Assessment RouTine (SMART) Farm Tool and; (ii) using the respective sustainability scores, we compare synergies and trade-offs between themes using the non-parametric Spearman correlation test. Generally all farms had high scores in the social, followed by the environmental themes, and low scores in the economic and governance themes, irrespective of the certification status. We find that certification improves the sustainability performance of farms, mainly through the enhancement of the 'cooperative effect' which ultimately has positive effects on other sustainability dimensions. This was evident among the certified coffee farms which obtained significantly higher scores in all dimensions than the non-certified farms. We thus found more synergies between sustainability themes among certified than non-certified farms. However the extent of the synergies and trade-offs vary significantly with certification type and other contextual factors. These findings call for caution in generalising certification effects on sustainability of agricultural production systems.

Keywords: SAFA-Guidelines, SMART, coffee, organic production, fair trade, certification, Uganda

Introduction

Sustainability assessments of agricultural production systems are increasingly of interest. Agricultural production systems relying on non-renewable resources, leading to water and air impairments, biodiversity losses, soil contamination and degradation, as well as health risks to society. This invokes controversial discussions around feeding a growing population, abating climate change, and utilising natural resources efficiently (Reganold et al., 2001). Hence, sustainability assessments are usually challenged with defining what-is-sustainable (Lien et al., 2007), in the context of sometimes conflicting societal goals and heterogeneous impacts of production systems due to stochastic processes and social specificities (Ikerd, 1993). Some authors have attempted to define sustainable production systems and practices in the form of specific 'dos' and 'don'ts'. For example Kesavan et al. (2008) pointed out that sustainable production systems make the best use of environmental goods and services while not damaging these assets; Pretty (2008) argued that sustainable production systems should aim to adopt technologies and practices that are accessible to and effective for farmers, and lead to improvements in food productivity; while Reganold (2012) emphasised that sustainable production systems should not only focus on profitability, but also the contribution to the well-being of farmers and their communities. Given the multiplicity and interlinkages of sustainability goals, it is apparent that some goals can be mutually reinforcing (synergies) while others (trade-offs) compete in pursuit of sustainability (Jackson-Smith, 2010). Synergistic interactions allow for simultaneous enhancement of more than one sustainability goal, while conflicting ones result in trade-offs which can arise for example between food for the household versus expanding area under cash crop production. Equally there is a desire to use production practices that protect soil, air, water, and biological resources versus applying synthetic pesticides and fertilisers that can have adverse effects on human and ecosystem health (Reganold et al., 2001). Hence, revealing synergies and trade-offs allows policymakers and other stakeholders to understand the hidden consequences of preferring one production system to another (Haase et al., 2012).

A common ground of sustainability assessments is seen in a solid conceptual and methodological basis to support empirical analysis. Assessments not only provide a benchmark for the production systems under question but also can provide guidance for decision makers by revealing impacts and trade-offs of on-going or proposed measures. Sustainability assessments also provide improved insight into the effects of management measures and farming systems on individual sustainability aspects and overall sustainability (van Calker, 2005). Whether *ex-ante* or *ex-post*, the sustainability assessment of agricultural production systems requires a combination of different models and methods in order to deliver useful information about the impacts of proposed changes in the systems (Thornton & Herrero, 2001).

Many approaches to sustainability assessment have been proposed in the literature. In a comparison of 50 sustainability assessment frameworks for livestock and crop production systems, Ran et al. (2015) found that they differ in a number of aspects including the general objectives and aims, target audiences, environmental issues addressed and indicators selected as well as the spatial and temporal scales covered. The MESMIS framework (MESMIS, for its Spanish acronym) has been applied in agricultural sustainability evaluation to more than 40 case studies across Europe and Latin America (Speelman et al., 2007). The framework is built upon four principles: (i) sustainability is defined by seven dynamic, systemic attributes: productivity, stability, reliability, resilience, adaptability, equity and self-reliance; (ii) sustainability evaluations are only valid for a specific management system, on a specific spatial and temporal scale; (iii) the evaluation process is participatory to capture diverse opinions; and (iv) sustainability is assessed through the comparison of systems either simultaneously or throughout time (Lopez-Ridaura et al., 2002). However, in a meta-analysis of 15 MESMIS case study evaluations, Astier et al. (2011) found that the framework explicitly focused on quantifiable indicators, which excluded many important indicators from being incorporated in the evaluation.

In another detailed comparison of the scope and precision of six frameworks and approaches (Appendix 1), out of 35 approaches identified in the literature Schader et al. (2014) concluded that no single approach serves all purposes of sustainability assessment. Hence, the

Sustainability Assessments of Food and Agriculture Systems (SAFA) guidelines were developed by the Food and Agriculture Organisation of the United Nations (FAO, 2014). The guidelines aim at harmonising sustainability assessments and making methods and results of sustainability assessments in the food sector more transparent and comparable. By providing a transparent and aggregated framework for assessing sustainability, SAFA seeks to harmonise sustainability approaches within the food value chain as well as furthering good practices. Each of the SAFA dimensions is made up of multiple themes with different goals (Appendix 2). Sustainability goals can be mutually reinforcing or conflicting. Synergies create opportunities for potential win-win situations where pursuit of achievement of one sustainability theme goal generates benefits in other themes, while trade-offs arise when conflicts emerge among sustainability themes, resulting in win-lose or lose-win situations (NAS, 2010). There is, however, still limited understanding of the interactions between the SAFA themes under different production contexts.

Sustainability-oriented certification (e.g. organic, fair trade) has been widely used to define best practice in primary production, processing and trading of agricultural products. These certifications are typically adopted voluntarily and paired with compliance verification, and labels to differentiate certified from non-certified products in the marketplace (Milder, 2013). Despite their growing popularity, there are contradicting reports on the impacts of these certified systems to various elements of sustainable livelihoods. Consequently, the objectives of this article are to: (i) assess the sustainability performance of certified (organic and or fair trade) and non-certified smallholder farms in both Robusta and Arabica coffee production systems in Uganda; and (ii) compare synergies and trade-offs between sustainability themes among these farms.

