Master's Degree Thesis

Sustainability Assessment Tools for Small Scale Agri-Food Projects in Sweden

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2025

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Thesis submitted for completion of Master of Strategic Leadership towards Sustainability, Blekinge Institute of Technology, Karlskrona, Sweden.

Abstract:

This study explored the usefulness of sustainability assessment tools for small-scale agri-food projects in Sweden, focusing on the 2000 m² project initiatives in Älvsbyn and Stockholm. Employing a critical, integrative approach, two frameworks that is the Five-Level Model of the Framework for Strategic Sustainable Development (FSSD) and Binder et al.'s (2010) framework guided the evaluation of the five selected tools: SMART, RISE, SAFE, SAEMETH, and LiteFarm. This research developed a conceptual framework combining these two methodologies, enabling a structured assessment across normative, systemic, and procedural dimensions. Results highlight SMART as the most comprehensive tool, offering broad coverage of environmental, social, and economic dimensions and robust procedural strengths. RISE follows. LiteFarm can also be used for its fair sustainability coverage, open access, and farmer-friendly visuals. SAFE and SAEMETH, despite their systemic and participatory design, show limitations in practical use and clarity. The findings suggest that SMART and RISE are best suited for full sustainability evaluations in complex contexts like the 2000 m² concept, while LiteFarm serves well for rapid assessments.

Keywords:

Food System, Sustainability Assessment Tools, Small Scale Agri-Food Projects, Framework for Strategic Sustainable Development (FSSD), 2000 m² Concept

Statement of Contribution

The following master’s thesis is the result of a five-month co-design process, where four students of the Master of Strategic Leadership Towards Sustainability (MSLS), at the Blekinge Institute of Technology / Blekinge Tekniska Högskola (BTH), Sweden, explored the topic of sustainability assessment tools for small scale agri-food projects in Sweden.

Part of the Sustainability Sciences, positioned in the transdisciplinary field of Sustainable Development (SD), the research has been conducted by applying a Strategic Sustainable Development (SSD) lens. Based on the programme department’s strategic sustainability background, the Framework for Strategic Sustainable Development (FSSD) builds the research’s major methodological and linguistic foundation.

It was with a common understanding and interest in the topic that a collaborative manner led the research from the start to its end. The team’s disciplinary, cultural, and generational diversity enriched and informed different research perspectives. All four members of the group thereby contributed to the research to their best available capacities, bringing forth unique and complementary competencies.

The team’s governance drew on the sociocratic decision-making process of consent circles, rather than majority voting. Hence, all team members were involved and equally responsible for the important questions of the dissertation. Based on each person’s expertise and skill set, the team aimed at strategic task and role divisions. For the review of existing assessment tools, each member specialised on one tool particularly, whilst not exclusively.

The two researchers, Pallavi Priya and Bidisha Mukherjee led the tools’ detailed analyses and comparison process. Data integration and evaluation was shaped by all four team members, with major contribution of the respective tool expert. Pallavi Priya, Bidisha Mukherjee, joined by Holly Gurling and Ann Cathrin Nachtwey synthesised the results and enriched the discussion of the research. Pallavi Priya led; Bidisha Mukherjee, Ann Cathrin Nachtwey and Holly Gurling concluded the scientific work.

In the writing process of the complete report, everyone was given the leadership to contribute to their individual preferences and capabilities. Feedback was provided and integrated throughout the whole research and writing process. A shared leadership approach, informed by the Art of Hosting (AoH) participatory approach, guided internal and external team meetings. Ann Cathrin Nachtwey, on behalf of the team, took on the stakeholder communication.

Each team member put forth the intent to conduct and deliver a scientific valuable contribution to the science community. The team therefore co-designed this report with joint effort, based on a topic of shared curiosity and interest. Throughout the time of co-creation, personally and professionally, the team lived through a memorable learning experience, trusting the team and process.

Acknowledgements

We would like to acknowledge our privileged access to technologies and digital infrastructures to write a master's thesis, remotely, with an international team of researchers. We understand that without technological devices, it wouldn't have been possible to conduct the research, let alone enrol and follow the MSLS programme.

We would herewith like to send out our gratitude to everyone who made this intercultural and intergenerational master's thesis possible. It wouldn't have been without the contribution and support of the following people that we closed our 5-month remote research.

First, we would like to acknowledge our primary advisor, Pierre Johnson for being available for feedback and questions. His suggestions and guidance directed the team throughout all research phases. Likewise, we would like to thank our secondary advisor Dr Merlina Missimer, who offered her advice in the form of both class and email consultations.

Special thanks to our external advisor, Professor Edith Callaghan for her wisdom, advice, and hours of coaching us throughout our research into sustainable food systems. With many years of experiences in the field, her expertise on the topic provided extra mentorship. Many thanks also to her colleague Dr Liesel Carlsson, who offered her availability for any research relevant questions.

A big thank you note to the whole MSLS department with all staff members, especially those teaching and encouraging us. High acknowledgement for the scientific research foundation and life work of the programme founders, Professor Göran Broman and Professor Karl-Henrik Robèrt.

Another thank you note goes to the Charminorr ekonomisk förening and associated partner organisations, to Karin Bodin from Polarbröd and to Carina Roos, Project Manager of 2000 m² Älvsbyn, for their trust, project support and stakeholder communication.

We would like to collectively thank all research respondents, interviewees and Focus Group Discussion participants, who shared their valuable time and insights with us. We highly appreciate the in/direct support we received to compose a cross-organisational master's thesis.

Moreover, we would like to mention our MSLS classmates, with whom we started our 10-month MSLS journey with. As a small-scale international study community, we co-learnt from a great diversity of backgrounds. We therefore like to honour and celebrate our strong cohort of 2025.

Last but not least, a heartfelt thanks to our families, friends, and beloved partners who supported us, while dedicating much of our time and attention to our co-creation. It truly wouldn't have been without their back support, that our dissertation came together wonderfully.

Statement of Positionality

A positionality statement offers insight into the political and social context in which a researcher is embedded (Holmes, 2020). Within qualitative research, the researcher's worldviews and beliefs may influence the overall research design, data analysis, and the conclusions drawn. Such insights help inform the reader about the framework within which the researcher approaches the study and offer a space for reflexivity, acknowledging that positionality, values and beliefs may change over time. As Holmes (2020) suggests, a researcher's positionality reflects characteristics including nationality, age, gender, political and religious beliefs, social class, ethnicity, previous professional experiences, and the specific project context.

Pallavi Priya – As a sustainability professional, my work is rooted in interdisciplinary approaches and multi-stakeholder collaboration. With a background in Chemistry (Hons.) and a Master's in Livelihoods and Social Entrepreneurship from Asia's premier Social Science university, I bring over six years of experience advancing the SDGs across 17 Indian states. My journey spans grassroots implementation on food security and climate-resilient agriculture, to policy consultancy with EY on coal mine rehabilitation, and corporate sustainability leadership for a global FMCG brand. I am committed to creating evidence-based, inclusive solutions for sustainable future.

Bidisha Mukherjee – I am a sustainability consultant from India with over 15 years of diverse experience; I bring a deep-rooted commitment to environmental stewardship and inclusive development. My academic journey – from a Master's in Ecology and Environment to pursuing a Master's in Strategic Leadership towards Sustainability at BTH – reflects my enduring pursuit of systemic, future-oriented solutions for a thriving planet. Guided by the Indian ethos of *Vasudhaiva Kutumbakam* (meaning *"the world is one family"*), my work is inspired by the interconnectedness of life, traditional ecological wisdom, and the resilience of local communities. I have collaborated with global financial institutions like the Asian Development Bank and the World Bank to design and implement sustainable infrastructure development projects that are not only environmentally responsible but also socially empowering. Through my work, I aspire to honour India's cultural legacy while co-creating sustainable futures that nourish both people and the planet.

Ann Cathrin Nachtwey – I am an alumna of Global Project and Change Management (BBA), now pursuing the Master's in Strategic Leadership towards Sustainability (MSc). Inspired by the 16 Principles of the Earth Charter, I am an ambassador of the Earth Charter International community. Endeavouring to translate theory into practice, cultural diplomacy powered by nature, expressed through the arts and storytelling, lays at the heart of my work. Passionate in planting imagination seeds to (re)imagine futures, I am a freelance researcher and trainee in organic fruit farming.

Holly Gurling – My work and education have been in the fields of geographical and earth systems science. I am interested in food systems transformations, participatory processes and food supply networks. I have worked on many food systems change projects in Australia, funded by the State and Federal Australian Government. I was project lead for Tropical Agri-Food Industry Network, and I worked for farmer-led non-profit Sustainable Table in remote Northern Queensland and with Open Food Network Australia. These experiences led me to move to Sweden to understand the food systems and strategic sustainability from a European perspective. I grew up in England and my mother is Australian with European roots. My own epistemological position could be described as relativist or interpretivist, rather than positivist.

Glossary

Agri-Food System: All of the interconnected activities and actors involved in getting food from the field to the table.

Complex System: A system that comprises different parts that interact in complex relations, while producing behaviours that at times can be counterintuitive and unpredictable.

Component: A part or element of a framework; an identified theme, sub-theme, or indicator under the reviewed assessment tools.

Five-Level-Model (5LM): A model that facilitates the analysis, decision-making, and planning process in complex systems. It consists of five categorical, interrelated levels; System, Success, Strategic Guidelines, Actions, and Tools (Robèrt et al. 2021).

Framework: A structure underlying a system, built on a particular set of rules, ideas or beliefs.

Framework for Strategic Sustainable Development (FSSD): A foundational, systems-thinking methodology designed to support strategic sustainable development theory and practice, including a supportive set of tools.

Indicator: The smallest subject under a secondary and main subject, often a measurement or value.

Parameter: A numerical or measurable factor forming one part of a set that defines a system or sets the conditions of its operation.

Practitioners: A person actively practices an art, discipline, or profession on the field level, representing different stakeholder roles.

Socio-ecological System: The system combined of the biosphere, the society, and the complex interactions and relations between them (Robèrt et al. 2021).

Stakeholder: Any person or group who has an in/direct interest (or stake) in an organisation or community and can affect or be affected by the organisation's actions, objectives, and policies.

Strategic Sustainable Development (SSD): An overarching, science-based lens and approach to understand sustainable development and create change for sustainability in a systemic, systematic, and strategic way.

Structural Obstacles: Social constructions that are firmly established in society and upheld by those with power, therefore difficult to overcome or avoid by the people exposed to them (Missimer, Robèrt, and Broman 2017).

Sub-theme: A secondary subject that forms part of a larger main subject (theme).

Sustainability: A state of society which is in full compliance with the eight Sustainability Principles (SPs), in which the socio-ecological system, and the ability of future generations to meet their needs is not systematically undermined (Robèrt et al. 2021).

Sustainability Challenge: Systematic errors of societal design and basic operations that are driving negative effects on the socio-ecological system, including the obstacles to address those errors (Robèrt et al. 2021).

Sustainability Principles (SPs): The eight basic principles for a sustainable society in the biosphere, underpinned by scientific laws and knowledge. The eight SPs are:

In a sustainable society, nature is not subject to systematically increasing…
…concentrations of substances extracted from the Earth's crust;
…concentrations of substances produced by society;
…degradation by physical means;

and people are not subject to structural obstacles to…
…health.
…influence.
…competence.
…impartiality.
…meaning-making.

Sustainable Development (SD): The transition from the current, unsustainable society towards a sustainable society, with continued development within sustainability constraints thereafter (Robèrt et al. 2021).

System: A set of interconnected parts whose behaviour depends on the characteristics of the parts, the interactions and relations between them (Robèrt et al. 2021).

Systems Thinking: The organised study of systems, their connections, dependencies, feedback and behaviour.

Theme: A main subject that is being discussed.

Usefulness: The quality of having utility and especially practical worth or applicability in the specific field.

Abbreviations and Acronyms

5LM	Five-Level-Model
8 SPs	Eight Sustainability Principles
BFH	Berner Fachhochschule / Bern University of Applied Sciences
BTH	Blekinge Tekniska Högskola / Blekinge Institute of Technology
DGA	Degree of Goal Achievement
e.g.	*“exempli gratia”* meaning *“for example”*
EEA	European Economic Area
etc.	*“et cetera”* meaning *“and so on”*
FGD	Focus Group Discussions
FiBL	Forschungsinstitut für Biologischen Landbau / Research Institute of Organic Agriculture
FSCI	Food System Countdown Initiative
FSD	Food Systems Dashboard
FSSD	Framework for Strategic Sustainable Development
GDPR	General Data Protection Regulation
IPCC	Intergovernmental Panel on Climate Change
MSLS	Master of Strategic Leadership towards Sustainability
RISE	Response Inducing Sustainability Evaluation
ROI	Return on Investment
RQ	Research Question
SAEMETH	Sustainable Agri-Food Evaluation Methodology
SAFA	Sustainability Assessment of Food and Agriculture
SAFE	Sustainability Assessment of Farming and Environment
SAT	Sustainability Assessment Tool
SD	Sustainable Development
SFS	Sustainable Food System
SMART	Sustainability Monitoring and Assessment RouTine
SP	Sustainability Principles
SRQ	Sub-Research Question
SSD	Strategic Sustainable Development
TAPE	Agroecological Performance Assessment
UN	United Nations
WFP	World Food Program

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1. Introduction

Food systems have a fundamental impact on planetary and human health, life, and well-being. It is one of the primary concerns to manage some of the most compelling global challenges of present days (Schneider et al. 2023). The High-Level Panel of Experts (HLPE) on Food Security and Nutrition defines a sustainable food system as one that *"delivers food security and nutrition for all in such a way that the economic, social and environmental bases to generate food security and nutrition for future generations are not compromised"* (HLPE 2014, 12*)*. The United Nations Food and Agriculture Organization (UN-FAO) (FAO 2018) supports this viewpoint further. It is one of the most frequently referenced definitions of a sustainable food system (Carlsson et al. 2017). According to a recent United Nations report (UN), titled *Making Food Systems Work for People and Planet: UN Food Systems Summit +2 Report of the Secretary-General (2023),* food systems are one of the major drivers of environmental pollution. It estimates that the global food system accounts for more than one third of greenhouse gas emissions, up to 70 percent of freshwater use and as much as 80 percent of biodiversity loss. There is growing momentum from international bodies to influence public policy, private sector and civil society actions to transform food systems from their current unsustainable and inequitable trajectories towards healthier, more equitable, sustainable and resilient futures (Schneider et al. 2023). The UN hosted its inaugural Food Systems Summit (UN-FSS) in 2021 to show how food systems are linked to the Sustainable Development Goals (SDGs) and to give nations a platform to create national strategies for food system change. Within two years, in 2023, 126 countries adopted national pathways and 155 appointed national convenors for food systems, indicating their continued interest in, and commitment to changing food systems (United Nations 2023, A). Food systems are also prominently featured in recent UN Climate Change Conferences and in the Kunming-Montreal Global Biodiversity Framework (2022) targets (Schneider et al. 2023). Production and consumption of food in Sweden have undergone profound transformations over time, spurred by the liberalisation of trade, on-farm structural changes, leading to fewer but larger and more specialised farms, and fewer actors in the retail and food industry sector (OECD 2018; Hansson et al. 2024). Within Sweden, there is a growing need to influence public policy, private sector and civil society actions to transform food systems, from its current unsustainable and inequitable trajectories, towards healthier, more equitable, sustainable and resilient futures.

Overview of the Global Food System

According to the FAO (2018), for a food system to be considered as sustainable, it needs to concurrently generate positive value along all three sustainability dimensions - economic, social and environmental. From the economic perspective, a food system could be considered as sustainable if the activities conducted by various actors or support service providers are commercially viable. The activities should generate economic benefits for all stakeholders, such as ensuring wages for workers, profits for enterprises, paying taxes to governments, and improving supply networks for consumers. In terms of social sustainability, a food system can be considered sustainable when there is equity in the distribution of the economic value-added services, taking into account vulnerable groups categorised by factors like gender, age and ethnicity. Of fundamental importance, food system activities need to contribute to the advancement of socio-cultural outcomes, such as nutrition, health, traditions, labour conditions, and animal welfare. From an environmental or ecological perspective, sustainability can be determined by ensuring that the impacts of food system activities on the surrounding natural environment are neutral or positive, considering factors such as biodiversity, water, soil, animal and plant health, carbon footprint, water footprint, food loss, waste and toxicity. The global food system is widely considered to be a major influence on global environmental change, with associated impacts on the environment, society and economy, including human health and social equity. It is a system which is under pressure to meet the needs of a growing and urbanising global population (Godray et al. 2010). It has been argued that the intersection of economic, social and economic pressures on the global food system demands coordinated action to ensure environmental stewardship and food security (Carlsson et al. 2017). With the interconnected and complex nature of the global food system, respective researchers, within sustainability science, may take a holistic approach and one that accounts for environmental, social and economic dimensions.

Sustainability Challenge in Food Systems

The global food system is a major driver of environmental degradation, contributing to approximately 20–30% of greenhouse gas emissions, significant biodiversity loss, and widespread deforestation (IPCC 2019). This is compounded by inefficient resource use and unequal access, leading to a paradoxical co-existence of undernutrition and obesity worldwide (Tilman and Clark. 2014). The planetary boundaries are often undermined by the current agri-food system, which is focussed on maximising economic productivity, with resulting trade-offs between food production, social, environmental and ecological impacts (Rockström et al. 2023). Efforts to address the sustainability challenge of the global food system has resulted in a landscape of colliding paradigms and trade-offs between food production, and environmental and social impacts (Mausch et al. 2020). It is broadly agreed that the adoption of sustainable practices is important to continue to meet food demand, reduce environmental impacts and generate social improvements such as poverty reduction and human health improvements (IPCC 2019). There is geographically uneven access to nutritious food, with hunger and malnutrition alongside food waste and obesity in other regions (Chong. 2023). Economically, small scale farmers, who produce a significant share of global food, are facing risk from volatile markets and have inadequate support systems which limits their ability to adopt sustainable practices (World Bank, 2020). The interconnections between these challenges create several feedback loops that often exacerbate inequalities (Garnett et al. *Philosophical Transactions of the Royal Society B.* 2013). The global food system often undermines natural cycles in ecological systems, while also being socially unsustainable. Efforts have also been made in designing comprehensive indices that measure our collective progress towards sustainable food systems (IPCC 2019), including innovations towards the UN Sustainable Development Goals (Herrero et al. 2021). This includes an increasing consideration of the social sustainability dimensions of food systems, addressing social challenges in the food system such as food insecurity, health and safety, security and social cohesion (Hani et al. 2003). Within the field of Strategic Sustainable Development (SSD) there is a more precise and strategic definition of sustainability as it relates to the global food system (Carlsson et al. 2017). This previous work has laid solid ground for further strengthening.

Agri-Food System Sustainability in the Swedish Context

As reported by Eriksson (2018, cited in Hansson et al. 2024), Sweden relies heavily on various imports in the agri-food system, such as fruits and vegetables, fossil fuels, synthetic fertilizers,

and protein feedstuffs. Consequently, food consumption in Sweden exerts considerable environmental pressure not only within the country's borders but also on neighbouring countries (Cederberg et al. 2019, as cited in Hansson et al. 2024). As mentioned before, the Swedish society undervalues the food system sustainability, which is why research motivating and accelerating this transformation is highly needed. A study conducted by Eliasson et al. (2022) revealed the perspectives of Swedish food practitioners in relation to the achievement of a sustainable food system in Sweden. The study observed that food producers share concerns about the society's ignorance of the true value of food. The loss of appreciation for food was identified as a contributor to the sustainability challenges in the current Swedish food system. This is mentioned both in national and international contexts. Therefore, policy and incentives need to be strengthened to increase sustainable practices, and to raise the perceived value of food, to make sustainable food systems economically viable.
Aligning with this, Sweden has made good progress in integrating sustainability into the agenda of its national development strategy (Rad and Sonesson 2024). New strategies emphasise sustainable agriculture practices, the reduction of food waste and transitioning to local food systems to meet sustainability targets (Swedish Ministry of Agriculture 2020). Notably, Sweden became one of the first countries globally, to include environmental sustainability perspectives in the official dietary guidelines (FAO 2021; Hansson et al. 2024).

The 2000 m² Concept: A case study for sustainable production and consumption in the Swedish context

2000 m² represents an innovative and educational farming concept, inspired by Associate Professor Artur Granstedt's studies on regenerative farming. The concept seeks to transform how food is being produced and consumed, while respecting the limits of our planet. According to Charminorr on the Recept från 2000 m² website, if all the cultivable land were equitably shared among the global population, everyone would have around 2000 m² of land (Charminorr n.d.; Tortia 2024, 26). This principle forms the foundation of Artur Granstedt's farming concept known as 2000 square meters. There are various 2000 m² projects across the EU (Haerlin and Tao 2020). With only about 2000 m² of arable land per person on Earth, the concept emphasises the need to use this limited space wisely and innovatively to create thriving, sustainable foodscapes for current and future generations. The idea of a 2000 m² cultivation concept for sustainable production and consumption is illustrated through various real-life projects across Europe. In Sweden itself, this concept is put into practice near Stockholm, with three prominent circular gastronomy-focused initiatives. The same concept, as a collaborative case study, is being implemented in Älvsbyn, Norrbotten County, located in Northern Sweden, where focus lays on the everyday food sufficiency of the community and implementation of regenerative elements within the socio-ecological system.

The primary case project for this research, 2000 m² Älvsbyn is managed by a local organisation named Charminorr ekonomisk förening (economic association) and carried out in collaboration with Älvsby Folkhögskola, Skatauddens Lantgård, Stiftelsen Anna Borgeryds minnesfond and Polarbrödsgruppen AB, the third largest bread company in Sweden. The CHARM initiative was launched in the winter of 2021 with the idea of establishing Northern Sweden as a knowledge region for the food of the future, with Älvsbyn as a hub for sustainable food and beverage production. Therefore, in the summer of 2023, a 2000 m² piece of land was readied for cultivation with the help of pigs to supply manure, enriching the soil with nutrients. Various crops such as pasture, oats, peas, colza, flaxseed, beans, tomatoes, squash, and potatoes were cultivated to implement the 2000 m² concept (polarbrod 2024). Based on the principle of growing quality food for all, encompassing equality and nutritious food production within planetary boundaries, 2000 m² highlights the importance of ecological sustainability, resource efficiency, nutrition, and biodiversity conservation as mentioned by Charminorr, on their website (Charminorr n.d).

Role of Sustainability Assessment Tool in Evaluating Farm Sustainability

According to Chopin et al. (2021), many sustainability assessment tools have been proposed by the research community to assess farm sustainability with the objective to support farmers in agricultural management or policy makers by informing them about the anticipated effects of policy implementation (ex-ante) or to assess their consequences after implementation (ex-post). The author further mentioned that within the hierarchical structure of these assessment tools sustainability is broken down into dimensions, which are further broken down into themes, also called sub-dimension or components that represent the main objectives to be achieved by farming systems. The tools then use a broad range of indicators to capture the impact of the farming system on the multiple dimensions of farm sustainability (Chopin et al. 2021). Thus, the sustainability assessment tools play a crucial role to ensure sustainability objectives at farm level. However, Rad and Sonesson (2024), in their study *Drivers of a more sustainable future food system – Lessons from Sweden* argued that there is still no established standardised methodology to assess sustainability in many systems, including food (Chaudhary et al. 2018). The authors have indicated that while various tools have been developed, these primarily exist in form of guidelines, directives, and sustainability assessment tools. They underscored this point by referencing multiple tools/frameworks within agri-food systems and highlighted the diverse limitations associated with them. For instance, they noted that the UN-FAO's Sustainability Assessment of Food and Agriculture Systems (SAFA) Guidelines (2014) constitute a global tool but have limited applicability at the local level. Additionally, they discussed a participatory approach grounded in the Framework for Strategic Sustainable Development (FSSD) by Carlsson et al. (2017), as well as a sustainability assessment framework designed to evaluate the performance of food systems in UK cities (as referenced in Rad and Sonesson 2024). The ideas of sustainability goals are widely recognised; however, several studies have identified critical gaps in their implementation. Decision-makers across the system lack effective tools to assess food systems, guide actions, or evaluate progress (Schneider et al. 2023; Da Silva Vieira et al. 2025; Acs et al. 2025). In line with the perspective put forth by Rad and Sonesson (2024), Acs et al. (2025) also highlighted that there are various proposals and theories of change to monitor food system transition that have been developed by different groups of researchers (Gustafson et al. 2016; Béné et al. 2019; Fanzo et al. 2021; Hebinck et al. 2021). However, these frameworks diverge in terms of perspective, purpose, granularity, what they track and contextualise within broader socio-economic and environmental conditions (Acs et al. 2025). In response, more recently, more tools have been developed to track global food system transformation, such as the Food System Countdown Initiative (FSCI) and the Food Systems Dashboard (FSD) (Schneider et al. 2023). Schneider et al. (2023) in his scholarly article, titled *“The Status of Global Food Systems Approaching 2030”*, discuss the outcomes of the Food Systems Countdown Initiative (FSCI). This initiative, which engaged more than 50 researchers and collaborated with prominent UN entities, including the UN-FAO and World Food Program (WFP), was established to develop an independent tracking and assessment system based on a curated set of indicators covering various aspects of food systems. According to theses researchers, as food systems become more widely under-stood from a systems perspective, the large set of FSCI indicators provides some guidance to consider and archive sustainability objectives.

