



## Article

# Willingness to Pay for Crowdfunding Local Agricultural Climate Solutions

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**Abstract:** The recent rise in climate concern among citizens worldwide is coinciding with a rising interest in agricultural climate solutions. The future scaling-up of these solutions, however, requires more knowledge about the mitigation potential, costs and financing options, including crowdfunding (CF). Our objective is to explore the driving factors behind the public's willingness to pay for crowdfunded climate mitigation projects at the farm level. In this study, four mitigation options from the perspective of farmers were identified: solar panels on the barn roof, biogas from animal manure, drag hoses for improved manure dispersal, and the addition of biochar to soils. The study investigates the optimal characteristics of crowdfunding campaigns to finance such mitigation measures. The most influential factors on the respondents' WTP is neither climate concern nor proximity, but instead the knowledge regarding CF, combined with how comprehensible and salient the suggested measure is. The main implications are that future projects that aim to achieve broad participation in CF campaigns need to communicate well, to improve both public knowledge of the funding mechanism (CF) itself and the comprehensibility and salience of the agricultural measure.

**Keywords:** crowdfunding; agricultural economics; climate change; willingness to pay; carbon offsetting; sustainable agriculture



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## 1. Introduction

In this article, we study the Norwegian public's willingness to pay in crowdfunding campaigns to achieve additional climate mitigation measures at the farm level. The purpose is to establish whether such crowdfunding can be an additional source of finance for farmers by enabling the private sector and the public to invest more in local food security and sustainable agriculture. If the response is positive, crowdfunding could be a potential source of "additional capital to existing support schemes that are available to farmers" through the Norwegian government's agricultural subsidy program, rather than to replace it [1]. Earlier studies have established that Norwegians show a strong preference for locally produced and distinctive food [2]. A recent survey further found that 70% of Norwegians consider it urgent to act on climate change [3], while another survey reported that 70% of Norwegians consider themselves to have a personal responsibility to act on climate mitigation [4].

Together, such preferences could possibly influence willingness to pay (WTP) a premium for local, climate-friendly food and energy production, particularly if their extra contribution is seen as "earmarked" for climate action [5,6]. Internationally, a number of new crowdfunding platforms have appeared for funding farm-based carbon mitigation and so-called nature-based solutions, such as the Terraton initiative, MoorFutures, Nori or Puro Earth (for details, see [www.terraton.indigoag.com](http://www.terraton.indigoag.com), [www.moorfutures.de](http://www.moorfutures.de), [www.nori.com](http://www.nori.com) and [www.puro.earth](http://www.puro.earth), accessed on 18 June 2021). There is, however, a lack of data and evidence on factors influencing the consumer demand for such climate-positive measures

within the agricultural sector. In the literature, there exists a large number of studies on the WTP regarding greenhouse gas (GHG) emission reductions in general, but in order to develop crowdfunding campaigns that would enable consumers to offset their emissions locally through specific, climate-friendly, and farm-level measures, novel insights are needed at local, national and international levels. We thus seek to investigate the following question: What factors determine the public's willingness to pay for crowd-funded, additional greenhouse gas mitigation and storage at agricultural farms, both locally and nationally?

While such a question has, to the best of our knowledge, not been studied before, answering these research questions entails exploring two main uncertainties. The first concerns the individual consumers' perceptions of responsibility and interest in contributing to climate measures within the agricultural sector. If people consider Norwegian agriculture to already be too highly state-regulated and subsidized, then they might not see it as their individual responsibility, either as green consumers or citizens, to financially support additional initiatives in agriculture.

Second, if there exists a broad, untapped interest among the public, how important are the degree of concern for climate change and the characteristics of the local agricultural climate measures themselves for their WTP? How do green consumers perceive what they are potentially buying or giving money to? We investigate which models of crowdfunding are preferred by the general public, and what price margin, i.e., WTP, they perceive for a set of greenhouse-gas mitigation measures.

