



Farmers' interest in crowdfunding to finance climate change mitigation practices

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ABSTRACT

Agricultural activities and associated land use change are a major contributor to global anthropogenic greenhouse gas (GHG) emissions, making climate change mitigation in the agricultural sector all the more critical. However, farmers' willingness to adopt GHG abatement depends, to a large extent, on the financial implications of new practices. Climate change mitigation is unlikely to be adopted without external (financial, socio-cultural, or other) incentives. The research presented in this paper considers farmers' preferences for financing climate change mitigation practices through public crowdfunding. As a first study of its kind, we investigate farmers' attitudes towards climate change mitigation, knowledge of crowdfunding as a fundraising method, and interest in using public crowdfunding campaigns to finance on-farm mitigation practices. Based on a choice experiment survey with 443 Norwegian farmers, we show that knowledge about crowdfunding as an alternative finance method is generally low. Respondents who are interested in using crowdfunding prefer donation- or reward-based crowdfunding models that cover the full cost of mitigation over a loan-based model or campaigns that only fund a proportion of the costs. A financially secure farming business, previous exposure to crowdfunding, and a strong sense of responsibility to abate climate change are associated with higher farmers' interest in using crowdfunding. We find that farmers in Norway are hesitant to be publicly presented as recipients of crowdfunding, which suggests that crowdfunding is best set up as joint campaigns (e.g. with other farmers) that are run by intermediary organisations (rather than by individual farmers). Our findings highlight that, while opportunities to use crowdfunding as a fundraising method for agricultural climate change may be limited, properly designed campaigns can provide an effective instrument to engage certain groups of farmers in on-farm climate change mitigation.

1. Introduction

Globally, agricultural activities (excluding land-use change and forestry) contributed about 11.8% to anthropogenic greenhouse gas (GHG) emissions in 2017 (FAO, 2020), making agricultural GHG mitigation critical to limiting the impacts of climate change. While a major producer of global GHG emissions, the agricultural sector has many opportunities to contribute to climate change abatement. Options for lowering emissions include changing feed composition, improving soil drainage, creating biogas from manure, adjusting the quantity and timing of fertilizer application, changing soil management practices, and increasing use of biofuels and renewable energy (Jia et al., 2019).

Changes in agricultural practices can also increase carbon sequestration and storage in soils and vegetation, thus providing a potentially important carbon sink. However, there are significant barriers to the uptake of mitigation practices by farmers and adoption of voluntary emission reductions has been low to date (Barnes and Toma, 2012; Dumbrell et al., 2017; Hurlbert et al., 2019; Smith et al., 2005).

Under the Paris agreement, Norway is committed to reducing emissions of climate gases by at least 50% and up to 55% of the 1990 levels by 2030 on the path to becoming a low-emission society by 2050—with 17% of the total commitment coming from the agricultural sector (Kongelige Klima og Miljødepartement, 2021). This requires somewhat over-proportional cuts from the sector, as only 8.8% of national GHG

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emissions originate from agriculture, predominantly from enteric fermentation (Norwegian Environment Agency, 2021). Agricultural emissions have already decreased—by 7.8% between 1990 and 2019 (largely due to more efficient milk production and reduced use of synthetic fertilisers). However, CO₂-e emissions per kg of meat and milk product are higher in Norway than in other Nordic countries (van Oort and Andrew, 2016), thus further reductions appear possible. The Norwegian Government and farmers' organisations signed an agreement in 2019 to reduce the sector's GHG emission by 2030—predominantly by improving soil, livestock, and manure management. The agreement leaves farmers free to choose which mitigation approaches to employ (Norges Bondelag, 2019). To date, however, farmers' response to climate change mitigation has been weak (Brobakk, 2018; Flemsæter et al., 2018; Rønningen et al., 2021), with estimates that only 2% of Norwegian farmers stating they implemented measures in response to climate change (adaptation or mitigation) by 2018 (Brobakk, 2018).

Socioeconomic constraints may prevent farmers from adopting climate change measures. First, farmers can be 'locked-in' to current production systems through socio-cultural norms and expectations (Burton and Farstad, 2020; Farstad et al., 2020; Mills et al., 2020) as well as technological, financial, and physical constraints (Rønningen et al., 2021; Smith et al., 2007). Second, farmers may be sceptical about climate policies being able to deliver the desired GHG reductions without affecting farm productivity and economic viability (Brobakk, 2018; Kragt et al., 2017; Niles et al., 2016). Third, a lack of funding for mitigation measures influences farmers' ability to change their practices (Mills et al., 2020; Otte et al., 2019; Sánchez et al., 2016). For example, even though the Norwegian government has provided some funding, uptake remains relatively poor (Brobakk, 2018; Otte and Vik, 2017), raising the issue of whether current government support is sufficient to initiate the necessary investments in mitigation technologies and practices (Otte et al., 2019).