This research underscores the potential of these metrics in shaping forthcoming international sustainability targets but also draw attention to notable gaps in existing data tracking matrices. The gaps span all themes, for example, for livelihood indicators beyond agriculture, food loss and waste, and governance of food systems. Although there have been some advancements, exemplified by the FSD, an expanded and systematic data collection approach is essential to effectively steer the transformation of food systems (Schneider et al. 2023). According to the FAO (2014), the structure of the food system is dynamic and driven by complex and varied trends such as urbanisation, population growth, climate change and so on. The structure generates incentives for actors and influences their capacities, which ultimately determines their conduct. Actors in the food system are also interdependent on each other and can impact each other's incentives and capacities to act. The overall performance of the food system, measured in terms of sustainability, is the result of the intertwined conduct of all actors in the system. Firms, farms, consumers, for instance, all can have the power to influence food system performance and initiate change. Such performance, in turn, will generate positive and/or negative feedback that influences the conduct of actors and the structure of the system in an evolutionary process (behaviour change within dynamic food systems). Therefore, any initiative to facilitate a self-sustained process of sustainability performance improvement needs to hold a system-systems approach. A systems approach to measuring performance is about assessing the performance of the food system along all sustainability dimensions: economic, social and environmental. This holistic vision allows us to identify potential synergies and to reveal trade-offs between the three dimensions, to ensure that while our targeted impact is positive, the overall impact on the system will also be positive. Practically, this means combining expertise from various relevant areas and different organisations and establishing clear indicators to monitor the impacts on each dimension of sustainability (FAO 2014).

Assessment tools to evaluate and measure farm sustainability are well described in the academic literature. One of many ways to understand the different kinds of assessment tools available is by viewing them on a continuum from rapid to full sustainability assessments (Marchand et al. 2014). Rapid sustainability assessment tools are, for example, self-evaluations done by farmers based on their knowledge (de Olde et al. 2016). Marchand et al. (2014) found that rapid sustainability tools usually require less of a time investment and are characterised as less complex, offering more subjectivity, transparency and greater user-friendliness. On the other side of the continuum, are full sustainability assessment tools. These are characterised as expert-based assessments usually requiring a higher time and money investment. They offer higher complexity and scientifically underpin output accuracy, with lower transparency and user-friendliness. In this way, sustainability assessment tools can play different roles, depending on the goal of the users. The field is advancing rapidly, with a clearer view of the role and type of assessment tools in sustainable food transitions, with many new tools coming on the market. Comprehensive sustainability assessment tools user-friendly and applicable for sustainability assessment of small scale agri-food projects are still lacking.

Frameworks for the Assessment of Sustainability Assessment Tools

There are numerous frameworks to evaluate sustainability assessment tools in the agri-food system. These frameworks include the Multi-Criteria Sustainability Assessment Framework Binder et al. 2010, and Evaluation Framework Schader et al. (2014). These frameworks, alongside the FSSD, have the potential to integrate and emphasise system thinking, transdisciplinary approaches, and participatory perspectives to promote sustainability, but to date, these have never been applied in the agri-food system. The Binder et al. 2010 Framework stresses the importance of systemic, transdisciplinary methods and stakeholder involvement in sustainability assessment tools. The FSSD and Binder et al. 2010 frameworks complement each other and are utilised together in this study to assess sustainability assessment tools at the later stage. Chapter 4 of this report elaborates on how this synergy was utilised and benefitted the study. The following provides a concise overview of both frameworks:

Framework for Strategic Sustainable Development (FSSD)

Many researchers in this field have emphasised the adoption of a unifying framework that will provide a systems perspective and a common scientific definition of sustainability, while support a strategic approach towards sustainable development. Carlsson et al. (2017) suggests that the systems perspective is essential in the context of sustainability challenges, as those issues are complex in nature and solutions typically extend beyond institutional boundaries that require participatory approaches and community level engagement planning. The FSSD as proposed by Robèrt and Broman (2017) presents a systematic method to combine social and ecological sustainability within different complex organisational or systemic settings, including small scale agri-food systems. Embracing this viewpoint could prove as beneficial in the comprehensive assessment and enhancement of tools for integrating sustainability in small scale agri-food projects. It is worth noting that, within the FSSD, the economic dimension is regarded as components of the social dimension. The FSSD approaches social sustainability from a social system's perspective. It defines sustainability as the elimination of systematic degradation mechanisms for essential aspects of both the ecological and social system, explained through Sustainability Principles (SPs) (Missimer, Robèrt, and Broman 2017). These eight SPs for a sustainable society within the biosphere are rooted in scientific knowledge and theories; they include:

In a sustainable society, nature is not subject to systematically increasing…

…concentrations of substances extracted from the Earth's crust (SP1);
…concentrations of substances produced by society (SP2);
…degradation by physical means (SP3);
and people are not subject to structural obstacles to…

…health (SP4).
…influence (SP5).
…competence (SP6).
…impartiality (SP7).
…meaning making (SP 8).

Since the economic system is identified as a part of the social system that people depend on, conditions within the economic system that systematically undermine people's capacity to meet their needs, would fall under the social principles.

The Five-Level-Model (5LM) of the FSSD is a conceptual framework developed to assist in critical analysis and planning in a complex system, which has been adopted in evaluating the available sustainability assessment tools/frameworks suitable for small scale farm performance assessment. The SPs of the FSSD helped to integrate the tools' sustainability objectives within the boundary conditions to ensure that the farm continues to operate and develop desirable outcomes that will help the agri-food system transition towards sustainability.

The Normative, Systemic and Procedural Dimension in the Assessment of Sustainability Assessment Tools

Binder et al. (2010) developed a framework for evaluating sustainability assessment methods by separately analysing their normative, systemic and procedural dimensions based on the suggestion of Wiek and Binder (2005). The approach suggested by Wiek and Binder (2005) fulfils the systemic, normative, and procedural requirements of an appropriate sustainability assessment. It provides a consistent set of targets considering the systemic relations among the indicators, giving stakeholders a concise guideline for sustainable decisions, with awareness of the synergistic and contradictory effects of their decisions. The framework breaks sustainability assessment down into three interconnected dimensions:

Normative dimension: The normative dimension deals with the underlying values and goals of the assessment. It encompasses the sustainability concept being used, the type and goal setting of the assessment. Evaluating tools through this dimension helps to understand their specific sustainability perspective, and the objectives they are designed to achieve.

Systemic dimension: The systemic dimension focuses on how the system under assessment is represented and analysed, including aspects like system representation, considering sufficiency and parsimony, and indicator interaction. It supports the understanding of how a tool handles indicator interaction.

Procedural dimension: The procedural dimension relates to the practical steps and processes involved in conducting the assessment. It includes the preparatory/setup phase, which involves defining the user group, contextualisation, stakeholder involvement, and scale. It also covers the steps of indicator selection, measurement, and the assessment itself, followed by application and reporting. Evaluating tools based on their procedural aspects highlights their usability, participatory nature (e.g., stakeholder involvement and participation), and provides clarity of their methodology at all stages.

This three-dimension framework enables a detailed and multifaceted understanding of each tool's characteristics, which allow for a comprehensive evaluation, structured comparison, and supports identification of tool-specific strengths and weaknesses. Further, by revealing the characteristics of tools across these dimensions, the framework supports users in selecting the most appropriate tool for their specific context and goals (Binder et al. 2010)

Relevance of Sustainability Assessment Tools

To address these multifaceted challenges, the relevance of tools and approaches for defining and assessing sustainability within the food system is clear. Currently, there is no internationally accepted benchmark defining sustainable food production that sets clear criteria for what qualifies as a *"sustainable"* or *"unsustainable"* food system. However, there are numerous frameworks, initiatives and indicators for assessing environmental and social impacts of food systems (FAO 2014). These varied tools help track progress towards sustainability, particularly within local food systems. Despite the absence of standardised methodologies, there are relevant tools for monitoring the success of food systems (Chaudhary et al. 2018). By integrating systems thinking, participatory approach and context-specific indicators, these tools may help to bridge the gap between concepts and local implementation of sustainability at farm level (Carlsson et al. 2017).

Binder et al. 2010, in the study titled "*Considering the normative, systemic and procedural dimensions in indicator-based sustainability assessments in agriculture*" argue that indicator-based sustainability agriculture assessment tools predominantly focus on environmental and technical issues, with shortcomings in the social and economic sustainability dimensions. Assessing seven sustainability assessment tools in their study, the authors found trade-offs between different tools depending on whether they follow a 'top-down' farm assessment method, 'top-down' regional assessment method or 'bottom-up' transdisciplinary method, with stakeholder participation incorporated in the process. It is pointed that 'top-down' sustainability assessment tools may offer the advantage of easier comparison and benchmarking, however, the application and implementation of findings may be a limitation. Their analysis suggests that sustainability assessments which include all sustainability dimensions, integrate participatory or transdisciplinary methods, and support a 'bottom-up' approach, are the most suitable ones.

Challenges in Existing Sustainability Assessment Tools for the Agri-food System

The challenge is two-fold: First, despite valuable efforts to make these tools accurate and manageable in the agri-food system, no internationally accepted benchmark clearly defines what sustainable food production entails, nor is there a widely accepted definition of the minimum requirements for a system to qualify as *"sustainable"* (FAO 2014).

- Sustainability assessment tool in agriculture often relies on indicators that prioritise environmental aspects over economic and social sustainability. They fail to address the interconnections and trade-offs between the various elements of complex agri-food systems (Binder et al. 2010). The holistic vision inherent in the definition of sustainability creates many difficulties when applied to systems with an elevated complexity. For this reason, various tools consider different methods of assessments, which often tend to only concentrate on one or two dimensions, such as environmental protection and economic sustainability, with less often themes on social acceptance (Peano et al. 2015).
- Additionally, there may be a lack of integration and multi-stakeholder engagement when using the tools in practice. Many tools fail to incorporate participatory methods that engage diverse stakeholder groups, such as farmers, consumers, policymakers etc. This can lead to a lack of trust, relevance and buy-in from actors for sustainability initiatives, particularly in small scale and community-based projects (Binder et al. 2010; Rad and Sonesson 2024).
- Regarding the practical application of frameworks and assessment tools; frameworks like the FSSD promote systems thinking, their practical implementation often requires specialised expertise. This can be a barrier for small scale agri-food projects that lack resources for ongoing technical support and training (Carlsson et al. 2017). There may be a gap between high level sustainability assessment tools and those which can be applied in practice, at a local level, with existing resources and practical economic and social barriers.
- Possible tensions between goals and findings of assessment tools are being mentioned. A Danish study looking at the adoption of tools in practice, and the perceived relevance of the Response-Inducing Sustainability Evaluation (RISE) tool for farmers across 37 organic farms, highlighted the opportunity for tools to present a starting point for discussion at the farm-level and to foster learning about sustainability (de Olde *et al.* 2016). However, combining monitoring and learning functions at the farm-level may lead to tensions as identified by Marchand et al. (2014).

A disconnect between local perspectives and global and local culturally diverse contexts has been identified, as sustainability assessment tools designed with a global perspective can limit the effectiveness in addressing specific local contexts. For instance, socio-cultural nuances and traditional practices, such as those in indigenous Sámi circles and communities, may not align with standardised frameworks (FAO 2014; Kastner, 2024).

To summarise, sustainability assessment tools play a crucial role in the transition of food systems towards sustainability. Despite the wide array of tools available for assessing the sustainability of food systems, the literature on the subject suggests that existing tools have limitations stemming from systemic, normative, and procedural perspectives. Leading international organisations such as the UN bodies and the FAO, as well as reputable researchers, strongly advocate for the development of assessment tools that embrace transdisciplinary, participatory, and systemic thinking approaches, engaging stakeholders throughout the tool design process and in the implementation phase to ensure their optimal applicability. The existing system is progressively adapting to integrate these principles into sustainability assessment tools for the agri-food and farming sectors.

2. Background of Fields

Food Systems Transformation Towards Sustainability: Diverse perspectives

The transformation of food systems toward sustainability is a complex and multidimensional process that bridges disciplines and perspectives. Within the field of sustainability research, a wide range of terminologies and evaluative frameworks are used to describe and assess agri-food projects. These differences are shaped by local contexts and are communicated in different languages. For example, In Sweden, small farms are commonly referred to as *"gård"* or *"mikrogård"*. In France, the term *"microfarm"* is more frequently used. A recent research report titled *"Transformations Towards Sustainable Food Systems: Contrasting Swedish Practitioner Perspectives with the European Commission's Farm to Fork Strategy"* explores the alignment between the European Union's (EU) Farm to Fork Strategy and the views of Swedish food system practitioners. The study highlights that pathways toward sustainable food systems are *"diverse, contested, and context-dependent"*, emphasising the need for these complexities to be better reflected in policy development. This insight resonates with ongoing academic debates about the role of local food systems in sustainability transitions (Carlsson et al. 2017). The EU's Farm to Fork Strategy aims to address sustainability goals by promoting shorter supply chains and supporting local food systems as part of its ambition to meet the UN SDGs by 2030 and make Europe the first climate-neutral continent by 2050.

What is a small scale agri-food project in this study context?

A 'small scale agri-food project' within this study aligns with the definition by FAO (2023) as small holder or small-scale farming over areas varying from less than one hectare to 10 hectares, which 2000 m² falls within. There are many small scale agri-food projects and smallholder farmers seeking to monitor and communicate positive sustainability outcomes across the world. According to the FAO (2023), agri-food systems are all the interconnected activities and actors involved in getting food from the field to the table. This involves everything, from agricultural production and processing, to distribution, consumption, and waste management.

What is sustainability in our study context?

Agri-food systems and sustainability encompass diverse and multidisciplinary areas of research that addresses the environmental, social, and economic challenges arising from the ways food is produced, processed, distributed, and consumed. As such, agri-food and food systems can be recognised as socio-ecological systems, involving the complex and dynamic interactions and relations between human and natural components (Robèrt et al. 2021). Sustainability in food systems is commonly assessed across several dimensions: environmental, economic, social and political (El Bilali, Strassner, and Ben Hassen 2021, 2), including nutrition, food availability and affordability, socio-cultural well-being, resilience, food security, and waste and loss reduction (Gustafson et al. 2016, 3; Chaudhury 2018, 2). Further, the concepts of nutrition and food security link to understandings of sustainable food systems and generating food security for future generations (Global Panel on Agriculture and Food Systems for Nutrition 2020).

Sustainability, as understood through the strategic sustainable development lens implies a transition with economically viable steps towards ecological and social sustainability (Carlsson et al. 2017). Sustainability can be understood as a 'non-compensatory measure' meaning that if any of the components of ecological, social and economic sustainability is not ensured, then the system cannot be described as fully sustainable (Zahm et al. 2008). This links to the popularised concept of the win-win of the 'triple bottom line' in sustainability. However, the triple bottom line has been recalled by John Elkington in 2018 after first introducing the concept in 1994, on the basis that *"none of these sustainability frameworks will be enough, as long as they lack the suitable pace and scale and the necessary radical intent needed to stop us all overshooting our planetary boundaries"*. What he argues we need now, is systemic change (Elkington 2018).

Within the academic field of sustainability and sustainable development the economic, social and ecological dimensions or sub-systems of sustainability have been represented in different ways within the literature, particularly in relation to agri-business and economics. In this thesis the team chose to embrace the nested dimensions or systems model, where the economy sub-system is nested within the social sub-system, within the ecological system (Purvis et al. 2019) or biosphere, which is consistent with the understanding of the economy, holding an integral role in human activities and decision, as described within the FSSD (Carlsson et al. 2017). This contrasts with the notion of the three pillars of sustainability or concentric circles representation (Purvis et al. 2019), which may be a more popular understanding of sustainability as it relates to the food system and economic sustainability. It is important to note that within the wider discourse, there are many different interpretations and concepts used to communicate sustainable or regenerative food systems within the idea of the nested model. For example, economic sustainability can be understood through the orienting metaphor of a doughnut (Wahland et al. 2022), as proposed by Kate Raworth in Doughnut Economics (2018). Here, the economic dimension is understood to be nested within the social and ecological system, with all economic activity taking place in the *"safe and just space for humanity"* (Raworth, 2018).

Within the field of food systems sustainability, frameworks such as the SAFA Guidelines, Social-Ecological System (SES) Framework, SAEMETH Framework, and others provide structured approaches to measure and guide sustainability efforts (Peano et al. 2015; FAO 2014). Additionally, the TAPE (Tool for Agroecology Performance Evaluation), developed by the UN-FAO is another systems-oriented sustainability assessment tool. TAPE encompasses components including environmental, economic, social and cultural dimensions, covering health, nutrition and governance. Agroecology is an alternative and systemic approach that builds on local and ecological knowledge (HLPE 2019; Mottet et al. 2020). Within this broader context, the researchers for this case study analysis define sustainability according to the definition based on the FSSD (Missimer, Robèrt and Broman, 2017). Within the food systems sustainability field, the FSSD is described as well tested and used by scholars and practitioners to frame complex, multi-scalar, and *"real-world"* challenges (Carlsson et al. 2017). The FSSD is a sustainability assessment methodology that aligns with systems thinking, combining ecological, social, and economic dimensions, and considering feedback loops, interconnections, and impacts. It was chosen because the framework is strategic, systemic and systematic as well as metaphorically strong and flexible to adapt to different contexts. The FSSD takes a transdisciplinary approach, bridges theory and theoretical concepts, with practice and practical tools.

What defines a 'useful' sustainability assessment tool?

There are different ways to consider the usefulness of sustainability assessment tools, considering factors including (but not limited to): usability, accessibility, functionality, user-friendliness and cost effectiveness. It is assumed that some assessment methods may be more useful than others, depending on project scale, context and the various definitions of success by those who are interested in understanding progression towards sustainability outcomes.

Through the Binder et al. (2010) review of seven different assessment tools, it was found that bottom-up, integrated participatory or transdisciplinary methods with stakeholder participation throughout the process are the most suitable for sustainability assessment in the agricultural field.

The researchers have chosen to interpret ‘usefulness’ conceptually in terms of the definition of social and ecological sustainability within the normative FSSD (Missimer, Robèrt and Broman 2017). The researchers have also considered useful in a subjective and applied sense, drawing upon both the qualitative experience of consultants and experts in food sustainability assessment tools and through the applied case study context of the ‘small scale agri-food project’ called 2000 m² in Northern Sweden. This research seeks to build upon the understandings of patterns in the most useful themes, sub-themes and monitoring indicators of sustainability, in a way that aims to be more comparable across different sustainability assessment tools in the agri-food system. This positions the research as part of a growing contribution on a global and national scale to food system sustainability, factoring in the well-understood need to support communities in ‘speaking for themselves’ at a local scale (Carlsson et al. 2017), building from the ‘bottom-up’ with attention to local context and diversity. According to the Cambridge definition of the word ‘useful’ means *“helping you to do or obtain something”* (Cambridge Dictionary, n.d.). Embracing this definition of ‘useful’, and what has been stated above, this study defines a useful sustainability assessment tool as one that also practically helps the small scale agri-food system to make a transition towards sustainability. In alignment with the FSSD conceptually, such tools should also be useful in practice: easily accessible to farmers, demonstrate cost-effectiveness, possess user-friendly attributes, and yield sustainability assessment outcomes that are easily understandable by farmers.

Problem Statement

In essence, tools for evaluating sustainability play a critical role in steering the transformation of food systems towards sustainability. While the number of available sustainability assessment tools is growing, not all of them incorporate interdisciplinary, participatory approaches, and a systemic view for evaluating sustainability holistically on the farm level. Some tools may offer this perspective, yet no single tool likely fits all situations. Therefore, the quest of this study is to find out the most useful tools tailored for small scale agri-food contexts, with particular focus on 2000 m² case studies in two locations Älvsbyn and Stockholm (Sweden), that aim to bring transformation in the agri-food system by design. This curiosity has been expressed in the research questions and sub-questions.

2.1 Purpose of the Study

The purpose of this study is to find out the most useful sustainability assessment tools for small scale agri-food projects at the farm level. This is done by first identifying the key dimensions, themes and indicators required to track farms’ progress towards sustainability in the agri-food system; then to use this understanding to find out the most useful sustainability assessment tools for small scale agri-food projects such as 2000 m² in Älvsbyn and Stockholm, Sweden. With the same purpose in mind, a primary research question with three sub-questions has been defined.

2.2 Research Questions

Based on the identified gaps in the present literature, linked to the case studies of 2000 m² in Sweden, the research adapts and explores the following questions.

Main Research Question:

RQ: What are the most useful assessment tools for small scale agri-food project alignment towards sustainability?

Sub Research Questions:

SRQ 01: What are sustainability assessment tools available for evaluating small scale agri-food projects through a systems thinking approach?
SRQ 02: What are the essential components of sustainability assessment tools for evaluating small scale agri-food projects?
SRQ 03: What is the usefulness in practice of the reviewed sustainability assessment tools?

2.3 Research Scope

This study aims to identify the most useful sustainability assessment tool for evaluating the alignment of small scale agri-food projects towards sustainability, with a specific focus on the 2000 m² concept and projects. The scope is limited to small scale farms, or agri-food projects, operating in agro-climatic zones like the ones in Stockholm and Northern Sweden. The study specifically explores indicator-based sustainability assessment tools out of plethora of the tools/method and processes to assess sustainability. Frameworks that are theoretically sound but lack defined indicators for measuring sustainability performance have been excluded from this study. Also, niche or proprietary tools that may be used in the field but are not published in peer-reviewed literature were also excluded from the analysis. The tools reviewed in this study are primarily guided by either the triple bottom line approach (addressing environmental, social, and economic dimensions) or principle-based approaches. While the approach was not a strict inclusion criterion, the presence of clear indicators covering at least these widely accepted three dimensions of sustainability was a necessary requirement for the tool selection. The research topic was proposed by stakeholders of the Charminorr ekonomisk förening and put forward by the MSLS department in 2023. It is with this research, that the topic has been chosen and conceptualised by a student team of the 2025 cohort. In contact with stakeholders in Älvsbyn and Stockholm, the research has been designed in support of the 2000 m² concept theorised by Associate Professor Artur Granstedt. Critical analysis of the 2000 m² concept itself was not part of the research scope.

Key Audience

The primary target audience for this research comprised the stakeholders and farmers participating in 2000 m² in Älvsbyn and Stockholm. Nevertheless, the conclusions drawn from this study are also applicable to a wider audience. This includes stakeholders of other 2000 m² projects in Sweden and throughout Europe, scholars and practitioners specialising in sustainability assessment methods for agri-food projects both in more general contexts and specifically focusing on small scale endeavours. Findings may also be relevant to researchers and institutions committed to enhancing sustainability assessment methodologies, concepts, tools, and frameworks in this field.

The assessment of the selected five tools: Sustainability Monitoring and Assessment RouTine (SMART), Response-Inducing Sustainability Evaluation (RISE), Sustainability Assessment of Farming and Environment (SAFE), Sustainable Agri-Food Evaluation Methodology (SAEMETH), and LiteFarm through the FSSD lens, could be especially valuable to entities like the Research Institute of Organic Agriculture / Forschungsinstitut für Biologischen Landbau (FiBL), the Bern University of Applied Sciences / Berner Fachhochschule (BFH), the FAO, various academic departments, and other parties engaged in the development of these tools. The adoption of the FSSD approach coupled with Binder et al. 2010 unveils fresh perspectives that can aid in refining the available sustainability assessment tools gradually.

Stakeholders

With focus on 2000 m², the research draws on the ideas and experiences of the two Swedish case studies in Älvsbyn (2023) and Stockholm (2018-2021). While the former is still in practice until 2026, the latter is closed, potentially on pause. In communication with both project initiators and managers, the team sought valuable insights in support of the research. Therefore, two case specific stakeholder maps of the 2000 m² projects have been created and attached (see Appendix L). Key stakeholders' names have been included and colour coded in relation to their participation in the primary research.

The first stakeholder map provides an overview of the project execution under the umbrella of the Charm Initiative (2021) in Älvsbyn, Sweden. Realised with support of the Charm Fabriken, on the ground of the BeSt Lantbruk Nybyn, in collaboration with the Polarbrödsgruppen AB, Älvsby Folkhögskola, and Skatauddens Lantgård, the project is co-financed and owned by the Älvsbyn municipality. In relation to the 2000 m² case study, project North Table, in cooperation with the Kreativ Industriell Symbios (KIS), highlights a past community project.

The second stakeholder map offers an overview of the project execution in the Rosendals Trädgård in Stockholm, Sweden. In support of the transitioning towards sustainable foodscapes, following the 2000 m² concept, a collaboration of stakeholders explored a new food culture. The project has therefore been recognised and publicised by the Circular Gastronomy, in the form of network cooperation and support. Studio 2000 was the follow-up project co-creation of a living rural city kitchen experiment. Arkadien is the most recent vision project integrating and acting on learnings from the past. BERAS International is the central research foundation promoting all efforts on sustainable food systems.

3. Methodology

This chapter expands on the methodological approach adopted to conduct the research, which is chronologically described in the following section. After the research approach, which presents the research design and phases; the research methods, together with their rationale of use are outlined. Followed by the analytical framework of the data analysis, integration and evaluation (Figure 3.1); throughout the chapter, research processes have been described through visuals and text.

