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Crowdfunding of Climate Mitigation Measures in Agriculture: Developing a Sustainable Business Model Concept

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Abstract

Purpose: The purpose of this article is to develop a sustainable business model (SBM) concept for local crowdfunding of climate measures in agriculture. Many climate measures entail significant capital costs preventing farmers from their adoption, and existing finance schemes have experienced limited success. Crowdfunding can be a novel financing tool for farmers to implement climate measures in agriculture.

Design/Methodology/Approach: We apply the adapted SBM canvas framework and argue that the framework presents a suitable tool for identifying and validating business models for a local crowdfunding program.

Findings: By applying the adapted SBM canvas tool and through an extensive mixed method approach, the study identifies 6 relevant design principles for SBM development and relates them to different dimensions in the SBM canvas.

Practical Implications: The study develops a proven business model concept that can be implemented by practitioners and farmers to facilitate the adoption of climate change mitigation measures, overall contributing to the transition to a low emission society.

Originality/Value: This study demonstrates the existing limitations of the adapted SBM canvas and suggests how it can be improved by integrating external structural constraints that can be a barrier to business model development. Moreover, we contribute to the SBM literature by being the first to connect Design Science with crowdfunding and the adapted SBM canvas.

Keywords: crowdfunding, agriculture, sustainable business models, climate mitigation

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Introduction

Governments worldwide have committed to ambitious climate goals via the Paris Agreement, a legally international binding treaty on climate change with the goal to limit global warming to below 2, preferably to 1.5 degrees Celsius, compared to pre-industrial levels (UNFCC, 2022). The agricultural sector is part of this treaty. Agricultural activities related to crop and livestock production release a significant amount of anthropogenic greenhouse gas (GHG) emissions globally. In 2018, agriculture and related land use emissions accounted for 17 percent of global GHG emissions from all sectors (FAO, 2020). Significantly reducing GHG emissions from agriculture requires a combination of complementary actions including carbon capture, renewable energy and changing soil management, and soil practices (Hansen, Bakke Haavik, Bergslid, Elvatun, van Gool, Lunnan, Røthe, and Walland, 2018; Hohle, Bardalen, Haugen, Kvalevåg, Øygarden, Hanssen-Bauer,Walland, and Brunvatne, 2016). However, the uptake of climate change mitigation measures by farmers has been low due to a complex combination of social, cultural (Burton and Farstad, 2020; Davidson, Rollins, Lefsrud, Anders, and Hamann, 2019), psychological (Kreft, Huber, Wuepper, and Finger, 2021) and structural (Wreford, Ignaciuk, and Gruère, 2017) constraints.

In addition, many climate measures entail significant capital costs preventing farmers from adopting these (Wreford et al., 2017). Hence, farmers' limited financial capacity can be a barrier to adoption (Baumgart-Getz, Prokopy, and Floress, 2012). Moerkerken, Blasch, van Beukering, and van Well (2020) show in their study on Dutch farmers that economic reasons such as saving or earning money are negatively influencing the willingness to adopt climate mitigation measures. Similar, Dumbrell, Kragt, Meier, Biggs, and Thorburn (2017) show that abatement costs differ across different farms in Australia and can in some cases be very high and even reduce profitability. Furthermore, a study on adoption of carbon farming practices among Australian farmers argues that they hesitate to invest in these due to uncertainty about policies and the economic and environmental impact of these practices (Dumbrell, Kragt, and Gibson, 2016).

Common policy approaches for enabling adoption of climate measures and overcoming economic constraints are subsidies, grants, tax incentives and voluntary offset programs (Cooper, Boston, and Bright, 2013). However, these have experienced limited success and there is a need for more tailored interventions that address the different needs of specific farmer groups (Barnes and Toma, 2012). The availability of credit to cover implementation costs is important (Wreford et al., 2017). Furthermore, cost-sharing, microfinance and R&D finance can be possible instruments to establish adoption (Wreford et al., 2017). In recent years, alternative finance systems have emerged (Caputo, Schiocchet, and Triose, 2022). Crowdfunding defined as obtaining funding from a large pool of investors, where each one provides a relatively small amount of money, often without standard financial intermediaries (Shneor and Maehle, 2020) is one of them. Crowdfunding can be a novel financing tool for farmers to implement climate measures in agriculture.

This study focuses on the case of Norway as crowdfunding of climate mitigation measures can be particularly relevant for Norwegian agriculture. In 2019, the two largest farmer organisations signed a voluntary agreement with the Norwegian government to reduce GHG emissions and increase carbon capture from agriculture, which accounts for approximately 9.1 % of Norwegian GHG emissions (Miljødirektoratet, 2021). The goal is to reduce emissions by 5 million tonnes of CO_2-equivalent for the period 2021-2030 (Regjeringen, 2019). Experts assume that such a target is feasible, but it requires a rapid implementation of a comprehensive set of climate measures (Miljødirektoratet, 2020).

Norway is a small, developed country with high per capita income and high levels of social trust, suggesting a high crowdfunding potential (Ziegler, Shneor, Wenzlaff, Wang, et al., 2020). Crowdfunding has experienced a significant growth in Norway recently (Shneor, 2020) and previous research has shown that well-designed crowdfunding campaigns can be a promising tool to incentivise climate change mitigation on farms (Kragt, Burton, Zahl-Thanem, and Otte, 2021).

The current article is based on an international research project aiming to assess the potential of a local crowdfunding system enabling instalment of climate-friendly technologies on the Norwegian farms.

This article puts together the findings from all work packages in the abovementioned project. The aim is to develop a sustainable business model (SBM) concept for local crowdfunding of climate measures in Norwegian agriculture. For designing such a SBM concept, we apply the adapted SBM canvas framework (Bocken, 2015 in Bocken Schuit, and Kraaijenhagen, 2018) and argue that the framework presents a suitable tool for identifying and validating BM for a local crowdfunding program. However, we show through our research that it can be improved by integrating external structural constraints that can influence the implementation of a business model.
Hence, we contribute to the literature by applying the SBM canvas to a new field of research and combining it with crowdfunding. Combining crowdfunding and sustainability is a contribution in itself, as there is still lack of research "at the interface of crowdfunding and sustainability." (Böckel, Hörisch, and Tenner, 2021:447). Furthermore, by focusing on reduction of GHG emissions from Norwegian agriculture, we contribute to more research on national level barriers to climate mitigation adoption (Wreford et al., 2017) and address socio-economic transitions in agriculture.