This paper explores a mechanism that could overcome the financial barriers, by investigating the potential to use crowdfunding as a means of enhancing GHG mitigation on farms. We focus on crowdfunding because the crowdfunding mechanism directly addresses two drawbacks of a popular form of private contribution to mitigation efforts—voluntary carbon offsetting. Voluntary carbon offsets can be distrusted by consumers because of the uncertainty of how the money is spent (Higham et al., 2016) and a lack of transparency (Zhang et al., 2018). We hypothesise that local crowdfunding of climate change measures will obtain a higher perceived credibility than those located in other countries (Zhang et al., 2019) and offer more certainty in how individuals' voluntary contributions are spent. However, if such local schemes are to be initiated, we first need to establish how farmers would respond to crowdfunding opportunities and, in particular, which crowdfunding design attributes are most likely to encourage participation.

Crowdfunding is not a new idea but gained wide popularity with the emergence of social media and online crowdfunding websites designed to provide a direct link between entrepreneurs and backers. Worldwide, the crowdfunding sector has grown dramatically, with US \$304.5 billion facilitated through the alternative finance sector in 2018 (Cambridge Centre for Alternative Finance, 2020). Crowdfunding has been formally defined as “pooling small financial contributions from a potentially large pool of interested backers, while using the internet, and often without standard financial intermediaries” (Shneor and Maehle, 2020: 141).

There are three key entities involved in a crowdfunding campaign: The so-called *backer* (i.e. crowd-funder, investor) invests in a crowdfunding campaign; the *entrepreneur* (i.e. founder, creator) sets up a crowdfunding campaign; and the *crowdfunding platform* runs the campaign and connects backers with entrepreneurs. Four models of crowdfunding exist. *Donation-based* crowdfunding, where a backer supports a crowdfunding campaign without expecting anything in return. *Reward-based* crowdfunding, where backers receive a small non-monetary reward for their contribution (e.g. a t-shirt, art work, or thank-you card). *Loan-based* crowdfunding, where funds are loaned by

the backers and paid back with interest by the entrepreneur over time. Finally, in *equity-based* crowdfunding (the most active form of investment) backers receive shares or similar rights in the business being supported.

While a number of studies into crowdfunding have identified success factors of campaigns in terms of attracting investors/backers (e.g. Bento et al., 2019; Cha, 2017; Colombo et al., 2015; Hörisch, 2015), research that investigates the perspective of entrepreneurs has been limited (Butticè and Rovelli, 2020; Ryu and Kim, 2018; Troise and Tani, 2020). Entrepreneurs often start a crowdfunding campaign because they are unable to raise funding from more traditional sources (Gerber and Hui, 2013b; Mæhle et al., 2020). Motivations for entrepreneurs to use crowdfunding for creative (e.g. film or music) or charity projects included raising funds, connecting with potential customers, testing product concepts, or increasing product awareness (Ryu and Kim, 2018). To the best of our knowledge, there are no studies to date that investigate the characteristics and motivations of crowdfunding entrepreneurs in an agribusiness context.

A recently emerging field of research has considered crowdfunding for sustainability (e.g. Motylska-Kuzma, 2018; Petruzzelli et al., 2019; Testa et al., 2019; Wehnert et al., 2019). Sustainable businesses focus on social or environmental goals, in addition to economic returns (Mæhle et al., 2020). This balance between economic, social, and environmental objectives could make sustainable businesses less attractive for traditional (e.g. venture capital) investors, therefore crowdfunding could play a pivotal role for sustainability-oriented initiatives (Maehle, 2020; Messeni Petruzzelli et al., 2019). Research on sustainability oriented crowdfunding has focused mainly on project characteristics and backers' motivations, rather than on the entrepreneurs who set up environmental- or social-oriented crowdfunding campaigns (Böckel et al., 2021; Maehle, 2020). In addition, the available studies on crowdfunding and climate mitigation identify huge unexploited potential for financing climate change mitigation or adaptation (Ordanini et al., 2011; von Ritter and Black-Layne, 2013).

Our research contributes to the scarce literature on crowdfunding for climate change mitigation in agriculture. The current paper assesses whether Norwegian farmers are interested in using crowdfunding, and their preferences for different ways in which crowdfunding campaigns can be set up. We present a novel approach to measuring entrepreneurs' preferences and characteristics using choice experiment methodology. To the best of our knowledge, there are no other crowdfunding studies that have focused on the agricultural sector and farmers' willingness to set up crowdfunding campaigns.

The paper is organised as follows. Section 2 outlines the farmers' survey and the design of the choice experiment used to collect the data. In Section 3, we present the results, in particular examining farmers' experiences with climate change and crowdfunding, and preferences for crowdfunding campaign features. In the fourth and final section, we discuss the implications of our research for the design of successful crowdfunding campaigns to finance climate change mitigation in the Norwegian agricultural sector.