## 2. Background and Identification of Climate Measures on Norwegian Farms

### 2.1. Green Consumers: Motives for and Barriers against Buying Green and Locally

The emergence of environmentally conscious consumers has led to a growing literature on the economics of morally contingent motivation [7]. According to Sparkman and Walton [8], consumers will aim to "conform to normative information about other people's current attitudes" on which products are morally superior to buy. As Nyborg, Howarth and Brekke [9] point out, "such behavior is plainly at odds with the traditional assumption that consumers are rational actors who pursue a narrow conception of self-interest" [9] (p. 352). Consequently, Nyborg et al. [9] maintain that consumers might gain a benefit by choosing a morally superior, green product, equal to the value of attaining a more favorable self-image. The extent to which a consumer "acknowledges a personal responsibility for the issue at hand" determines its subjective benefit [9] (p. 352). In other words, if you believe that your actions lead to climate change and that this has negative consequences, your concern will motivate you to counteract this.

Identifying the total amount that individuals are willing to pay, in their role of green consumers, to reduce greenhouse gas emissions cannot be achieved from looking at current market indices. As the price of carbon is usually not specified in regular consumer exchanges, these prices need to be conferred indirectly, often through contingent valuation (CV) methodology. A contingent valuation captures the added value that consumers associate with a given service or product, such as a campaign for improving the state of the environment. Consumer attitude surveys, often employed to investigate individuals' interest in "green products", consistently identify a disposition to choose products displaying higher quality and safety standards, often associated with sustainability [10].

The individual WTP for environmental (public) goods also depends on one's perceptions of personal risks, environmental benefits and the costs of inaction (replacement costs or existence/bequest values). Stoknes [11,12] and others have argued that the individual perception of the urgency and pertinence of global warming depends on five key psychological barriers. The first relates to the perceived **distance** between the individual, on the one hand, and both the climate problem and its solutions on the other. In many ways, the Earth's climate problems, as well as solutions such as emission trading systems (like the EU's ETS) and global offsetting (like the UN's clean development mechanism, the CDM) remain something psychologically distant to most people. Cognitive **dissonance** is another key barrier. If what we know to be the "correct", sustainable behavior conflicts with our

current unsustainable behavior, we often resign ourselves to and even disregard such facts altogether, in order not to have to deal with the incongruence. In such cases, **denial** of the problem might occur. Denying that climate change is happening altogether or taking comfort in the idea that it might be happening regardless of human actions allows people to avoid the uncomfortable dissonance between what they do and what they believe. The social and political **identity** of people is yet another barrier [12]. Indeed, systems of understanding, valuing, and filtering information are often centered on cultural and historical identities formed through kinship and cultural values, rather than on a factual basis.

Key to the concept of local crowdfunding of climate measures in the agricultural sector is whether people ascribe a higher value to local causes, those that are visible in their neighborhood. Taking action to influence the emissions and sites nearest ourselves lessens the psychological distance and dissonance [12] (p. 102). Given that most existing carbon offsetting schemes are targeting mostly distant climate mitigation projects at the international level, such as the UN CDM carbon offsets or EU ETS allowances, our study sought to test whether local measures would generate a higher level of interest among the population.

Feitelson [13] first used the term “place attachment” to refer to the “emotional bonds that arise from familiarity, a sense of belonging or ideology that plays a role in motivating individuals to attend to, care for and take actions on behalf of particular places” [14] (p. 61). This relates to a broader argument by Hulme [15] that climate change issues are situationally perceived, incorporating people’s relationship with places. Attachments to an area perceived as “home” comprise a special form of “place”, and the degree to which this attachment exists seems to be associated with factors such as “length of dwelling, property ownership, high perceived neighborhood cohesion”, a high feeling of safety, and different forms of action and pro-environmental behaviors [14] (p. 62). According to Devine-Wright [14], there is a body of evidence describing “the role of place attachments in predicting attitudes toward low carbon energy projects”. In one study, place attachments explained 20% of the variance in attitudes toward low-carbon energy projects in that neighborhood [14].