The paper is structured as follows. First, we present the theoretical background by discussing sustainable business models and crowdfunding. Then, we describe our methodological approach and provide an overview of the main results. After that, we discuss our main findings by aligning them with the existing theoretical perspectives and identifying the possibilities to extend the theory. Finally, we conclude by debating our contribution, current limitations, and future research opportunities.

Crowdfunding for sustainability

Sustainable business models

Business models can play an important role in societal transitions (Ruggiero, Kangas, Annala, and Lazarevic, 2021). Recent years have witnessed a growing interest towards sustainability both among businesses and their stakeholders which has been reflected in the increased research focus around sustainable business models. A sustainable business model (SBM) can be defined as "a simplified representation of the elements, the interrelationship between these elements, and the interactions with its stakeholders that an organisational unit uses to create, deliver, capture, and exchange sustainable value for, and in collaboration with, a broad range of stakeholders" (Geissdoerfer, Bocken, and Hultink, 2016:1219). The main idea is to embed sustainability into the business model, so that a company can achieve sustainable outcomes as to an increasing degree expected by its stakeholders. SBMs have three distinctive characteristics making them different from traditional business models: creating value for multiple stakeholders, society, and the environment; delivering non-financial value, e.g., social and environmental values; considering not only value creation, but also value destroyed as a result of company's negative effects on society and environment and value uncaptured (Goni, Gholamzadeh Chofreh, Estaki Orakani, Klemeš, Davoudi, and Mardani, 2021).

There is a growing demand for sustainable business model tools, but they are still rare (Geissdoerfer et al., 2016). One of the few tools available is an adapted sustainable business model canvas (Bocken, 2015 in Bocken et al., 2018), see Figure 1. This tool is based on the Business Model Canvas from Osterwalder and Pigneur (2010), which represents one of the most well-known business model tools. It consists of nine basic business model components visualized through a canvas, and its main purpose is to help mapping, designing, and inventing new business models. The main benefits of the Business Model Canvas are its simplicity and practice-orientation. However, this simplicity leads to important limitations. For instance, according to the traditional business model logic, the Canvas focuses only on financial success and satisfying customer needs, neglecting other social and environmental values (Kraaijenbrink, 2012 in Ching and Fauvel, 2013).

To adjust to the growing focus on sustainability, there is a need to adapt this business model mapping tool. Sustainable organizations aim to embed sustainability in the core purpose of the firm, and

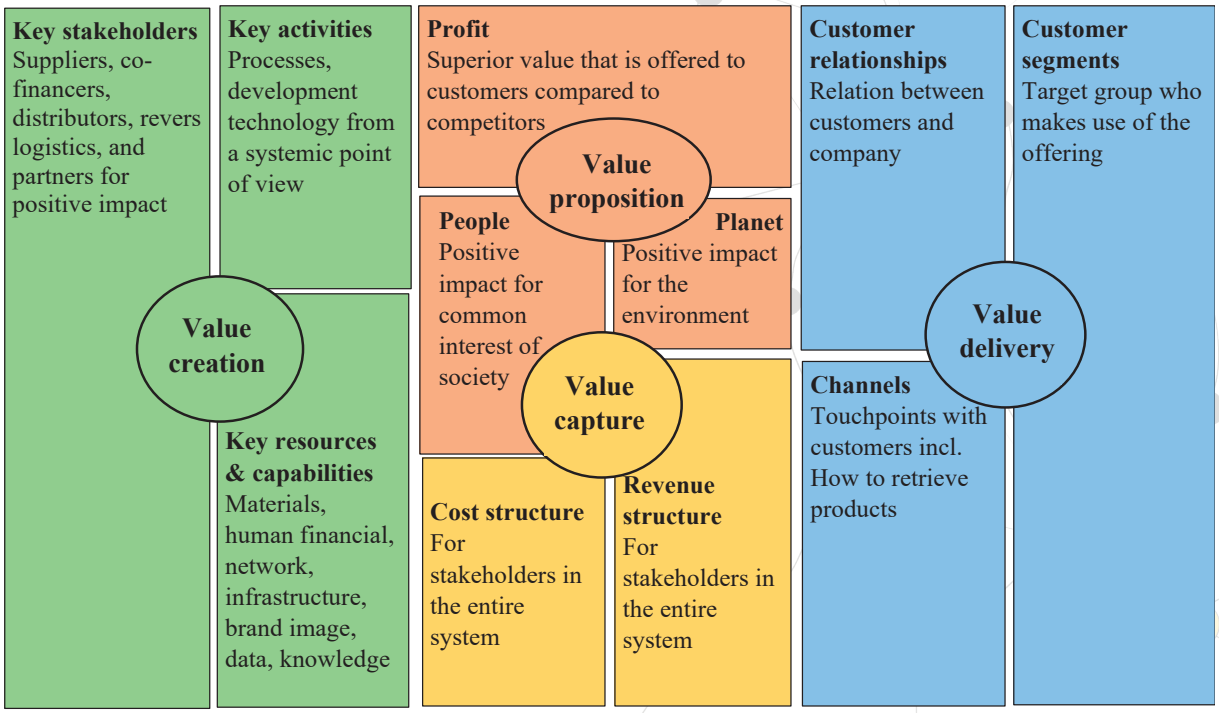

Figure 1: Adapted sustainable business model canvas (Bocken, 2015 in Bocken et al., 2018:82).

the value proposition needs therefore to encompass environmental and social values in addition to the economic one (Bocken, Short, Rana, and Evans, 2013; Bocken, Short, Rana, and Evans, 2014). This is reflected in the adapted sustainable business model canvas.

Crowdfunding

The idea behind crowdfunding is to acquire funding from a large pool of investors, where each of them provides a relatively small contribution (Shneor and Maehle, 2020). Despite the small amounts given by each investor, the collective contribution can be rather significant if the necessary number of investors is reached. Crowdfunding has experienced substantial growth in recent years, with the global crowdfunding market valued at USD 12.27 billion in 2021 and forecasted to double by 2027 (Statista Research Department, n.d.).