2. Methodology

We conducted a nationwide survey of Norwegian farmers. The survey development was informed by a literature review, a focus group with five Norwegian farmers, and a workshop with representatives from the banking sector, representatives from farmer organisations, and crowdfunding experts.

The questionnaire (included in the Supplementary Materials) consisted of four parts. The first part included questions about the respondent's socio-demographic background and farm characteristics. The second part focussed on respondents' perspectives about crowdfunding, for example, farmers' likelihood to participate in different types of crowdfunding and trust in different organisations that could set up and run a crowdfunding campaign. Questions in survey Parts 1 and 2

were based on information from the literature on what motivates and prevents entrepreneurs from starting their own crowdfunding campaign and on what characteristics can influence participation in crowdfunding (Gleasure, 2015; Ryu and Kim, 2018). The third part of the questionnaire addressed climate change impacts and respondents' adoption of various on-farm mitigation practices. Respondents were asked whether they would be willing to try out new climate mitigation measures funded through crowdfunding (on a scale from 1 = very likely to 5 = very unlikely). The survey did not identify specific climate measures, asking respondents instead to think about their most preferred climate measure to increase the applicability of the survey questions to different farm contexts.

The fourth and final part of the survey consisted of six discrete choice experiment questions (Alpizar et al., 2001; Carlsson, 2011). These choice questions aimed to elicit respondents' preferences for different crowdfunding models and are described in the next section.

2.1. Discrete choice experiment design

Discrete choice experiments (DCEs) are a tool used in marketing, health, food, and environmental economics to assess people's preferences for different characteristics (called 'attributes') of a good or service (Hole, 2008; Kragt et al., 2019; McFadden, 1986; Rigby et al., 2009; Spencer-Cotton et al., 2018). They are based in random utility theory (McFadden, 1974) and Lancaster's characteristics demand theory (Lancaster, 1966). The underlying theories state that individuals derive utility from the characteristics that make up a good rather than directly from the good itself, and that individuals aim to maximise their overall utility. The utility that an individual derives from a good cannot be observed directly, but can be inferred indirectly by examining the choices made by each individual.

In DCEs, a good or service is broken down into several attributes (i.e. the characteristics that make up the good). These attributes are used to create different alternatives of the good or service, which are presented to respondents in a series of choice questions. Each choice question will show the respondent different alternatives, and respondents are asked to choose their most preferred alternative in each set. The probability that an individual chooses a specific alternative from the set presented can be estimated by conditional or mixed logit models (see Section 2.3). If these models also include socio-demographic or behavioural characteristics of the respondent, the analyst can predict the preferences of different types of respondents.

In our study, the good or service under consideration is the crowdfunding campaign and its characteristics. Four attributes expected to be most relevant to farmers were identified through a mixed method approach including a literature review, focus group with farmers, and an expert workshop (Otte et al., 2019 and Table 1).

1) **Crowdfunding model:** To investigate farmers' interest in crowdfunding, we need to test preferences for different forms of crowdfunding since they embed very different levels of ownership and commitment. In our survey, we tested three crowdfunding models: donation-based, reward-based, and lending-based. Donation-based crowdfunding presents the lowest commitment required by farmers (receive a payment without providing anything in return to backers),

while lending presents the highest form of commitment (farmers are expected to keep in contact with investors and pay the loan back over time with interest). Equity-based crowdfunding was not considered in our survey because equity-based models require a change to business governance structures, whereas the other three models do not require such a change.¹

- 2) **Collaboration:** Some mitigation measures are more viable if carried out jointly with other farmers (e.g., biogas production that processes manure inputs from multiple farms-Chiriaco and Valentini, 2021). Thus, collaborating in a crowdfunding campaign to raise funding jointly with a group of farmers may be relevant. We investigate farmers' interest in setting up joint crowdfunding projects.
- 3) **Proportion of project funding:** Because climate measures will have different costs to each farmer and farming context, there was no payment vehicle included in the choice sets (compare Aravena et al., 2014; and Burton et al., 2017). Instead, we presented the proportion of the (climate change mitigation) project that would be financed through crowdfunding as another characteristic of farmers' interest. The thresholds were chosen based on feedback from a focus group with farmers to ensure user-relevant financial targets.
- 4) **Co-finance:** Climate change mitigation measures could be 100% financed through crowdfunding. However, the potentially high investment costs for on-farm climate change mitigation and the resulting high amounts of funding needed, could discourage potential backers from financing the project and reduce the chance of crowdfunding success (Cordova et al., 2015; Lagazio and Querci, 2018). Providing co-finance for crowdfunding agricultural climate mitigation measures can help to lower the funding goal, could make projects more feasible and interesting to backers, and may be attractive to farmers. Here we tested whether farmers favour crowdfunding augmented by a bank loan, or by their own capital.