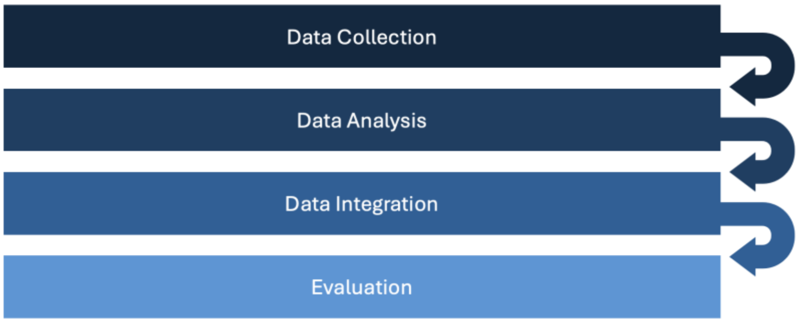

Figure 3. 1 Four research steps.

3.1 Research Approach

To conduct the research and retrieve relevant data that supports the research quest, the research approach and design is in line with the study scope.

Research Design

Research designs are plans and procedures for research that span the decision from broad assumptions to detailed methods of data collection and analysis (Creswell and Clark 2017). It is an integral part of the research process which can help avoid the situation in which the evidence does not address the initial research questions (Yin 2003). In this research, four main components were considered: research questions, data collection methods, data analysis techniques, and validity. The design used in the context of this study is a qualitative research design with a combination of multiple qualitative data collection methods in each phase of this study. The following methods have been chosen for data collection: desktop review followed by in-depth content analysis, expert interviews and Focus Group Discussions (FGDs). In designing this research, careful attention was given to ensuring the validity of information at every stage. A particular concern was the potential for researcher bias during the content analysis of each tool, which could affect the credibility of the findings. So, this information needed to be weighed to eliminate fictitious or false statements as well as personal opinions and biases of both the information supplier and recipient (Stake 1995). This triangulation of methods helped to cross-verify data and strengthen the overall reliability of the results, compensating for potential weaknesses in individual approaches (Golafshani 2003).

Research Phases

This research was conducted with a two-phase approach, to collect both secondary and primary data (Figure 3.2). Information was retrieved from present literature and practical experiences from the field. The research design therefore supported the connection and translation of theory and practice.

Phase 1: The first research phase encompasses the background study, finding out existing agri-assessment tools and selecting five out of the 40 reviewed tools, based on the criteria inspired by de Olde et al. 2016. Then, the five selected tools were reviewed from a 5LM view through the FSSD lens, which provided through level-questions a generic structure to categorise complex issues. The tools were evaluated according to its systems, success, strategic guidelines and action structures, to assess the tool in relation to its strategy to move towards its vision.

Phase 2: In the second research phase, the experts of the selected five tools (i.e. SMART, RISE, SAFE, SAEMETH & LiteFarm) were interviewed to gather their diverse perspectives. Post interviews, data analysis was conducted. In parallel, two Focus Group Discussions (FGDs) were set up and hosted, online, with practitioners of 2000 m² from both case study locations. Stakeholder consultation was chosen to gain an in-depth understanding of the perceptions on the practical usefulness of the assessment tools in context of the 2000 m² concept.

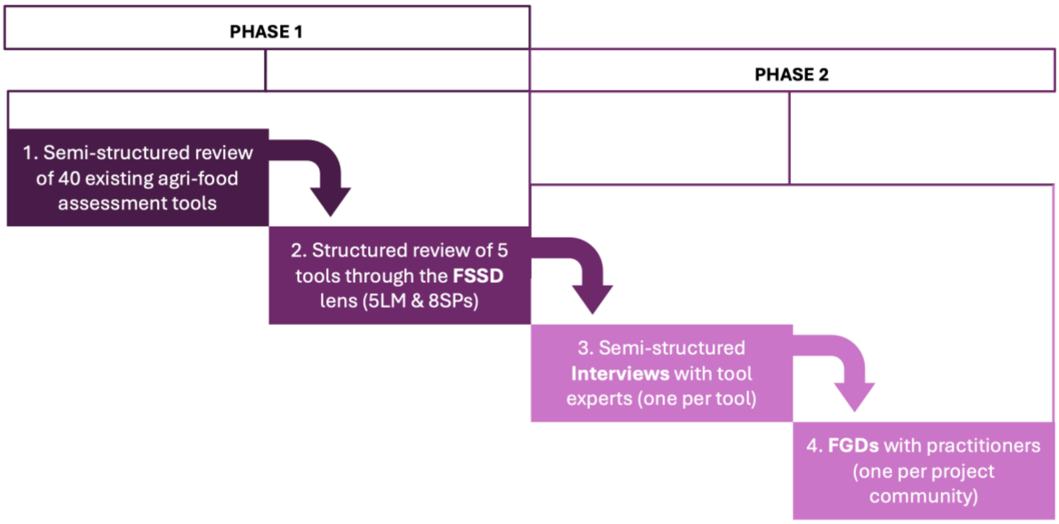

Figure 3. 2 Two research phases.

3.2 Research Methods

As mentioned above, the following methods have been adopted for qualitative data collection for this thesis.

- Semi-structured literature review (also referred to as desktop research)
- Structured review process through the FSSD lens (in form of a detailed content analysis)
- Semi-structured interviews with tool experts (one per tool)

- Focus Group Discussion (FGD) with practitioners (one per project community, two FGDs in total)

A semi-structured literature review, followed by a structured review process enabled detailed tool content analyses; combined with semi-structured expert interviews. With a pre-set of open-ended questions, space for topic deviation and further exploration was embraced. FGDs with practitioners focused on hosting dialogues on experiences and practices from the field. The combination of these above-mentioned techniques not only enabled a deeper exploration of the topic and tools but also maintained balance of consistency and flexibility. With the use of these qualitative research methods, parts of the research design informed and (re)shaped each other, based on the changing needs of the research.

Semi-structured Review

The objective of the literature review was to gather existing sustainability assessment tools for agri-food projects, find out criteria for evaluating their degree of usefulness, develop a systemic understanding of those tools, and find out a suitable framework to interpret this data. For this purpose, a semi-structured literature review was used which allowed a flexible review of the existing literature, using a set of themes while allowing for the inclusion of emergent insights (Snyder 2019). The study reviewed various sustainability assessment tools for the agri-food system, developed and put forth by international development organisations, like the UN-FAO, academic institutions, researchers and practitioners. This included information from relevant materials, such as peer-reviewed journal articles, user tool manuals, grey literature (e.g., reports and policy documents), and other academic and practical documents. These were primarily gathered from online archives, such as: the BTH Library, Scopus, ScienceDirect, SpringerLink and Google Scholar. Some of the most relevant review and scientific literatures (Alaoui et al. 2022; Berbec et al. 2018; Binder et al. 2010; Curran et al. 2020; de Olde et al. 2016; Marchand et al. 2014; Peano et al. 2015; Schader et al. 2016; Sottile et al. 2016; Talukder and Blay-Palmer 2017; Van Cauwenbergh et al. 2007; Wohlers et al. 2021) were identified through a snowball method of a literature survey (Wohlin et al. 2020). The main keywords for finding the research literature included Sustainability# AND Food System# and Sustainability# AND Tool# AND small scale agri#. In addition, several other literatures were identified through mixed data sources. This whole process resulted in a comprehensive list of 40 relevant tools (Appendix N). Further, adhering to robust selection criteria, inspired by de Olde et al. 2016, five tools from the list of 40 were identified for detailed content analysis (discussed in detail in the following section). Selection Criteria were:

1. Only tools specifically designed to assess farm-level sustainability performance through an indicator-based assessment approach were considered in this research.
2. Only tools developed with a system's thinking perspective and participatory methods were considered.
3. To ensure scientific rigour, the tool must be published in a peer-reviewed scientific journal and/or peer-reviewed scientific report. The publication must be written by the tool developers and focus on the tool. Thereby, tools that are only mentioned in reviews, without any other scientific publication, are excluded.
4. The tool should be available in English/Swedish.
5. It must be focused on at least three dimensions of sustainability, defined in our research through environmental, social, and economic sustainability indicators.

6. The tool must be suitable for the Northern-West European context, and projects like 2000 m².

Based on the criteria five tools were identified, those were:

1. Sustainability Monitoring and Assessment RouTine (SMART) Farm Tool (referred to as SMART or SMART Farm)
2. Response-Inducing Sustainability Evaluation (RISE) Version 3.0
3. Sustainability Assessment of Farming and the Environment (SAFE) Framework
4. Sustainable Agri-Food Evaluation Methodology (SAEMETH) Framework
5. LiteFarm

Content Analysis

The objective of the qualitative content analysis method was to gain a deeper understanding of the five selected tools, and to compare and contrast them to find out the most useful tools in context of this case research. Qualitative content analysis is a research method for the subjective interpretation of the content of text data through the systematic classification process of coding and identifying themes or patterns (Hsieh and Shannon 2005). A deductive content analysis, which is often known as a directed content analysis method was applied, with the FSSD as a theoretical framework to pre-define themes and guiding questions for data collection from the source used, as informed by Hsieh and Shannon (2005). Sources analysed included peer-reviewed journal articles, user tool manuals, review papers, and official websites of the tool developing organisations. Data was collected and analysed using ten pre-formulated questions aligned with the FSSD's 5LM elements, combining the framework of Binder et al. 2010. The final questions were formulated carefully to cover all the inter-related levels i.e. system, success, strategic guidelines, action and tool level. The guiding questions are included and attached as part of the research tool template (Appendix A).

Expert Interviews

The purpose of the expert interviews was to gather the expert's in-depth insights and specialised knowledge on the tools' design and application through a semi-structured interview guide with open-ended questions that allow for a flexible, nuanced emergence and exploration (Maggi Savin-Baden and Claire Howell Major 2023). The qualitative data from expert interview helped to refine the tools assessment conducted through the content analysis methods as part of research phase one. Even though the research team was familiar with the tools, prior to developing the interview schedule; a semi-structured interview method was chosen because of a data lack of user experiences, and only little information on its real-world use, especially by farmers themselves. Also, many of the tools reviewed are periodically updated, based on new field studies and experiences. Thus, it was anticipated that experts would offer detailed insights on the tool's practical use and implementation.

Sampling: The discussion of sampling in qualitative research revolves around non-probability sampling. This type of sampling essentially has to do with the selection of units, with direct reference to the research questions being asked (Bryman 2012). For the expert interviews, purposive sampling, also known as selective sampling, was chosen. Hence, participants who are especially knowledgeable or experienced with the selected tools were contacted (Savin-Baden and Major 2023). The researchers curated a list of 25 tool experts from peer-reviewed journal/or websites, to then purposefully invite them for a 40-minute online interview via the video-conferencing platform Microsoft (MS) Teams; 8 from SMART, 5 from SAEMETH, 5 from RISE, 4 from SAFE, and 2 from LiteFarm were emailed with the aim to interview one expert per tool. In total, five interviews were planned; however, the team couldn't secure an interview, alternatively interview survey response for SAEMETH. Therefore, the total number of interviews conducted was four, instead of the originally prepared five expert interviews. The interviewed experts are professionals, with most of them being involved in, and responsible for the development, implementation, or control of the respective tool.

Focus Group Discussions

To address the third research questions, two Focus Group Discussions (FGDs) were hosted, online, with practitioners of 2000 m² from both case study locations (Älvsbyn and Stockholm). They offered an in-depth understanding of diverse stakeholder perspectives and perceptions on the practical usefulness of the assessment tools, in context of 2000 m² and their experiences working in the agri-food system. The FGDs were ideal for understanding and seeking the practitioners' consensus on the tools' usefulness in practice, rather than relying on individual meaning making alone. Also, Creswell and Clark (2017) suggests that FGDs likely yield the best results when the interviewees are similar, cooperative, and when the time to collect data is limited, which was the case for this research.

Sampling: Participants were selected through a combination of two non-probability sampling methods: purposive and snowball sampling, to ensure the participants' practical experience with the 2000 m² concept. A snowball sampling technique was especially used when it was difficult to reach potential participants (Patton 2002). In total the research team contacted 12 stakeholders (5 connected to the case study in Älvsbyn and 7 linked to the project initiatives in Stockholm), of which 7 confirmed their participation. The FGD with the community in Älvsbyn, in the North of Sweden, hosted 4 key stakeholders of recent 2000 m² project experimentation. The FGD with the community around Stockholm, in the West of Sweden, hosted 3 key stakeholders of paused and new 2000 m² project initiatives. Each discussion lasted approximately 90 minutes and was facilitated using a semi-structured guide to allow flexibility while maintaining focus on key research areas. The online hosting methods were guided by participatory methods with support from an experienced workshop host and practitioner in the Art of Hosting (AoH), to facilitate a group discussion where all participants felt welcomed to speak.

3.3 Data Analysis

For the data analysis of this research, the FSSD lens coupled with the Binder et al. 2010 framework were used for the first two sub-research questions. For the third sub-research question, the inductively retrieved content from the expert interviews and FGDs was used.

FSSD Lens Review with Elements of the Framework from Binder et al. 2010

As mentioned previously, for the detailed content analysis of the selected tools, 10 questions were developed using the 5LM of the FSSD, which were combined with elements of the framework from Binder et al. 2010. A research tool template consisting of 10 questions, provided guidance for the content analysis of the five selected tools, allowing the team to explicitly derive research relevant information. The review also facilitated a clear analysis of, both the distinctions and inter-relationships between the different elements, under various layers. Carlsson et al. (2017) proposed that the FSSD could provide a rigorous approach to integrate social and ecological sustainability in small scale agri-food projects. Therefore, the selected five tools were thoroughly evaluated through the FSSD to find out the essential components and indicators encompassing a systemic, transdisciplinary, and participatory view of sustainability assessment tools for evaluating small scale agri-food projects. Some of the questions for the evaluation of tools were inspired by Binder et al. 2010 by considering the normative, systemic and procedural dimensions in indicator-based sustainability assessment in the agri-food system. A normative, systemic and procedural aspect analyses provide a more comprehensive insight into the tools, as argued by de Olde et al. (2016). In the normative aspects, the sustainability concept, goal, scoring method and tool functions are described (Marchand et al. 2014). A normative level helps to make sustainability efforts more locally relevant and aligned with the needs of stakeholders, which the FSSD's broader, high-level vision may not always fully incorporate. The systemic aspects address the ability of the tool to translate the complexity of a system (Binder et al. 2010). The procedural aspects include, amongst other aspects: user-friendliness, data availability and effectiveness (de Olde et al. 2016). The procedural dimension emphasises stakeholder engagement and process transparency. The indicator-based framework stresses the importance of involving key stakeholders throughout the sustainability assessment process, ensuring that their perspectives are integrated into both goal setting and decision-making. This approach fosters a stronger sense of co-ownership and accountability, which the FSSD does not explicitly focus on. For the guiding questions along the 5LM (as adopted from de Olde et al. 2016), refer to Appendix P. The synergy between those two frameworks aims to ensure that the tools' sustainability assessment is both measurable and aligned with long-term goals, facilitating adaptive, goal-oriented decision-making across different sectors and levels of governance. An example of the applied research tool review that guided the content analysis is attached under Appendix O.

Comparison of the Thematic Sustainability Objectives of the Selected Tools with Regards to the 8 Sustainability Principles

The selected assessment tools are also compared with respect to their sustainability objectives in the major thematic areas, under the ecological, social and economic dimensions, inspired by the methods used by Alaoui et al. (2022). Each theme is connected with its sustainability objectives, assigned indicators and monitoring parameters. The themes and indicators play a central role in defining and operationalising the sustainability assessment of specific tools. Besides guiding the tool's application, it ultimately gave answers on how well the tool supports system and strategic thinking towards sustainable agriculture. The comparison of sustainability objectives of the key thematic areas across the five selected tools, allowed with the use of the SPs, outlined in the FSSD, an insightful deeper understanding of their strategic relevance and limitations. It also underscored the importance of integrating both ecological thresholds and social foundations within the selected sustainability assessment tools. In the tables under the result chapter, the summary objectives are linked with the SPs (Appendix P), which helps to visualise the mis/alignment of indicators corresponding to the selected frameworks.

Applied Techniques for Data Collection

The dimensions, themes, sustainability objectives, and monitoring indicators of all five tools (SMART, RISE, SAFE, SAEMETH and LiteFarm) were systematically extracted and organised into an excel file. This was done for each sustainability dimension independently, to enable a detailed comparison and contrast of what each tool measures. Subsequently, the identified monitoring indicators were mapped against the SPs, with SP 1 to SP 3 covering the ecological dimension, and SP 4 to SP 8 addressing the social dimension. The mapping aimed at assessing the extent to which the tools' monitoring indicators align with the sustainability objectives as defined by the FSSD, which serves as both the conceptual and analytical framework for this study. The outcome of this process directly addressed the second research sub-question as presented in the results chapter. The analysis provided insights into what, and how comprehensively each tool captures a holistic understanding of sustainability at the farm level, to find out the most useful tool for the 2000 m^2 concept.

The technique used for deriving research relevant findings from the expert interviews and FGDs was inspired by a thematical and selective coding method. Each interview and group discussion transcript was coded based on thematic patterns, supporting the answering of the three research sub-questions. It was with a question focused and selective approach that complementary data enriched the research findings. After the semi-systematic review and content analysis of existing tools, the participatory consultation with stakeholders supported and elaborated on the research analysis.

3.4 Data Integration

To integrate the retrieved data from different sources and outlined findings, internal and external consultations supported the process.

Internal Consultation

Internal brainstorm meetings with all four researchers present helped in the exploration and alignment of research relevant questions. On a regular basis, first weekly, later daily calls facilitated remote co-working and continuous exchange. It was via MS Teams, that the international student team came together online. Aside from routine meetings with AoH practices, the team communicated via the Meta social messenger service WhatsApp.

Internal consultation with the research primary advisor took place in form of in-person, on Campus, or offline meetings. With the available amount of 40 hours, the team consulted the advisor's feedback gradually throughout the 5-month research period. In the writing process of the dissertation, excerpts were shared, reviewed and returned via email communication. Thus, several feedback loops provided suggestions and guidance. The secondary advisor offered time for open questions and workshop consultation.

External Consultation

External consultation with two renowned researchers of their fields shaped the research design and analysis. It was through regular advisory meetings that the research approach and process has been constantly adapted to the ever-changing food research landscape. In conversation with the two experts, familiar with the FSSD, additional resources and references have been shared mutually. It was hence through extra feedback rounds that the research benefitted from strategic networking.

3.5 Evaluation

To evaluate findings and draw on results, the team aimed at a high degree of reliability and validity throughout the whole research process. Data security and privacy were approached and respected, accordingly.

Reliability and Validity

To ensure research **reliability**, hence consistency and replicability, possible random errors were minimised through careful attention to the execution of data collection and analysis. It was through a purposively chosen two phase research design, incorporating four data collection techniques that the obtained data enriched and complemented research findings. All four researchers were involved in all four methods, including their ongoing revision. All steps of the data analysis and integration involved at least two researchers, while the entire team monitored the process. Hence, a detailed documentation accompanied the whole research. The team therefore relied on personal and collective notetaking, while also recorded team and advisory meetings. Throughout the study, the team remained explorative and open for divergence. Research transparency was increased by welcoming questions, comments, and references, at any time.

To assure research **validity**, hence accuracy and trustworthiness, possible systematic errors were minimised through careful attention to the preparation of data collection and analysis. The team therefore consulted its primary and secondary advisors, while also strengthened validation through peer-evaluation during workshops and process presentations. Thus, to answer the main and sub-research questions, methods were aligned for the purpose of the study. Data, methodological, and researcher triangulation strengthened the research threefold. Through the incorporation of the FSSD, a new research tool was developed for the purpose of this study (Appendix A). Research participants were elected based on their expertise of the reviewed assessment tools and connection to the 2000 m^2 case studies in Sweden. All respondents were familiarised with the research topic and set-up. To strengthen coherency, both the Interview Protocol (Appendix D and E) and FGD Guide (Appendix I) were composed accordingly. During the participatory methods of data collection, different probing techniques were used to facilitate a trustful knowledge exchange, after which a follow-up survey was sent (Appendix K). At the end, all respondents were given the option to receive and review their data, which was stored in research distinct folders.

Data Security and Privacy

The research adhered to the binding European General Data Protection Regulation (GDPR) set for the European Union (EU) and/or European Economic Area (EEA). It was therefore under European policies, that the research complied with one of the internationally strongest privacy and security law systems. Scoped as global research with a European and particular Swedish case study focus both international and European standards applied. Aligned with the guidelines set by the Blekinge Institute of Technology, Sweden, the research team upheld national and institutional ethical standards.

Accordingly, all participants were informed and asked about their voluntary involvement and contribution to the research. Formal consent was sought in form of an Interview Consent Form (Appendix B), accompanied by a case study information paper (Appendix C). Likewise, a FGD Consent Form (Appendix F) and Agenda (Appendix H), together with tool summaries (Appendix G) and an overview presentation (Appendix J) were shared. Highlights of the formal consent include the retention of full data rights, the possibility to withdraw from the interview or group discussion at any time, and the option of anonymisation. It was only with permission of video recording, including the use of the transcribing tool called otter.ai, that the researchers carried out the data collection, thereafter, analysed and stored the information on an external storage device. The collected and generated research data is only accessible to the four researchers and academic colleagues of the research department until 2027. If not permitted otherwise, the retrieved data is not shared with third parties. Any change to the Consent Form ought to be communicated to the participants, requiring their explicit approval. Finally, the full dissertation will be shared with all research participants, in appreciation of their contribution.

4. Results

This chapter presents the findings from both primary and secondary research, structured according to the sub-research questions. The first part of this section provides an overview of the five selected sustainability assessment tools followed by presenting the results of the 5LM review, linked with the first sub-research question. In the second part, the sustainability objectives of the tools' dimensions have been compared, to identify the essential components of those tools linked with the second sub-research question. In the third part, the data obtained from stakeholder consultations has been presented to reveal insights for practical usefulness of the sustainability assessment tools.

SRQ 01: What are sustainability assessment tools available for evaluating small scale agri-food projects through a systems thinking approach?

This section is divided into two parts:

- Overview and summaries of the five selected sustainability assessment tools
- Comparative results of the five selected tools through the 5LM and integrated (FSSD and the Binder's Framework) framework approach (as outlined in the methodology chapter)

Overview and Summaries of the Five Selected Sustainability Assessment Tools

In this section, all the five selected sustainability assessment tools: RISE, SMART, SAFE, LiteFarm, and SAEMETH are described in terms of their structure, purpose, methodology, and scope, revealing a range of approaches in assessing sustainability across environmental, social, and economic dimensions. The result of the integrated tool's review has been presented below in tabular form (Table 4.1).

SMART – The Sustainability Monitoring and Assessment RouTine (SMART) framework was developed by FiBL in 2014 to assist farms and enterprises in the food sector for assessing their sustainability level in a credible and transparent manner. The specific software is used to compute context-specific indicators that are compiled individually for each case, farm, and/or enterprise. The tool operationalises the SAFA Guidelines, which provide a hierarchical structure of dimensions (environmental, economic, and social), themes, and sub-themes; a horizontal layer is added through the fourth dimension of governance. There are a total of 58 themes, 327 indicators, and 1769 relations drawn between sustainability themes and indicators. With the help of the SMART-Farm Tool, the specific sustainability performance of farms can be recorded, analysed and assessed in a systematic manner. The data needed for the assessment is semi-quantitative and collected using a standardised interview procedure. The software should be handled by scientists and/or field practitioners. The extensive list of indicators includes transversal environmental topics from water pollution to soil quality and degradation, air quality, fertilizer consumption, biodiversity, energy use and even animal welfare. Examples of the broad list of environmental indicators in the framework include pesticide presence in water, greenhouse gas emissions, phosphorus crops content, conservation of species and the use of renewable energy. Social indicators are also included in the SMART tool, assessing employees' rights and wage level for a dignified life. The social dimension also includes gender equality and non-discrimination, cultural diversity, health coverage and access to medical care. Finally, economic indicators cover a set of various themes, from profitability to vulnerability, accountability, the resilience of investments and value of the local economy (Alaoui et al. 2022; Research Institute of Organic Agriculture [FiBL] 2025; Schader et al. 2016; Schader et al. 2019)

RISE – The Response-Inducing Sustainability Evaluation (RISE) Framework was developed by the Bern University of Applied Sciences (BFH), School of Agricultural, Forest, and Food Sciences in Switzerland, in 1999, for the evaluation of environmental, social and economic sustainability of farm operations. It includes a total of 46 indicators addressing environmental, social, economic and land management aspects condensed into 10 themes. RISE has undergone an iterative development process incorporating user feedback and expert consultations since its launch. Data is collected with a questionnaire-based interview with the farmer or farm manager, followed by data computation and presentation. The framework should be used by agronomists or specialists in agricultural advisory services. The RISE aligns with systems thinking approaches and sustainability assessment frameworks that integrate life cycle analysis, resource efficiency, and social sustainability. It is based on the sustainable development concept introduced in the Brundtland Report and follows a principle-based approach with strong scientific soundness. It views the farm as a dynamic, interconnected, multi-dimensional system. RISE effectively guides farms towards sustainability by providing a structured, data-driven framework for continuous improvement. The sustainability polygon and traffic light system help farmers to identify and prioritise areas for improvement. The tool also provides recommendations for future decisions and action planning (Alaoui et al. 2022; Berbec et al. 2018; Hani et al. 2003; Marchand et al. 2014; Olde et al. 2016; Talukder and Palmer 2017).