Crowdfunding involves three main actors: the fundraiser, the backer, and the platform. Fundraiser is defined as any individual or organization making a public call for financing a project, while backer is any individual or organization providing this financing. A crowdfunding platform serves as a market maker bringing fundraisers and backers together via a common trusted system (Shneor, Zhao, and Flåten, 2020).

There are two principal types of crowdfunding; investment-based and non-investment based (Shneor, 2020). The investment crowdfunding includes two main models, i.e., debt-based and equity-based. The debt-based crowdfunding is represented by peer-to-peer loans, where investors receive fixed periodic income as well as repayment of the loan. The equity-based crowdfunding is when backers invest in equity or bond-like shares issued by a business, via the internet (Ahlers, Cumming, Günther, and Schweizer, 2015). In the non-investment crowdfunding, backers provide funding without expectations of monetary returns (Shneor, 2020). Here there are two models; donation- and reward-based. Donation-based crowdfunding is characterised by backers donating money to support a certain cause based on philanthropic motivations. Reward-based crowdfunding is when backers receive various non-monetary rewards or products, it is often used for pre-sale.

The literature identifies several benefits of crowdfunding in addition to an obvious financial one. For instance, crowdfunding can give a company or a product cost-efficient marketing publicity through increased exposure (Belleflamme, Lambert, and Schwienbacher, 2014) and "word of mouth" (Lehner, 2013). Moreover, studies (Lam and Law, 2016) demonstrate that crowdfunding offers entrepreneurs an unusually high degree of independence in decision making, feedback from the crowd, and public support and legitimacy.

Crowdfunding was also identified as an ultimate source of funding for sustainable entrepreneurs, as socially relevant aspects may attract attention from many backers (Belz and Binder, 2017). Since the invested amounts in crowdfunding are usually rather small, the backers tend to consider not only financial but also intangible benefits, e.g., social and environmental ones (Cumming, Leboeuf, and Schwienbacher, 2017). Sustainability orientation is shown to positively affect funding success for crowdfunding projects (Calic and Mosakowski, 2016).

Several studies (Bocken et al., 2014; Testa, Nielsen, Bogers, and Cincotti, 2019) therefore argue that crowdfunding can help develop and scale up sustainable innovations. Lack of funding represents one of the main obstacles for sustainable development as it is often difficult to acquire financing for sustainable projects, e.g., climate mitigation measures, via traditional investment channels (Ortas, Burritt, and Moneva, 2013). Compared to pure for-profit projects, sustainable projects are more ambiguous and complex as they are pursuing multiple goals, e.g., economic and environmental ones (Bocken et al., 2014; Belz and Binder 2017). Balancing several goals may also extend the time for projects to reach profitability. Some sustainable projects such as climate mitigation measures in agriculture often do not lead to increased productivity in the short term and are associated with monetary and non-monetary costs (Wreford et al., 2017). Mitigation benefits represent a global public good while the costs are often carried locally by farmers. Mitigation is also associated with uncertainty and effect can only be seen in the future (Wreford et al., 2017). Altogether, this makes sustainable projects less attractive for traditional investors (Messeni Petruzzelli, Natalicchio, Panniello, and Roma, 2019). It is therefore necessary to investigate new alternative financing possibilities such as crowdfunding (Testa et al., 2019).

Connecting crowdfunding with carbon offset programs

In this study, the innovative idea was to connect crowdfunding to volunteer carbon offset programs in aviation. Nowadays, travellers can voluntarily compensate for their climate emissions from air travel by paying for carbon offset projects[1]. A wide range of companies and NGOs working with voluntary carbon credits have recently emerged. However, the uptake of these measures has been low and carbon-offset programs have suffered from a "cowboy" atmosphere (Danda and Hartmann, 2011) where the systems used very different approaches to calculate and compensate for emissions, making them complex and opaque (Gössling, Haglund, Kallgren, Revahl, and Hultman, 2009). In addition, many carbon offset projects are located in countries far away, which contributes to a high level of distrust amongst the general public (Conte and Kotchen, 2010). Crowdfunding could enhance current carbon offset programs by providing the required transparency for funders/backers that these programs currently lack. Local crowdfunding differs from carbon offsetting since it enables backers to choose from a variety of climate projects and follow up their progress. Furthermore, it allows to develop a sense of ownership and personal connection (Shneor and Vik, 2020) that carbon offsetting does not provide. It could even be possible for travellers - who want to locally compensate for some of their climate emissions - to pass by the farm they are crowdfunding. Hence, a local climate crowdfunding program could be a promising tool to help farmers to install new climate technologies and at the same time a good way for the general public to compensate for some of their emissions from the transport sector.

[1] Through a carbon offset project airline passengers and corporate customers can compensate for their proportion of an aircraft's carbon emissions on a particular journey by investing in carbon reduction projects (IATA, 2022).

Methods

Research approach and study design

The study applies a proof-of-concept approach, defined as "the realization of a certain method or idea to ascertain its scientific or technological parameters" (National Science Foundation 2014, 14-569 in Kendig, 2016: 736). The objective of the study is to demonstrate and verify concepts that theoretically may have real world application, and to determine their feasibility but not necessarily to implement them. For doing this, we apply a design science research approach, which "focuses on developing design principles that provide the main guidelines to develop targeted solutions for a problem in a specific context" (Van Aken and Romme, 2009 in Van Burg, Jager de, Reymen, and Cloodt, 2012: 458). Design principles "involve a coherent set of normative ideas and propositions, grounded in (e.g. entrepreneurship) research, which serve to design and construct detailed solutions" (Van Burg, Romme, Gilsing, and Reymen, 2008: 116 in Van Burg et al., 2012: 458). In our study, the design principles represent business model attributes that shape the different dimensions of the adapted SBM canvas (Bocken, 2015 in Bocken et al., 2018).