The attributes were organised using a D-efficient design (Ferrini and Scarpa, 2007) of 18 choice sets, which were split into three blocks so that each respondent answered six choice sets. Each choice question presented three crowdfunding alternatives and a fourth 'opt-out' option (Fig. 1).

Farmers were told to imagine that they would implement their preferred climate mitigation action on their farm and set up a crowdfunding campaign to raise money to support that action. They were then asked to choose the most suitable alternative out of the three crowdfunding options shown in each choice set.

2.2. Survey administration

A national survey of Norwegian farmers was conducted in November 2018. A random sample of farmers with sole proprietorship of at least 0.5 ha of farmland was drawn from the Register of Producers at the Norwegian Agriculture Authority (Landbrukets Dataflyt, 2018). The questionnaire was sent out to 2000 farmers by post, with a reminder sent three weeks later. Respondents had the opportunity to return the questionnaire on paper, or to use a link to a webpage to complete the survey online.

2.3. Data analysis

Two lines of inquiry were used to analyse the data, with all data analysis conducted in STATA 15.0. Respondents' stated likelihood to try out new climate mitigation measures funded through crowdfunding (measured on a scale from 1 = very likely to 5 = very unlikely) was analysed using ordered probit models. Because these model results align with the choice models, the probit modelling results are presented in Table A1 of the Supplementary Materials. The choice experiment data

Table 1
Attributes and levels used in the crowdfunding choice experiment questions (translated from Norwegian).

Attribute	Attribute levels
Crowdfunding model	Donation, Reward, Loan
Collaboration with other farmers	Yes, No
Proportion of the project financed through crowd-funding	30%, 60%, 100%
Source of co-finance (if any)	Bank loan, Own capital, No additional sources (if crowdfunding financed 100%),

¹ We thank an anonymous reviewer for this insight.

We want you to choose the option that you consider to be most suitable for you. Imagine that these three options are the only options available to get support through a crowdfunding campaign for your preferred climate action. Please consider each question independently from the other choice questions. Tick your one preferred option.

	<u>Alternative 1</u>	<u>Alternative 2</u>	<u>Alternative 3</u>	
Type of crowdfunding	Donation	Reward	Donation	None of these alternatives
Proportion of the project financed through crowdfunding	30% financed through crowdfunding	60% financed through crowdfunding	100% financed through crowdfunding	
Source of additional funding (in addition to crowdfunding campaign)	70% financed through own capital	40% financed through a bank loan	No additional funding source	
Collaborating with other farmers in the crowd-funding campaign	Yes	No	No	
I prefer →	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Fig. 1. Example of a choice question as shown to respondents in our farmers' survey.

were analysed using multinomial and mixed logit models (Hensher et al., 2005) with each attribute level dummy coded to allow for potential non-linearity in preferences. Results of a basic multinomial logit (MNL) model are described in the Supplementary Materials Table A3. A more state-of-the-art mixed logit model is presented in this paper (Section 3.3). The mixed logit model allows us to relax the often-violated Independence of Irrelevant Alternatives (IIA) assumption of the MNL model (McFadden, 1986); accounts for unobserved heterogeneity in preferences across respondents; and takes into account that each respondent has made repeated choices in a panel data format. The model was estimated using 500 Halton draws.

3. Results

Of the 2000 distributed questionnaires, 395 farmers completed the questionnaire on paper and another 70 completed the questionnaire online, resulting in a total of 465 returned questionnaires (a response rate of 23.3%). Because of missing responses to some questions, the total number of respondents included in the analyses was 443.

3.1. Socio-demographic characteristics of the sample

The majority of respondents were male in their 50s, with about one-third of respondents having completed a university degree (Table 2). The primary production activities carried out on the farm were sheep rearing (29%), beef and dairy cattle (24% and 22%), and grain growing (26%). The sample is largely representative of the Norwegian farming population (Table 2). Our sample is somewhat overrepresented by organic farmers and farmers that are actively transitioning to organic, possibly due to organic farmers being more interested in completing a survey on climate change mitigation.

3.2. Farmers' experiences with climate change and crowdfunding

Nearly half of the farmers thought that climate change was due in

equal parts to natural processes and human activity (44%), while a further 42% thought that climate change was 'mainly' or 'exclusively' due to human activity (Table 3). Nearly 60% agreed or strongly agreed with the statement "It is more important to reduce GHG emissions in other sectors than agriculture". At the same time, nearly 39% agreed or strongly agreed that it is their personal responsibility to reduce GHG emissions from agriculture, and 16% agreed that there are too many GHG emissions from Norwegian agriculture.