## 2.2. Selected Studies of WTP of Climate Measures

A range of international studies indicates that people are indeed willing to pay for mitigating carbon emissions. Investigating the WTP for carbon emissions reductions regarding car use, Hulshof and Mulder [16] found that, on average, a Dutch person was willing to pay EUR 199 per tCO<sub>2</sub> emitted in driving (USD ~210/tCO<sub>2</sub>), when considering what car to buy. MacKerron et al. [17] found that the mean WTP for a flight’s verified carbon offset among young British adults was GBP 24 per person (USD ~30/tCO<sub>2e</sub>). Citing Nyborg et al. [9], they identified that “a number of respondents who were unwilling to pay said they would be happy to do so if this were made a collective obligation, or if they believed that others would do so too” [17] (p. 1379). Kotchen, Boyle and Leiserowitz [18] studied attitudes toward paying a premium on carbon pollution in order to achieve the US 2020 climate target (17% reduction). They found that, on average, each person was willing to pay between USD 79 and USD 89 per year. They also found that the WTP was highly sensitive to educational level, household income and age. They also attributed the variance to opinions about climate change [18].

Kragt, Gibson, Maseyk and Wilson [19] concluded that Australians were willing to pay approximately AUD 1.13 AUD per tCO<sub>2e</sub> (approx. USD 1/tCO<sub>2e</sub>) reduction in Australian agriculture, through a nationwide carbon farming scheme. They also recorded a WTP for restoring and protecting native vegetation to be AUD 19 per hectare (approx. USD 14/ha) of increase in farmland area. Researchers from Statistics Norway (SSB) have investigated the Norwegian public’s WTP for preserving agricultural landscapes in rural areas of Norway [20]. They find that, overall, the Norwegian population price the current cultural landscape and biodiversity values at a high level. Their study indicates that the rural populations living close to abandoned pastures have a higher WTP than urban

and semi-urban residents, but that non-use values from ecosystem attributes such as carbon sequestration and biodiversity are constant across the country [20] (p. 1). In a similar fashion, a recent study of Finnish consumers identified a significant valuation of the “ecological and socio-cultural benefits of diversified food production systems in Finland” [21] (p. 988).

### 2.3. The Identification of Relevant Measures for GHG Mitigation in Norwegian Farms

When aiming to mitigate and reduce net emissions from farming, there are a number of GHG sources in the Norwegian agricultural sector that are relevant to consider. While this study examines WTP among consumers, a related study has examined the Norwegian farmers’ willingness to participate in a local climate crowdfunding program [1]. Based on this large national survey of the supply-side, i.e., the farmers, four mitigation options were identified as the most relevant climate measures. Three criteria were applied when identifying which measures to include in the demand-side of the survey: (1) the measure must be practically feasible for the farmers to implement; (2) the measure needs to show clear mitigation benefits at local farms in Norwegian agriculture, and (3) the measure must provide several benefits at farm-level, ranging from improved resource utilization, cost savings or improved soil quality while reducing emissions. The four selected measures were: solar panels on the barn roof, biogas from animal manure, drag hoses for improved manure dispersal, and the addition of biochar to soils. Table 1 summarizes some of the most important context for the Norwegian agricultural sector as well as the national Crowdfunding market.

**Table 1.** Characteristics of the structure of the Norwegian agriculture and crowdfunding markets.

Category	Unit
Number of farms [22]	No. of businesses
Large (>30 hectares)	10,373
Medium (5–30 hectares)	22,256
Small (<5 hectares)	21,305
Average production volume (for human consumption) [23]	in 1000 tons
Meat	348
Vegetables and fruit	219
Cereals	1607
Biochar production capacity in Norway (2020, tons per year) [24]	1800
Crowdfunding in Norway, total turnover (2020, mNOK) [25]	892

Source: [22–25].

Several farmers have installed **solar panels** on their barn’s roof. The barn roof surfaces are large and often shade-free. Solar panels could increase the share of renewable energy consumption if the energy gained replaces that of fossil fuels. The energy received by the solar panels must be utilized immediately; therefore, the farm energy demand has to be closely coupled to the solar panel production profile and storage, in order for it to be a cost-effective solution. In Table 2, we used the European mix (396 g CO<sub>2</sub>/kWh), as this paper has international relevance. Estimates with the Norwegian mix (31 g CO<sub>2</sub>/kWh) are given in Supplement 1 (Supplementary Materials). The latter mix results in the estimated impact of electricity use on GHG emissions being much lower, due to the high share of hydropower in the Norwegian electricity mix (95–98%) (see Supplement 1 for details and assumptions for all four measures).