SAFE – The Sustainability Assessment of Farming and Environment (SAFE) Framework is a multi-scale, indicator-based assessment framework developed in Belgium from 2003 to 2005, by a multidisciplinary team of researchers, including the input from farmers. Its objective is to assess the sustainability of agricultural systems by combining environmental, economic, and social indicators at various spatial levels, including the farm, regional, national, parcel, and watershed level. For assessing soil and biodiversity, it uses landscape ecosystem assessments, while for environmental, social and economic issues it uses administrative units. The tool is designed for a broad audience of stakeholders, such as scientists, policy makers, and administration officers. While the specific indicators are tailored to the Belgian agricultural context, the underlying methodology is generic and potentially transferable to other geographical areas. SAFE integrates and acknowledges the interconnectedness between the ecological, social, and economic dimensions of the food system through a holistic, multi-scale, and essential indicator-based approach. The environmental dimension considers resources and ecosystem integrity, focusing on buffer and stock/supply regulation functions. The economic dimension focuses on economic viability. The social dimension considers food security and safety, quality of life, and social and cultural acceptability. It adopts a systemic view of the agricultural and food system, highlighting the interdependence and necessity of assessing trade-offs and synergies. The tool is built upon the 'Triple Bottom Line' and uses a 'top-down' approach with some stakeholder participation. Data collection for SAFE involves specific protocols, various collection devices (e.g., logbooks, questionnaires, accountancy records etc.), and existing databases. Compared to tools like RISE and the SAFA Guidelines; SAFE is considered less user-friendly (Cauwenbergh et al. 2007; Sauvenier et al. 2005)

SAEMETH – The Sustainable Agri-Food Evaluation Methodology (SAEMETH) is a monitoring tool developed by a group of European researchers to evaluate the sustainability of small scale agri-food supply chains. The tool aims to address the limitations of conventional evaluation approaches that often lack a holistic integration of economic, social, and environmental dimensions. It is a monitoring tool with an interpretive structure, designed for user-friendliness and strong communication through a long-term participatory approach. The framework is based on the economic, agro-environmental, and socio-cultural dimensions of sustainability. Its focus is on user involvement and qualitative indicators, making it accessible and understandable for small scale actors. The hierarchical structure allows users to start with a global vision and narrow down to local indicators. The tool also emphasises the interconnectedness between the different dimensions of the food system. SAEMETH is applied through a participatory approach involving stakeholders, including farmers. The process involves defining and weighing sustainability dimensions, components, and indicators relevant to the specific context. Data related to indicators are collected, and sustainability performance is assessed and visualised using radar and bar graphs to identify strengths and weaknesses. The results are then discussed with producers to understand their perspectives and validate the assessment, empowering them to prioritise actions for farm improvement. While no complementary software is mandatory, the tool's application involves adopting specific production protocols. The choice of indicators was based on data availability, which might not always align with scientific relevance. Some important quantitative indicators, particularly those related to specific agro-ecological practices, may be excluded due to the focus on qualitative data only (Peano et al. 2015; Sottile et al. 2016)

LiteFarm – LiteFarm version 1.0.0 was publicly released in July 2020 as a free, open-source, online farm management tool. It is a participatory science research project hosted at the University of British Columbia (UBC). Its objective is to equip farmers with the tools they need to make informed and responsible decisions about the health of their farm, their livelihood, their community and the planet. Since its release, LiteFarm has been continually developed through collaboration between farmers, researchers, designers, and developers, creating localised modules and new features for an audience tailored use. The tool provides built-in decision-making support and pathways for farmers to earn additional income through third-party organic certifications and participatory guarantee systems. This tool is an example of a digital tool built for accessibility and feasibility. Designed specifically for agroecological and diversified farmers, the LiteFarm tool follows the principles of food and data sovereignty and is based on the agroecological principles and a holistic understanding of sustainability. The working definition of sustainability for LiteFarm is the capacity of a system to function perennially or to produce a reliable output in the long-term (Kroese 2019). The tool's structure, based on the Tool for Agroecology Performance and Evaluation (TAPE) Guidelines, inherently gives prominence to a comprehensive evaluation across all three dimensions of sustainability, which encompasses a wide array of sub-themes within these dimensions. The LiteFarm tool's sustainability assessment framework by Wohlers et al. 2021 draws and connects interactions is informed by the TAPE, RISE and Indicateurs de Durabilité des Exploitations Agricoles (IDEA) Frameworks. There are a total of 17 parameters, making up 9 different sustainability indicators, encompassing the environmental, social, and financial sustainability of smallholder farms (Wohlers et al. 2021; LiteFarm n.d.)

SRQ 02: What are the essential components of sustainability assessment tools for evaluating small scale agri-food projects?

The following section addresses the second sub-research question by identifying the essential components of sustainability assessment tools used to evaluate small scale agri-food projects. It provides a brief overview of the five selected tools, focusing on their major dimensions, themes, sustainability objectives, and monitoring indicators in a hierarchal way. These monitoring indicators are then analysed with the Sustainability Principles of the FSSD to see their degree of alignment. A comprehensive alignment analysis, indicating the degree of alignment, was not possible to conduct, mainly due to the extensive nature of the indicators and the difficulties of assessing all downstream effects of the agri-food system.

This approach offered valuable insights, with the SPs serving as guiding principles rather than prescriptive criteria. It is again worth noting that, since the economic sub-system was identified as a part of the social system, conditions within the economic system that systematically undermine people's capacity to meet their needs, fall under the social principles. The results of this study have been presented in Table 4.2 (Summary of results along the environmental dimension), 4.3 (Summary of results along the social dimension) and 4.4 (Summary of results along the economic dimension) respectively.

Table 4. 1 Results of the 5LM Review.

Colour key of the tables:

+	indicates that yes, significant or partial alignment was identified
-	indicates that no alignment was found
	indicates that no precise information was found

		SMART	RISE	SAFE	SAEMETH	LiteFarm
System Level						
Systemic aspects	System perspective is taken into consideration	+	+	+	+	+
	Dimensions of sustainability	Social Wellbeing, Economic Resilience, Environmental Integrity, & Good Governance	Social, Economic, & Environmental	Social, Economic, & Environmental	Socio-cultural, Economic, & Agro-environmental	Social, Economic, & Environmental
	Underlying assumptions are clearly interpreted	+	+	+	+	+
	Proper knowledge about the system(s) in which the tools operate is presented	+	+	-	-	-
	Interconnectedness among the indicators is recognised	+	+	+	+	+
Success Level						
Normative aspects	Goal of the tool is clearly defined	-	-	-	-	-
	Concept of sustainability that is adopted	Principle based approach	Principle based approach	Triple bottom line approach	Principle based approach	Principle based approach
	A clear definition of Sustainable Food System(s) (SFS) is integrated	-	-	-	-	-

Strategic Guideline Level						
Procedural aspects	Clear strategic guidelines for different stakeholders are put forward	+	+	-	-	-
	Both long-term and short-term planning is considered (balance between synergy and trade off; long-term goals and Return on Investment (ROI))	+	+	-	-	+
Action Level						
Procedural aspects	Tool is periodically improved, contributing to the desired goal of the tool and sustainability objectives	+	+	-	-	+
	The definition of success is communicated clearly to the farmers/stakeholders	-	-	-	-	+
Tool Level						
Procedural aspects	Accessible (e.g., cost effective, easy to use, etc.) for farmers to support the achievement of the defined success	-	-	-	+	+
	Results are relatively easy to be interpreted by the farmers	+	+	-	-	+

Table 4. 2 Summary of results along the environmental dimension (with the SPs 1-3).

Themes	**Sustainability Objectives**	**Monitoring Indicators**	**Significant or partial alignment with SPs**	**Tool**				
				SMART	**RISE**	**SAFE**	**SAEMETH**	**LiteFarm**
Water	Water management	*Water use efficiency*	SP 3	+	+	+	+	+
	Water security	*Quantity and quality of supply water*	SP 3	+	+	+	-	+
	Conservation of water resources	*Prevent overexploitation*	SP 3	-	+	+	-	+
	Water quality	*Water quality parameters*	SP 2	+	-	+	-	-
Land & soil	Soil quality, soil health	*Soil management, and physical and chemical properties of soil*	SP 1|SP 2	+	+	+	+	+
	Prevention of land degradation	*Level of erosion, compaction, nutrient content, and soil fertility decline*	SP 3	+	+	+	-	-
Air	Clean air	*Air quality monitoring*	SP 1|SP 2	+	+	+	-	-
Energy and climate	Increase energy use efficiency, energy management, reduce GHG emission	*Measures to save energy, energy conservation, and renewable energy source*	SP 1|SP 2	+	+	+	+	+
Biodiversity	Conservation of ecosystem diversity, prevention of vegetation loss, reduce pesticide use intensity	*Species conservation practice, functioning and connectivity of ecosystem services, change in land cover, genetic diversity, management, and production of pesticide use*	SP 2|SP 3	+	+	+	+	+
Animal husbandry	Animal well being	*Animal health*	SP 3	+	+	-	-	-
Material use	Keep the material flow in closed loops and protect the environmental damage due to storage, use and disposal of materials	*Sustainable source of material, optimum material usage, recycling of material, and material flow*	SP 1|SP 2	+	+	-	-	-
Waste management	Reduce non-degradable waste material	*Waste reduction and disposal*	SP 2|SP 3	+	-	-	-	-

Table 4. 3 Summary of results along the social dimension (with the SPs 5-8).

Theme	Sustainability Objectives	Monitoring Indicator	Significant or partial alignment with SPs	Tools				
				SMART	RISE	SAFE	SAEMETH	LiteFarm
Employment contract/ agreement	Workers' stability and workplace security	*No forced labour, no child labour, freedom of association, and right to bargaining*	SP 6	+	-	-	-	-
Workload	Allowance for overtime compensation and quality of life	*Working hours*	SP 7	-	+	-	-	-
Wages	Provision of reasonable life quality for workers and their families	*Wage level*	SP 7	+	+	-	-	-
Health safety	Safe working environment for the well-being of farming families	*Labour conditions, family's health, education, access to and use of social infrastructure, community integration, and feeling of independence*	SP 4|SP 7	+	-	+	-	+
Social acceptability	Well-being of societal function	*Social equity, amenities reduced, pollution level decreased, and quality and taste of food is maintained*	SP 5|SP 6|SP 7	-	-	+	-	-
Decent livelihood	Enjoyment of livelihood, time for culture, nutritionally adequate diets, training and education, access to means of production	*Life quality, development capacity, fair access to production income, production/consumption, and diversity of main food types*	SP 4|SP 6|SP 7	+	+	+	+	+
Gender equality/ equity	No gender discrimination, inclusion, provision of maternity leaves, non-discrimination, support to vulnerable people	*Gender equality and equity, and non-discrimination*	SP 7	+	-	+	+	-
Cultural diversity	Maintenance of educational, scientific, cultural, and spiritual heritage and preservation of the	*Open house by farmers*		-	-	+	+	-

	intrinsic natural and human dimensions of local products							
Governance and institutional access	Strong partnerships that bring in resources, knowledge, and support	*Access to extension services, cooperatives, policies, and markets*		+	+	+	+	-
Internal relationships	Trust building and cooperation within local agri-food networks	*Relationship among internal stakeholders*		+	-	+	+	-
Product use	Improvement of the intrinsic characteristics of the product, minimising waste and maximising value	*Conservation, transformation, and organoleptic quality of the product*		+	+	+	+	-
Health and nutrition	Human health and nutrition, reduce exposure to pesticides	*Exposure to pesticide, and dietary diversity*	SP 4	+	-	+	+	+

Table 4. 4 Summary of results along the economic dimension.

Theme	Sustainability Objectives	Monitoring Indicators	Tool				
			SMART	RISE	SAFE	SAEMETH	LiteFarm
Profitability	Maintain short- and long-term profitability of the business/autonomy	*Net income*	+	-	+	-	+
		Liquidity, stability, profitability, indebtedness, and livelihood	+	+	-	-	+
	Maximise economic returns from resources used to support long-term farm sustainability	*Total output from total input (TFP), labour productivity, and total output from total input (J)*	-	-	+	-	+
	Costs of unit production are lower than the price per unit of product sold	*Cost of production, and production efficiency*	+	-	-	-	+
Vulnerability	Mitigating production risks such as unpredictable weather conditions and pathogen infestations	*Production risk*	-	+	-	-	-
	Diversified income structure (marketing channels and buyers) and production contract with buyer	*Stability of the market, product versatility, Diversity of agricultural income sources and added value*	+	+	+	+	+
	Internal and external risks such as demand uncertainty, shortage in workforce	*Non-production*	+	+	-	-	-
	Financial liquidity to withstand shocks	*Financial liquidity / independence*	+	+	-	-	+
	Reduce reliance on external finance to build resilience and independence	*% of real net farm income from all subsidies' solvency*	-	-	+	-	-
Accountability	Products can be traced along the value chain	*Traceability system*	+	-	-	-	-
Investment	Sustainable performance and development of a community aiming at long-term sustainability	*Resilience*	+	-	-	-	-
		Inter-generational continuation farming, and land tenure arrangements	-	-	+	-	-
		Economic alliances, and client reliability	+	-	-	+	+
Local economy	Benefit of the local economies through procurement from local suppliers	*Local procurement*	+	-	-	+	-

SRQ 03: What is the usefulness in practice of the reviewed sustainability assessment tools?

This section addresses the third sub-research question, focusing on the practical usefulness of the sustainability assessment tools. Insights were gathered directly through research phase two, which engaged in participatory consultation with stakeholders, semi-structured interviews with tool experts and semi-structured FGDs with practitioners of 2000 m² in Sweden. Attention was drawn to their experiences and perceptions around the practical usefulness of sustainability assessment tools in the context of 2000 m². It is important to note that the practitioners in the FGDs had not used the reviewed tools themselves and, instead, offered broader insights based on their experience in the field. Therefore, the tool experts brought in their experience with the reviewed tools. Thematic analysis of the transcribed data revealed the following major themes:

- **Key factors for viability and success of small scale agri-food projects in Sweden**

Stakeholder consultation highlighted key factors for viability and success to maintain and sustain small scale agri-food projects in Sweden. Success was tied with economic sustainability, ensuring farmers and others are paid for their work and sustainable practices. Key factors for viability involved the creation of new layers of value, beyond price (per kilo), focusing on nutritional values, food origin, quality and taste. Certifications, strong brands and diverse communication channels were mentioned with the potential to lead and establish new food cultures.

Efficiency stood out as key, especially with regards to the agri-food system. Therefore, a close relationship between agriculture and gastronomy was emphasised to help reduce food waste. Linked to collaboration sufficiency, looking at regions and connecting farmers for circularity, was shared to be more relevant than individual self-sufficiency; building resilient network alliances is crucial. A (re)connection to the place/land, fostering circulating systems with minimal external inputs and integrated animals, was seen as a viable model.

Synergies of mutual support and benefit to different stakeholders emphasised collaborations, with unexplored potential for product-service, and service-service cooperation. Sustainability performance assessment of farms and along the product value chain from farm to fork was seen to allow for comparability and best practices, possibly stimulating soft competition to support the transitioning towards sustainable foodscapes.

One participant in the FGDs shared that the *"The economic system has never, ever included nature. We've been using nature for free, at least in this part of the world, and that's how we have built our growth. And we've taken the resources from other countries to do this, and now there is nowhere else to go. Now (in Sweden) we can see that the slack in the growth, and that is considered a huge problem, but it doesn't have to be so."*

- **Definition of sustainability in practice**

During the field research, participants echoed the perception of sustainability being a direction, rather than a fixed definition, acknowledging its constant development. Hence, sustainability requires a long-term perspective, considering future generations. Accordingly, moving towards sustainability, means moving away from short-term economics and excessively cheap food, degrading planetary and human health. Practical sustainability which doesn't diminishes the well-being of present and future generations, incorporates regenerative practices, respecting available land resources.

Sustainability performance assessments of small scale agri-food projects can help to reveal the complexity of a farm ecosystems, which allows for more conscious sustainability measures. Zooming in and out, looking at, and beyond the system boundaries of a farm can provide a bigger picture view, showing regional interconnections. Practices directed towards sustainability require context-specific, new layer embedment. The 2000 m² methodology was presented as a practical model which encompasses layers of equality, solidarity, biodiversity, and efficient resource use.

One participant in the FGDs said *"I've never got any closer to anything that actually is more sustainable than the 2000 square meters (project) because it adds in every single layer of sustainability. It has equality and solidarity, a sharing of the arable land that is left on planet Earth […]. So, everything is packed into those 2000 square meters. The big question is, how do you make it available for the many?"*

- **Applying sustainability assessment tools in practice**

One of the primary objectives of applying sustainability assessment tools is to add or create value for implementing sustainable practices, especially with respect to soil quality and health. Based on the idea of a multi-layered value system approach, one of the respondents referred to the *"Land Banking Group"*, a newly developed banking system for Nature Equity management.

In both FGDs, participants addressed the importance of integrating long-term perspectives into the tool's assessment and application, also regarding returns on investment (ROI). Therefore, the coverage of all four capital investments, human, financial, natural, and technological, have been mentioned. This was considered as particularly motivating when assessment findings are used for strategic foresight planning and decision-making.

Aside from raising awareness, building upon experimental learning experiences; the purpose of the tools' application was agreed to lay in the translation of data into action on the ground. What is described as a balancing act between how much data is required, available, and entered into the tool's dataset, highlights the matter of data sovereignty, with return on research (ROR) for the farmer. Consent from the farmers to use their data, including their withdrawal at any time, is critical.

One tool expert shared that *"Many researchers or government studies come to farms, take their (the farmers) time, […] data, but whatever research insights come out of that study are usually not given back to them. So that's something that may make (tool users) feel a little bit cheated, like they are used only for data extraction."*

- **Key components of sustainable assessment tool from practitioners' perspective**

While the most useful part of the sustainability assessment is considered to begin with the translation of theory into practice, often not part of the tool but method, after the assessment is done; key components of the tool, in relation to the 2000 m^2 methodology include the proportions or acreage needed to cultivate the land square meters per person or product.

Furthermore, components that measure nutritional yield per area, thus guide crop selection based on nutritional values are requested. To evaluate self-sustaining farm systems with integrated animals and minimal external inputs, components of circularity are mentioned. Soil health, measured by metrics like total carbon sequestration was emphasised particularly. Thereby also the role of soil fungus/mycorrhiza was recognised as an important assessment component.

Climate impact assessments, specifically carbon sequestration, water use, and biodiversity were considered as increasingly significant factors in the environmental dimension. Working and family hours were seen as intertwined, making them difficult yet important to assess on the social dimension. Efficiency, particularly related to reducing food waste through close agri-gastronomy alliances was highlighted.

Sustainability assessment was thereby commonly understood to provide a holistic analysis of the farm’s performance on all three dimensions. Showing balance and constraints of farm practices to mirror and highlight current disconnects between systems’ capacity and demands; attention was drawn to data communication to make abstract findings, like resource limits, tangible. Visual data representations were suggested to aid with accessibility across different stakeholder groups and in learning the tool’s application.

One FGD participant said, *“We have to be careful with the planet, with the forests, the fields, everything from the bees and the mosquitoes to the big animals; it's like a circle and you need every part of the circle […] that's sustainability.”*

5. Discussion

In the discussion below, the researchers have critically analysed the findings from the results of the study, linking this to the existing literature and reflecting upon some wider implications in terms of practice and further research. To enhance clarity and coherence, the discussion chapter follows the same structure as the results chapter, allowing for direct comparison and interpretation of results.

SRQ 01: Sustainability assessment tools available for evaluating small scale agri-food projects through a systems thinking approach

Critical Analysis of the Selected Sustainability Assessment Tools

At the **System Level** all five tools have adopted holistic system perspectives, but they described their system differently. While all the tools explicitly acknowledge the interconnectedness among the three dimensions of sustainability, SMART stands out as the most comprehensive tool available for undertaking sustainability assessment in a systematic manner (Landert et al. 2020; Aloui et al. (2022). SMART emphasises upon all three dimensions of sustainability in a more balanced way, while other tools focus more upon only one or two dimensions. RISE and SAFE are primarily focused on the ecological dimensions; SAEMETH on socio-cultural and LiteFarm on agro-ecological dimensions of sustainability.

In the Systemic Aspects of the conceptual framework proposed by Binder et al. (2010) it is understood that to obtain an adequate system representation, simplicity alongside the tool sufficiently representing the complexity of the system, are essential factors along with indicator interactions. Thereby, three important parameters are considered in the comparative framework (5LM): how the tool interprets its underlying assumptions, if the tool covers proper knowledge about the system of operation and the interconnectedness among the indicators. As shown in the results table, all of the tools are able to interpret their underlying assumptions quite clearly. With its comprehensive assessment approach and hierarchical framework, SMART successfully analyses the trade-offs and synergies among its dimensions. The tool highlights that the activities and outcomes in one area can have implications on other areas. Thus, it aims to move beyond simply measuring performance of an individual area in isolation, in a comprehensive manner (Schader et al. 2016). RISE interprets its underlying assumptions about the farm's sustainability through the lens of a continuum balance between 'optimal' and 'unacceptable' for key areas, rather than prescribing a definitive 'sustainable' or 'unsustainable state'. The tool also aims to capture trade-offs and synergies between economic viability, environmental sustainability, and social responsibility (Berbec et al. 2018). The hierarchical approach of SAFE offers an assessment through a systematic breakdown of principles, criteria, indicators, and reference values. It considers the agro-ecosystem as highly dynamic in nature while the indicators are often intrinsically static, being a snapshot of measurement (Van Cauwenbergh et al. 2007). SAEMETH emphasises context-specific evaluation with the assumption that each small scale agri-food system is unique and must be evaluated in light of socio-cultural and territorial characteristics. There is also an assumption that a participatory as well as interdisciplinary approach is essential for capturing the complex nature of sustainability. The foundational assumption of LiteFarm relies upon its farmer-centric design, especially targeting smallholder farmers. Therefore, it minimises the complexity of its input data level while keeping the 'background calculations' or processing information, within the app 'maximised'. Combining farmers' input with scientific research would enhance the accuracy and relevance of sustainability assessment at the farm level. However, only SMART and RISE provide proper knowledge about their system of operation. From the interconnectedness among the indicator's perspective, SMART stands out as the best tool with highest number of indicators (327 in total) and their complex relationship (1769 in total) with broad coverage of thematic areas (58 in total); followed by RISE, LiteFarm, SAFE and SAEMETH in the systemic aspects.

At the **Success Level** (Normative Aspects of the Binder's Framework), none of the tools are able to offer a clear definition of sustainable food systems, nor a specific goal. While SMART, RISE and SAEMETH adopted the principle-based approach of sustainability (de Olde et al. 2016); SAFE (Talukder and Palmer 2017) was understood to be built on the 'Triple Bottom Line approach' in the sense that it addresses ecological, social and economic dimensions equally. LiteFarm is based on an agroecological principled approach (Kroese 2019; Mottet et al. 2020).

At the **Strategic Guideline Level**, SMART and RISE provide clear guidelines for their stakeholders in the form of analysis reports encompassing all the sub-themes, highlighting the interconnectedness of their practices. The reports can be translated into actionable steps to improve the farm's sustainability performance. SMART uses an impact matrix whereas RISE uses a weighted scoring system to analyse the interactions among the indicators determined by expert judgement. RISE has been considered as a user-friendly tool by Talukder and Palmer (2017) and Alaoui et al. (2022). The tool expert (RISE) indicated that the participatory approach adopted by RISE ensures that farmers and advisors can work together to find a solution that is locally relevant. According to Marchand et al. (2014), de Olde et al. (2016) and Berbec et al. (2018) farm assessments with SMART and RISE provide holistic results on farm sustainability and help to visualise strengths and weaknesses of a farm. This can be useful in finding and implementing new management strategies. SMART, RISE and LiteFarm also help stakeholders in both short-term and long-term planning.

At the **Action Level**, these three tools have undergone an iterative process of development resulting in periodic improvement. However, except for LiteFarm, none of the tools clearly articulate or communicate a definition of success to their stakeholders. At the Action Level, the results generated by SMART and RISE are easy to interpret by the farmers due to their visual and colourful representations of the results. However, these two tools are considered more complex due to hefty data requirements and complicated calculation methods. In comparison, LiteFarm is simpler, easier to use, free of cost, open-sourced, and app-based. Therefore, it may be more suitable for guiding strategic decisions in small scale contexts.

Referring to Binder et al. (2010), to assess the Procedural Aspect, criteria such as timeliness, comprehensiveness, transparency and credibility are considered as key to success. During the FGDs (as mentioned in the Results above), the participants highlighted long term planning, clear communication, and visual data presentation as crucial parameters for the usefulness of the tool. From this perspective, SMART and RISE can be considered as better choices followed by LiteFarm, SAEMETH and SAFE.

SRQ 02: Essential Components of sustainability assessment tools for evaluating small scale agri-food projects

As mentioned in the introduction, within the hierarchical structure of the assessment tools, the themes and indicators serve as a structural framework for translating broad sustainability objectives into measurable and actionable components (Chopin et al. 2021). The themes represent the key domains that are aligned with the overarching sustainability goals of each tool – whether it focused on ecological balance, social justice, or the long-term viability of farming. As such, the themes help to clarify what matters most in terms of sustainability for the tool in question. On the other hand, the indicators are the specific variables or metrics used to evaluate performance within each theme. The indicators show how progress is being measured, and are essential for monitoring, comparison, and continuous improvement. All five selected tools (SMART, RISE, SAFE, SAEMETH and LiteFarm) were designed to evaluate and promote sustainable agricultural practices across different scales. The tools differ in how they put the concept of sustainability into application and how they make it workable and measurable in practice, primarily through their selection and structuring of themes and indicators. Comparing the sustainability objectives of key thematic areas across the five selected tools with the SPs outlined in the FSSD proved particularly insightful. This comparison helped to identify essential components, and to assess the depth of alignment with sustainability principles (as defined within the FSSD). By the interpretation of the results shown in Table 4.2-4.4, the following inference has been obtained. The inferences have been organised across the three dimensions.