The survey included additional questions about farmers' interest in on-farm practices that have climate change mitigation benefits (see Supplementary Materials for full survey). This indicated that farmers have already implemented, or are most interested in implementing the following practices: (1) using wood instead of steel or concrete for their barn; (2) installing solar panels on their barn or cowshed; (3) investing in precision agriculture equipment; and (4) investing in pipeline manure injection systems (Table 3). Over 80% of respondents stated that the costs of climate change mitigation measures were somewhat or very important to their adoption (data not shown).

Knowledge about crowdfunding was generally low. Of the 443 respondents, 85 had heard of crowdfunding (19.2%), and 25 had either previously conducted their own crowdfunding campaign or given money to a crowdfunding campaign (5.6%). This lack in familiarity with crowdfunding came through in other survey questions, with many "don't know" or missing responses to the attitudinal questions on crowdfunding ($n \leq 302$ in Table 3).

Perspectives on crowdfunding were tested through a series of attitudinal statements (Table 3). A majority of respondents (between 66% and 72%) agreed or strongly agreed that (a) they preferred to apply through a shared campaign rather than conducting their own; (b) crowdfunding would be too time consuming; (c) they did not want to be presented publicly as a recipient of crowdfunding; and (d) crowdfunding would be most relevant if an external organization could set up and run the campaign.

Considering a range of external organisations that could run a campaign, agricultural advisory services and farmer organisations were

Table 2
Socio-demographic statistics of the Norwegian farmers' sample (n = 443).

Variable		Mean (st.dev)/% of responses ^a	Population means ^b
Gender	Male	84.6%	83.8%
	Female	15.4%	16.2%
Age (years)		54.6 (11.7)	52
Has completed a university degree (undergraduate or postgraduate (0/1))		32.7%	na
Total household income in 2017 ('000 NOK)		715 (326)	na
Main source of income	Farm as only source of income	35.8%	na
	Have off-farm income	64.2%	na
	Organic farmer or in transition to organic farming	9.1%	5.1%
Productive area of the farm (hectares)		27.8 (25.9)	24.9
Productive area of the farm (hectares)	<10 ha	27.3%	27.8%
	10–49 ha	59.4%	60.1%
	≥50 ha	12.6%	12.1%
Main production activities ^c	Dairy	21.5%	19.8%
	Beef	24.4%	34.6%
	Pigs	5.4%	5.7%
	Sheep	28.9%	36.4%
	Grain	25.7%	26.3%
	Forestry	18.3%	na
Perception of farm debt relative to turnover	Big/Too big	16.7%	
	Small/Medium	52.4%	
	Don't have debts	25.1%	
Expectation of financial returns from the farm	Expect to increase over the next five years	20.5%	
	Expect to decrease over the next five years	35.4%	
	Expect no change over the next five years	29.4%	
	Don't know	9.0%	

^a Because of missing data, not all variables add up to 100%.

^b Population data on farmer characteristics from [Statistics Norway \(2018\)](#). Not all statistics are available at the population level.

^c In the survey, we asked respondents to report their *main* production activities, while population data is available only for the proportion of all farms who are involved in these production activities. Forestry data is not available as this is considered a secondary activity.

the most trusted as campaign organisers. Existing crowdfunding platforms such as Bidra or Spleis were least trusted by farmers (even less than Banks), although it should be noted that a large proportion of respondents were not familiar with crowdfunding platforms (with 40.1% “don't know” or missing responses when asked about trust in crowdfunding platforms).

We asked respondents how likely it would be that they would use crowdfunding through different models (donation, reward, or loan-based). Interest was generally low, with just under 14% of respondents stating that they were ‘somewhat likely’ or ‘very likely’ to use donation-based crowdfunding. Around 6% of respondents stated that it was ‘somewhat’ or ‘very likely’ they would use reward-based or loan-based crowdfunding models for a campaign.

We then asked specifically whether farmers would be willing to test out new *climate measures* financed through crowdfunding (on a scale

Table 3
Farmers' opinions and experiences with climate change and crowdfunding.

Question	% of responses	
<i>I think climate change is caused by ... (n=415)</i>		
I don't think climate change is happening	1.2	
Mainly or only natural processes	13.3	
Equally due to natural processes and human activity	43.6	
Mainly or exclusively human activity	41.9	
<i>Agreement with statements about climate change^a</i>		
It is more important to reduce GHG emissions in other sectors than agriculture (n = 422)	59.7	
As a farmer, it is primarily my responsibility to reduce GHG emissions from agriculture (n = 413)	38.9	
It is primarily the government's responsibility to reduce GHG emissions from agriculture (n = 408)	32.2	
There are too many GHG emission from Norwegian agriculture (n = 403)	16.0	
<i>Implementation of potential mitigation measures</i>		
	<i>Already implemented</i>	<i>Likely to implement^d</i>
Use of wood in the barn instead of steel and concrete	37.0	19.4
Precision agriculture based on GPS, automated steering, etc.	11.7	19.6
Pipeline manure injection systems	10.4	17.1
Solar panels on the barn or cowshed	1.6	22.9
<i>Agreement with statements about crowdfunding^b</i>		
I would prefer to apply for financial support for mitigation measures through a shared crowdfunding fund rather than conducting my own campaign (n = 274)	72.3	
Crowdfunding would be too time consuming for me (n = 233)	67.8	
I do not want to be presented publicly as a recipient of a crowdfunding campaign (n = 302)	67.5	
Crowdfunding is most relevant to me if I can get help from an external organization who can set up and run the campaign for me (n = 261)	66.3	

^a Proportion of responses stating ‘Very likely’ or ‘Somewhat likely’ to implement these practices in the next five years.