To obtain information for each dimension of the SBM canvas and hence identify the design principles (BM attributes), we apply a mixed method approach

Table 1

Method	Description	Year
Focus group with farmers	5 farmers (both organic and conventional) with an interest in climate change mitigation measures.	2018
National survey with farmers	National survey sent to 2000 Norwegian farmers by mail and email	2018
Focus groups with general public	2 focus groups (5 participants at the first and 7 participants at the second)	2018-2019
Focus group with a company	Focus group with an energy company currently involved in a carbon credit program, 7 participants	2019
Survey with general public	Survey sent to 1500 respondents in the general population	2020
Stakeholder workshops	An iterative process throughout the project including 3 meetings	2017-2020
Workshop with the commercial aviation sector	Workshop session at the national aviation conference with representatives of the commercial aviation sector	2019

Table 1: Overview of the methods applied in the study

consisting of a mix of qualitative and quantitative studies with multiple relevant stakeholders relevant for the business model design. Table 1 provides an overview of the methods applied in the project.

Such a comprehensive approach is necessary due to the complexity of developing a BM concept for crowdfunding climate mitigation measures in agriculture, which requires involvement of multiple stakeholders from different sectors (e.g., agriculture, alternative finance, consumers, and transport companies). The applied mixed method approach helps to identify, create, and validate the design principles (Van Burg et al., 2012). Figure 2 illustrates the role of each method for construction of the design principles. To identify the first relevant design principles for the SBM, we carried out two focus group interviews with farmers and relevant backers and one stakeholder workshop. In the next phase, we supplemented these findings with two surveys with farmers and the general public to create more measurable and quantifiable design principles. These were then validated again during a stakeholder workshop and a workshop with the commercial aviation sector, to explore how local crowdfunding can be integrated into global carbon offset programs. As a result, a final SBM concept for local crowdfunding was designed.

This paper synthesises the findings of the whole research project. The next section presents a concise description of each method with references to the relevant previously published articles in this project where more information about the choices and details of each method can be obtained.

Workshop with external stakeholders

To determine the social and environmental layer of the SBM canvas, there is a need to include a stakeholder perspective (Joyce and Paquin, 2016). Hence, we conducted in total 3 iterative workshops with external stakeholders during the project period (between 2017-2020). The aim of the workshops was twofold. First, we identified primary design principles for the SBM that later were measured in a quantitative study. Second, the workshops helped to validate the preliminary identified concepts of the business model design that were derived from the work packages on farmers' and the general public's willingness to participate in a local crowdfunding scheme. The stakeholder group consisted of representatives from the two Norwegian farmers' unions, a local taxi company, a travel agency, the Norwegian Environment Agency, a sustainable bank, a crowdfunding platform, a national airline, a company offering a range of services to companies and the public for reducing GHG emissions, and a governmental agency stimulating entrepreneurship and green growth in Norway. In addition, the stakeholder group included several experts, e.g., a researcher specialized in crowdfunding, an interested farmer who earlier invested in climate measures, and an environmental activist. Several researchers from the different work packages in the project attended the

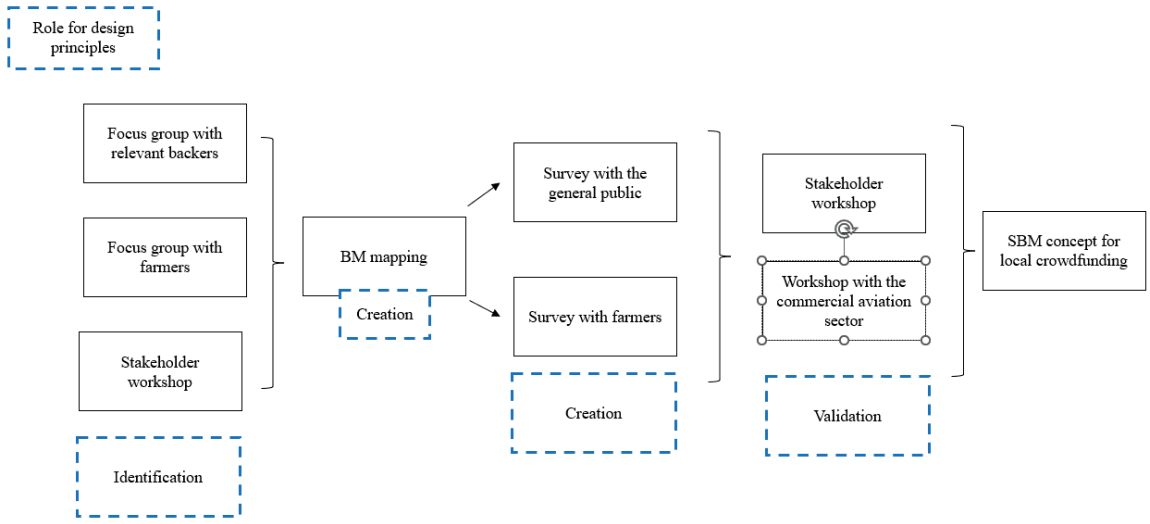

Figure 2: The role of each method for constructing design principles for SBM concept

stakeholder sessions to gain direct insights from the stakeholders. In average between 10 and 16 participants were present during the workshops (see for more information Haring, 2019).

Focus group with farmers

We conducted a focus group with 5 Norwegian farmers in 2018. Farmers were selected through a previous climate project led by one of the research partners. The group included both organic and conventional farmers. The aim was to explore preferences for various types of crowdfunding and climate measures and potential socio-cultural factors that can limit or foster farmers' interest to participate in a local crowdfunding system. Furthermore, the focus group provided qualitative validation for a planned choice experiment. The focus group was carried out at one of the involved farms in October 2018 (see for more information Farstad and Hårstad, 2022).

Survey with farmers

We sent out a nationwide survey by email and mail to 2000 farmers in November 2018. A total of 465 respondents completed the questionnaire with an overall response rate of 23.3 percent (Otte, Zahl-Thanem, Hansen, and Maehle, 2019). The questionnaire was divided into 4 sections. Part 1 included questions about farmer's socio-economic background and farm characteristics, followed by part 2 that investigated farmers' perceptions of crowdfunding and willingness to participate in a local crowdfunding program for financing climate mitigation measures. Part 3 asked about farmers' perceptions of climate change and interest in adopting various climate mitigation measures. Part 4 consisted of 6 discrete choice experiment questions to investigate farmers' preferences for different types of crowdfunding (see for more information Kragt et al., 2021 and Otte et al., 2019).