The next section describes the data collection process, the SMART tool and data collection, and the empirical methods used for analysing synergies and trade-offs. This is followed by descriptive and empirical results, which we discuss and draw conclusions from in the last section.

Data and Methods

Study context and selection of farms

Coffee production in Uganda

Uganda produces both Robusta *(Coffea canephora*) and Arabica *(Coffea arabic*a) coffee, of which 90% is produced by smallholder farmers. Arabica coffee is commonly found in the high altitude areas of the eastern, western, and southern regions of the country (USAID-APEP, 2008). Robusta coffee is a native Ugandan coffee type grown in almost all parts of Uganda (Figure 1). For both coffee types, a number of varieties are available. Robusta coffee can be produced as clonal coffee, a fast maturing and better yielding type than Arabica coffee (USAID-APEP, 2008). On average, the production of coffee in a low-input system generates around USD100 per hectare, while production of improved coffee (e.g. clonal) in the same input system generates about USD 150 per hectare (Kraybill & Kidoido, 2009). However, a high-input system of either local or improved varieties can raise gross margins four-fold or more (Kraybill & Kidoido, 2009). Coffee is usually intercropped with bananas, annual crops or trees. These intercropping systems offer many agronomic benefits to smallholder farmers for example increase in organic matter or nutrient recycling, soil conservation, longer productivity life cycle of coffee plants and higher biodiversity values (Moguel et al., 1999; Diaz, 2012) and are more profitable than banana or coffee monocropping systems (van Asten et al., 2011). According to Jassogne et al. (2012), the highest yields can be obtained in systems without shade or with low shade levels. However, these same systems often represent higher production risks (especially drought, pests and diseases), resulting in intensive use of external inputs. In polyculture and agro-forestry systems, high yield quality can be obtained with a low level of external inputs and allowing a better adaptation to climate change, higher carbon stocks, and more ecological services (Jassogne et al. 2012).

Selection of farms

The survey was carried out in the western part of Uganda, covering both Arabica and Robusta production systems, between July and September 2015. A survey of 360 coffee-producing households belonging to Robusta and Arabica production systems was conducted. A two-stage sampling approach was applied. Firstly primary cooperatives belonging to organic and fair trade (FO), fair trade only (FT) and conventional/non-certified (CN) categories were selected. Selected primary cooperatives were structurally similar, in terms of farm sizes, altitude and location, chosen based on physical observations, literature review and selected interviews. Secondly random samples of 60 farming households were drawn from farmer lists obtained at each of the FO, FT and CN primary cooperatives. Arabica coffee farmers are located at the foothills of the Rwenzori Mountains at altitudes between 1400 and 2200 metres above sea level. Only certified farmers are organised in primary cooperatives, each with a washing station for wet-processing of Arabica coffee. As a result, surveyed CN farmers were drawn from neighbouring villages using a list of farmers provided by the local agriculture office, for comparison purposes. On the contrary, Robusta coffee farmers are located at altitudes between 1600 and 1900 metres above sea level. Farmers are organised in both certified and non-certified primary cooperatives for bulking of dried coffee cherries and onward delivery to the market. The primary cooperatives thus operate at parish level with an average membership of 300 coffee farmers.