Ecological Dimension

In the ecological dimension, the thematic areas are broadly divided into water, land and soil, air, energy and climate, biodiversity, material use, and depending on the key farming activities, also waste management and animal welfare. The key thematic areas for this comparative assessment have been set considering the global sustainability objectives of the agri-food system and extracting all the themes available in the various tools used for comparison and contrast.

Among the selected tools, SMART demonstrated the longest list of themes (21 in total), sub-themes (58 in total), and indicators (327 in total). The key thematic areas covered by the tool are atmosphere, water, soil, biodiversity, material and energy and animal welfare in the dimension of environmental integrity. Its broader sub-themes covers transversal environmental topics such as air quality and greenhouse gas (GHG) emissions (under atmosphere) aligned with SP 1 and SP 2, water quality aligned with SP 2, water withdrawal aligned with SP 3, soil quality and land degradation aligned with SP 2 and SP 3 respectively, ecosystem, species, and genetic diversity (under biodiversity) aligned with SP 3, material and energy use, waste reduction (under material and energy) aligned with SP 2 and animal welfare aligned with SP 3.

As mentioned earlier, RISE and SAFE are primarily focused on the ecological dimension covering a broad range of thematic areas and long indicator lists in this aspect. RISE has a total 10 number of themes and 46 indicators. The broader thematic areas in the environmental dimension cover soil use (soil management practices aligned with SP 2 and SP 3, soil erosion and compaction aligned with SP 3), water use (water management practices, water security and resource conservation aligned with SP 3; water quality aligned with SP 2), energy and climate (energy management and GHG balance aligned with SP 1 and 2), material use and environmental protection (material flow, fertilizer use, air, soil and water pollution aligned with SP 1 and SP 2), biodiversity and animal husbandry (aligned with SP 3) related to farm activities. SAFE covers the broader thematic areas like air, soil, water, energy, biodiversity and ecosystem integrity and a large list of indicators in the environmental dimension. SAEMETH consists of 5 key thematic areas (biodiversity, region, soil and water, crop defense and energy) in the agri-environmental dimension and has most of the necessary indicators except GHG balance, material flow and waste management. The tool represents some unique parameters inside its key thematic areas such as crop diversification and intercropping, conservation of local varieties and breeds, encouraging traditional farming, production and processing methods, conservation of threatened and unique landscape, seed banking, natural crop defense system etc.; thereby making the selection of the tool very much relevant to small scale contexts. In contrast, although LiteFarm is developed upon agro-ecological principles, it encompasses a comparatively lower number of themes in the key thematic (soil, water, energy and climate and biodiversity) areas under the environmental dimension. Moreover, LiteFarm does not cover many necessary parameters related to farm sustainability such as – air, water and soil pollution, material flow, fertilizer and pesticide uses, waste management etc.

In the FGDs, the participants mentioned the following components as essential for farm level sustainability: soil health, crop selection, nutritional balance, climatic impact, biodiversity, water use and reduction of food waste. From this perspective, in the ecological dimension, SMART can be considered having significant alignment with ecological SPs followed by RISE, SAFE, LiteFarm and SAEMETH.

Social Dimension

In the social dimension, the key thematic areas broadly encompass the following necessary aspects of farm sustainability: employment and contract agreements, workload, wages, health and safety, social acceptability, decent livelihood, gender equality, cultural diversity, governance and institutional access, internal relationship, product use, health and nutrition. Out of these, SMART includes thematic areas like human health and safety decent livelihood, fair trading practice, labour rights, equity and cultural diversity aligned with the social SPs. RISE has very limited coverage in the social dimension with only two thematic areas (working condition and quality of life). Although SAFE is primarily focused on the environmental dimension, the tool consists of a good number of indicators covered under four broader thematic areas such as food security and safety, quality of life, social and cultural acceptability. SAEMETH is primarily focused upon the socio-cultural dimension with a broad coverage of this aspect. Like the agro-environmental dimension, it includes some unique features such as maintaining balance and equity for improvement of a farm's internal relationships. The tool places emphasis on the improvement of the relationships with public institutions and private entities, influencing public policy, participating and maintaining relationships with local, national and international food-networks, including a greater media attention and improved product labelling etc. However, the tool does not integrate some crucial parameters related to farm sustainability in the social dimension such as employee contract, wages, health and safety, social acceptability etc., thereby it only partially aligns with some of the social SPs. In comparison, LiteFarm covers four thematic areas in the social dimension (working conditions, health and nutrition, society and culture, quality of life) with a good coverage of key thematic areas. However, LiteFarm does not include some important parameters in relation to farm sustainability like social acceptability and governance etc., thus, having a partial alignment with the social SPs. It is worth mentioning that all of the selected tools focus on on-farm activities to define their boundary conditions, thereby deliberately excluding most of the upstream and all of the downstream activities. Therefore, all the tools could only be described to have significant or partial alignment with the social SPs.

Economic Dimension

According to the data presented in the results (Table 4.4), there are a total of 14 monitoring indicators. Among them, SMART covers 10 indicators, RISE covers 5, SAFE covers 5, SAEMETH covers 3, and LiteFarm covers 7. SMART encompasses a wider range of economic indicators and SAEMETH has the fewest. RISE and LiteFarm have fair coverage of monitoring indicators. SMART includes various unique indicators across all five themes in the economic dimension, such as traceability, local procurement, and resilience. RISE, although having fewer indicators in number, shares similarities with SMART in terms of indicators. Additionally, SAFE introduces several unique indicators that highlight the interconnectedness of the economic dimension with the environmental and social dimensions, such as Total Factor Productivity (TFP) and Labor Productivity (LP). SMART focuses on tracking conventional economic aspects like production, cost of production, and production efficiency to maximise profits in monetary terms. LiteFarm emphasises indicators related to profitability and production efficiency from both economic and resource perspectives. SAFE also promotes monitoring the percentage of real net farm income from subsidies to reduce farm dependency on subsidies gradually. This is a unique element of SAFE. SMART has traceability as a unique indicator to ensure product traceability throughout the value chain. Broadly, LiteFarm covers indicators across 4 themes, except accountability, emphasising that the tool has broad economic indicators coverage.

SAFE incorporates some indicators that other tools categorise as economic indicators into the social dimension. Sauvenier et al. (2006) state that the primary role of the agro-ecosystem's economic function is to bring prosperity to the farming community, ensuring the economic sustainability of the agro-ecosystem. It is important to highlight that economic viability is often crucial for several aspects of the social dimension as well, such as access to social activities and being dependent on income levels. Therefore, it can be said that the social indicators within SAFE are designed with economic viability in mind, aiming to reduce structural barriers to health, influence, and impartiality, aligning with SP 4 to SP 7.

In conclusion, it is evident that SMART and LiteFarm capture economic benefits for most of the stakeholders, such as ensuring wages for workers (captured under the social dimensions of these tools), profits for enterprises, paying taxes to governments and local bodies, and improving supply networks for consumers. SMART goes a step ahead to further track down the agri-food value chain and ensure traceability. SMART also has 48 specific measurable indicators related to productivity and farm income, 46 indicators related to quality of life, which are themes under the social dimension of sustainability but closely linked to the economic dimension (Landert et al. 2021, 12). RISE and SAFE fairly capture the economic benefits for the enterprises but lack emphasis on the supply chain. While SAFE and SAEMETH include indicators to enhance relationships with both external and internal stakeholders in the social dimension, they do not explicitly mention the economic dimension. In terms of the economic aspects, SAEMETH focuses solely on two components: development in production factors and their efficiency/dynamism, which involve a market-oriented approach to diversification and the search for new sales outlets for producers, mainly concentrating on enterprises and farmers, while neglecting other stakeholders throughout the value chain (Peano et al. 2015, 6721–6741). According to the FSSD, the economic system is identified as a sub-system of the social system that people depend on. The interconnectedness of the economic sub-system within the social system may explain why different tools have unique ways of choosing indicators within these two dimensions. These are not considered to be mutually exclusive, as within the FSSD, the economic system is embedded within the social system (Missimer, Robèrt, and Broman 2017).

SRQ 03: The usefulness in practice of the reviewed sustainability assessment tools

The tool expert interviews and FGDs generated multiple perspectives on the usefulness of sustainability assessment tools in practice, in the context of 2000 m² in Älvsbyn and Stockholm. This discussion may hold relevance more generally for comparable projects. Drawing on the wisdom of those who have decades of practical experience, the insights shared supportsed the conclusion that a practical or applied understanding of usefulness is context-specific, subjective and dynamic. This is a notion suggested first by Schader et al. (2014), as there is no one-size-fits-all sustainability assessment tool that suits all contexts. Especially at the local level, Carlsson et al. (2017) agree that there is no perfect set of predefined indicators of sustainability, with the more useful indicators in a given context being 'developed, refined and adapted' to be helpful in practice for managing decision making. What was considered by interviewees and FGDs participants to be most useful or relevant seemed to depend on the project's scale, location, objectives, and the capacities of the person performing a sustainability assessment or using a tool. This perhaps makes intuitive sense, considering the complexity of agri-food systems from the global to local scales, considering plant and animal biodiversity, soil health, dynamic climatic conditions, and all of the social and economic variables that exist. From this, it can be argued that all of the selected tools are likely to be useful, and the decision for which is most useful can best be decided in context by the practitioners on the ground.

An important consideration, as discussed further under Research Limitations, was that the FGD participants did not have personal experience with the shortlisted reviewed tools. Therefore, the findings are based around what participants had learnt from their relevant work in the field more broadly. The interviewed tool experts had in many cases used the tools in practice and had general insights about the tool's usefulness in applications at the small scale.

Key Factors for Viability and Success of Small Scale Agri-food Projects in the Swedish Context

Economic viability was raised in the FGDs as a main consideration for the success of small scale agri-food projects in terms of time, usability, and knowledge return for farmers. The farm to fork journey, across the value chain is a key aspect to consider for a small scale agri-food project's economic viability. This links to the language chosen by the EU's Farm to Fork Strategy as referenced by Eliasson et al. (2022), which communicates the many elements of the agri-food system and food supply chain. The FGDs revealed how within Sweden's agri-food system there may be substantial variances in consumer food preferences, based on geography, for example, in the North, consumers were described to eat less vegetarian food and more meat. 2000 m² thereby aims to reduce unsustainable meat consumption. Given the potential lack of local end consumers in Northern Sweden, the agri-food project's revenue model, perhaps with diversified revenue streams, may be an important consideration for sustainability tool budget. The tool expert for the RISE tool explained that agri-food project sustainability analyses, when done by a trained auditor with RISE, are normally externally funded. This can be part of regional collaborations and 'top-down' EU funded projects. These kinds of collaborations could have the added benefit of allowing greater comparisons and synergies between projects, scaling up the sustainability transition in Sweden.

Assessment tools could be used innovatively and strategically in order to showcase the true value of food to consumers, from a human health, nutrition and soil health perspective. There was a need expressed by one FDG participant to create *"new values"* beyond *"just the price of a kilo"*. This links to a wider conversation in the FGDs about the importance of organic certification and participatory guarantee systems, and other ways that agri-food products can truly reflect ecological and social values on the market. It was acknowledged in the FGDs more generally that the amount that consumers pay currently in the marketplace does not reflect the true value and ecosystem-wide costs of production. It emerged that the language of economic viability, as distinct from economic sustainability, may be a more useful framing and language choice to convey the nuance of the nested systems approach (Purvis et al. 2019) to the three dimensions of sustainability, consistent with the FSSD (Carlsson et al. 2017).

Economic discussions on a broader scale fall beyond the scope of this thesis to address in very great depth. However, both of the FGDs strongly emphasised the major point that one of the systemic problems inherent within the current Swedish agri-food system is the fixed focus on metrics of Gross Domestic Product (GDP) and Growth, with one participant expressing that *"The economic system has never, ever included nature. We've been using nature for free, at least in this part of the world, and that's how we have built our growth"*. The suggestion that there is a systemic failure in the current economic paradigm, as it relates to the farming context, was raised by more than one of the FGD participants. There was an awareness shared that this broader system may hamper the ability of small scale agri-food projects to progress on the social and ecological dimensions of sustainability in practice. The FDGs also highlighted the interconnected structural and economic challenges facing Swedish farmers, including ageing demographics, financial precarity, as well as limited access to user-friendly tools. These insights mirror concerns raised by Carlsson et al. (2017) regarding the socio-economic barriers that hinder the widespread adoption of sustainability tools within the agri-food system. On a global scale, small scale farmers face risks from volatile markets and have inadequate support systems, limiting their ability to adopt sustainable practices (World Bank, 2020). How these systemic obstacles will be addressed at the local scale is an important question. Alternative approaches, such as the Doughnut Economics model (Raworth, 2018) have been put forward in the environmental economics literature, and were raised in the FGDs, highlighting a movement away from incremental reforms or market-led approaches to systems change or transition models that work within the planetary boundaries. The conceptual model of Doughnut Economics was suggested in the FGDs to be complementary to the FSSD as defined in Missimer, Robèrt and Broman (2017). The metaphor of the doughnut could provide useful orientation for communication of the nested or bounded economic dimension of sustainability, as is suggested by Wahland et al. (2022), to stakeholders in small scale agri-food projects.

Given the recent rise in cloud capital and data-rich technological innovations within the agri-food system, an additional consideration to come from the expert tool interviews concerns data sovereignty, which is the right of tool users to own and take back their data at any time. The interview results suggest that some tool users wish to maintain their data. One tool expert shared that *"Many researchers or government"* assessors come to farms, taking time and data and *"whatever research insights that come out of that study are usually not given back to them. So that's something that may make them feel a little bit cheated, like they are used only for data extraction"*. The team may infer from this quote that there is a sentiment shared broadly by some farmers and agri-food project managers that the data of their projects is being exploited for marketing purposes, or by organisations that have an agenda to mandate or incentivise the tool's use for profit or political purposes. For farmers, and others, to use the tools, there needs to be consideration of Return on Research (ROR), asking the rhetorical question: is it worth their valuable time and data to participate?

Ecological Sustainability

What seemed to be a useful consideration for the ecological dimension of sustainability assessment tools was the complexity of the system, even at the small scale. For the 2000 m² project in Älvsbyn, various crops including pasture, oats/peas, colza, flaxseed, beans, tomatoes, squash, and potatoes have been grown on the plot, (as shown in photographs in Appendix M). These crop varieties require different quantities of manures and different soil conditions. One participant of the FGDs shared that *"If you want very good outcomes, it depends on the soil, the year and many factors - to decide what to measure."* This is an applied example of how the success of the project may depend on the adoption of frameworks that are flexible enough to allow for the unique requirements of the farm system, even at the very small scale. Successful uptake of a tool in practice, may need to allow for project specific factor variance over time, which a single measurement, at one time stamp, may not fully capture. Soil data integrations compatable with LiteFarm (such as Land-PKS, Cropio) as well as GHG estimator tools (e.g. COMET-Farm), and carbon footprint, water usage and biodiversity tools (e.g. Cool Farm Tool) may be useful in parallel with full sustainability assessment tools (see Future Research). This could generate improved outcomes for horticulture projects, by reducing the amount of manure or other nutrient-dense inputs, so that the conditions are optimal for the growth of the particular crop types in question.

Many full sustainability assessment tools provide a one-time picture, or a detailed snapshot of the current situation, when the assessment is done, usually over 1-3 days. These time-stamp metrics may not be sufficiently representative of the flux inherent in living ecological systems. One of the tool experts shared that continuous monitoring and evaluation is especially important to capture ecological systems complexity. A feature of some rapid sustainability assessment tools is ongoing monitoring, as described by Marchand et al. (2014), but rapid sustainability assessments may miss some of the more comprehensive measurements needed to capture biodiversity values, GHG emissions and other important ecological sustainability indicators. Furthermore, the ecological dimension may not be fully captured at the small scale because continuous monitoring may be out of time and budget scope. This is an example of some of the trade-offs inherent in deciding which tool (across the ecological dimension) to use in practice.

Social Sustainability

The FGDs revealed that shared opportunities for learning and sense making are important for continuous progress towards social sustainability. The application of sustainability assessment tools may offer intangible values when theory is turned into practice, in the form of facilitated workshops on the farm. There are many opportunities for sustainability assessment tools to be used in ways that facilitate collaboration and meaning making. One reflection that emerged from the research is that the use of the tools may indirectly stimulate soft competition between projects that could foster learning opportunities and incentivise the adoption of new sustainability practices over time. One tool expert validated this in sharing that *"The conversation actually starts when you do the assessment, usually they (the farmers or farm managers) are very talkative and realise a lot of things during the farm tour."* In this way, the use of the tool by an expert consultant or a farmer, may start an ongoing process of incidental learning, perhaps reaching more diverse audiences. This finding aligns with the suggestion within the literature from Binder et al. (2010) that 'bottom-up', integrated participatory or transdisciplinary methods, with stakeholder participation embedded in the process, are the most suited to small scale farming projects. To further understand social and practical applications of sustainability assessment tools, Carlsson et al. (2017) posits that applied research with further case studies helps to test, develop and validate sustainability assessment tools. The FGDs reinforced the view that small scale community-based 'bottom-up' approaches could be a successful way of scaling food systems transformations. The 2000 m² model has already been replicated and scaled across Europe, with inspiring resources and tools shared freely online. An important finding in terms of the usefulness in practice of sustainability tools, is that the projects are embedded in a social field, with one FDG participant saying that *“There is nothing called self-sufficiency. It's collaboration sufficiency that we need to look at.”* This raised the question of how diverse agri-food communities can connect and work across different contexts to build collaboration sufficiency with the use of sustainability assessment tools.

Definition of Sustainability in Practice

For practitioners and stakeholders in 2000 m² projects, the principles of sustainability included: giving direction, rather than a fixed definition of sustainability and acknowledging that it is an ongoing process. One participant of the FGD shared an appreciation of *“every part of the circle […] that's sustainability.”* There was a consensus shared that sustainability within the agri-food system is about moving away from short term economics and excessively cheap food, that degrades planetary and human health. For one participant, the case study was very significant for sustainability communication in Sweden’s agri-food system. Their definition of sustainability in practice was in relation to the 2000 m² concept in Stockholm itself. The participant shared that *“I've never got any closer to anything that actually is more sustainable than the 2000 square meters (project) because it adds in every single layer of sustainability. It has equality and solidarity, a sharing of the arable land that is left on planet Earth. It is about eating more diversity and [...] throwing away less[...], the big question is, how do you make it available for the many?”*

The FGDs revealed that the concept of 2000 m² is focused on the themes of equity and fairness. These factors are integral to their understanding of sustainability. Another interesting finding from the research and FGDs was that the 2000 m² practitioners already are using an applied tool or method called the 2000 m² calculator, which is available online. The participants of the Stockholm FGD described using the 2000 m² tool as a basis for crop planning, meal design, and even business strategy redefinition. They integrated concepts like circular systems, nutrient cycling, and soil carbon as qualitative indicators. Within the Stockholm 2000 m² case study, they have successfully employed crop rotation and have calculated nutritional density per square meter to make decisions. The 2000 m² calculator has been used to create ‘empathic meals’ for the Rosendals Trädgård in Stockholm and thus communicate sustainability concepts to a wider audience across Sweden.

Overall, a lesson learnt from the FGDs was that sometimes the more theoretical definitions of sustainability, as exemplified by the FSSD (Missimer, Robèrt, and Broman 2017), may not totally resonate with the language used or concepts that practitioners hold. However, within the FGDs there was a shared and nuanced understanding of what sustainability is, as understood within a social-ecological complex system as well as a shared commitment to working in a similar direction on the ground.

Applying Sustainability Assessment Tools in Practice

There was a general need expressed by the FGD participants for tools that enable reflection, adaptation and forward-looking planning. When considering the purpose of application of sustainability assessment tools, there may be a trade-off between complexity and user-friendliness. In some contexts, sustainability assessment tools may be too complex for the continued application at the small scale. Successfully using the tool in practice, may require significant time investment or technical knowledge. In the FGDs, it was acknowledged that the inaccessibility of a tool or burdensome complexity might reduce uptake and usefulness. One tool expert shared that in practice *"It's always a balancing act between how much data is required, because the researcher always wants more, and how much data a farmer has available and wants to enter."* User-friendliness was found to be important to the FGDs participants. However, complexity may not always be a limiting factor because the tool user's preferences cannot be assumed. There is a *"difference between farmers and farmers. There are farmers loving tools and want them to be as complicated as possible and others just as simple as possible."* Looking at the systems complexity inherent in case study, the findings from the interviews and FGDs validate the need for applied tools to evaluate social, ecological and economic values and dimensions. Finally, what seems to be especially important in practice, alongside economic viability, is that tools tangibly support actions towards sustainability that actually show value to the people who eat the food, the consumers and the wider community. Measuring market relevant (e.g. organic, fair trade, participatory guarantee or ecological) values across both short-/ and long-term time horizons may be vital to apply, communicate and scale agri-food project sustainability at a local, community and global level.

Discussion of the Usefulness of the Reviewed Tools in the Context of the 2000 m² Project in Älvsbyn

For the 2000 m² case study in Älvsbyn, or other comparable small scale agri-food projects in Sweden, the choice of tool or tools can be made with reference to Table 5.1, looking at the resources available and then proceeding with one of these tools; or, alternatively, by exploring the other 40 reviewed tools (Appendix N). Importantly, there are many more considerations for practical usefulness than the ones which have been addressed in the table below.

Table 5. 1 Tool overview and checklist.

Tool	Access	Cost	Consultation
SMART	Closed access [Via the FiBL website.]	Charged [Open to project funding.]	Trained auditor / External advisor [Training course offered.]
RISE	Closed access [Via the BFH website.]	Charged [Open to project funding.]	Trained auditor / External advisor [Training course offered.]
SAFE	Closed access	Unknown	Technical expert
SAMEATH	Unknown	Unknown	Technical expert
LiteFarm	Open access [Via the LiteFarm website.]	Free [Google or Email account.]	Self-led software application [Via the LiteFarm app.]

This table provides an overview of access, cost and consultation requirements for the five reviewed tools.

The reviewed tools sit on the continuum from rapid to full sustainability assessment as described by Marchand et al. (2014) and de Olde (2016). Marchand et al. (2014) describe full sustainability assessments as being usually technical expert led assessments, requiring a higher time and cost investment. They offer higher levels of complexity and scientifically underpinned output accuracy, with lower transparency and user-friendliness. Marchand et al. (2014) describe rapid sustainability assessments as normally requiring less of a time and cost investment, with less complexity. They offer more subjectivity, transparency and greater user-friendliness.

Short list of recommended tools for the 2000 m² project in Älvsbyn:

- SMART - Full sustainability assessment tool
- RISE - Full sustainability assessment tool, with characteristics in-between SMART and LiteFarm
- LiteFarm - Rapid sustainability assessment tool

In summary, certain tools like SMART, RISE or LiteFarm were found to come with a stronger network and user base, with local and/or regional reference points to other agricultural organisations, including research institutions. This communal support and farmer alliances may strengthen 2000 m² practitioners as influencers within local and regional agricultural networks, creating synergies with relevant stakeholders in the small scale agri-food context.

A practical and strategic consideration in the selection process of a useful tool in a small scale agri-food context, might be the availability of training courses and freely accessible learning resources to learn how to apply a professional sustainability assessment tool oneself. Undergoing an introductory course of the tool's application can be in many cases considered as sustainable and strategic, both with regards to cost and continuous sustainability performance monitoring.

5.1 Research Limitations

Tool development and advancement: The current market offers a great number of accessible and useable agri-food assessment tools for evaluating sustainability aspects. Along scientific and technological advancements, many of these existing tools are being refined and regularly updated by the tool's development team. With the concrete example of this research, this has been the case for the RISE and LiteFarm. Therefore, a limitation of this research is that it may lose relevance over time, as the tools are being updated and improved, constantly.

Information coverage: The review process of the five selected assessment tools revealed a different information coverage for each tool. Thus, not all the tools were equally accessible to study for the purpose of this research. While expert interviews aimed at providing additional knowledge about the system in which the tools operate in, not all respondents had the same level of expertise and familiarity of the respective tool. Besides, with a semi-structured interview design, not all questions were explored in the same way or to the same level of depth, across all four (instead of five) interviews.

Participatory research: Like all qualitative studies with a participatory research design, many factors influence the participants' availability, research focus and capacity to contribute, especially when data is collected live and/or in a group. To respond to such unforeseeable limitations in an all-encompassing way, the research team focused on a close communication, while also followed up with a survey link (Appendix K), welcoming research relevant after-thoughts, additional resources, and feedback.

Language: As an international student team, coming together in Sweden; from the start, the team has been aware of not having a native or local team reference. None of the four team members spoke the Swedish language, proficiently. Since this has been raised and talked about since the beginning, extra resources, such as translators have been considered. At the end, thanks to a high level of English proficiency and mutual support for single word translations, no extra measures were required.