Focus groups with potential backers

In the original project description, the general public was identified as the main group of backers. The target group was described as consumers/individuals who are looking for ways to reduce or compensate for their GHG emissions. However, early in the project the research team realized that companies should also be included as potential backers since they can provide more stable financing over a longer period through the subscription to a local carbon offset program. Hence, we also conducted a focus group with a relevant company. In total, we carried out two focus groups with the general public and one with a company. Each focus group lasted for approximately two hours. In the beginning, the researchers shortly introduced the project, defining crowdfunding and describing different crowdfunding models. After that, four crowdfunding scenarios were presented. These scenarios included four different climate mitigation measures: solar panels on the barn roof, biogas from animal manure, drag hoses for improved manure dispersal, and the addition of biochar to soils.

The first focus group included 5 informants and was carried out in November 2018. Informants were recruited through the university network of the involved research partner and represented different age groups, genders, and socio-economic backgrounds. All informants were more concerned about climate change than an average consumer. The second focus group took place in September 2019. It included 7 informants representing a parent group from a school in the outskirts of Oslo. The aim with this selection approach was to attract the informants with a less biased green profile, so that we could identify potential constraints with the BM concept. The company focus group was carried out with an energy company involved in a carbon credit program and recruited through the network of one of the researchers. This focus group was conducted in September 2019 and included 7 participants. The focus group interviews were transcribed and analyzed with special focus on the issues such as knowledge of and willingness to pay for climate mitigation measures in agriculture through crowdfunding (see for more information Stoknes, Soldal, Hansen, Kvande, and Skjelderup, 2021).

Survey with the general public

A survey was sent to a representative sample of the general Norwegian population via email in January 2020. This was done by using a professional survey panel. In total 1500 responded to the survey. The survey was designed based on insights from the three focus groups described above. It consisted of four main

parts. The first part included an introductory section and inquired socio-economic background of the respondents. The second part addressed respondent's attitudes to supporting climate change measures and to Norwegian agriculture in general. The third part included a general introduction to crowdfunding before introducing a choice experiment, where respondents were asked to estimate their willingness to pay for four chosen climate mitigation measures. The fourth part investigated perceptions about who should be responsible for mitigating climate emissions from Norwegian agriculture (see for more information Stoknes et al., 2021).

Workshop with the commercial aviation sector

The most important player in carbon offset programs is the commercial aviation sector. Hence, we addressed this stakeholder group to explore whether local climate crowdfunding of agricultural projects can be integrated in their current globally targeted carbon offset programs.

The project team organized a session entitled "Carbon credits in aviation opening for local possibilities" at the national aviation conference in 2020 in Bodø, Norway. One of the main researchers led the session accompanied by a representative of a local taxi company from the stakeholder group.

The purpose of the workshop was to show relevance of the project for the industry and investigate the possibility of combing travel related climate emissions from taxi trips to local airports and flying. 18 conference participants had signed up for the workshop including representatives from different Scandinavian airlines, the Civil Aviation Authority of Norway and the Ministry of Transport.

Results

Workshops with external stakeholders

The first workshop was conducted in the first project year (December 2017) to introduce the stakeholders to the project and provide a common understanding of crowdfunding. During this meeting the stakeholders elaborated on different types of crowdfunding and identified types of climate measures that would be interesting to finance by the public. The second stakeholder workshop was carried out in February 2019. During this meeting, the first project findings were presented to the group including insights from the focus group discussion with farmers and general public. The stakeholders performed a BM design exercise where they evaluated relevance and feasibility of different BM design principles identified by the research team. Table 2 provides an overview of the BM design principles discussed during the workshop.

Table 2.

BM design principles	Possible dimensions
Crowdfunding type	Donation
	Reward
	Loan
Co-finance	Bank loan
	Governmental support
	Own capital
Potential backers	Travellers/general public
	Companies
Intermediary organization	Farmer organizations
	Agricultural advisory
	Crowdfunding platform
	Bank
	Research institute

Table 2: Overview of the BM design principles discussed by the stakeholders in February 2019

During this session it became clear that it would be difficult to raise enough financing through donation-based crowdfunding, which is the preferred model by farmers and the general public. Hence, it is necessary to combine it with other forms of co-financing, e.g., funding provided by public governmental agencies supporting sustainable innovations. However, these agencies cover only a share of the costs, between 25-50 percent (see Otte et al., 2019), which means that crowdfunding can finance the lacking capital.

In October 2020 a final stakeholder workshop was arranged for further validation. The stakeholders discussed five preliminary BM concepts developed after all the data collection across the work packages (see Appendix 1 for an overview of the business model concepts). The stakeholder group also addressed the next steps after the end of the research project. They concluded that it would be difficult to integrate agricultural climate mitigation measures into a carbon credit program since the current regulations do not allow this. The stakeholder group therefore suggested taking a step back and testing out in practice the feasibility of financing climate mitigation measures through crowdfunding in general. Furthermore, the stakeholders identified a need for a platform as a kind of intermediary organization that can certify climate projects, so that backers can be assured that their money will have the aspired climate effect.

Focus groups with farmers

The farmers in the focus group were not familiar with the term crowdfunding and none of them had tried it. Concerning the types of crowdfunding, donation seemed to be the most comfortable one because it does not require anything in return and is not time-consuming. However, some informants mentioned that a reward model felt to be fairer since backers got something in return. As for the types of rewards, the farmers wanted something that was not too time-consuming and did not interfere with the daily farm management. Farm visits were suggested by the researchers and the informants agreed that it was a good option, but it would take up too much time and resources. Loan based crowdfunding sounded like a rather foreign concept as the informants were not used to taking up a loan from individuals and questioned its safety.

Survey with farmers

The survey results indicated that only 20 percent of the farmers had prior knowledge about crowdfunding. Farmers with a university degree and heavy users of social media (> 2 hours per day) had a greater likelihood of heaving heard of crowdfunding. The preferred type of crowdfunding was a donation-based one, due to its simplicity and easiness to execute. This form of crowdfunding does not require any extra work for farmers, and it does not require as close contact with backers as other types of crowdfunding (e.g., reward- and loan-based). This also supports the findings from the focus group with farmers.

Famers perceived external financial contribution as important for implementing climate measures (66 percent stated that this was either very or pretty important). Many farmers (57 percent) agreed that co-financing from governmental authorities would increase the likelihood of their participation in a crowdfunding campaign. Further, a relatively high proportion of the farmers (33 percent) were willing to invest their own capital to cover the amount that was not covered by crowdfunding.