^b Proportion of responses stating ‘Agree’ or ‘Strongly agree’ with the quoted statements.

from 1 = very likely to 5 = very unlikely). Out of the 379 responses received, 100 respondents (26.4%) stated that they were ‘very likely’ or ‘somewhat likely’ to test out new climate measures funded through crowdfunding. Results of ordered probit models on this stated likelihood (Table A1 in Supplementary Materials) revealed that organic farmers, and respondents who expect their farm to grow over the next five years, were more likely to test new climate measures through crowdfunding. Respondents who think that climate change is due to human activity, who prefer shared crowdfunding, who agree that there are too many GHG emissions from Norwegian agriculture, and who agree that it is their responsibility to reduce emissions are also more likely to test out new climate measures through crowdfunding. An important deterring factor to using crowdfunding as a financing tool for climate mitigation actions is being publicly presented as a recipient of funding, indicating that the public nature of crowdfunding platforms could present a barrier to their use in Norway.

3.3. Preferences for crowdfunding campaign features

A mixed logit model was used to explore farmers' preferences for different attributes of crowdfunding campaigns. In line with results reported above, farmers were, on average, hesitant to adopt any of the

crowdfunding options presented in the choice sets. The 'opt-out' option ("None of these") was selected in every question by 141 respondents (32.8%), and is reflected by the positive coefficient for the Alternative Specific Constant (ASC) in Table 4. The ASC coefficient is insignificant due to the high level of heterogeneity in responses. The apparent preference for none of the crowdfunding options shows (a) the lack in familiarity with crowdfunding; and (b) the relatively limited interest of the sampled farmers in participating in crowdfunding campaigns.

The most preferred set-up for a crowdfunding campaign was a donation- or reward-based model over the loan-based crowdfunding model, as indicated by their positive and significant coefficient estimates. We also find a positive preference for campaigns where farmers collaborate. Respondents were less likely to choose options that covered 30% or 60% of the project costs, compared to a fully (100%) funded crowdfunding campaign. There were no differences in preferences

Table 4
Norwegian farmers' preferences for crowdfunding: results from mixed logit model on choice experiment survey data (standard errors in parentheses).

Variable ^a	Coeff. (st. error)	p-value	St.Dev. (st.error)	p-value
<i>Choice attributes</i>				
ASC (=1 for 'none of the crowdfunding alternatives')	0.842 (1.657)	0.611	5.911 (0.597)	0.000
Donation-based (relative to loan-based)	1.479 (0.202)	0.000	1.547 (0.275)	0.000
Reward-based (relative to loan-based)	1.062 (0.154)	0.000	1.287 (0.189)	0.000
Collaborate (yes = 1)	0.342 (0.147)	0.020	1.664 (0.186)	0.000
Proportion funded 30%	-1.751 (0.227)	0.000	1.784 (0.208)	0.000
Proportion funded 60%	-0.413 (0.163)	0.012	0.163 (0.282)	0.563
Own Capital (relative to Bank Loan)	0.142 (0.160)	0.375	1.671 (0.200)	0.000
<i>Socio-demographic variables interacted with the ASC</i>				
Age (yrs)	0.097 (0.025)	0.000		
Female (0/1)	2.075 (0.728)	0.004		
Income ('000 NOK)	-0.002 (0.001)	0.017		
Expects my financial returns from farming to increase over the next five years (0/1)	-3.280 (1.150)	0.004		
Has previously given money to or conducted own crowdfunding campaign (0/1)	-3.453 (1.233)	0.005		
(Strongly) Agrees with "I prefer to apply for financial support for mitigation through a shared crowdfunded fund rather than conducting my own campaign" (0/1)	-5.513 (0.824)	0.000		
(Strongly) Agrees with "There are too many GHG emissions from Norwegian agriculture" (0/1)	-3.990 (0.848)	0.000		
(Strongly) Agrees with "As a farmer it is primarily my responsibility to reduce GHG emissions from agriculture" (0/1)	-0.952 (0.651)	0.144		
(Strongly) Agrees with "I do not want to be presented publicly as a recipient of a crowdfunding campaign" (0/1)	2.417 (0.700)	0.001		
Log likelihood	-1873.2			
Pseudo-R ² ^b	0.248			
Number of choice obs. ^c	2,284			

^a Units of measurement in parentheses after each variable.