**Table 2.** Estimated annual on-farm emissions reductions for four agricultural measures.

Climate Measure	Main Mechanism and Impact	Tons CO <sub>2e</sub> Saved/Year <sup>-1</sup>	Cost per kgCO <sub>2e</sub> in NOK
Solar power on barn roof	Production and source of electric energy	22	46
Biogas plant, based on the farm's own manure	Production of electric energy/reduced CH <sub>4</sub> emission from manure storage/improved fertilization effect of manure, and thus, a reduced need for fertilizer purchase	150	40
Drag hose with dribble bars for manure spraying	Reduced NH <sub>3</sub> volatilization during the spraying of manure and N <sub>2</sub> O emission after spraying, improved fertilization effect of manure, and thus, a reduced need for fertilizer purchase. Less energy used for manure spraying	11,600	1.2
Pyrolysis of the farm's wood chip to biochar	Increased carbon soil storage, syngas and heat	116	16

Note: The impacts from a reduced need for electricity, lower greenhouse gas emissions or increased carbon storage are estimated as emitted CO<sub>2e</sub> at present, minus the emitted CO<sub>2e</sub> with the measure. European grid mix is used for CO<sub>2e</sub> related to used or saved electrical energy. See Supplementary Materials for details. Emission reduction potentials are estimated based on field research on the Skaun dairy farm in Trøndelag, Norway.

The production of **biogas** from animal manure leads to reduced emissions of methane and nitrous oxide from fertilizer storage, and reduced emissions of CO<sub>2</sub> if the biogas replaces fossil-fuel diesel or heating oil [26], but the investment cost is relatively high for small farms [27]. Farm-scale biogas production has a high climate potential but is still in its infancy in Norway. Costs and mitigation benefits depend on several factors, such as the reduced storage time of livestock manure, the degree of utilization, transport distance, and the use of biogas and bio residues/digestate. For smaller farms, especially dairy farms, where quantities of manure are produced, the investment cost of a biogas plant can be high (>5 million NOK). Coupled with a typical modest energy demand relative to energy production, it is not straightforward to realize economically viable plants. Now, plants are being realized at relatively large farms that have a correspondingly high energy demand. Farm-scale plants can receive funding from Innovation Norway (50% of the investment cost).

Using a drag hose, in combination with dribble bars, is an efficient way to improve **manure management** at the farm level. With a drag hose, the manure is transported through a hose connected to a tractor instead of being transported with a slurry tanker. This saves energy for the transport of heavy slurry. In addition, the energy used for the pump can be from electrical energy based on renewable sources. With dribble bars, manure is pumped from the drag hose to a series of separate hanging hoses. The combination of a drag hose and dribble bars does increase the nitrogen efficiency of added slurry. This leads to a reduced need for purchased fertilizer nitrogen and, thus, to less energy used for the production and transport of fertilizer nitrogen and lower emissions of the GHG nitrous oxide (N<sub>2</sub>O) from the production and use of fertilizer nitrogen. Reduced ammonia volatilization and reduced soil compaction are important for enhanced nitrogen efficiency. Reduced soil compaction will also decrease nitrous oxide emissions from applied nitrogen through manure and fertilizers [28,29]. N<sub>2</sub>O is the largest source of GHG, from manuring and fertilizing the soil. Thus, reduced N<sub>2</sub>O emissions through an improved manure strategy will have a large impact on GHG emissions.