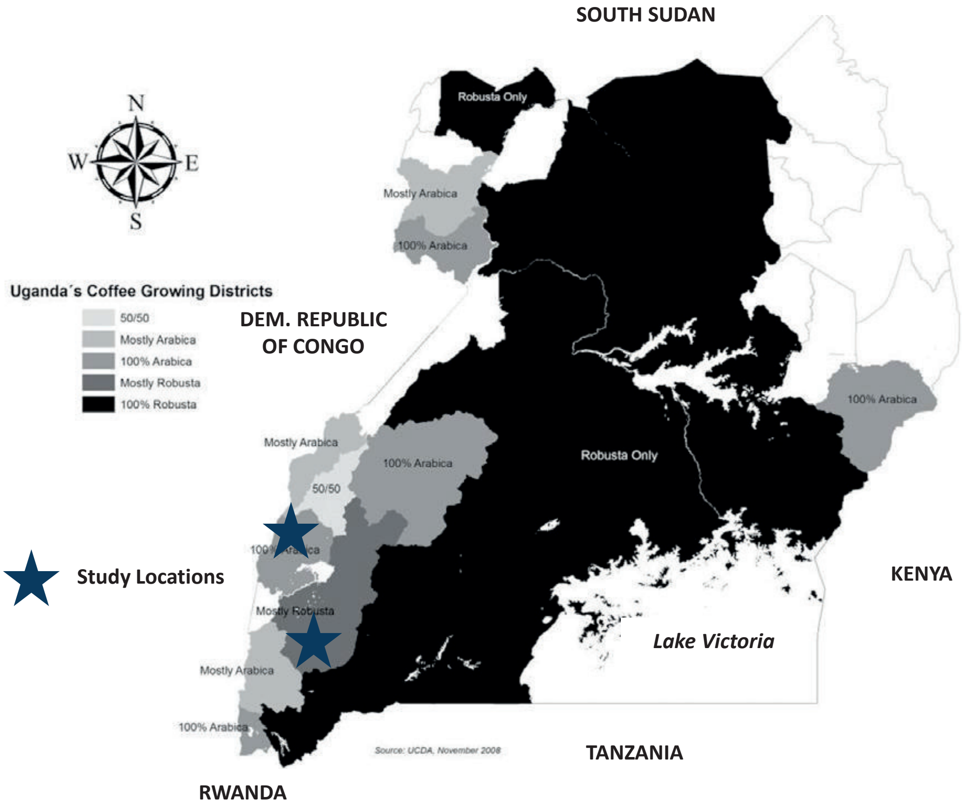


Figure 1. Map of Uganda showing the study locations *(Source: UCDA, 2008)*

The SMART farm tool

Based on the SAFA guidelines, the Research Institute of Organic Agriculture, FiBL, developed an indicator-based Sustainability Monitoring and Assessment RouTine (SMART) Farm Tool (Jawtusch et al., 2013). The tool consists of a large pool of indicators from which suitable indicators can be chosen according to the assessment context. The tool operationalises the SAFA guidelines by defining science-based indicator sets and assessment procedures derived from a review of scientific literature and existing sustainability assessment tools (Jawtusch et al., 2013). For each SAFA sub-theme, there is a number of indicators that in combination allow for an assessment of the level of goal achievement, which is expressed on a scale from 0 to 100%. Zero (0)% represents a state where all applicable farm activities are counteracting the goal achievement, while 100% represents a state where the respective sustainability goal has been fully achieved by implementing all relevant beneficial activities on a farm and avoiding all relevant detrimental activities to the greatest extent possible. It analyses the degree of goal achievement with respect to the 58 themes defined in the SAFA guidelines, using an impact matrix that defines 327 indicators and 1,769 relations between SAFA sub-themes and SMART indicators (Figure 2). SMART explicitly does not draw the system boundaries along the physical boundaries of a farm but considers all sustainability impacts which the farm and its activities have along the upstream value chain. Thus, impacts from purchased inputs (seeds, feedstuffs, fertilisers, pesticides, etc.) are also considered (Schader et al., 2016). This is important to maintain comparability across farms, as farms induce off-farm impacts via these imports to different degrees.

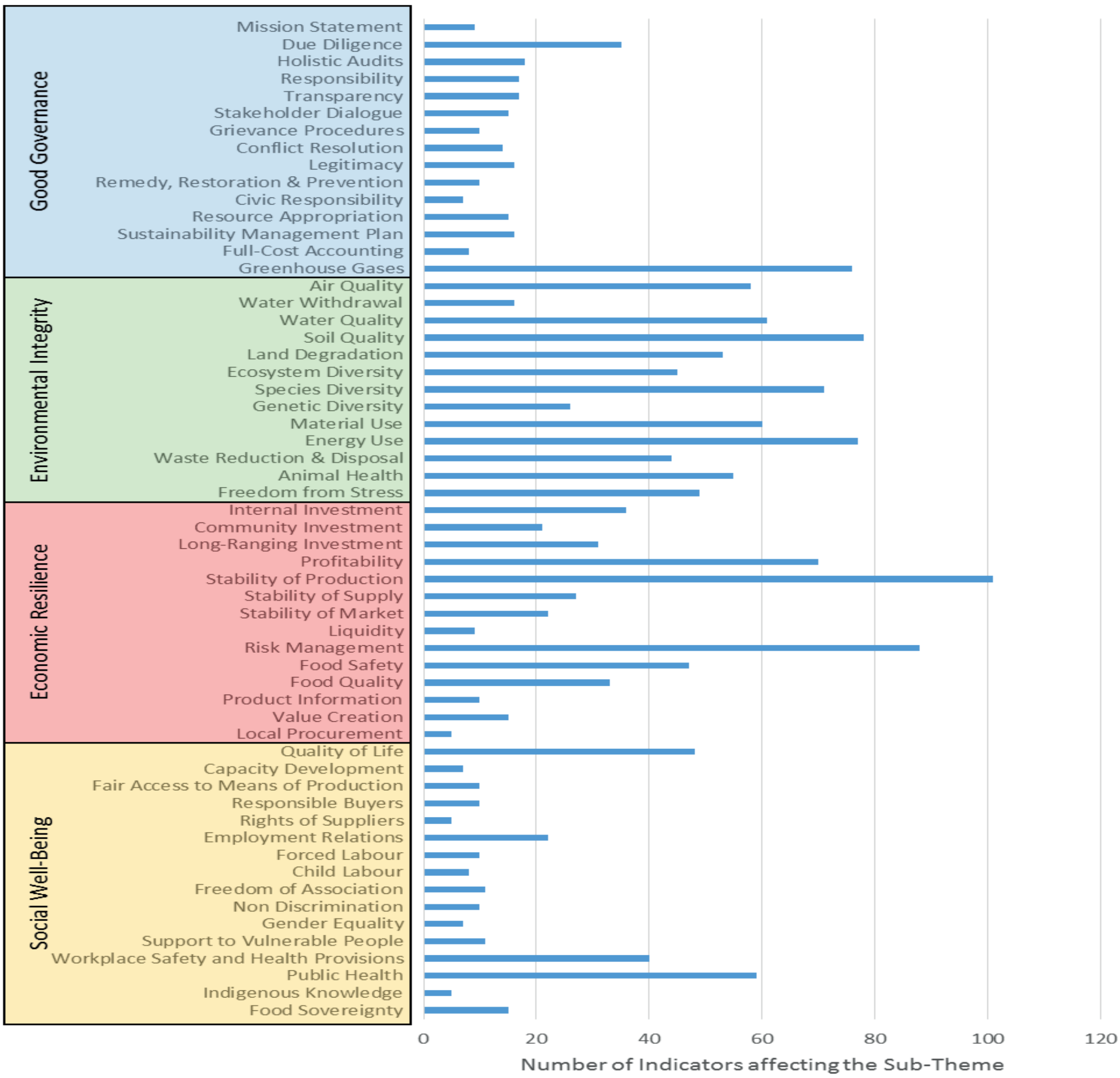


Figure 2. Number of indicators in SMART linked to the SAFA sub-themes *(Source: Schader et al., 2016)*

Data collection and analysis of synergies and trade-offs

Data used to assess the sustainability performance of coffee farms were collected by a specially-designed farm questionnaire. The farm questionnaire related to indicators automatically selected from the SMART Farm Tool for their relevance with the farm type and context (see Schader et al., 2016). The indicators were pre-tested on a selected number of farms for their applicability to the context. Collected data was then entered directly into the SMART Farm Tool which normalises the data on a predefined scale varying from 0% to 100% and computes scores per theme.