English-speaking world: Despite the semi-structured literature review process using the world wide web, assuming that most of the research on the topic is accessible in English language; the team acknowledges the inevitable focus on the English-speaking world. Thus, research studies, including frameworks and tools written in any other language than English, have not been looked out for. Subsequently, the research blind spot lay outside the English-speaking world.

Focus group discussion: The group discussions with key stakeholders in 2000 m², provided valuable insights into the real-world applicability of sustainability assessment tools. Given the qualitative nature of the research, one consideration that limits the applicability of the FGDs to address the research question of which tool is practically the most useful in practice, was the reality that none of the participants had hands-on experience with the selected sustainability assessment tools (SMART, RISE, SAFE, SAEMETH and LiteFarm). However, the FGD participants did have a very high level of understanding of sustainability in practice.

Timeframe: The research team was bound to the semester schedule of the MSLS programme. Thus, the study was designed and conducted within the given timeframe set by the research institution. A short research window thereby made a visit of the 2000 m² site in Älvsbyn difficult, while also hindered the implementation of a full Delphi inquiry. This limited the extent to which the team could validate the reviewed tools' usefulness.

Biases: Researchers bias could reflect in the final selection and evaluation of tools. A non-probability sampling technique, such as purposive and snowball sampling may have led to an overrepresentation of certain perspectives, limiting diversity. Due to the expert's limited availability, the SAEMETH interview, prepared as a survey, had been cancelled last minute. Hence, the review for the SAEMETH Framework was not complete and lacked the expert's insights. The research and especially tool evaluation may therefore be subject to subjective and sampling biases.

Generalisability: Finding a sustainability assessment tool that balances theoretical rigour with practical applicability for different small scale agri-food projects might prove as being difficult. With focus on two case study projects of 2000 m² in Sweden, findings and results are highly contextualised. However, a remote location of the project in Älvsbyn (in the Northern part of Sweden) may limit full perspectives and contextualisation. A synthesis of data from multiple sources (literature, expert interviews and FGDs) could have presented challenges in maintaining consistency and coherence across different perspectives and contexts.

5.2 Future Research

Tool Reviews

Future research could follow up on the detailed review of the five chosen tools. Alternatively, a different selection of agri-food assessment tools can be reviewed, following the same research methodology. All tools could be further explored based on their applicability and use on the farm level.

Particularly, LiteFarm's effectiveness could be enhanced in practice by optionally using other technologies, such as open source, free tools developed via OpenTEAM (Open Technology Ecosystem for Agricultural Management). Many additional digital tools can be used alongside LiteFarm, notably the Fieldprint Platform, with the online Fieldprint Calculator Tool for sustainability transitions, assessing and measuring the environmental impact of commodity crop production and identifying opportunities for improvement. Soil data integrations (Land-PKS, Cropio) greenhouse gas estimates (COMET-Farm), and carbon footprint, water usage and biodiversity (Cool Farm Tool).

Research Validation

Future research could follow up and further validate the identified key components of the agri-food assessment tools, including their translation from theory into practice. The considered most straightforward research could explore the tools' applications on the 2000 m² site in Älvsbyn. Hence, a prospective study could pick up and close the research as a full circle.

Research Scalability

Future research could follow up and expand on the research scope to medium and/or large-scale farms, exploring the applicability and use of tools on different farm sizes. Therefore, a similar approach and methodology could be used to conduct further studies.

Economic Dimension

Future research could follow up and further explore the economic sustainability dimension by looking at the economic and financial viability of farms, in particular. Concepts such as the Doughnut Economics could be linked and studied in relation to this research. Furthermore, sustainable business or flourishing community models could be explored in relation to the 2000 m² case projects.

Software Programmes

Future research could follow up on the revision of existing and development of new agri-food sustainability assessment tools. Special attention could go to software programmes. They are not always built on a scientific framework but do have the advantage of being continuously tested by users, with innovative new, potentially useful, features.

6. Conclusion

This research investigated which sustainability assessment tools are most useful for evaluating small scale agri-food projects in Sweden, focusing on the 2000 m² concept. Using a critical, integrative approach, the study applied two frameworks: the Five-Level Model (5LM) of the Framework for Strategic Sustainable Development (FSSD) and Binder et al. (2010). Five indicator-based tools were selected from an initial pool of 40: SMART, RISE, SAFE, SAEMETH, and LiteFarm. The study assessed their usefulness in the context of 2000 m² project initiatives in Älvsbyn and Stockholm by exploring the normative, systemic, and procedural dimensions, incorporating both theoretical and practitioner perspectives.

The study developed a conceptual framework that proved as effective and relevant, with the FSSD providing a general structure for assessing sustainability and Binder et al. (2010) operationalising it for the agri-food context through specific assessment questions. Future research could build on this approach to evaluate agri-food systems across different scales and contexts, further strengthening the methodology over time. For this study, combining the two methodologies provided a clear structure to assess the tools and present findings coherently within the short timeframe and the 2000 m² case study context.

The operational definition of that most useful sustainability assessment tools for small scale agri-food systems for this study are those that support a transition to sustainability through participatory, 'bottom-up', and transdisciplinary approaches, aligning with the FSSD. Most tools reviewed, except SAFE, adopt principle-based methods suggesting fair coherence with the FSSD conceptually. Also, the review shows that all tools incorporate transdisciplinary, 'bottom-up', and participatory approaches.

Among the five tools assessed, SMART stands out for its balanced coverage of environmental, social, and economic dimensions, with the highest number of indicators and strong thematic integration. SMART and RISE also rank highest procedurally for their transparency, timeliness, and usefulness in planning. LiteFarm, while simpler, offers strong visual communication and accessibility, making it suitable for quick assessments. SMART aligns closely with key ecological concerns such as soil health, biodiversity, and water use. Socially, it covers equity, livelihoods, and cultural aspects, while RISE and the other tools have more limited coverage. Economically, SMART and LiteFarm are the most effective, with SMART offering unique features with deeper value chain analyses and stronger alignment with ecological sustainability principles as defined by FSSD.

Considering the complexity of the 2000 m² project, SMART, followed by RISE, is best for full sustainability evaluations. However, if practitioners of the 2000 m² concept wish to consider a rapid sustainability assessment, LiteFarm can be the one to start with unique features and an easy to access, open source and free application with fair coverage of sustainability. SAFE and SAEMETH, despite their systemic and participatory approaches, face limitations in clarity, accessibility, and practical application.

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8. Appendices

Appendix A: Research Tool

Research Tool

For Evaluating the Selected Sustainability Assessment Tools

[Adaptation of the 5LM of the FSSD]

Tool Level:

Tool Introduction:
[Developers/developing organisation with associated developers; year of development; geographic demarcation; brief history; tool audience and users; tool design etc.]

Guiding Questions: *(What is the tool's foundation and purpose?)*

1. Is the tool built upon existing sustainability assessment tools?
2. Are there any complementary tools that are either mandatory or optional to be used alongside the tool to enhance its effectiveness?

System Level:
Guiding Questions: *(If, to what extent can we identify complexity in those tools?)*

3. How does the tool acknowledge the interconnectedness between the ecological, social, and economic dimensions of the food system?
4. What are the underlying assumptions or simplifications to systems embedded in the tool?

Success Level:
Guiding Questions: *(What are elements of success, and how are they coming forth with the tool?)*

5. What are the highlighted (ecological, social, and economic) elements of success?
6. How are interactions drawn, connecting the tool's specific layers (e.g., themes, sub-themes, components, indicators etc)?

Strategic Guidelines Level:
Guiding Questions: *(What are the opportunities and returns of the tool for sustainability alignment?)*

7. How can the tool guide strategic decisions in small scale food projects towards sustainability, while being flexible for adaptation?
8. To what extent does the tool regenerate stable and reliable (ecological, social, and economic) returns?

Action Level:
Guiding Questions: *(How is the tool accessed, applied, and used to fulfil its purpose?)*

9. How is the tool applied and used to prioritise actions on the farm level?
10. How accessible is the tool to collect and evaluate the data?

Appendix B: Interview Consent Form

Interview Consent Form

Title: **Sustainability Assessment Tools for Small Scale Agri-Food Projects in Sweden**

Interview date:
Interview frame:
Interview platform:

Thank you for agreeing to take part in the above-mentioned research project. We appreciate your availability to share your experience and knowledge with us. After confirming a date and time that suit you best, the interview will be scheduled for a maximum of *45 minutes* via the video-conferencing tool *Microsoft Teams*.

Research conducted in an institution of the European Union (EU) and/or European Economic Area (EEA), requires the compliance with the General Data Protection Regulation (GDPR) on information privacy. Accordingly, we herewith like to ask for your formal consent to ensure that you are informed about your involvement and contribution to the research. To contextualise the research, we kindly refer you to the case study information paper accompanying this form. Aligned with the guidelines set by the Blekinge Institute of Technology, Sweden, we uphold high ethical standards, which we summarise and invite you to sign in the following.

The interview will be scheduled and conducted via the institutions and researchers' own Microsoft Teams account. To not miss any of the research relevant information, the interview is recorded and transcribed (with the help of the tool otter.ai). The research participant thereby withholds the right to withdraw from the interview process at any time, without needing to justify their decision. Thereafter the transcript of the interview will be analysed by the research team. The retrieved data, including the interview recording and transcript, will be stored on Microsoft Teams only, with limited access to the four researchers and academic colleagues of the research department. Data will be evaluated anonymously; content or direct quotations from the interview, will be referenced according to the participant's preference. Therefore, two options are put forward below. The research team respects and follows the choice indicated within this form.

The original interview recording will be destroyed, after the completion of the research project. The transcript as well as any other documents will be stored on an external storage device, only accessible to the four researchers until 2027. Any changes to the conditions stated above will be communicated, requiring the participant's explicit approval.

Please indicate your preference of review and name disclosure, *here*.

	I am informed and allow the use of the transcribing tool called otter.ai during the interview process. Otherwise, the team will only rely on Microsoft features.
	I wish to review and receive a copy of the interview transcript, or any other data collected during the research pertaining to my participation.
	I agree to be quoted openly, allowing the mentioning of my full name in context of the research study, including potential publications.
	I agree to be quoted anonymously, not allowing the mentioning of my full name in context of the research study, including potential publications.

By signing this form, I understand and agree that;

1. I am voluntarily taking part in this research.
2. The interview will be recorded and transcribed.
3. The researchers may be using a transcribing tool called otter.ai.
4. I withhold the right to withdraw from the interview process at any time.
5. The transcribed interview will be analysed for the purpose of this research study.
6. I confirm my indicated preference for review and name disclosure.
7. I am aware of and read the case study information paper in preparation of the interview.
8. I don't expect to receive any benefit or payment for my participation.
9. I can ask any questions before and/or after the interview process.
10. I am free to follow up on the research and contact one of the researchers in the future.

Research participant:

______________________________ ______________________________

Participant's signature; date

______________________________ ______________________________

Researcher's signature; date

Research supervisors:

This research has been reviewed and approved by the department of the Master's in Strategic Leadership towards Sustainability (MSLS) at the Blekinge Institute of Technology, Sweden. It is supervised and supported by two internal and one external advisor; please contact us for more detailed information.

Contact information:

Pallavi Priya
On behalf of the Research Team

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LinkedIn: Pallavi Priya

Appendix C: Case Study Information

Case Study Information

Research Title:

→ ***Sustainability Assessment Tools for Small Scale Agri-Food Projects in Sweden***

Research Question:

- *What are the useful assessment tools for small scale agri-food project alignment towards sustainability?*

Research Objective:
The purpose of the study is to evaluate existing sustainability assessment tools and find out the most useful assessment tool applicable for small scale agri-food projects. By identifying the essential components and key indicators among those tools, the study aims to determine how progress toward sustainability can be effectively tracked within small scale agri-food systems. To ground our analysis, the study is using a case study based on the 2000 m² experimental food system model, operational in Älvsbyn, Northern Sweden. Please find *below* a brief overview of the project:

*2000 m² is an educational and transformative concept based on the Associate Professor Artur Granstedt's research (2018) on what is internationally and within the United Nations called regenerative agriculture, or circular agriculture, with a focus on the entire cultivation and food system. It aims at *rethinking food production and consumption within planetary boundaries*. The concept provides direction to increase soil fertility and strengthen biodiversity in arable land. With approximately 2000 m² of arable land per person on Earth, the project emphasises the need to use the limited space innovatively to create sustainable and thriving foodscapes for current and future generations. The project seeks to address today's major challenges in the food system, including environmental degradation, biodiversity loss, climate change, and food waste.

- Having a sustainability agri-food assessment tool will provide a structured framework for evaluating the project's environmental, social, and economic impacts; ensuring that the project's practices align with glocal sustainability goals.

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Appendix D: Interview Protocol (live)

Interview Protocol

Introduction

- Welcoming the speaker

"Welcome and thank you for your time today!"

- Introducing the research team

"We are a group of four researchers (Pallavi, Bidisha, Holly, and Ann) from the Master's in Strategic Leadership towards Sustainability (MSLS) programme at Blekinge Institute of Technology, Sweden, conducting a study on ***sustainability assessment tools for small scale agri-food projects****. As part of our research, we are reaching out to experts in this field to gather insights on existing tools."*

- Summarising the research briefly

"We are exploring how different sustainability assessment tools support small scale agri-food projects in aligning toward sustainability. The goal is to better understand what makes certain tools more useful, bridging theory and practice".

- Addressing formalities of the **Interview Consent Form**

"You received our Interview Consent Form via email, upfront. It includes information on your rights, how your data will be handled and a note that we may use otter.ai (a GDPR-compliant tool) for creating transcripts. Please let us know if you have any questions before we proceed."

- Explaining the interview set-up

"The interview will take about 45 minutes, and we'll go through a mix of nine (ten) open-ended, tool- and case-specific questions."

- Highlighting an explorative research approach

"This is an exploratory semi-structured interview—there are no right or wrong answers. We're here to learn from your insights and experiences."

Asking for the permission and announcing the start of the interview recording

"Do we have your permission to start the recording now? (…) Okay, we are now starting the recording."

Conversation

- Asking the interviewee for a short personal/professional introduction (name, work, and project(s) etc.)
- Transitioning and inviting knowledge sharing on the research topic (questions below)

1. *Could you describe your experience with the (respective) tool for evaluating agri-food projects?*
2. *Have you applied the (respective) tool at the* ***small scale*** *and if so, what were your learnings?*
3. *What is the goal of the (respective) tool (from the tool's perspective)?*
4. *How do you define sustainability in the context of agri-food projects?*
5. *Which components were most essential, and why?*
6. *In which context is the (respective) tool most used?*
7. *How accessible is the (respective) tool among stakeholders especially in farmer groups, and why?*
8. *(Can farmers who use the tool, see information from other farms? e.g., Can they compare their cohort in same size/region?)*

Case Study Information: 2000 m² Project in Älvsbyn and Stockholm, Sweden

Referring to the one-pager about the 2000 m² Project shared with the **Interview Consent Form**, upfront.

---

9. *Could you reflect on how the (respective) tool (or other tools) might be applied to an experimental project like the 2000 m² concept in Northern Sweden? Do you have any recommendations, based on your experience? And why?*
10. *Are there any other tools you come across which are more applicable for small scale farming?*

Announcing the end of the interview recording

“That brings us to the end of the interview, thank you very much. We are now stopping the recording.”

Closure

- Welcoming any open questions about the research and/or topic

“Please feel free to share any open questions you might have about the research and/or topic.”

- Welcoming any additional resources and contact references

“Please feel free to share any additional resources and contact references you might have.”

- Offering future contact and exchange

“If you’re open to it, we’d like to stay in touch, perhaps via LinkedIn or other networks.”

- Thanking the research participant

“Many thanks for your time and research contribution, the team very much appreciates your availability to add to our dissertation. Your research support is highly acknowledged.”

Appendix E: Interview Protocol (survey)

Interview Protocol
[Survey format for the SAEMETH Framework]

Introduction

- Welcoming the speaker

"Welcome and thank you for your time today!"

- Introducing the research team

*"We are a group of four researchers (Pallavi, Bidisha, Holly, and Ann) from the Master's in Strategic Leadership towards Sustainability (MSLS) programme at Blekinge Institute of Technology, Sweden, conducting a study on **sustainability assessment tools for small scale agri-food projects**. As part of our research, we are reaching out to experts in this field to gather insights on existing tools."*

- Summarising the research briefly

"We are exploring how different sustainability assessment tools support small scale agri-food projects in aligning toward sustainability. The goal is to better understand what makes certain tools more useful, bridging theory and practice".

- Addressing formalities of the **Interview Consent Form**

"You received our Interview Consent Form via email. It includes information on your rights, how your data will be handled (and a note that we may use otter.ai (a GDPR-compliant tool) for creating transcripts). Please let us know if you have any questions before we proceed."

- Explaining the interview survey set-up

"The interview survey will take about 40 minutes, and we'll go through a mix of nine open-ended, tool- and case-specific questions."

- Highlighting an explorative research approach

"This is an exploratory semi-structured interview survey—there are no right or wrong answers. We're here to learn from your insights and experiences."

Conversation

A short personal introduction (name, work, and project(s) etc.)

Please write here.

1. Could you describe your experience with the SAEMETH framework for evaluating agri-food projects?

Please write here.

2. Have you applied the SAEMETH framework at the small scale and if so, what were your learnings?

Please write here.

3. What is the goal of the SAEMETH framework (from the tool's perspective)?

Please write here.

4. How do you define sustainability in the context of agri-food projects?

Please write here.

5. Which components were most essential, and why?

Please write here.

6. In which context is the framework most used?

Please write here.

7. How accessible is the framework among stakeholders especially in farmer groups, and why?

Please write here.

Case Study Information: 2000 m² Project in Älvsbyn and Stockholm, Sweden

[Please refer to the one-pager about the 2000 m² Project accompanying this survey.]

8. Could you reflect on how the framework (or other tools) might be applied to an experimental project like the 2000 m² concept in Northern Sweden? Do you have any recommendations, based on your experience? And why?

Please write here.

9. Are there any other tools you come across which are more applicable for small scale farming?

Please write here.

Closure

We welcome any open questions about the research and/or topic you might have.

Please write your questions here.

We welcome any additional resources and contact references you might have.

Please write your questions here.

- Offering future contact and exchange

"If you're open to it, we'd like to stay in touch, perhaps via LinkedIn or other networks."

- Thanking the research participant

"Many thanks for your time and research contribution, the team very much appreciates your availability to add to our dissertation. Your research support is highly acknowledged."

Appendix F: FGD Consent Form

Focus Group Discussion (FGD) Consent Form

Title: **Sustainability Assessment Tools for Small Scale Agri-Food Projects in Sweden**

FGD date:
FGD frame:
FGD platform:

Thank you for agreeing to take part in the above-mentioned research project. We appreciate your availability to share your experience and knowledge with us. After confirming a date and time that suit the group best, the FGD will be scheduled for a maximum of *90 minutes* via the video-conferencing tool *Microsoft Teams*.

Research conducted in an institution of the European Union (EU) and/or European Economic Area (EEA), requires the compliance with the General Data Protection Regulation (GDPR) on information privacy. Accordingly, we herewith like to ask for your formal consent to ensure that you are informed about your involvement and contribution to the research. To contextualise the research and provide an insight into the FGD preparations, we kindly refer you to the tool summaries and question guide accompanying this Form. Aligned with the guidelines set by the Blekinge Institute of Technology, Sweden; the team upholds high ethical standards, which we summarise and invite you to sign off in the following.

The FGD will be scheduled and conducted via the institutions and researchers' own Microsoft Teams account. To not miss any of the research relevant information, the FGD is recorded and transcribed (with the help of otter.ai). The research participant thereby withholds the right to withdraw from the discussion at any time, without needing to justify their decision. The transcript of the FGD will be analysed by the research team, thereafter. The retrieved data, including the FGD recording and transcript, will be stored on Microsoft Teams only, with limited access to the four researchers and academic colleagues of the research department. Data will be evaluated anonymously; content or direct quotations from the group discussion, will be referenced according to the participant's preference *(below)*.

Important, please note that during the group discussion your identity cannot be anonymised; it will be highly protected afterwards. All participants are therefore asked to keep all comments made during the exchange confidential, not sharing any personal information with third parties outside the FGD.
The original FGD recording will be destroyed, after the completion of the research project. The transcript as well as any other documentations will be stored on an external storage device, only accessible to the four researchers until 2027. Any changes to the conditions stated above will be communicated, requiring the participant's explicit approval.

Please indicate your preference of review and name disclosure, *here*.

	I am informed and allow the use of the transcribing tool called otter.ai during the discussion. Otherwise, the team will only rely on Microsoft features.
	I agree to be quoted openly, allowing the mentioning of my full name in the context of the research study, including potential publications.
	I agree to be quoted anonymously, not allowing the mentioning of my full name in the context of the research study, including potential publications.

By signing this form, I understand and agree that;

11. I am voluntarily taking part in this research.
12. The FGD will be recorded and transcribed.
13. The researchers may be using a transcribing tool called otter.ai.
14. I withhold the right to withdraw from the discussion at any time.
15. The transcribed FGD will be analysed for the purpose of this research study.
16. I confirm my indicated preference for name disclosure.
17. I am aware of and looked at the FGD relevant tool summaries and question guide.
18. I don't expect to receive any benefit or payment for my participation.
19. I can ask any questions before and/or after the discussion.
20. I am free to follow up on the research and contact one of the researchers in the future.

Research participant:

______________________________ ______________________________
Participant's signature; date

______________________________ ______________________________
Researcher's signature; date

Research supervisors:

This research has been reviewed and approved by the department of the Master's in Strategic Leadership towards Sustainability (MSLS) at the Blekinge Institute of Technology, Sweden. It is supervised and supported by two internal and one external advisor; please contact us for more detailed information.

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Appendix G: FGD Tool Summaries

Tool Summaries

The selected five frameworks/tools are evaluated along the three sustainability dimensions i.e. ecological, social and economic, specifically, according to their thematic areas, sustainability objectives, respective monitoring indicators and measurable parameters. Afterwards, they are aligned along the 8 Sustainability Principles (SPs) of the Framework for Strategic Sustainable Development (FSSD) to identify indicators of success. Feel free to read more about the five tools in this shared google folder.

RISE 3.0 TOOL

The Response-Inducing Sustainability Evaluation (RISE) version 3.0 is an indicator-based framework/tool for the sustainability assessment of agricultural production at the farm level. It was developed at the Bern University of Applied Sciences, School of Agricultural, Forest, and Food Sciences (HAFL) in Switzerland in 1999. RISE has undergone an iterative development process incorporating user feedback and expert consultations since its launch. RISE aims to provide a holistic assessment of farm-level sustainability, considering ecological, social, and economic dimensions. It can be used for both certification procedures and as an advisory tool. The target group includes all stakeholders in agriculture, society, administration, and business. The analysis begins with data collection through a questionnaire-based interview with farmers on their farm's ecological, social, and economic aspects. There are a total of 46 sustainability indicators condensed into 10 themes. RISE data is compared against benchmark data and normalised to a scale of 0 to 100, where 100 represents optimal sustainability and 0 represents an unacceptable situation. A theme score is calculated using the arithmetic mean of equally weighted indicator scores. RISE version 3.0 is aligned with the United Nations' Sustainable Development Agenda 21 (1992), UN Sustainable Development Goals (SDGs), and other international frameworks. Its indicators are structured according to the principles of SAFA guidelines (2013). During its development, RISE 2.0 was cross compared against various sources like OECD, GRI, MOTIFS, KSNL, Unilever, ILO, and IDEA. RISE aligns with systems thinking approaches and sustainability assessment frameworks that integrate life cycle analysis, resource efficiency, and social sustainability. It is based on the sustainable development concept introduced by Brundtland and follows a principle-based approach with strong scientific soundness. It views the farm as a dynamic, interconnected, multi-dimensional system. RISE effectively guides farms towards sustainability by providing a structured, data-driven framework for continuous improvement. The sustainability polygon and traffic light system help farmers to identify and prioritise areas for improvement. The tool also provides actionable recommendations.

SMART-FARM TOOL

The Sustainability Monitoring and Assessment RouTine (SMART) Farm Tool was developed by FiBL in 2014 to assist farms and enterprises in the food sector for assessing their sustainability level in a credible and transparent manner. The specific software is used to compute context-specific indicators that are compiled individually for each case study. The SMART-Farm Tool was developed to address the deficiencies in existing sustainability assessment tools for food systems, which often focused on single dimensions or themes and lacked comparability. More than 60 agricultural and sustainability experts contributed to the development of the tool. With the help of the SMART-Farm Tool, the specific sustainability performance of farms can be recorded, analysed and assessed in a systematic manner. Data needed for the assessment are semi-quantitative and collected using a standardised interview procedure. The software should be handled by scientists and/or field practitioners. The extensive list of indicators includes transversal environmental topics from water pollution to soil quality and degradation, air quality, fertilizer consumption, biodiversity, energy use and even animal welfare. Examples of the broad list of environmental indicators in the framework include pesticide presence in water, greenhouse gas emissions, phosphorus crops content, conservation of species and the use of renewable energy. Social indicators are also included in the SMART framework, assessing employees' rights and their wage level for a dignified life. The social dimension also includes gender equality and non-discrimination, cultural diversity, health coverage and access to medical care. Finally, economic indicators cover a set of themes, from profitability to vulnerability, accountability, the resilience of the investment and value of the local economy (Alaoui et al. 2022).