Farmers preferred agricultural advisory services and farmers' organizations as potential intermediary organizations instead of crowdfunding platforms, banks, and research institutions. The survey results showed also that Norwegian farmers preferred receiving money from companies instead of general public. The analysis also indicated that farmers expressing positive attitudes towards crowdfunding were more positive towards collaborating with other farmers. Furthermore, solar panels were one of the most likely implemented climate measures that farmers would carry out in the next 5 years (see for more information Otte et al., 2019, Kragt et al., 2021).

Focus groups with potential backers

The focus group referred to fundraising for schools and bands in Norway, when they first were introduced to the idea of crowdfunding. Several informants also mentioned these types of fundraising as a possible barrier because people would prioritize donating to their own neighbours/children rather than someone they do not know, e.g., a farmer. Some

informants argued that willingness to pay for climate projects in agriculture could be also low since individual backers assumed that the farmer could obtain his/her funding from other funding sources. Informants reported that they had donated money previously and their limit was 400-500 Norwegian kroner (ca. 40-50 euro). Beyond that, they believe that it would be too much for individuals to contribute to agricultural projects which, to them, seemed to have high costs. Almost all informants in both focus groups expressed that it was important to get to know the farmer behind the crowdfunding campaign and they emphasized the importance of a good and personal story framing the campaign.

Furthermore, they expressed that they had little knowledge of whether the chosen climate mitigation measures would actually help reducing GHG emissions. However, they were more positive towards solar panels due to higher familiarity of this type of technology and its visibility. They also emphasized the importance of an online platform or a kind of trustworthy intermediary organization, so that they could be sure that the donated money was spent on the actual project (see Stoknes et al., 2021).

Survey with the public

The survey results indicated that 48 percent of the respondents were familiar with the concept of crowdfunding. The most popular form was donations (34 percent stated that if they were going to crowdfund, they were likely to choose this model). Lending was the least popular form of crowdfunding (15 percent). The respondents stated that the most trustworthy intermediary for operating agricultural crowdfunding campaigns would be research institutes. Two thirds of the respondents expressed some interest in crowdfunding climate measures in agriculture (29 percent said they were somewhat likely to do so, and 33 percent said they were likely to do so). The average willingness to pay for climate measures in agriculture was 161 Norwegian kroner (ca. 16,1 euro). Of four chosen climate measures, solar panels were given the highest average at 187 Norwegian kroner (ca. 18,7 euro), while the average willingness to pay for biogas was 177 Norwegian kroner (ca. 17,7 euro), drag hoses – 142 Norwegian kroner (ca. 14,2 euro), and biochar – 141 Norwegian kroner (ca. 14,1 euro). This can be explained by the fact that both drag hoses and biochar are more "invisible" climate measures which impact cannot be seen directly by the backers, compared to solar panels. In addition, backers lack knowledge of these measures and hence doubt their climate effect (see for more information Stoknes et al., 2021).

Workshop with the commercial aviation sector

During the workshop, there was a discussion around the difficulty to connect GHG emissions from agriculture with the volunteer carbon credit market. The participants were wondering how to make sure that costs for the measures and emission reduction in agriculture can be translated to the emissions from the aviation. There were also doubts whether agriculture was the appropriate industry to connect with the aviation and whether the term "local" could be seen broader and therefore other local green projects (not only agriculture) could be included. Many potential backers who now pay for carbon credits while buying an airplane ticket lack a personal connection to agriculture and knowledge about the agricultural climate measures.

One of the airlines mentioned that they implemented two ways for customers to contribute to a more climate friendly air travel: payment for carbon credits abroad and payment for biofuel which is more sustainable than conventional fuel. However, the airlines stated that not many customers chose to compensate for their emissions; moreover, they preferred paying for biofuel instead of carbon offset projects because it felt as a more concrete measure. As customers' willingness to pay was not high (on average 30-40 Norwegian kroner or 3-4 euro), it would be difficult to finance climate mitigation measure quickly. Nevertheless, the workshop participants were positive about the idea of local carbon credits in addition to traditional ones if the local climate projects would have a more general character instead of focusing only on agriculture.

Summary of findings: Identified BM design principles for local crowdfunding of climate measures

We identify 6 relevant BM design principles through the mixed method approach. Table 3 summarizes the findings by presenting the main inputs for each

Table 3.

Crowdfunding of climate mitigation measures in agriculture

BM design principles	Main inputs for SBM design	Data collection
Type of crowdfunding	Farmers and the general public prefer donation- and reward-based crowdfunding.	Focus groups, choice experiment in the national survey with farmers and the general public
Additional financing	Farmers are interested in support from public institutions. Low willingness to pay per backer requires additional finance.	Focus groups, choice experiment in the national survey with farmers and the general public
Collaboration between farmers	Norwegian farmers are hesitant to stand out publicly as recipients of crowdfunding. Hence, they prefer joint campaigns with other farmers. Some climate measures require collaboration between farmers (e.g., biogas).	Choice experiment in the national survey with farmers
Existence of intermediary organization	Agricultural advisor and farmer organizations are preferred by farmers. The general public prefers research institutes.	Choice experiment in the national survey with farmers Survey with the general public
Types of backers	Consumers and companies are relevant groups. Farmers prefer companies over individuals.	National survey with farmers
Type of climate mitigation measure	Solar PV panels are the most known and preferred climate measure among farmers and the general public.	National survey with farmers and the general public

Table 3: Identified design principles and their values for SBM design

principle and the data sources. We can see that preferences stated by different stakeholders (e.g., general public and farmers) overlap to varying degree for shaping the BM design principles.

The first BM design principle is *the type of crowdfunding*. The results from the focus groups, surveys and the choice experiment with farmers and the general public indicate that both groups prefer donation and reward-based crowdfunding over loan-based crowdfunding[2]. This demonstrates that their preferences overlap[3].

The second BM design principle addresses the need for *additional financing*. Results from the mixed method approach show that Norwegian farmers are interested in additional support from public institutions to back up the crowdfunded amount, especially since the results from the survey with the general public show that the willingness to pay per backer is relatively low (see Stoknes et al., 2021).