Using the respective sustainability scores for the SAFA themes obtained with SMART, we evaluated the synergies and trade-offs using the non-parametric Spearman rank-correlation test (Spearman, 1904). All analyses were performed using IBM SPSS Statistics version 21

(IBM, 2012). Positive correlation coefficients ($0<r_s\leq+1$) represent synergies between the respective sustainability themes (right hand side of the y-axis), negative correlation coefficients ($0>r_s\geq-1$) represent trade-offs between the respective sustainability themes (left hand side of the y-axis) and zero correlation coefficients ($r_s=0$) represent no effect between the respective sustainability themes. To compare scores between and within certification categories, the analysis of variance (ANOVA) was used.

Results

Sustainability performance of farms

The sustainability scores varied significantly between the Arabica and Robusta production systems and within the certification categories (Table 1). FO farms performed better than FT farms which performed better than CN farms in both Arabica and Robusta production systems. The score patterns within the Robusta and Arabica production systems were similar but significantly different between the respective certification categories (Figure 3). Generally farms scored high in the social, followed by environmental, and low in the economic and governance themes, irrespective of the certification status. Specifically, certified Arabica farms scored better than certified Robusta farms in most themes. On the contrary, non-certified Robusta farms scored higher in nearly all themes than non-certified Arabica farms. This could be attributed to the fact that, unlike non-certified Arabica farms, the non-certified Robusta farms were organised in a primary cooperative thus engaging in some collective activities. The sustainability performance of the specific certification categories according to the themes is described as follows:

Governance themes: all farms scored high in terms of participation and rule of law themes, with low scores in accountability and holistic management themes. Non-certified farms scored very low in terms of holistic management, accountability and corporate ethics in both production systems.

Environmental themes: scores of some environmental themes (i.e. materials and energy, land and atmosphere) were generally low in both production systems even among certified farms. Arabica farms generally had higher scores than Robusta farms.

Economic themes: all systems scored high in the product quality and information theme but generally low in investment, vulnerability and local economy themes. However certified Robusta farms scored higher in terms of the local economy theme than Arabica farms. The high local economy scores could be attributed to the fact that many Robusta farms employed permanent workers (33.9%), which is not the case with Arabica farms (0%).

Social themes: although Robusta farms scored consistently high across social themes certified Arabica farms scored low in terms of the equity theme. This could be attributed to the fact that with limited external labour sources, the unique steep terrain and wet processing requirements posed heavy workload challenges for both women and children. It was equally observed that men were not equitably involved to avert the workload challenges. As a result, farmers had formed ‘solidarity groups’ of five people dominated by women, for labour assistance on a rotational basis e.g. during peak harvesting seasons, carrying coffee to the washing stations, coffee pulping and drying at the washing stations.

Table 1. SMART assessment scores for FO, FT and CN farms

Sustainability themes	Arabica FO (n=60)		Robusta FO (n=60)		Arabica FT (n=60)		Robusta FT(n=60)		Arabica CN (n=60)		Robusta CN (n=60)		Total (n=360)	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Corporate ethics	0.52	0.01	0.12	0.04	0.15	0.00	0.18	0.05	0.18	0.00	0.54	0.01	0.28	0.18
Accountability	0.47	0.04	0.06	0.03	0.13	0.01	0.11	0.03	0.09	0.03	0.61	0.05	0.25	0.22
Participation	0.82	0.03	0.50	0.04	0.52	0.02	0.51	0.01	0.58	0.03	0.84	0.02	0.63	0.15
Rule of law	0.73	0.02	0.45	0.02	0.48	0.03	0.48	0.02	0.62	0.03	0.74	0.00	0.58	0.12
Holistic management	0.39	0.00	0.00	0.00	0.02	0.00	0.05	0.03	0.00	0.00	0.39	0.00	0.14	0.18
Atmosphere	0.49	0.03	0.43	0.02	0.44	0.02	0.45	0.03	0.41	0.02	0.49	0.03	0.45	0.04
Water	0.57	0.01	0.58	0.02	0.64	0.02	0.62	0.03	0.58	0.03	0.58	0.03	0.59	0.04
Land	0.51	0.03	0.45	0.02	0.48	0.02	0.48	0.02	0.40	0.01	0.49	0.03	0.47	0.04
Biodiversity	0.69	0.03	0.69	0.02	0.69	0.02	0.69	0.02	0.62	0.03	0.67	0.04	0.68	0.04
Materials and energy	0.50	0.02	0.44	0.01	0.48	0.02	0.48	0.02	0.39	0.02	0.51	0.02	0.47	0.04
Animal welfare	0.76	0.00	0.72	0.01	0.72	0.00	0.69	0.02	0.74	0.00	0.75	0.01	0.73	0.02
Investment	0.47	0.04	0.30	0.03	0.33	0.02	0.31	0.03	0.22	0.04	0.45	0.02	0.35	0.09
Vulnerability	0.45	0.03	0.44	0.03	0.46	0.03	0.45	0.03	0.37	0.04	0.48	0.01	0.44	0.04
Product quality and information	0.70	0.02	0.51	0.02	0.61	0.01	0.55	0.01	0.51	0.01	0.80	0.03	0.61	0.11
Local economy	0.25	0.03	0.40	0.03	0.40	0.01	0.40	0.02	0.18	0.04	0.28	0.04	0.32	0.09
Decent livelihoods	0.60	0.01	0.44	0.02	0.45	0.00	0.45	0.01	0.39	0.03	0.61	0.02	0.49	0.09
Fair trading practices	0.94	0.04	0.64	0.01	0.66	0.01	0.65	0.01	0.79	0.00	0.96	0.03	0.77	0.14
Labour rights	0.69	0.12	0.59	0.02	0.62	0.00	0.63	0.02	0.36	0.01	0.77	0.08	0.61	0.14
Equity	0.21	0.08	0.59	0.08	0.60	0.00	0.61	0.01	0.00	0.00	0.32	0.16	0.39	0.24
Human health and safety	0.66	0.00	0.61	0.02	0.61	0.01	0.61	0.00	0.66	0.00	0.66	0.00	0.63	0.03
Cultural diversity	0.90	0.04	0.70	0.02	0.72	0.01	0.71	0.02	0.86	0.05	0.92	0.00	0.80	0.10