SAFE TOOL

The Framework for Assessing Sustainability levels in Belgian agricultural systems (SAFE), is a multi-scale, indicator-based framework developed in Belgium (2003-2005) by a multidisciplinary team of researchers with input from farmers. Its objective is to assess the sustainability of agricultural systems by combining environmental, economic, and social indicators at various spatial levels, including farm, regional, national, parcel, and watershed. For soil and biodiversity, it uses landscape ecosystem assessments, and for some environmental, social and economic issues, it uses administrative units.
SAFE aims to provide a holistic assessment of sustainability impacts on the agro ecosystem, addressing sustainability levels unlike some other frameworks. The tool is designed for a broad audience of stakeholders involved in agriculture and sustainability, such as scientists, policy makers, and administration officers. While the specific indicators are tailored to the Belgian agricultural context, the underlying methodology is generic and potentially transferable to other geographical areas.
SAFE builds upon existing sustainability assessment tools such as Indicator-Based Sustainability Frameworks, OECD Agri-Environmental Indicators, Multi-Scale Sustainability Assessments (including DPSIR), Agro-Ecological Zoning (AEZ), MESMIS, and RISE. It is also aligned with EU Common Agricultural Policy (CAP) Sustainability Indicators. A key differentiating factor of SAFE is its combination of multi-scale assessment, encompassing field, farm, and regional levels, offering a flexible and adaptable platform for the Belgian context. No complementary tools are described as mandatory or optional for the use of the SAFE tool.
SAFE integrates and acknowledges the interconnectedness between the ecological, social, and economic dimensions of the food system through a holistic, multi-scale, and essential indicator-based approach. The environmental dimension considers resources and ecosystem integrity, focusing on buffer and stock/supply regulation functions. The economic dimension focuses on economic viability. The social dimension considers food security and safety, quality of life, and social and cultural acceptability. It adopts a systemic view of the agricultural and food system, highlighting the interdependencies and the necessity of assessing trade-offs and synergies. Stakeholder involvement is considered as essential to identify relevant sustainability issues and weigh the importance of indicators. The system boundaries in SAFE are primarily restricted to on-farm activities of the production cycle, excluding most upstream and downstream activities, except for the calculation of energy indicators and indirect CO_2 emissions related to farmer input choices. While acknowledging the dynamic nature of agro ecosystems, SAFE uses a yearly timescale for indicator calculation, with the recommendation for monitoring trends over several years due to cyclic behaviours and variations. SAFE is built upon the Triple Bottom Line approach and uses a top-down approach with some stakeholder participation, defining sustainability in terms of agricultural productivity.
While case studies for SAFE were conducted on larger scales (minimum 51 ha), it can be applied at the parcel or farm scale to guide strategic decisions for small scale food projects towards sustainability. SAFE serves as an assessment tool to identify, develop, and evaluate more sustainable agricultural production systems, techniques, and policies, thereby helping to improve long-term ecological, social, and economic stability. Economic viability is considered as a pre-condition for several aspects of the social dimension. Data collection for SAFE involves specific protocols, various collection devices (logbook, questionnaires, accountancy records), and existing databases. Compared to tools like RISE, SAFA, IDEA, or MOTIFS; SAFE is considered less user-friendly.

LiteFarm TOOL

LiteFarm version 1.0.0 was publicly released in July 2020 as a free, open-source, online farm management tool. It is a participatory science research project hosted at the University of British Columbia (UBC), aiming to improve access to digital agricultural tools for farming communities and to enhance understanding of sustainable agriculture. LiteFarm is funded by the Centre for Sustainable Food Systems at UBC and other grants. Since its release, it has been continually developed through collaboration between farmers, researchers, designers, and developers to create localised modules and new features. LiteFarm is now used in over 155 countries on more than 5,000 farms by 5,600 users.

Unique in its category, LiteFarm provides built-in decision support and pathways for farmers to earn additional income through mechanisms like payment for ecological services (PES) and Organic/Ecologic certifications. These features help incentivise sustainable land use while expanding global data collection efforts on diversified farms. LiteFarm's mission is to meet farmers where they are to equip them with the tools, they need to make informed and responsible decisions about the health of their farm, their livelihood, their community, and the planet. UBC partners with farmer organisations to pilot and refine tools that improve farm profitability and environmental and social sustainability.

The platform's code is licensed under GPLv3, inviting global collaboration to improve its services. Non-commercial by design, LiteFarm is an example of a tool that transcends conventional for-profit training and categories of extended value chains, instead aiming to actively support agroecological decision-making that goes into farming and decision making, applying the agro-ecological principles and supporting alignment towards sustainable agriculture practices. At its core, the digital tool is built for accessibility and is tailored to a diverse audience, including sustainable farmers, communities, researchers, and cooperatives.

Designed specifically for agroecological and diversified farmers, LiteFarm follows the principles of food and data sovereignty and is based on the agroecological principles, based on a holistic understanding of sustainability as an academic and theoretical foundation. When the tool was first made, it was designed to fill a niche as the world's first community led, not-for-profit digital platform that connects farmers and scientists for participatory assessment of social, environmental, and economic outcomes in farming systems. LiteFarm acknowledges the interconnected and holistic ecological, social and economic dimensions of the food system. The working definition of sustainability for the LiteFarm tool is the capacity of a system to function perennially or to produce a reliable output in the long-term (Kroese 2019).

The tool's structure, based on the TAPE Guidelines, inherently gives prominence to a comprehensive evaluation across all three dimensions of sustainability, which encompasses a wide array of sub-themes within the social, ecological, and economic metrics. The digital tool's effectiveness can be enhanced in practice by optionally using other technologies, such as open source, free tools developed via OpenTEAM (Open Technology Ecosystem for Agricultural Management). Many additional digital tools can be used alongside LiteFarm, the Fieldprint Platform, with the online Fieldprint Calculator Tool for sustainability transitions, assessing and measuring the environmental impact of commodity crop production and identifying opportunities for improvement. Soil data integrations (Land-PKS, Cropio) greenhouse gas estimates (COMET-Farm), and carbon footprint, water usage and biodiversity (Cool Farm Tool). The LiteFarm development team prioritises accessibility and feasibility for farmers when developing the tool features. Feedback and learnings are integrated; hence, LiteFarm is constantly being updated and adapted.

The LiteFarm tool's Sustainability Assessment Framework draws and connects interactions between its layers through a hierarchical structure, informed with reference to the TAPE (The Tool for Agroecology Performance and Evaluation), RISE and IDEA frameworks. Within the tool's framework and current application, there are a total of 17 parameters making up 9 different sustainability indicators encompassing the environmental, financial and social sustainability of smallholder farms.

SAEMETH TOOL

The Sustainable Agri-Food Evaluation Methodology (SAEMETH) is a research tool designed to evaluate the sustainability of small scale agri-food supply chains. It was inspired by the Slow Foods Presidia project, which emphasises a more conscious relationship between food and its sustainable production. SAEMETH aims to address the limitations of conventional evaluation approaches that often lack a holistic integration of economic, social, and environmental dimensions. It is a monitoring tool with an interpretive structure, focusing on qualitative indicators and designed for user-friendliness and strong communication through a long-term participatory approach. The framework is based on the economic, agro-environmental, and socio-cultural dimensions of sustainability. The tool is primarily intended for farmers and food supply chain actors, particularly technicians of small scale systems.

SAEMETH offers a holistic and participatory framework that integrates economic, social, and environmental dimensions. Its focus is on user involvement and qualitative indicators, making it accessible and understandable for small scale actors. The hierarchical structure allows users to start with a global vision and narrow down to local indicators. The visual representation of results facilitates analysis and prioritisation of actions. The tool also emphasises the interconnectedness between the different dimensions of the food system. SAEMETH employs a multi-level framework:

- **Level 1:** Dimensions - Socio-cultural, Agro-environmental, and Economic. These dimensions are given equal importance in the total measure of sustainability.
- **Level 2:** Components - Each dimension is broken down into specific components (e.g., Product use, Internal relationships, External relationships, Culture/terroir for Socio-cultural). These components are given equal weight within each sustainability dimension, reflecting trade-offs and priorities of target users.
- **Level 3:** Indicators - Each component is further detailed by specific, measurable indicators that provide concrete data for evaluation. The weights attributed to each indicator are subjective but based on the pre-supposition that all indicators and components are equally important.

SAEMETH is applied through a participatory approach involving stakeholders, including farmers. The process involves defining and weighing sustainability dimensions, components, and indicators relevant to the specific context. Data related to indicators are collected, and the sustainability performance is assessed and visualised using radar and bar graphs to identify strengths and weaknesses. The results are then discussed with producers to understand their perspectives and validate the assessment, empowering them to prioritise actions for improvement. The tool is designed to be flexible for decision-making across short, medium, and long-term periods. While no complementary software is mandatory, the application involves adopting specific production protocols and may benefit from activities like training and market development.

SAEMETH primarily relies on qualitative indicators, which simplifies potentially complex aspects of sustainability into subjective assessments. The choice of indicators was based on data availability, which might not always align with scientific relevance. The tool is designed to be applicable at local and regional levels only. Some important quantitative indicators, particularly those related to specific agro-ecological practices, may be excluded due to the focus on qualitative data. The analysed supply chains are often in an initial phase, so the data may not always show long-term effects of alternative management.

SAEMETH provides a framework for evaluating factors influencing the stability and reliability of ecological, social, and economic outcomes. Case studies have shown a substantial increase in socio-cultural sustainability due to increased stakeholder relationships. Economic returns, such as profit growth and increased bargaining power for producers, also indicate the efficiency of small scale systems tied to regional products. Ecological returns may take longer to manifest due to natural environmental processes.

Appendix H: FGD Agenda

Focus Group Discussion (FGD) Agenda

Welcome & Introduction

Welcome and check in question: *What motivates you in the food system?*

Research Summary

Presentation of selected sustainability assessment tools for small scale agri-food projects: RISE, SAEMETH, SAFE, SMART, and LiteFarm

Main Group Discussion

(Questions on sustainability, agri-food tools, and 2000 m² projects)

General questions:

1. How do you understand sustainability in the food and farming sector and in agri-food projects?
2. What is your experience in the agri-food and farming sector? *(2 minutes per person)*
3. In general, what is the main purpose of applying agri-food assessment tools for sustainability and what components do you consider most essential to achieving that purpose?
4. Are there ways that sustainability assessment tools could be better designed to facilitate communication? Could assessment tools be designed and communicated to facilitate application in a more participatory way with stakeholders across the agri-food system?

2000 m² specific questions:

5. Have you used any specific sustainability assessment tool for the 2000 m² project? Have you used any of the tools we have shared? (*If so, tell us about your experience. For example: how easy was it to use? Did it require specific knowledge? If so, which one, and how was your experience with it?)*
6. In your opinion, what are the key sustainability objectives within the context of the 2000 m² project and what sort of measurable indicators would help you understand if you are meeting that objective?
7. If sustainable small scale agri-food projects in Sweden were to become viable and successful, what would that look like? What would be the key factors that have gotten us there?
8. What is the role of assessment tools in achieving this?

Open Q&A

Appendix I: FGD Guide

Focus Group Discussion (FGD) Guide

Introduction

Time	**Activity**	**Objective**	**Note**
2 minutes	Welcoming everyone to the MS Teams space, appreciating their curiosity and time to contribute to the research	Creating a warm atmosphere	Inviting everyone to turn their cameras on
3 minutes	Explaining the research set-up (about 75-90 minutes), highlighting an explorative research approach (with no right or wrong answers), addressing formalities (**FDG Consent Form** – sent via email), inviting deep listening, and removing distractions (if possible)	Receiving oral consent to voluntarily take part in the research and recorded group discussion	Mentioning the use of otter.ai (advanced GDPR – proof research tool)
-	***Start recording***		
8 minutes	Check-in round, inviting everyone to say their name and role Question: What motivates you in the food system?	Giving one minute for people to reflect on the question before answering and allowing everyone the chance to speak and sense into the group	Asking the person who has just talked to "nominate" another person in the group
12 minutes	Summarising the research and process briefly (purpose and question) and transitioning and inviting knowledge sharing on the research topic (questions below) Frame: Our focus is small scale agri-food projects and farms. 2000 m² is our chosen case study. We invite you to talk about your experience in other contexts. *Hand-over to second researcher and host.*	Kicking off the discussion	Only two researchers keep their cameras on

Tool Review Presentation: RISE, SAEMETH, SAFE, SMART, and LiteFarm
Screen-sharing the Power Point Presentation.

General questions:

1. If sustainable small scale agri-food projects in Sweden were to become viable and successful, what would that look like? What would be the key factors that have gotten us there?
2. How do you understand sustainability in the food and farming sector and in agri-food projects? (*We are defining agri-food as all the interconnected activities and actors involved in getting food from farm to plate.)*
2. What is your experience in the agri-food and farming sector? *(2 minutes per person)*
3. In general, what is the main purpose of applying agri-food assessment tools for sustainability and what components do you consider most essential to achieving that purpose?
4. Are there ways that sustainability assessment tools could be better designed to facilitate communication? (and application in a more participatory way with stakeholders across the agri-food system?)

2000 m² specific questions:

5. Have you used any specific sustainability assessment tool for the 2000 m² project? Have you used any of the tools we have shared? (If so, tell us about your experience. How easy was it to use? Did it require specific knowledge? If so, which one, and how was your experience with it?)
6. In your opinion, what are the key sustainability objectives within the context of the 2000 m² project and what sort of measurable indicators would help you understand if you are meeting that objective?
7. **Invitation to reflect again on the first question to round up the discussion:** If sustainable small scale agri-food projects in Sweden were to become viable and successful, what would that look like? What would be the key factors that have gotten us there? What is the role of assessment tools in achieving this?

Closure

7 minutes	Welcoming open questions about the research and/or topic, asking for additional resources (now or via email), and offering future contact and exchange (e.g., via LinkedIn and network groups)	Being open and transparent	All researchers turn their camera on
6 minutes	Check-out round Question: What are your key takeaways from the conversation today?	Allowing everyone to reflect and speak	Space for open thoughts
-	***End recording***		
2 minutes	Thank you note and saying goodbye to the participants (small talk)	Being thankful	Important

Notes

Additional notes for the hosting team:
Tips for preparation: Prior to the meeting, send an agenda/flow stating your purpose and outcomes, along with basic online etiquette, and instructions on how to join the call and a note to download MS Teams. Ask participants to download the MS Teams platform if they have not already and remind them, they need to join from a computer with good internet connection. Best practice is to use and open the virtual room up to 15-20 minutes in advance to host people coming in early. It will give an opportunity to troubleshoot any issues before opening the session. In some programs, you can enable a waiting room.

Roles:
Host/co-hosts – To speak, present, listen and host well, holding a safe and respectful energetic container for the group and for the discussion to unfold naturally.
Timekeeper – The timekeeper may want to use a visual cue, like holding a sticky note to the camera instead of giving a verbal or audio cue.
Tech host – To support people that are having difficulties with their tech, also shows visuals (like a slide presentation), highlights a presenter (using Spotlight on MS Teams or Zoom), etc.
Also, paying attention to unintentional unmuting and other distractions, sharing the questions being explored in the document/chat as the host proposes it!

Remember:
Use of Silence
Remember silence is part of the conversation and can support deepening the conversation –
it is important to invite silence particularly in a virtual environment.
Movement
Pause every 30-45 minutes, invite people to get out of their chair, walk, move, have a drink etc.
Awareness of stakeholders in the room
Who is who and what are their roles and relationships?
(Remember we have a harvest of stakeholder maps/acknowledging and valuing relational capacity inherent in small scale agri-food projects like 2000 m².)

Appendix J: FGD Summary Presentation

Sustainability Assessment Tools for Small Scale Agri-Food Projects in Sweden

MSLS Master's Thesis

The Blekinge Institute of Technology (BTH)
Master's in Strategic Leadership towards Sustainability (MSLS)

May 5th, 2025 – Microsoft (MS) Teams

Pallavi Priya, Bidisha Mukherjee, Holly Gurling, and Ann Cathrin Nachtwey

Table of Contents

- **Research Questions**
- **Methodology**
- **Selection Criteria**
- **Tool Overview**

2

Research Questions

Main Research Question:
What are the most useful assessment tools for small scale agri-food project alignment towards sustainability?

Sub Research Question:
- *What are sustainability assessment tools available for evaluating small scale agri-food projects through a systems thinking approach?*
- *What are the essential components of sustainability assessment tools for evaluating small scale agri-food projects?*
- *What is the usefulness in practice of the reviewed sustainability assessment tools?*

3

Methodology

Qualitative mixed methods research study, including the following data collection methods.
- Semi-structured Literature Review
- Desktop Review
- Expert interviews (5 in total (one per tool))
- FGD (2 in total (one per community))

- Sampling Technique: Purposive & Snowball sampling
- Conceptual & Analytical Framework: Framework for Strategic Sustainable Development (FSSD)

4

Selection Criteria

- To address the need of the study the tool has to aim at assessing the sustainability performance at farm-level using an indicator-based sustainability assessment criterion.
- To ensure scientific rigor, the tool has to be published in a peer-reviewed scientific journal and/or peer-reviewed scientific report. The publication has to be written by the tool developers and focus on the tool. Thereby, tools that are only mentioned in reviews, without any other scientific publication, are excluded.
- It has to be focused on three dimensions of sustainability defined in our research i.e. *economic, environmental and social sustainability indicators*.
- The tool has to be suitable for the assessment of farms suitable for Northern Europe
- The tool has to be suitable for Northern West European context and projects similar to the 2000m^2 concept.

5

Tool Overview

- Response-Inducing Sustainability Evaluation (**RISE**) 3.0
- Sustainability Monitoring and Assessment Routine Tool (**SMART**)
- Sustainability Assessment of Farming and the Environment (**SAFE**) Framework
- Sustainable Agri-Food Evaluation Methodology (**SAEMETH**) Framework
- **LiteFarm** Tool

Note: Please find our *Tool Summaries* attached to the previous email.

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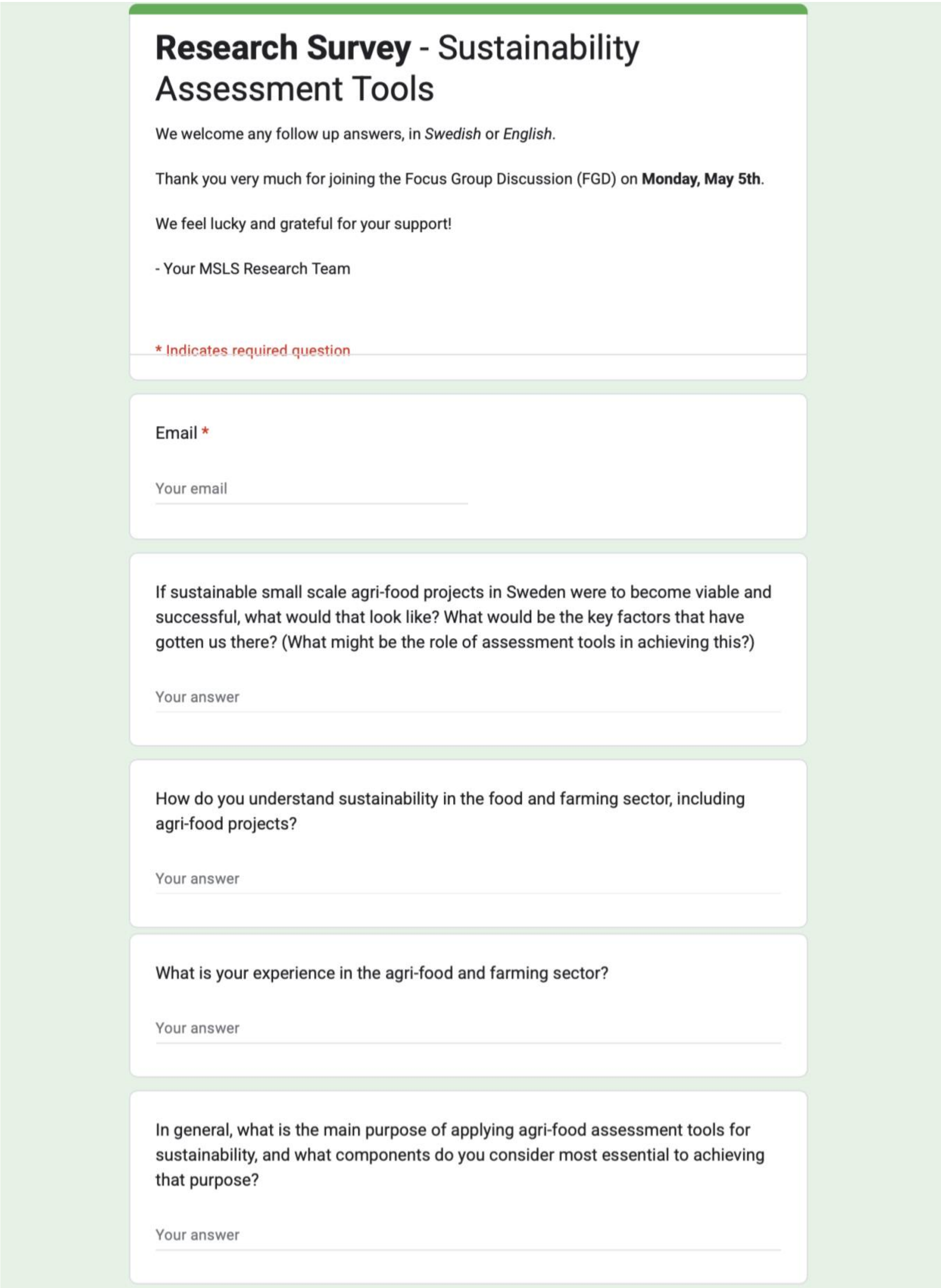
Thank you for your time and participation!

We warmly welcome any questions.

Holly Gurling
On behalf of the Research Team

Email: hogu24@student.bth.se
Phone: +46734821097

Appendix K: FGD Follow up Survey



Research Survey - Sustainability Assessment Tools

We welcome any follow up answers, in *Swedish* or *English*.

Thank you very much for joining the Focus Group Discussion (FGD) on **Monday, May 5th**.

We feel lucky and grateful for your support!

- Your MSLS Research Team

* Indicates required question

Email *

Your email

If sustainable small scale agri-food projects in Sweden were to become viable and successful, what would that look like? What would be the key factors that have gotten us there? (What might be the role of assessment tools in achieving this?)

Your answer

How do you understand sustainability in the food and farming sector, including agri-food projects?

Your answer

What is your experience in the agri-food and farming sector?

Your answer

In general, what is the main purpose of applying agri-food assessment tools for sustainability, and what components do you consider most essential to achieving that purpose?

Your answer

Are there ways that sustainability assessment tools could be better designed to facilitate communication? Could assessment tools be designed and communicated to facilitate application in a more participatory way, with stakeholders across the agri-food system? *

Your answer

Have you used any specific sustainability assessment tool for the 2000m² project? Have you used any of the tools we have shared? (RISE, SMART, SAEMETH, SAFE, and/or LiteFarm)

Your answer

In your opinion, what are the key sustainability objectives within the context of the 2000 m² project and what sort of measurable indicators would help you understand if you are meeting that objective?

Your answer

Space for your feedback and after-thoughts.