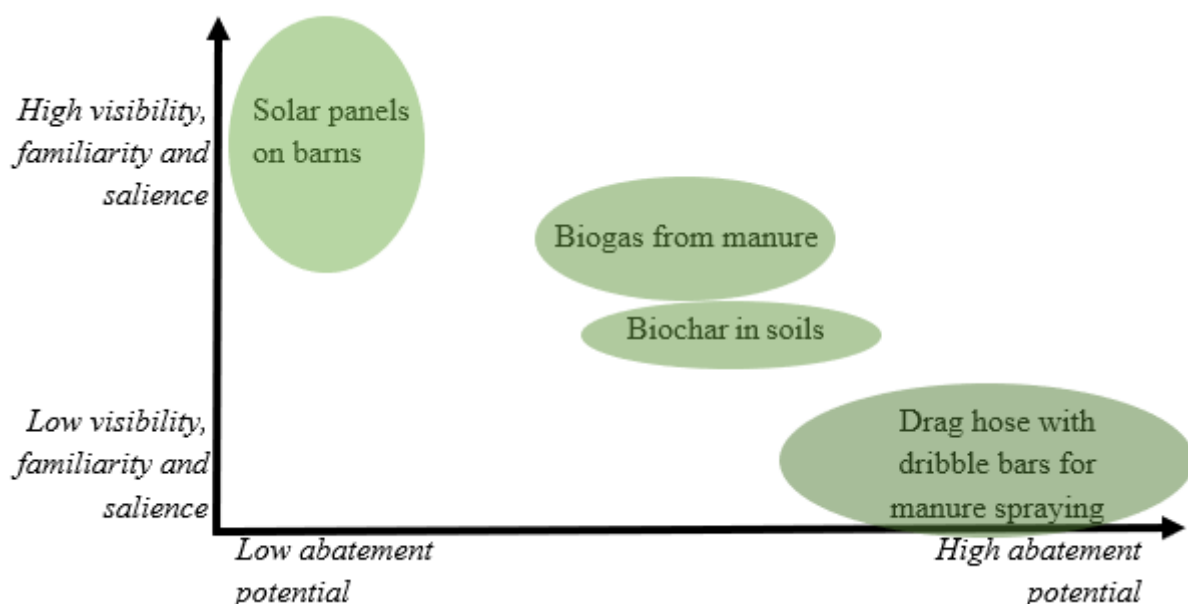
**Biochar** is a solid material obtained from the thermochemical carbonization of biomass (such as wood, manure, or leaves) in an oxygen-limited environment. The reason for the large focus on biochar over the last few years is the stabilization of carbon that occurs during pyrolysis. The aim is to utilize this to increase carbon storage in soils and, at the same time, improve the soil's agronomic performance and reduce N<sub>2</sub>O emissions from the soil [30]. In addition to stable carbon biochar, the process also produces syngas and

heat, which can be utilized for energy consumption. The climate potential is assumed to be high [31], but so far there only exist a few pilot units in Norway. In order to reduce emissions from agriculture by 10% by 2030, there is a need for 500–9000 extra pyrolysis units [26]. To utilize biochar efficiently, more knowledge is needed on which organic materials are most suitable to use for biochar production under Norwegian conditions, along with the most suitable temperatures and pyrolysis technologies, and how much carbon would be stored in the soil from the long-term perspective. The estimates given in the present article are based on a few Norwegian pioneer plants, with high uncertainty, as the underlying data are sparse.

At present, none of these climate measures seem viable for the individual farmer to be able to afford to invest in. All else being equal, we infer that the existing support scheme for Norwegian farmers will not result in new substantial investments that will realize these measures. In the absence of new initiatives, we hence investigate the potentiality of a novel approach to raising funds, i.e., crowdfunding campaigns, and their role in achieving further emissions reductions in Norwegian agriculture.

#### 2.4. Hypotheses

One key attribute of the measures is the immediate *comprehensibility* and *visibility* of the measures when installed and operational at the farm. Based on the literature above and the data from the focus groups we conducted, there is reason to expect a positive relationship between climate measures that are deemed salient, comprehensible and visible at the local level, and a willingness to crowdfund these types of climate technologies. This could create a certain bias toward tangible measures that people are used to seeing in their local areas and want to see more of (like solar panels), irrespective of their real abatement potential. We constructed a conceptual model, Figure 1, showing the attributes of the different climate technologies



**Figure 1.** Conceptual model of the relationship between climate abatement potential and the visibility and salience of relevant climate measures in agriculture.