ANOVA test – sustainability scores varied significantly across the certification groups at 5%; FO= fair trade and organic; FT = fair trade only; CN=Conventional/non-certified

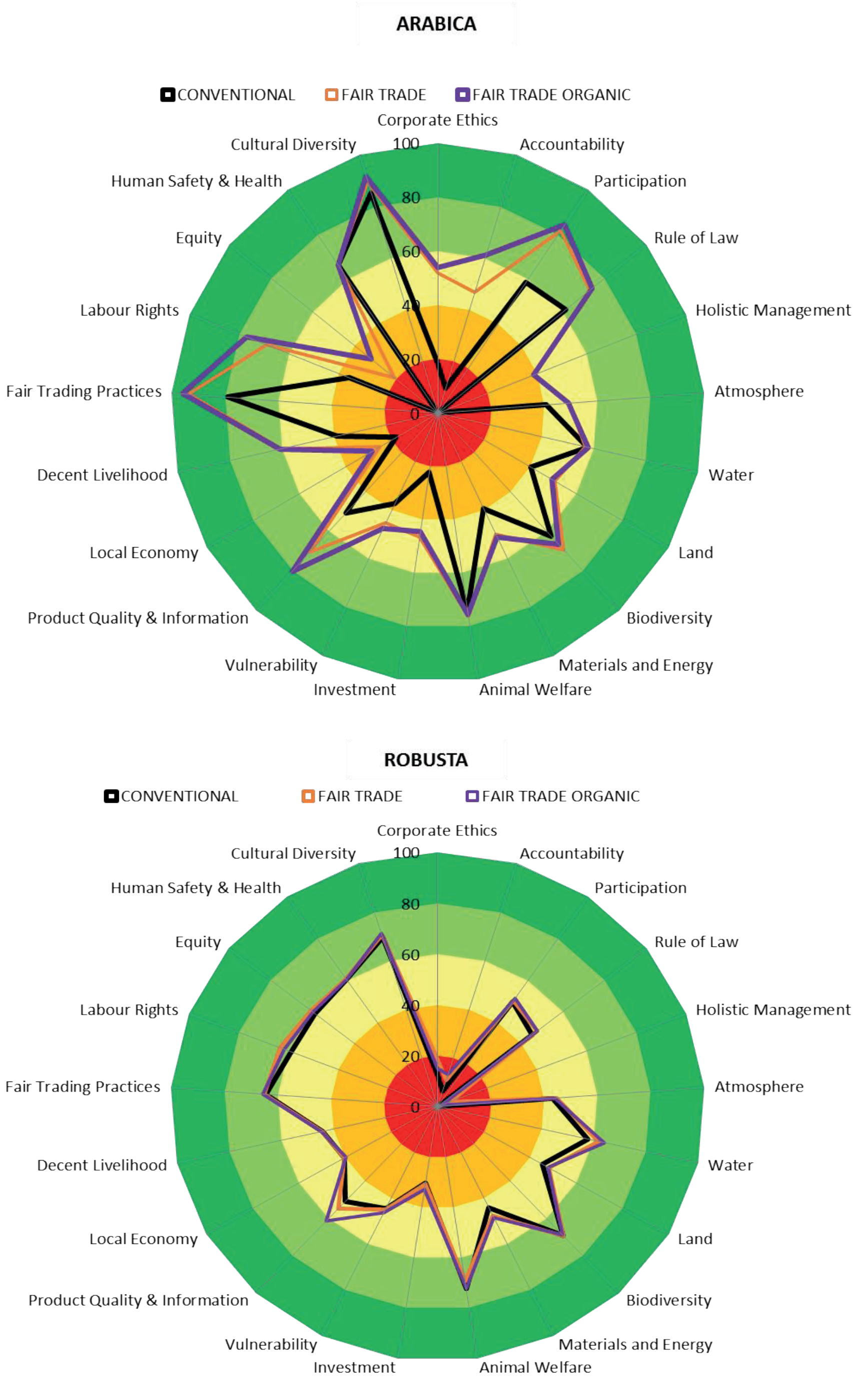
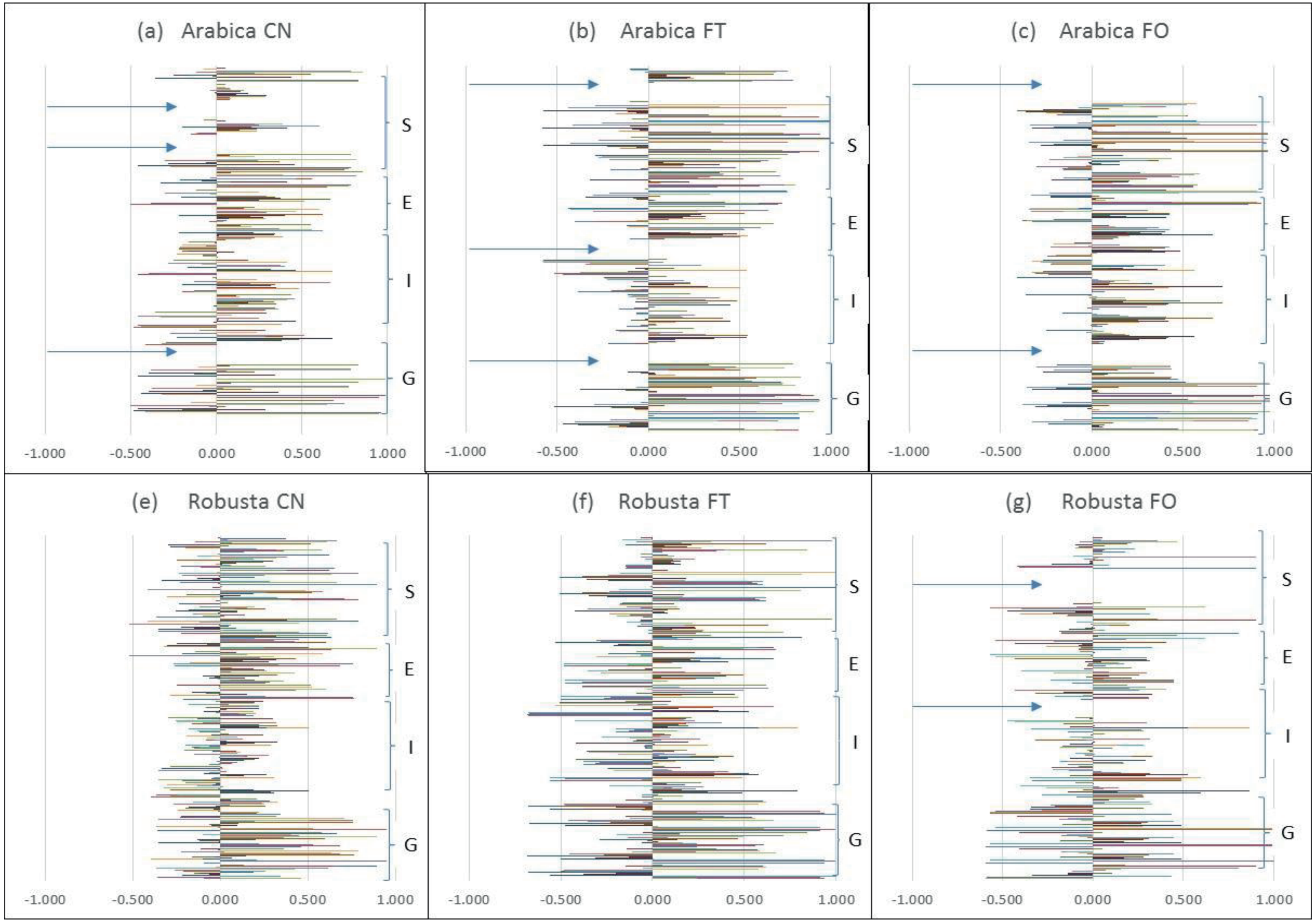