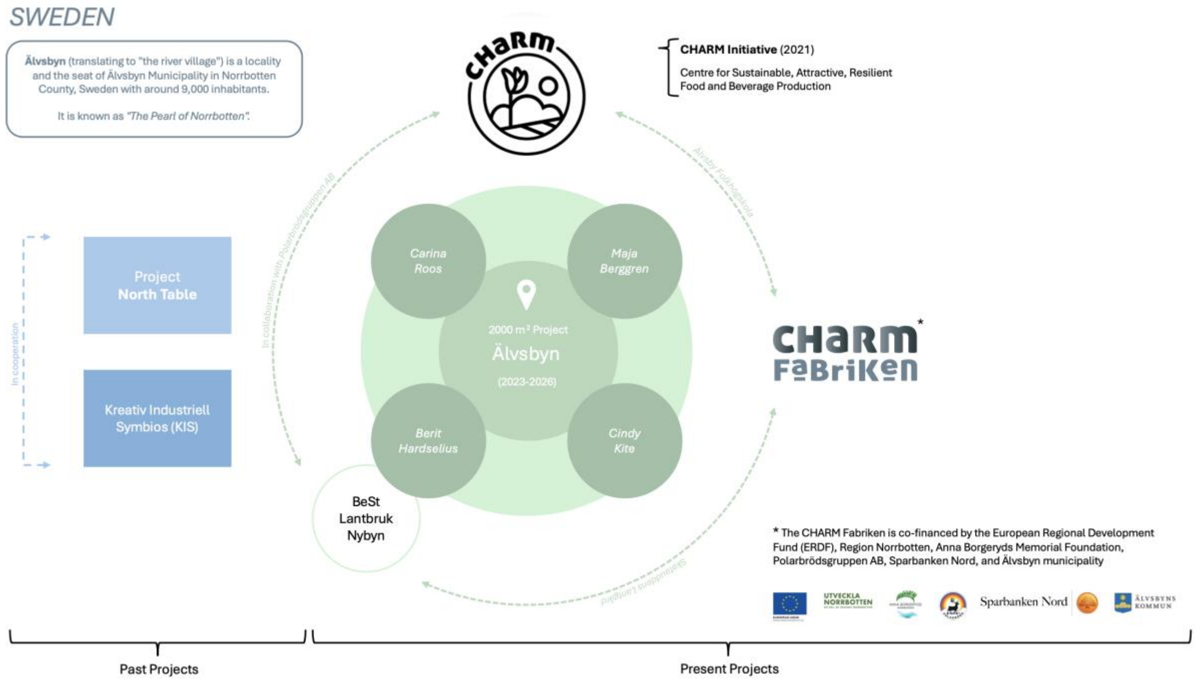
Your answer

Submit

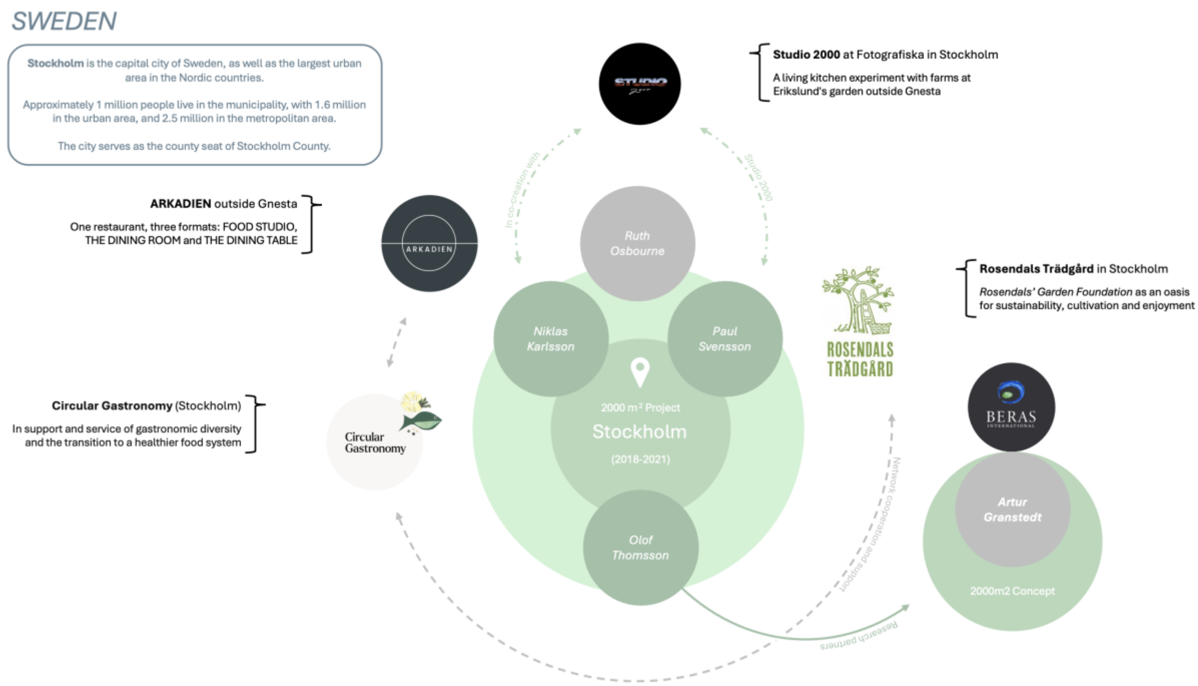
Clear form

Never submit passwords through Google Forms.

Appendix L: Stakeholder Maps



Stakeholder map mentioning the FGD participants (in green circles) from the 2000 m² project in Älvsbyn.



Stakeholder map mentioning the FGD participants (in green circles) from the 2000 m² project in Stockholm.

Appendix M: Pictures of the 2000 m² project in Älvsbyn

Two photos of the 2000 m² project site in Älvsbyn (2023), provided by Carina Roos.

Appendix N: Tool List of the 40 Reviewed Assessment Tools

List of the 40 Reviewed Assessment Tools

Number	Acronyms	Name of the Tool (alphabetical order)
1	4AGRO	The 4Agro Method
2	ACT	Agroecological Criteria Tool(s)
3	AFSSA	Agri-Food Systems Sustainability Approach
4	Agrecalc	Agrecalc Calculator
5	AVIBIO	AVIculture BIOlogique
6	CBEAT	Circular Bioeconomy Accounting Tool
7	CE@AFSC	Circular Economy in Agri-Food Supply Chains
8	CFT	Cool Farm Tool
9	COMET-Farm	COMET-Farm
10	Dia'Terre	Dia'Terre Tool
11	DPSIR	Driver-Pressure-State-Impact-Response Framework
12	FC	Fieldprint Calculator
13	FESLM	Framework for the Evaluation of Sustainable Land Management
14	FMEA	Failure Mode and Effect Analysis Framework
15	Foodmeter	Foodmeter
16	FSMD	EU Food System Monitoring Dashboard
17	HLPE-UN	Sustainable Food System Framework
18	IDEA	Indicateurs de Durabilité des Exploitations Agricoles
19	INSPIA	Initiative for Sustainable Productive Agriculture
20	LADA	Land Degradation Assessment in Drylands
21	LF	LiteFarm Tool
22	MASC	Multi-attribute Assessment of the Sustainability of Cropping Systems
23	MESMIS	(spanish acronym for) an Indicator-based Sustainability Assessment Framework
24	MOTIFS	Monitoring Tool for Integrated Farm Sustainability
25	MSAT	Multi-Dimensional Sustainability Assessment Tool
26	PG Tool	Public Good Tool
27	PGS	Participatory Guarantee Systems Tool
28	POEMS	Product-Oriented Environmental Management Systems
29	PSR	Pressure-State-Response Framework
30	RISE	Response-Inducing Sustainability Evaluation
31	SAEMETH	Sustainable Agri-Food Evaluation Methodology Framework
32	SAFA	Sustainability Assessment of Food and Agriculture Framework
33	SAFE	Sustainability Assessment of Farming and Environment Framework
34	SES	Social-Ecological Systems Framework
35	SIAT	Social Innovation Assessment Template
36	SLCA	Social Life Cycle Assessment
37	SMART	Sustainability Monitoring and Assessment RouTine Farm Tool
38	SOSTARE	SOSTARE Model
39	TAPE	Tool for Agroecology Performance Evaluation
40	TCCA	Transformational Climate Change Adaptation Framework

Appendix O: Example of the detailed 5LM Tool Review

Detailed 5LM Review of the SMART-Farm Tool

SMART-Farm Tool

Tool Level:
Tool Introduction:
[Developers/developing organisation with associated developers; year of development; geographic demarcation; brief history; tool audience and users; tool design etc.]

The Sustainability Monitoring and Assessment RouTine (SMART) Farm Tool was developed by the Research Institute of Organic Agriculture (FiBL) in 2014 to assist farms and enterprises in the food sector for assessing their sustainability level in a credible and transparent manner. More than 60 agricultural and sustainability experts contributed to the development of the tool (Curran, 2020). The specific software is used to compute context-specific indicators that are compiled individually for each case study. The SMART-Farm Tool was developed to address the deficiencies in existing sustainability assessment tools for food systems, which often focused on single dimensions or themes, and lack comparability. With the help of the SMART-Farm Tool, the specific sustainability performance of farms can be recorded, analysed and assessed in a systematic manner (Alaoui et al. 2022).

Data needed for the assessment are semi-quantitative and collected using a standardised interview procedure. The software should be handled by scientists and/or field practitioners. The extensive list of indicators includes transversal environmental topics from water pollution to soil quality and degradation, air quality, fertilizer consumption, biodiversity, energy use and even animal welfare. Examples of the broad list of environmental indicators in the framework include pesticide presence in water, greenhouse gas emissions, phosphorus crops content, conservation of species and the use of renewable energy. Social indicators are also included in the framework, assessing employees' rights and their wage level for a dignified life. The social dimension also includes gender equality and non-discrimination, cultural diversity, health coverage and access to medical care. Finally, economic indicators cover a set of themes, from profitability to vulnerability, accountability, the resilience of the investment and the value of local economy (Alaoui et al. 2022).

The Food and Agriculture Organisation (FAO) of the United Nations (UN) published the Sustainability Assessment of Food and Agriculture Systems (SAFA) Guidelines as a universal framework, providing a hierarchical structure of dimensions, themes, and sub-themes. The SMART-Farm Tool was created with the aim of operationalising these SAFA Guidelines at the farm level. The development of the SMART-Farm Tool involved the definition of science-based indicator sets and assessment procedures, including the Degree of Goal Achievement (DGA) with respect to the 58 themes defined in the SAFA Guidelines. The use of an impact matrix helped in the identification and connection of 327 indicators and 1769 relations between sustainability themes and indicators. A three-year process of selection and continuous refinement of the indicators thereby involved a team of experts including the authors and 18 external, theme-specific experts. This iterative process included testing different formulations of indicators and benchmarks and discarding overlapping indicators. The SMART-Farm Tool (Version 2.1) aims to provide comparable and reproducible results on the environmental, social, and economic sustainability performance of farms (Schader et al. 2016).

According to Landert et al. (2020), the SMART-Farm Tool is considered to be among the most comprehensive Sustainability Assessment Tool (SAT) for undertaking assessments, delivering on seven of the eight Bellagio Sustainability Assessment and Measuring Principles (see Arulnathan et al. 2020; Pintér et al. 2012). This was further emphasised in their paper by Alaoui et al. (2022), which states that SMART is the framework that considers, in a balanced way, the environmental, sociocultural, and economic dimensions of sustainability, whereas other assessments primarily focus on the environmental (RISE), environmental and economic (PG Tool), and sociocultural (SAFA) dimensions. Furthermore, as concluded by Landert et al. (2020), the tool is distinguished because of its integration of the contribution of stakeholders in its development, which supports user-friendliness (Alaoui et al. 2022).

Guiding Questions:

1. Is this tool built upon existing sustainability assessment tools?

The SMART-Farm Tool is based on the SAFA Guidelines, which were published in December 2013 by the UN-FAO. As FiBL also contributed to the development of these guidelines, the SMART-Farm Tool is fully consistent with the SAFA procedures and principles and allows an efficient application of the guidelines. To achieve the best possible tool acceptance, legitimacy and compatibility; further reference documents have been considered during the development, such as the Sustainability Reporting Guidelines of the Global Reporting Initiative GRI-G4, the UN Global Compact, the ISO 26000 "Guidance for social responsibility", the SA8000 Standard for Social Responsibility, the ILO work and social standards, as well as the indicator matrix of the Economy for the Common Good (FiBL 2025).

2. Are there any complementary tools that are either mandatory or optional to be used alongside the tool to enhance its effectiveness?

The SMART-Farm Tool can be used alongside specific tools targeted at single dimensions or topics, covering more quantitative measurements of resource efficiency, complementing the sustainability performance assessment. Research points to the use of extra tools for assessing biodiversity, such as the Credit Point System (CPS), and tools for assessing greenhouse gas emissions, such as the Cool Farm Tool (CFT). Landert et al. (2020) additionally refers to the economic farm assessment tool, called Comparative Agriculture System Model (COMPAS). Also, Life Cycle Assessments (LCAs) can provide more detailed data for specific sub-themes like energy use, greenhouse gases, and potentially profitability through calculations of gross margins. As a tool for extension, also the OCIS PG-Tool is mentioned (Schader et al. 2016). To provide direct advice to farmers in a didactic way, possibly in an extension context, tools like RISE are considered as more appropriate (Schader et al. 2016). While studies show that tools can enrich and complement each other, there is no standard method of how to incorporate data (Alaoui et al. 2022). Conclusively, while no specific tool is mentioned as strictly mandatory, the SMART-Farm Tool's effectiveness can be enhanced by optionally using topic-specific tools or more quantitative assessment methods for more targeted analysis. Alternatively, the SMART-Farm Tool can be combined with an advisory tool, like RISE, for farmer engagement. Until now, no standard approach for integrating data of different assessments is publicised (Alaoui et al. 2022).

System Level:
Guiding Questions:

3. How does the tool acknowledge the interconnectedness between the ecological, social, and economic dimensions of the food system?

The SMART-Farm Tool explicitly acknowledges the interconnectedness between the ecological, social, economic and governance dimensions of the food system through its comprehensive assessment approach and its analysis of trade-offs and synergies. As a comprehensive assessment framework, the SMART-Farm Tool operationalises the SAFA Guidelines, which provide a hierarchical structure of (environmental, economic, and social) dimensions, themes and sub-themes (Curran, 2020). In addition, the SAFA Guidelines incorporate governance as a horizontal and fourth dimension, assessing the farm's operational sustainability performance. By assessing farm performance across all 58 sub-themes, 21 themes fall under these four dimensions (Schader et al. 2016).

- The SMART-Farm Tool inherently recognises that activities and outcomes in one area can have implications for the others. For instance, a farming practice might improve economic profitability but negatively impacts environmental quality or social well-being. The tool is used to identify the degree of uniformity of impacts of indicators for each combination of sub-themes.
- The SMART-Farm Tool identifies instances where the same farm management strategies or indicators positively affect multiple sub-themes, even across different dimensions. For example, the indicator "Proportion of arable land under reduced tillage" has a positive impact on, both "Soil quality" (environmental), and "Greenhouse gas emissions" (environmental). This highlights how a single practice can contribute to multiple sustainability goals.
- The tool also identifies situations where indicators have positive impacts on one sub-theme but negative impacts on another, potentially across different dimensions. For instance, a higher cutting frequency of meadows might have positive impacts on "Profitability" (economic) but negative impacts on "Species diversity" (environmental). Analyses revealed major trade-offs within the environmental dimension and between the environmental and economic dimensions. Trade-offs

were also found between the social and economic dimensions and, to a lesser extent, between the social and environmental dimensions.

- The SMART-Farm Tool uses an impact matrix that defines 327 indicators and 1769 relations between sustainability themes and indicators. These relationships, determined by expert judgment, capture how specific farm practices (reflected by the indicators) influence various sustainability sub-themes across different dimensions. This detailed mapping of cause-and-effect relationships across all tool levels is fundamental to understand the interconnectedness of components.

The fact that the tool systematically analyses trade-offs and synergies both within and between these four dimensions puts emphasis on understanding the interrelationships between the social, ecological, and economic elements of farm sustainability. This suggests that the tool aims to move beyond simply measuring performance in each area in isolation and instead seeks to understand how actions in one area might affect the others. This procedure led to the selection of 327 indicators which are linked to 1 to 19 sub-themes of the SAFA Guidelines (Schader et al. 2016).

4. What are the underlying assumptions or simplifications to systems embedded in the tool?

Sustainability can be assessed at the farm level using a comprehensive set of indicators aligned with the SAFA Guidelines. The tool is based on the assumption that the incorporated guidelines are a valid and hierarchical structure (of dimensions, themes, and sub-themes) for evaluating sustainability in agriculture. The tool's assumption implies that these guidelines offer absolute, globally applicable, and internationally aimed sustainability objectives. Sustainability performance can thereby be quantified by measuring the Degree of Goal Achievement (DGA) with respect to predefined objectives for each of the 58 SAFA sub-themes. The DGA is expressed on a scale from 0 to 100% (Schader et al. 2016).

Trade-offs and synergies between different sustainability themes and dimensions exist and can be systematically analysed based on the relationships between indicators and sub-themes defined within the tool. The tool holds the assumption that these inherent relationships, identified through expert assessment of indicator impacts, can provide insights into potential conflicts and co-benefits of different farm management strategies. The tool's structure, concerning aggregation rules and algorithms quantifying the relationships between model components may thus be subject to assumptions and/or simplifications. Besides, auditor subjectivity in the evaluation of sustainability aspects may affect the calibration and validation of results. The framing of the sustainability problem and objective, as well as the provision and accuracy of data input shape the tool's application. Despite a multi-criteria sustainability assessment with a robust dataset for uncertainty analysis, the combined effect of all un-certainties cannot account for unforeseeable event (Schader et al. 2019).

<u>Success Level:</u>
Guiding Questions:

5. What are the highlighted (ecological, social, and economic) elements of success?

The tool's primary aim is to provide a holistic understanding of a farm's sustainability performance across all three dimensions, based on the SAFA Guidelines. The initial motivation for its development thereby arose from a need to address the limitations of tools' focus on one single dimension. Hence, the tool strives for a balanced assessment, giving prominence to a comprehensive evaluation across four dimensions, including governance. By encompassing a wide array of sub-themes within the social, ecological, and economic realms, the tool's main focus is to produce comparable and reproducible results of farm types at sub-theme level (Schader et al. 2016). With a broad coverage of all dimensions, the SMART-Farm Tool thereby supports communication and awareness raising among key stakeholders of the agricultural sector (Curran, 2020; Landert et al. 2020).

6. How are interactions drawn and connected between the tool's specific layers (e.g., themes, sub-themes, components, indicators etc)?

The SMART-Farm Tool draws and connects interactions between its layers through a hierarchical structure based on the SAFA Guidelines' dimensions, themes, and sub-themes. In total, the tool is based on 327 indicators for the 58 sub-themes. An impact matrix defines 1769 relations between these indicators and the sub-themes. The sustainability performance of a farm on relevant indicators (selected based on farm type and region) and their defined impacts (weights), determine the DGA for each sub-theme. Finally, sub-theme scores can be aggregated to the theme and dimension levels, showing the interconnectedness of sustainability aspects in the bigger picture (Schader et al. 2016).

Strategic Guidelines Level:
Guiding Questions:

7. How can the tool guide strategic decisions in small scale food projects towards sustainability, while being flexible for adaptation?

The SMART-Farm Tool Report contains valuable information on the farm's sustainability performance, its potential and areas of improvements. The retrieved data can therefore be summarised and translated to help in the future planning and decision-making for the farm management, commonly done through in-person consultation, facilitated through workshops. Since the tool does not stay within the physical boundaries of a farm, sustainability impacts are considered beyond systems boundaries, along the upstream value chain. Hence, zooming in and out allows to maintain comparability across farms (Schader et al. 2016) to take full responsibility and guide strategic decisions and actions accordingly.

8. **To what extent does the tool regenerate stable and reliable (ecological, social, and economic) returns?**

The SMART-Farm Tool provides feedback to farmers on their performance across all sub-themes, implicitly highlighting the interconnectedness of their practices. While the tool itself doesn't directly regenerate returns, it provides information that can inform decisions towards more sustainable practices, potentially leading to more stable ecological, social, and economic outcomes in the long-term. The analysis of trade-offs, particularly between environmental and economic dimensions, emphasises the need for a holistic perspective (Schader et al. 2016).

Action Level:
Guiding Questions:

9. How is the tool applied and used to prioritise actions on the farm level?

The SMART-Farm Tool can be applied in different context, from research to business management (Schader et al. 2016). To perform the analysis and collect data at the farm level, several actions need to be taken (Alaoui et al. 2022; FiBL 2025). The following steps are part of the tool-specific assessment procedure:

1. The first step is to clearly define the objectives and boundaries of the sustainability assessment. This will help determine which specific aspects of the farm will need to be evaluated with how much detail.
2. The second step is to collect the relevant data; therefore, a trained and qualified auditor conducts a farm and field visit. This is typically done by trained auditors who undergo a 5–10 days formalised training procedure. The farm visit typically lasts between 2 and 3 hours, and includes a general introduction, a farm tour, and the main interview with the farm manager.
    - During the interview, the auditor collects data necessary to evaluate the relevant indicators for the sustainability assessment. The number of indicators assessed on a single farm depends on a relevance check, which automatically selects a subset of indicators (from the total pool of 329) applicable to the specific farm type and regional context.
    - The compliance check feature of the tool auto-rates indicators that are compliant due to standards or regional context (e.g., organic certification implies no synthetic pesticide use). However, auditors still need to verify these assumptions if there is evidence to the contrary.
3. The third step is the evaluation of each selected and applicable indicator, based on the collected semi-quantitative data. Data from certifications, audits, or previous assessments can be integrated into the SMART-Farm dataset. The algorithms within the SMART-Farm Tool then calculate and describe the impact of each indicator on the farm's performance concerning a specific sub-theme. The DGA for each of the 58 SAFA sub-themes is calculated, which considers both the impacts of relevant indicators and the farm's performance on those indicators.
4. The fourth step is the analysis and reporting of the sub-themes and indicator-based assessment. The 58 sub-themes' scores can thereby be aggregated to 21 themes using equal weighting, while

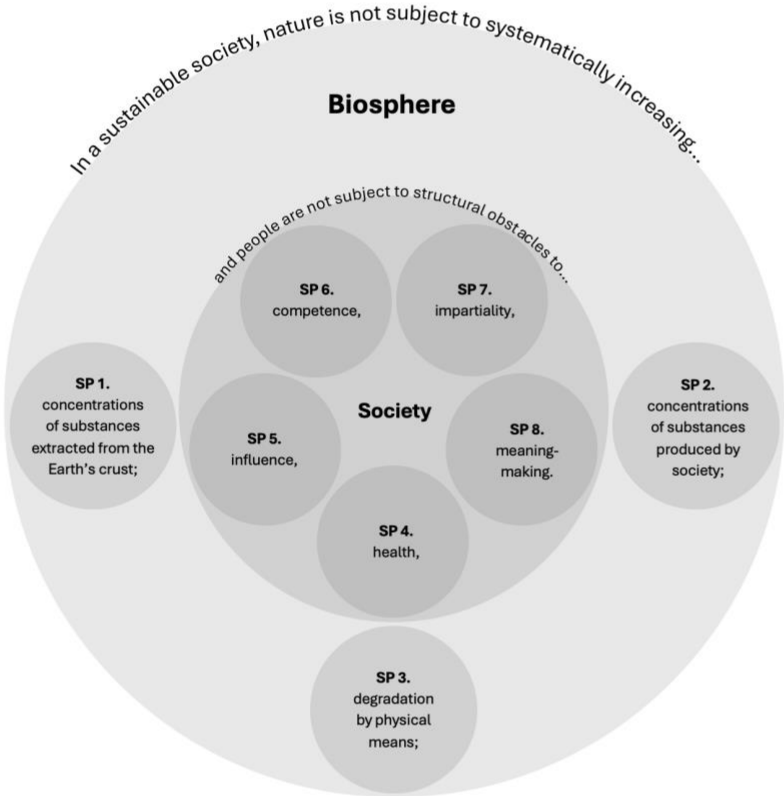
maintaining transparency of the individual sub-theme. The assessment results are provided in form of a detailed, automatically generated farm report, illustrating the farm's sustainability performance. Positive factors, as well as the improvement potential for each of the SAFA themes may influence and guide future planning processes.

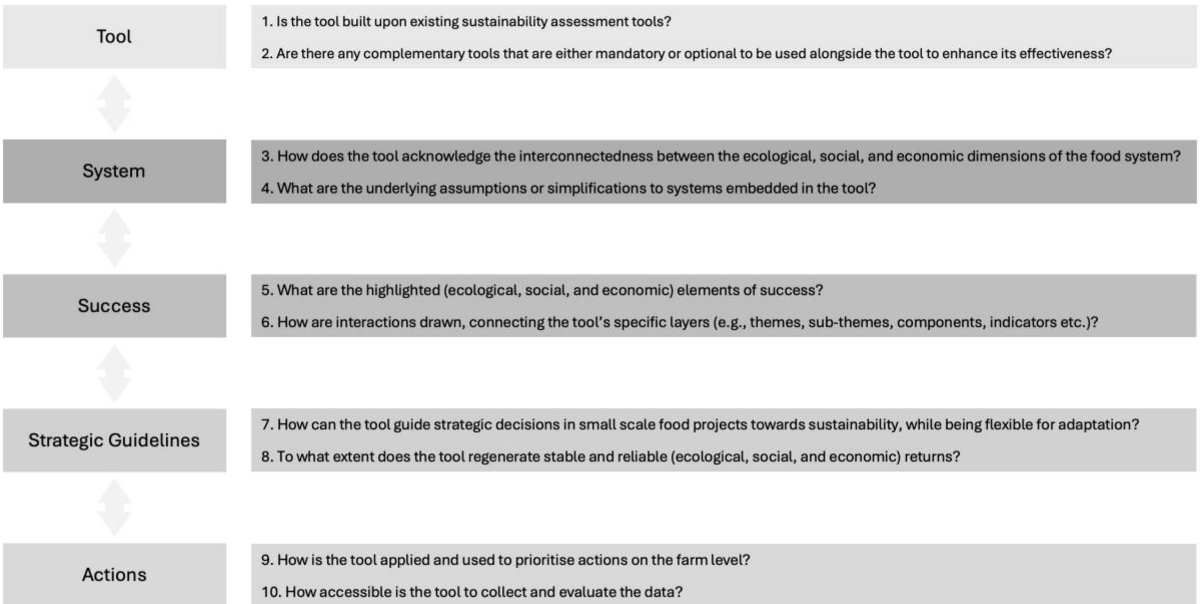
10. How accessible is the tool to collect and evaluate the data?

The tool isn't directly accessed by the end-user, which vary; rather a trained auditor is hired to do the assessment of the farm. The role of an auditor is thereby explicitly differentiated from the role of an advisor. Auditors can come in both as a service for the farmer or as a service for a third party. While the assessment can be part of larger, potentially funded projects, including different stakeholders, among them non-/ and governmental organisations, costs are involved. A comprehensive farm performance assessment, with high-quality results, especially when integrated within different assessments, induces higher costs (Schader et al. 2016).

The SMART-Farm Tool is registered under the Resource Identification Initiative RRID:SCR_018197, while also has a software and database storage on a central server.

Appendix P: Visualisation of the 8 SPs within the FSSD and research adopted 5LM





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