Building on the above, we sought to test the following hypotheses:

**Hypothesis H1.** *There is a commercially significant interest among the Norwegian public for crowdfunding climate measures in agriculture.*

If H1 is not falsified, then at least three secondary hypotheses, one for each major consumer factor, i.e., climate concern, proximity, and comprehensibility, are crucial for the future design of successful CF initiatives:

**Hypothesis H2a.** *The willingness-to-pay (WTP) is higher with attitudes of higher climate concern.*

**Hypothesis H2b.** *The WTP is higher, the more **local** a farm measure is perceived to be.*

**Hypothesis H2c.** *The WTP is higher for measures perceived as well-known, **comprehensible** and **salient**.*

### 3. Materials and Methods

Contingent valuation [32] is a common valuation method applied when there is no established market for the exchange of goods in question, or where the benefits of the goods are public in nature [33]. We investigate the public's willingness to pay to compensate for their own emission footprint by participating in crowdfunding campaigns for climate mitigation through local agriculture activities. The perceived utility here is an environmental, non-monetary attribute of reduced GHG emissions at the farm-level, close to where the contributor lives. In line with Nyborg et al. [9], we assume that economic agents also seek to make socially responsible investments, thus providing the necessary incentive for individuals to pay a certain premium for achieving environmentally desirable objectives.

Building on results from related research on the farmers' willingness to invest in extra climate measures [1], we designed a double-bounded contingent valuation experiment to capture the stated preferences of the Norwegian population for crowdfunding one or several of the four climate measures identified as being most suitable for application on Norwegian farms. Respondents were asked to indicate how much they would be willing to contribute to each of these measures, given the premise that they were offered through local crowdfunding campaigns at an imagined farm in their neighborhood. We decided on using an online form rather than performing field surveys, as they have several advantages: (1) they are an affordable way of reaching a larger proportion of the overall population in a geographically dispersed country such as Norway, (2) they do not suffer from interviewer bias, and (3) respondents are likely to feel more comfortable when answering sensitive questions and moving through the survey at their own pace. Still, online surveys also come with disadvantages: unlike face-to-face or telephone surveys, it is impossible to offer any clarification of questions, and some respondents may not fully comprehend what is being asked of them [17].

Contingent valuation methods do have a range of limitations and biases, common to all types of stated-preference valuations. Previous research highlights that stated preferences do not always match the revealed preferences or the actual WTP. This can be due to the well-known "hypothetical bias" and the risk of "cheap talk", where people tend to oversell their true WTP [34]. There is a risk of "complacency bias", where survey participants respond according to how they suspect the researchers want them to reply (sometimes referred to as social desirability bias, with respondents wanting to adhere to the social norms for the topic in question). In our case, there is a particular risk of "ill-formed preferences", in cases where respondents have not fully understood the alternative goods offered to them in the choice experiment. A final concern with this type of choice experiment survey is the risk of respondents answering strategically, in a way that is different from their true preferences. This is sometimes referred to as "strategic bias", where the key factor is whether the respondent has a special, pre-existing self-interest in the survey's reaching a certain conclusion [32,33].

#### 3.1. Mixed Methods Approach to Contingent Valuation Based on a National Survey

Our aim was to investigate the factors that influence the Norwegian public's willingness to pay (WTP) regarding local crowdfunding campaigns aimed at reducing GHG

emissions from Norwegian farms. We designed a national-level survey with a contingent valuation (CV) experiment on four key crowdfunding targets. The CV survey was modeled on similar attempts at CV in the literature [16,19,21], and was based on inputs from an interdisciplinary consortium of researchers, three focus groups, and a pre-test with 35 respondents.

To qualitatively explore the attitudes, understanding, concerns, and preferences for the measures among laypeople, we conducted three focus groups at the beginning of the data collection period. Focus-group methodology is widely used and allows a project to follow a well-established methodology and validity [35]. It also allowed research informants to explain not only what, or how much, but also why they think the way that they do. Two of the focus groups consisted of participants who were recruited individually, and one focus group consisted of people from the same company, a regional power utility. It gave us a total of 19 participants across the three focus groups. All participants were living in and around Oslo, eastern Norway.