Figure 3. Performance of Arabica and Robusta farmers with respect to different sustainability themes



G-Good governance, I-Environmental integrity, E-Economic resilience and S-Social well-being themes; arrows indicate themes with zero coefficients.

Figure 4. Graphical representations of correlations between sustainability themes among Arabica and Robusta coffee farmers

Analysis of interactions within sustainability themes

Using the sustainability scores obtained in Table 1, we analysed the interactions within sustainability themes using Spearman correlation coefficients (Figure 4). Three types of relationships are observed: positive (synergies), negative (trade-offs) and zero (no-effect) correlations. Greater synergies were observed between sustainability themes within Arabica than Robusta production systems. A similar relationship was observed between certified and non-certified farms within the Arabica production system. However, within the Robusta production system there were as many synergies and trade-offs among certified and non-certified farms. In fact CN farms have more synergies (less trade-offs) than FO farms (Figure 4). Additionally, Arabica farms had themes with zero correlations: corporate ethics, holistic management, fair trade practices and equity among non-certified farms; holistic management, human health and safety, and cultural diversity among FO farms; and holistic management, animal welfare, and human health and safety among FT farms. Equally, there are themes with zero correlations among FO Robusta farms (animal welfare, labour rights and equity). Looking at all farms irrespective of certification status, mostly positive and significant correlations were observed between the different themes (Figure 5).

Taking averages of the correlation values for each dimension, we found only positive correlations (synergies) between the dimensions (Figure 5: figures in oval shapes). Between the dimensions, synergies were greatest between the social and the governance dimensions (51.7%) and between the economic and environmental dimensions (33.1%). The synergies were lowest between the social and environmental dimensions (21.4%) and between the social and economic dimensions (26.7%).

Dimensions	Good governance					Environmental integrity						Economic resilience				Social well-being					
Themes	Corporate ethics	Accountability	Participation	Rule of law	Holistic management	Atmosphere	Water	Land	Biodiversity	Materials and energy	Animal welfare	Investment	Vulnerability	Product quality and information	Local economy	Decent livelihoods	Fair trading practices	Labour rights	Equity	Human health and safety	Cultural diversity
Corporate ethics	1.000																				
Accountability	.855**	1.000																			
Participation	.862**	.781**	1.000					+0.282					+0.319					+0.517			
Rule of law	.880**	.837**	.912**	1.000																	
Holistic management	.773**	.851**	.611**	.667**	1.000																
Atmosphere	.494**	.563**	.451**	.462**	.715**	1.000															
Water	-.437**	-.304**	-.499**	-.478**	-.206**	-0.071	1.000														
Land	.316**	.490**	.253**	.266**	.666**	.630**	.113*	1.000													
Biodiversity	-.165**	-0.037	-.226**	-.222**	.194**	.378**	.142**	.439**	1.000				+0.331					+0.214			
Materials and energy	.497**	.674**	.405**	.428**	.812**	.832**	0.070	.668**	.285**	1.000											
Animal welfare	.678**	.580**	.819**	.794**	.481**	.393**	-.494**	.227**	-.176**	.319**	1.000										
Investment	.552**	.726**	.593**	.570**	.824**	.719**	-.153**	.719**	.255**	.776**	.533**	1.000									
Vulnerability	.169**	.348**	.177**	.115*	.435**	.469**	.145**	.518**	.291**	.583**	0.100	.610**	1.000								
Product quality and information	.713**	.859**	.637**	.663**	.900**	.682**	-0.094	.639**	.146**	.835**	.519**	.845**	.530**	1.000				+0.267			
Local economy	-.430**	-.224**	-.534**	-.606**	-0.103	-0.061	.411**	.169**	.385**	0.054	-.703**	0.000	.304**	-.108*	1.000						
Decent livelihoods	.620**	.702**	.605**	.513**	.839**	.709**	-.288**	.653**	.270**	.749**	.480**	.865**	.547**	.767**	0.049	1.000					
Fair trading practices	.801**	.726**	.859**	.876**	.630**	.414**	-.449**	.247**	-.238**	.361**	.820**	.555**	0.043	.643**	-.618**	.507**	1.000				
Labour rights	.578**	.702**	.432**	.419**	.783**	.595**	-0.049	.606**	.229**	.683**	.201**	.683**	.447**	.790**	.241**	.694**	.406**	1.000			
Equity	-.389**	-.225**	-.499**	-.626**	-0.056	-0.023	.369**	.156**	.353**	.106*	-.673**	-0.014	.297**	-0.068	.907**	0.085	-.612**	.302**	1.000		
Human health and safety	.782**	.531**	.838**	.820**	.404**	.273**	-.516**	0.033	-.321**	.167**	.831**	.291**	-0.085	.385**	-.784**	.336**	.819**	.119*	-.750**	1.000	
Cultural diversity	.792**	.701**	.904**	.904**	.555**	.385**	-.476**	.169**	-.260**	.326**	.814**	.506**	0.076	.537**	-.654**	.518**	.855**	.244**	-.673**	.869**	1.000