^b Compared to a constant only model with LL = -2,490.

^c The number of choice observations is lower than the number of respondents (443) times the number of choice sets each respondent saw (6) because not all respondents answered all the socio-demographic questions.

between using own capital or a bank loan to cover any potential shortfall in finance for the project (as indicated by the insignificant estimate on 'own capital'). The standard deviation was significant for nearly all of the choice attributes except the 60% funding. This implies that preferences are heterogeneous across respondents.

The socio-demographic variables are interacted with the ASC to explain the characteristics of farmers interested in participating in crowdfunding campaigns. The positive coefficient on age and female means that older and female respondents were more likely to select the "none of these" (ASC) choice option (note, however, that we only had 15% female respondents in our sample). Characteristics associated with a higher interest to participate included: higher farm incomes; having previous experience with crowdfunding through donations or running a campaign; expecting higher financial returns from farming over the next five years; a preference for a shared rather than own campaign; agreeing that there are too many GHG emissions from agriculture; and agreeing that it is their responsibility as a farmer to reduce GHG emissions. Respondents who did not want to be presented publicly as a recipient of a crowdfunding campaign were more likely to select the "none of these" option.

4. Discussion

The research presented in this paper contributes to the knowledge on farmers' interest in using alternative finance options to fund climate change mitigation practices. In a first study of its kind, we use a choice experiment survey of 443 farmers in Norway to investigate farmers' interest in using public crowdfunding campaigns to raise finance for on-farm mitigation practices. Our results provide guidance for designing future crowdfunding campaigns with farmers in Norway. Results show that donation- or reward-based crowdfunding models are more likely to be taken up by farmers than loan-based crowdfunding. This is no surprise, given that a donation or reward generate funding at no or low costs to the farmers, while loan-based models require farmers to repay the loan with interest. Loan-based models may also involve continued communication between funders and the farmer, thus increasing their costs.

Farmers with a financially secure farming business, previous exposure to crowdfunding, or a strong sense of responsibility to abate climate change are more interested in using crowdfunding than other respondents and should thus be the primary targets for setting up GHG mitigation crowdfunding campaigns. This is consistent with existing studies where higher-asset farmers are more likely to change (Wood et al., 2014); and where farmers with stronger climate beliefs are more likely to adopt mitigation or adaptation practices (Arbuckle et al., 2013; Haden et al., 2012; Niles et al., 2016).

Respondents' preference for collaborative campaigns may be expected, as collaboration between farmers is common in Norway. Many farmers work together in small joint operations consisting of two to five farmers that pool the resources of what are generally small scale operations (Schei et al., 2012; Burton and Farstad, 2020). Eriksen and Selboe (2012) observe, for example, that in the case of a Norwegian mountain farming community, community members collaborated to manage climate variability by sharing equipment, exchanging labour, and sharing knowledge and experience. In a similar way, joint crowdfunding project has a range of other advantages over individual campaigns. Firstly, it can reduce individuals' campaign costs for example by reducing the time needed investor management (e.g. communications with backers-Agrawal et al., 2015). Secondly, it can lower the fear of personal embarrassment in case of failure (Gerber and Hui, 2013a) since the risk of setting up and running a crowdfunding campaign is shared with other farmers. Thirdly, involving a team of entrepreneurs in fundraising has been shown to positively influence campaign success (Lagazio and Querci, 2018). Finally, crowdfunding is a very social activity and as such might normally not be relevant for introverted individuals (Davidson and Poor, 2015). Collaborating with other farmers

can encourage more introverted farmers to consider crowdfunding.

Our results show that respondents prefer campaigns that cover the full costs of mitigation. This is expected, since many farmers are already financially stretched and thus are unlikely to be willing to take on more debt to finance climate change mitigation measures. However, some mitigation practices require high upfront investments, which increases the total amount of crowdfunding required if the campaign were to cover the full investment costs. Larger crowdfunding projects have been shown to be less successful, partly because backers may perceive them as unreasonable, thus discouraging investment (Lagazio and Querci, 2018). Additional experimentation is required to find the right ‘balance’ between the amounts of funding requested through crowdfunding and the costs of the mitigation project. While farmers preferred a fully funded project, they also demonstrated some willingness to invest their own capital if a project does not generate sufficient funding to cover the full mitigation costs.