The focus groups were sampled, based on the strategic selection of key stakeholder groups considered to be of interest to the concept design. Our focus group participants represented a good mix of gender, age, education, and work status. With little or no connections to agriculture, they originated from various parts of Norway, although they were currently living in and around Oslo. They were all recruited through the network of the project members.

The online survey was designed in four main parts: the first had an introductory section and inquired into the demographics of the respondents. The second part delved into respondent's attitudes to supporting climate change measures and to Norwegian agriculture. The third part started with a general introduction to crowdfunding and the different funding models, before introducing the choice experiment, and asked respondents to estimate their WTP for the four climate solutions. The fourth and final part explored perceptions about responsibility and agency for climate measures in Norwegian agriculture.

In the choice experiment, each measure was described as it would appear on a crowdfunding campaign website, with a short piece of text and a photo illustrating how this technology could look at the local-farm level. The texts were written as neutrally as possible, aiming to present each case as being equally attractive. Among the benefits mentioned was how each measure could help the farmer reduce emissions, improve soil quality, and cut future costs, but without giving specific mitigation numbers, as these are highly uncertain. We asked respondents to indicate how much they would be willing to contribute for each measure at the farm level, considered separately, by typing a discrete number between NOK 0 and 1000 (Norwegian kroner) (approximately USD 100 at 2021 currency rates).

### *3.2. Sampling and Recruitment Strategy*

The survey responses were collected using a professional survey panel, representing the overall Norwegian population, as of 2019. The survey was randomly administered by Userneeds, a survey service company, until 1500 survey responses were collected. The survey was administered in February 2020. We were especially interested in sampling across all regions of the country, both in rural and urban areas, proportional to the national population.

Our relatively large survey sample (1500 respondents) matches the Norwegian adult population quite closely, with median income levels a little above the national median and a larger proportion claiming a work-related relationship to agriculture.

## **4. Results**

The majority of the informants still believe that climate change is not mainly anthropogenic (see Table 3: 34% + 14% + 4% = 52%), contradicting the climate science consensus [36,37]. Only 39% state that it is mainly anthropogenic. Almost 2 in 3 (61%) claim to have good or adequate knowledge about climate change in agriculture.



**Table 3.** Respondent attitudes to climate change causation, agricultural knowledge, proximity and crowdfunding (N = 1500).

Which of the Following Matches Your View?	No. of Respondents	Share %
Climate change is exclusively natural	63	4%
Climate change is mainly natural	211	14%
Climate change is equally natural and anthropogenic	514	34%
Climate change is mainly anthropogenic	587	39%
Climate change is exclusively anthropogenic	61	4%
I don't believe that climate change is happening	20	1%
Don't know	44	2%

We also find that 48% are familiar with the concept of crowdfunding (Table 4). One in three agrees that the crowdfunding of climate measures can be a good solution for agriculture. On knowledge and preferences regarding the four possible crowdfunding models (donations, rewards, lending, equity), the most popular is donations, i.e., a gift to the farm. In fact, 34% of our sample state that—if they are going to support the scheme—they are likely to choose this model. Only 15% would consider lending, and 21% would consider equity (multiple choices possible). The type of actor perceived as most trustworthy to operate crowdfunding campaigns for the agricultural sector is research institutes.

**Table 4.** Respondent attitudes to climate change in agriculture and crowdfunding (N=1500).

How Do You View Your Own	Good	Adequate	Poor	Don't Know
knowledge about climate change in agriculture:	23%	38%	34%	6%
<b>How likely are you to donate to</b>	Likely	Somewhat	Unlikely	Don't know
local climate measures	33%	29%	31%	8%
national climate measures	26%	32%	35%	8%
international climate measures	25%	29%	39%	7%
<b>Have you previously encountered</b>	Yes	No		
the term "crowdfunding"	48%	52%		
<b>To crowdfund climate solutions</b>	Agree	Somewhat	Disagree	Don't know
is a good solution for agriculture	33%	25%	23%	19%

Our main research question is whether there is a significant level of WTP to make successful crowdfunding of farm-level climate measures feasible in Norway (H1). One-third (31%) say that they are *not* likely to donate to local climate solutions, while one-third (29%) say they are somewhat likely to do so, and the final third (33%) say they are likely. With two-thirds of the population expressing some interest in crowdfunding, these responses give some support to hypothesis H1. The share of respondents that are likely to support *local* measures is 8% higher than those that are willing to support *international* measures, hence giving weak support to H2b.