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Figure 5. Spearman correlation values between sustainability themes

Discussion and Conclusions

Sustainability assessments of agricultural production systems differ in terms of objectives, target audiences and indicators as well as spatial and temporal scales. This study aimed at comparing sustainability performance of certified and non-certified individual coffee farms in both Arabica and Robusta production systems in Uganda, using a set of pre-determined sustainability indicators from the SMART Farm Tool. Using the respective farm sustainability scores, we compared synergies and trade-offs between sustainability themes among the different farm categories. As highlighted by Schader et al. (2016), we find that the SMART Farm Tool is a useful tool to assess and benchmark farms across farm types and regions as well as sustainability themes and sub-themes. From a set of 327 indicators, between 200 and 292 indicators were on average applied in the assessment of each farm, depending on its complexity. Farms with more and diverse forms of livestock, hired labour, and which applied externally-sourced inputs like feeds, fertilisers and pesticides, had the largest number of indicators applied. Each assessment lasted between 2 to 3 hours and a farm report could be generated immediately after the assessment. This is consistent with Ran et al. (2015) who concluded that assessment methods need to be rapid to provide results in a cost-efficient manner if they are to assist with policymaking and decision-making. Despite its large set of indicators and the requirement of technical expertise to administer the tool, it is a quick way to identify strengths and weaknesses for assisting farmers in their transitions towards sustainable production.

Comparing sustainability scores at farm level showed that the sustainability profiles, represented by the score patterns, within each coffee production system were similar (Figure 3). However the sustainability scores between the Arabica and Robusta coffee production systems were significantly different. This is a result of the variability among coffee farms in Uganda in terms of their resource availability, objectives, history and opportunities (Jassogne et al., 2012). However the sustainability profiles within a given production system are similar irrespective of the certification status (Figure 3). Generally all farms had high scores in the social, followed by environmental, and low in economic and governance themes, irrespective of the certification status.

We find that the sustainability performance of farms significantly varies across certification categories, with higher sustainability scores among fair trade and organic (FO) certified farms. This is consistent with studies which have reported positive impacts of certification on smallholder livelihoods; for example organic certification has been reported to significantly contribute to the improvement of livelihoods and the ability of farmers to cope with challenges, mainly through knowledge transfer, access to capital and capacity building (Altenbuchner et al., 2014) as well as higher farm revenues (Bolwig et al., 2009). Comparatively, the effects of fair trade certification have been analysed in even more studies. In Uganda, Chiputwa et al. (2014) concluded that fair trade certification increases household living standards by 30% and reduces the prevalence and depth of poverty.

However, as indicated in Figure 3, no production system performed well in all sustainability themes. The individual farm scores varied across themes, owing to varied opportunities and challenges that the farms are exposed to either from within the coffee farms or the entire coffee system in Uganda; they can be climatic, institutional, cognitive, political or simply linked to the way coffee is produced. At different levels sustainability goals can be in direct conflict (NAS, 2010). This justifies the need to further analyse relationships between the sustainability themes at different levels. Generally, more synergies (less trade-offs) were observed between sustainability themes among Arabica than Robusta farms as well as among certified than non-certified farms. Such synergistic interactions could be the contributing factor to the higher sustainability scores among certified and among Arabica groups. We therefore conclude that certification generally allows for simultaneous enhancement of more than one sustainability goal. However, the proportion of synergies and trade-offs among certified and non-certified farms, and within certified (FO and FT) farms, varied widely. This is consistent with the sustainability performance scores identified. The results in Figure 3 indicate that the proportions of the synergies and trade-offs between sustainability themes does not seem to depend on the certification type. It is seemingly true that other contextual factors are important as well. This implies that the trade-offs and synergistic relationships are not necessarily stable, could change over time (Haase et al., 2012), and vary over a wide range of conditions (Walker & Salt, 2006). Priorities need to be set depending on the context of the farm, while policy could also support the transition process to more sustainable systems by carefully considering the likely impacts of proposed interventions.