Opportunities exist for replication studies that explore how farmers’ preferences may vary in different market contexts. Norwegian farmers receive high levels of market price support and other direct subsidies (OECD, 2020), which may distinguish preferences from those in more ‘liberal’ market environments like Australia and New Zealand. Cultural context also plays a role in preferences for different types of crowdfunding (Beatty et al., 2015). In Norway, socio-cultural norms such as the ‘Law of Jante’ might inhibit the use of crowdfunding among farmers. The Law of Jante is an important part of Norwegian culture, conveying the importance of not ‘sticking out’ or thinking that an individual might be better than the rest of society (Cappelen and Dahlberg, 2018). The Law of Jante is considered to be more visible in rural areas in Norway and is observed in our study in the significance of farmers not wanting to be publicly presented as a recipient of crowdfunding. Further research can show whether some models of crowdfunding are perceived as more or less desirable in different socio-cultural contexts and markets. Donation and reward-based crowdfunding align more with the notion of ‘civic agriculture’—the idea that agriculture involves social responsibility (e.g. to reduce GHG emissions) and is not purely economically driven (Brandth et al., 2013). Projects that rely on loan or equity-based crowdfunding may be perceived as more economically driven and could therefore be more acceptable in free market agriculture environments. In terms of implications for practice, we found that agricultural advisors and farmer organisations were the most trusted organisations among respondents. These organisations could step in as intermediaries to set up and run campaigns. Using intermediary organisations is likely to address some of the barriers to farmers’ adoption of crowdfunding, such as the Law of Jante and a perception that crowdfunding is too time consuming. Intermediaries can serve as ‘aggregators’ that bring farmers together to set up collaborative campaigns, which were preferred over individual action. For crowdfunding platforms, there is an opportunity to initiate training and products designed for such collaborative groups rather than targeting individual fundraisers. Crowdfunding platforms could also develop training for farmers on how to set up campaigns that are beneficial to their specific business context. Finally, there is a role for governments to create favourable regulatory frameworks that encourage the use of different crowdfunding business models by entrepreneurs (be they individual farmers or intermediary organisations). Properly designed incentives like matching funds for crowdfunding campaigns that target agricultural climate change mitigation could encourage investment from backers and can encourage farmers to use crowdfunding as a source of funding (Cicchello et al., 2019).

5. Concluding remarks

While our study provides insights into farmers’ interest in crowdfunding climate change mitigation, the research cannot confirm how much agricultural GHG abatement could be achieved through crowdfunding campaigns. Our question on crowdfunding climate mitigation

practices did not identify the specific mitigation practices that would be funded. This focus ensured that the choice experiment was widely applicable, as it is likely that different farmers have access to different abatement methods. However, it means that we don’t know which practices are most likely to be supported through crowdfunding. Further research into the costs (e.g. investment, transaction, maintenance) of new practices, the abatement potential of different on-farm mitigation practices, and farmers’ interest in such practices is needed to identify what mitigation measures are most likely to be adopted, and thus what the sector’s realistic abatement potential could be. Finally, it is worth reflecting on the appropriateness of crowdfunding climate change mitigation measures that could create private benefits to the entrepreneur (e.g. by reducing energy costs or by producing co-benefits). Economic theory suggests that measures that generate private benefits would be adopted without the need for public investment. However, in the context of climate change mitigation measures in agriculture, high investment costs or socio-cultural barriers may prevent adoption (Dumbrell et al., 2016; Kragt et al., 2017). In such cases, public investment is needed to overcome initial barriers, and may be warranted given the ultimate public benefits generated in terms of climate change mitigation. Crowdfunding could provide a vehicle for public backers to support directly to climate change mitigation and possibly partly offset their own carbon emissions.

We explored farmers’ preferences for different attributes of a crowdfunding campaign in the context of on-farm climate change mitigation practices. Further crowdfunding research is needed to investigate the attitudes of investors. What is the willingness of private (or corporate) backers to donate to a climate change crowdfunding campaign? What motivates investors to support a climate change crowdfunding campaign (e.g. offsetting private emissions or contributing to wider public benefits)? Do motivation or willingness vary with different campaign or farmer characteristics? Further research will need to examine whether farmers’ preferences match those of potential investors.

Our work has shown that Norwegian farmers’ knowledge about crowdfunding as an alternative finance method and interest to use crowdfunding as a means to fund climate change mitigation is generally low. Whilst this may signal limited opportunities for crowdfunding as a fundraising method, fewer campaigns are probably more realistic given that there are limited public backers available. We show that, if properly designed, crowdfunding can offer one of many promising tools to incentivise climate change mitigation on farms.

CRedit authorship contribution statement

Marit Ellen Kragt: Conceptualization, Methodology, Formal analysis, Investigation, Data curation, Writing – original draft, Writing – review & editing. **Rob Burton:** Conceptualization, Writing – original draft, Writing – review & editing, Funding acquisition. **Alexander Zahl-Thanam:** Formal analysis, Investigation, Data curation. **Pia Pirotschka-Otte:** Conceptualization, Methodology, Investigation, Writing – original draft, Writing – review & editing, Supervision, Project administration, Funding acquisition.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jclepro.2021.128967>.

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