The third BM design principle includes *collaboration with other farmers* in a crowdfunding campaign. The quantitative results from the choice experiment and the survey show that Norwegian farmers are hesitant to publicly stand out as recipients of crowdfunding. Hence, they prefer joint campaigns with other farmers. In addition, some climate measures require collaboration between farmers (e.g., biogas), which makes them suitable for a joint campaign. We can see here that technology requirements and farmers' preferences for collaboration overlap.

The fourth BM design principle addresses the existence of an *intermediary organization*. Here we can see that farmers prefer agricultural advisors and farmer organizations to take this role, while the general public opts for research institutes. Here we can see that preferences of farmers and the general public differ. This could be addressed by including researchers as quality controllers in agricultural crowdfunding campaigns hosted by agricultural advisors or farmer organizations.

The fifth BM design principle includes the *type of backers*. We can divide here between consumers/individuals and companies who can support local agricultural crowdfunding campaigns. The national survey with the farmers suggests that farmers prefer companies over individuals (Otte et al., 2019).

The sixth BM design principle captures the *type of climate measure* to be crowdfunded. Farmers and the general public might prefer certain climate measures over others. The results from the survey with the general public and farmers suggest that solar PV panels are the most known and preferred climate measure for both groups. This shows that the interest in types of climate measures overlap between both groups.

Discussion: Applying the adapted sustainable business model canvas to crowdfunding climate measures in agriculture

Aligning BM design principles with the adapted SBM canvas

In this section, we attempt to align the BM design principles presented above with the 4 different value related dimensions in the adapted SBM canvas (Bocken, 2015 in Bocken et al., 2018). Figure 3 shows the adapted SBM canvas for local crowdfunding of climate measures in agriculture.

We can see here that the overall ***value proposition*** is threefold. In terms of economic profit, the aim of the SBM is to provide funding to implement climate mitigation measures in agriculture. This entails a positive impact on people by providing travellers with the opportunity to compensate for their travel related GHG emissions and help farmers to finance climate measures on farms. Furthermore, by enabling the adoption of climate measures on farms the BM contributes to the reduction of GHG emissions, ensuring positive environmental impacts, also beneficial for

[2] We did not test for equity-based crowdfunding since Norwegian legislation and regulations were not fully implemented at the time of the research.

[3] The preference for non-investment crowdfunding can be explained by normative and altruistic motives that are typical for backers of sustainable projects (see Gerber and Hui 2013 in Maehle, Otte, and Drozdova, 2020:405)

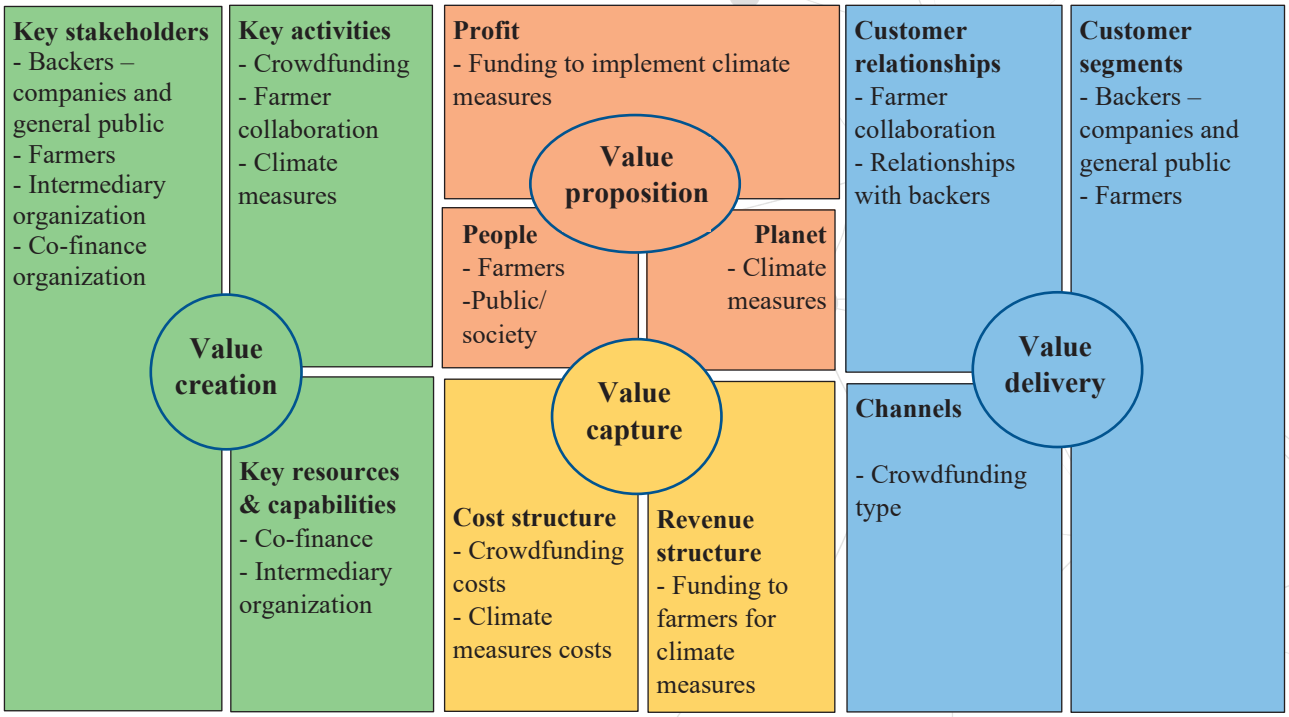

Figure 3: Adapted SBM canvas for crowdfunding climate measures in agriculture

the society at large. Concerning the ***value capture***, revenue streams to farmers are created through crowdfunding for adopting climate measures. The cost structure of the BM consists of the costs for crowdfunding. Crowdfunding platforms normally take a certain percentage of the funded amount to cover their transaction costs. In addition, the cost structure includes the costs for climate measures, which can vary a lot (see Otte et al., 2019). Concerning the ***value creation*** multiple stakeholders need to be involved including backers (companies and the general public), farmers, a trustworthy intermediary organization and a co-finance organization that can assist in financing the costs not covered by crowdfunding. Key activities include crowdfunding (in our case preferably donation-based), collaboration between farmers in setting up and running crowdfunding campaigns and the implementation of climate measures that are crowdfunded.