Possible sustainability impact pathways

Results have shown that certification contributes significantly to sustainability benefits. The question remains: how does certification improve sustainability performance of certified farms? Certification was originally perceived as a strategy for strengthening the position of coffee smallholders in the value chain. Hoebink et al. (2014) suggests that the direct interactions between producers and buyers in certified systems reduce the transaction costs and market risks and enhance transfer of knowledge on sustainability-enhancing practices. However, different certification labels provide different incentives for achieving these goals. Fair trade certification guarantees minimum prices paid to farmers at purchase and pays an additional fair trade premium to the cooperative union for capacity building and related community projects. All surveyed certified farms had fair trade certification and thus benefitted from this minimum price requirement, but only if they sold to the associated cooperative union which owns all certification documents. Due to the focus on community projects, determined at the cooperative union level, the effects of the fair trade premium were very difficult to assess at farm level. Comparatively organic certification, on top of fetching a higher bonus at the end of the selling season, places more emphasis on environmental sustainability (Chiputwa et al., 2014). Thus farms that are both fair trade and organic (FO) certified were expected to perform much better in terms of sustainability scores than farms that are only fair trade (FT) certified. Incidentally, the difference between environmental sustainability scores was only significant at $p<0.05$. Although FO and FT primary cooperatives are structurally similar, the FO primary cooperatives have a well-established farmer extension system. The organic certification system requires regular training and extension support for all certified farmers. As a result, there are specifically attached organic trainers for each of the organic certified groups. Unlike fair trade (FT) farmers, organic fair trade (FT) farmers are regularly reminded of required sustainable practices and thus better sustainability scores.

It is also clear that working in groups is an important element of both fair trade and organic certification schemes. Farmer groups are key for increasing the scale of production, quality assurance, and to guarantee the reliability of small holders as preferred suppliers in the value chain (Hoebink et al., 2014). Schader et al. (2016) further concluded that the governance dimension is very important with regard to achieving a good level of performance in the other sustainability dimensions. We therefore expect that the governance scores, which are closely related to group strength in a smallholder context, positively impacted scores in other dimensions and overall sustainability scores. Consistent with Jena et al. (2012), the ‘cooperative’ effect seemed more important than the ‘certification’ effect in influencing sustainability performance. In addition, looking at interactions between sustainability dimensions (Figure 5), the governance dimension had an overall stronger influence than other sustainability dimensions. We therefore conclude that certification enhances the achievement of governance goals through its influences on group organisation and collective capacities, which can result in positive impacts on other dimensions of sustainability. Although certification has a positive impact on sustainability performance, synergies and trade-offs widely vary depending on the production context. These contextual differences need to be considered when considering sustainability-enhancing interventions at farm, regional and national levels. These findings call for caution in generalising certification effects on sustainability of agricultural production systems.

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Appendix 1. Categorization of major sustainability approaches *(Source: Schader et al., 2014)*

Name*	Reference	Primary purpose	Level of assessment	Geographical scope	Sector scope	Thematic scope	Perspective on sustainability
AUI	www.blw.admin.ch	Monitoring	Farm	Switzerland	Universal	Environmental	Societal
COSA	Giovannucci et al. (2008)	Assessment	Farm	Developing countries	Coffee and Cocoa	Environmental Social Economic	Mixed with farm level as main area
FARMIS	Bertelsmeier (2005) Sanders (2007) Schader (2009)	Research, Policy advice	Sector	Germany, Switzerland	Universal	Environmental Economic	Societal
REPRO	Hülsbergen (2003)	Research	Farm, product	Germany and neighbouring countries	Universal	Environmental	Societal
RISE	Grenz et al. (2009)	Farm advice	Farm	Global	Universal	Environmental Social Economic	Mixed with farm level as main area
SALCA	Nemecek et al. (2011)	Research	Product	Switzerland	Universal	Environmental	Societal
SMART	Jawtusch et al. (2013)	Assessment, Monitoring	Food company, Farm	Global	Universal	Environmental Social Economic Governance	Mixed

**AUI - Agrar-Umweltindikatoren; COSA - Committee on Sustainability Assessment; FARMIS - Farm Modeling Information System; REPRO - Reproduction of Soil Fertility; RISE - Response-Inducing Sustainability Evaluation; SALCA - The Swiss Agricultural Life Cycle Assessment; SMART – Sustainability Monitoring and Assessment Routine.*

Appendix 2. Overview of SAFA dimensions, themes and sub-themes *(Source: FAO, 2014)*

Dimension	Theme	Sub-themes				
GOOD GOVERNANCE	CORPORATE ETHICS	Mission Statement	Due Diligence			
	ACCOUNTABILITY	Holistic Audits	Responsibility	Transparency		
	PARTICIPATION	Stakeholder Dialogue	Grievance Procedures	Conflict Resolution		
	RULE OF LAW	Legitimacy	Remedy, Restoration & Prevention	Civic Responsibility	Resource Appropriation	
	HOLISTIC MANAGEMENT	Sustainability Management Plan	Full-Cost Accounting			
ENVIRONMENTAL INTEGRITY	ATMOSPHERE	Greenhouse Gases	Air Quality			
	WATER	Water Withdrawal	Water Quality			
	LAND	Soil Quality	Land Degradation			
	BIODIVERSITY	Ecosystem Diversity	Species Diversity	Genetic Diversity		
	MATERIALS AND ENERGY	Material Use	Energy Use	Waste Reduction & Disposal		
	ANIMAL WELFARE	AnimalHealth	Freedom from Stress			
ECONOMIC RESILIENCE	INVESTMENT	Internal Investment	Community Investment	Long-Ranging Investment	Profitability	
	VULNERABILITY	Stability of Production	Stability of Supply	Stability of Market	Liquidity	Risk Management
	PRODUCT QUALITY & INFORMATION	Food Safety	Food Quality	Product Information		
	LOCAL ECONOMY	Value Creation	Local Procurement			
SOCIAL WELL-BEING	DECENT LIVELIHOOD	Quality of Life	Capacity Development	Fair Access to Means of Production		
	FAIR TRADING PRACTICES	Responsible Buyers	Rights of Suppliers			
	LABOUR RIGHTS	Employment Relations	Forced Labour	Child Labour	Freedom of Association and Right to Bargaining	
	EQUITY	Non Discrimination	Gender Equality	Support to Vulnerable People		
	HUMAN SAFETY & HEALTH	Workplace Safety and Health Provisions	Public Health			
	CULTURAL DIVERSITY	Indigenous Knowledge	Food Sovereignty			