Key resources and capabilities for creating the aspired value include the co-financing of climate measures through other types of financing (e.g., own capital, governmental funding) and the existence of an intermediary organization connecting backers and farmers, which can be represented by research institutes, crowdfunding platforms, banks or farmer organizations. The ***value delivery*** is characterized by customer relationships in form of farmer collaborations for setting up crowdfunding campaigns and the relationship between farmers and backers during the crowdfunding process (e.g., updates on the campaign website). The channel through which the value is delivered is the type of crowdfunding (in our case donation-based) and type of crowdfunding platform where the campaign is presented. Last but not least, customer segments include backers, which can be individual travellers and companies who want to offset some of their travel related climate emissions, and farmers who want to install climate measures on their farms and lack funding.

External constraints for SBM development

Despite it being more suitable for mapping sustainable business models, the adapted SBM canvas tool still has some limitations. One of them is its internal focus on the company itself and lack of attention to the external context in which the company operates. A more outward focus can help to identify new opportunities but also account for existing external

constraints. For instance, for local crowdfunding of climate measures, there is still uncertainty around their effect in agriculture.

Every farm is different in terms of different diets of animals, tillage intensity, soil composition, application of fertilizer etc. This makes it challenging to calculate the exact impact of investments in climate measures on the amount of GHG emissions from a specific farm per year (Stoknes et al., 2021: 12). This issue was raised during the stakeholder workshop by referring to the complexity of the carbon quota market, which is based on certain rigid methodologies. As a result, it is currently not feasible to transfer GHG emissions from one farm to GHG emissions from the aviation.

In addition, there is still lack of research on GHG-emission reduction linked to agricultural carbon credits (Lokuge and Anders, 2022). Current GHG mitigation policies in agriculture have mainly focused on carbon taxes while more attention should be given to exploring the possibility of carbon-credit and carbon-offset systems (Lokuge and Anders, 2022).

The voluntary carbon credit market has grown significantly in recent years (Lokuge and Anders, 2022) but agriculture has not been part of the EU Emissions Trading System (ETS) sector and hence there has not been a very ambitious climate policy concerning agriculture (Verschuuren, 2018). One way to realize the intended local crowdfunding SBM concept would be to include agriculture in carbon pricing mechanisms, such as the EU's ETS. However, this is a complex process and would require new rules and regulations. For example, in terms of climate measures related to soil carbon this would require farmers to establish a baseline level of soil carbon, and to monitor, report and verify the amount of CO_2 sequestered in the projects under the ETS offsets. In addition, governments would have to set commitment periods, and methodologies need to be developed to determine the scope and types of the allowed projects (Verschuuren 2018: 321). Hence, the realization of the SBM on crowdfunding climate measures in agriculture through carbon credits from aviation is doubted to be feasible as long as the appropriate policy framework is not established and there is no accuracy in emission accounting on farms. At the current stage, it is more feasible to focus on exploring the possibility of crowdfunding climate mitigation measures directly. However, with a change in politics this might transform.

Conclusion

This study developed a SBM concept for local crowdfunding of climate mitigation measures in agriculture and explored how local crowdfunding can be integrated into global carbon offset programs in commercial aviation. By applying the SBM canvas tool and an extensive mixed method approach, relevant design principles for SBM development were identified and related to different dimensions in the adapted SBM canvas. Furthermore, we provide the suggestions on how to improve SBM canvas by including the external context that can hamper the implementation of new SBMs. We demonstrate that it is not feasible at the current stage to implement a SBM for local crowdfunding of climate measures connected to the commercial aviation sector since current policy regulations do not allow including GHG emission reductions into the complex accounting system for carbon offsets. In addition, there is still uncertainty around the effect of climate measures in Norwegian agriculture.

This study is however characterized by several limitations. First, it is a proof-of-concept study conducted in one country (Norway), so it is important to consider its relevance at a larger scale (Banerjee, Banerji, Berry, Duflo, Kannan, Mukerji, Shotland, and Walton, 2017). The developed SBM is relevant to the Norwegian context where agricultural sector is highly regulated by the government. It would be interesting to conduct a comparative study including countries with less regulated agricultural production and a more liberal approach to see whether the results would differ depending on the political system. Furthermore, since this research is a part of a proof-of-concept study, it does not address how collaboration between the various stakeholders could lead to scaling up the suggested SBM. Future research can investigate the types of collaboration in the SBM, by applying Ciulli's et al. (2022)

framework and its four 'scaling-through-collaboration' strategies.

In addition, previous research has criticized the original BM canvas for not taking into account existing competition (Ching and Fauvel, 2013) and competitive strategy (Coes, 2014). This has not been addressed in this paper and for future research it would be interesting to investigate how far the local aspect of carbon credits can be a competitive advantage in comparison to traditional carbon credit programs where air travel passengers compensate for their emissions in international projects like rain forest projects in Brazil. Previous research has shown that local relevance is important for climate action (Stoknes, 2014) and that could be investigated to a larger degree.

Moreover, future studies can use other sustainable business model tools, e.g., the Triple Layered Business Model Canvas proposed by Joyce and Paquin (2016). It extends the original Osterwalder and Pigneur (2010)'s model by adding two layers: an environmental layer and a social layer. The environmental layer is based on a life cycle perspective of environmental impact, while the social layer incorporates a stakeholder management approach seeking to balance the interests of all the stakeholders instead of only maximizing company's gain (Joyce and Paquin, 2016).
To conclude, this study contributes theoretically to the SBM literature by being the first one to connect Design Science with crowdfunding and the adapted SBM canvas. In addition, it suggests how an adapted SBM canvas tool can be further developed by taking into consideration the external context, which can hamper or enable the implementation of SBMs. As for the practical implications, the study develops a proven business model concept that can be implemented by practitioners and farmers to facilitate/accelerate the adoption of climate change mitigation measures, overall contributing to the transition to a low emission society.

In terms of policy implications, we recommend policy makers to investigate the ways to improve the inclusion of agriculture in carbon pricing mechanisms, which will facilitate the market development of more tailored practices to finance climate mitigation measures in agriculture. This can provide the appropriate regulatory framework to accelerate the transition towards a more sustainable and climate friendly food production.

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