Table 5 summarize the mean willingness to pay (WTP) across measures, for all socio-demographic categories in the survey, as well as per measure. Across the entire sample, the individual average WTP per measure, i.e., one potential crowdfunded investment on one farm, is NOK 161 (USD ~18 in 2020). The standard deviations are large, indicating a very large variability in WTP. With "average WTP" we refer to their mean willingness-to-pay across the four measures (average WTP = (M1 + M2 + M3 + M4)/4 for each person). Among the socio-demographic factors (described in Table 6), we find a higher WTP among people who are younger, have higher incomes, have agriculture-related employment, and believe climate change is mainly or fully anthropogenic. The latter lends some support to H2a; the correlation coefficient ( $r = 0.09$ ) is statistically significant but not strong (see Table 6). Other

factors have a stronger correlation with WTP, such as age ( $r = -0.30$ ) and their attitude to CF as a good climate solution ( $r = 0.42$ ). The covariation matrix (Table 7) further illustrates that most attitudes varies with the attributes age, education and income.

**Table 5.** Average WTP, by socio-demographic characteristics, attitudes, and measure.

Category	Mean WTP	Std. Dev	Std. Error	
<i>All</i>	161 kr	239	6	
Male	172 kr	253	8	
Female	148 kr	220	9	
Age: 18–34	247 kr	264	12	
Age: 35–49	126 kr	204	12	
Age: >50	132 kr	229	8	
Low Education (no sec. school)	140 kr	230	25	
<b>Mid Educ. (practical sec. school)</b>	151 kr	252	14	
<b>Mid Educ. (academic sec. school)</b>	172 kr	248	15	
High Educ. (<4 yrs univ.)	155 kr	227	10	
Very High (>4 yrs univ.)	180 kr	243	13	
Low income (<400,000 kroner)	151 kr	231	11	
Middle income (400,000–800,000 kroner)	192 kr	259	20	
High income (800,000–1,000,000 + kroner)	196 kr	267	35	
Employed in primary sector (1)	335 kr	293	22	
Not in primary sector (2)	137 kr	220	6	
Did not answer (3)	230 kr	274	52	
Climate change (CC) natural (1)	151 kr	275	30	
CC mostly natural (2)	142 kr	243	16	
CC both natural and anthropogenic (3)	150 kr	240	10	
CC mostly anthropogenic (4)	182 kr	232	10	
CC fully anthropogenic (5)	233 kr	273	31	
CC not happening (6)	81 kr	158	53	
Likely to give locally (1)	342 kr	314	16	
Neither likely nor unlikely (2)	151 kr	228	11	
Not likely to give locally (3)	55 kr	138	15	
<b>WTP per measure, sorted by mean WTP</b>	<b>Mean WTP</b>	<b>Std. error</b>	<b>CI 95% UB</b>	<b>CI 95% LB</b>
Solar panels	187 kr	7.6	202	172
Biogas plant	177 kr	7.3	191	163
Drag hose	142 kr	6.5	155	129
Biochar unit	141 kr	6.5	153	128

**Table 6.** Correlation between WTP and socio-demographic variables and attitudes.

Variables vs. WTP	CORR	p-Value
Age × WTP	−0.30 ***	0.0001
Gender × WTP	−0.05 *	0.0488
Income × WTP	0.09	0.1584
Employment in agric. × WTP	0.27 ***	0.0001
Education level × WTP	0.05	0.4007
Climate attitude × WTP	0.09 *	0.0205
Climate change impact on agriculture	0.14 ***	0.0001
CF is a good climate solution	0.42 ***	0.0001
Only support local farmer	0.17 ***	0.0001

(\*:  $p < 0.05$ , \*\*\*:  $p < 0.001$ ; CF = crowdfunding).

**Table 7.** Covariation matrix, respondent attributes and attitudes.

Variable	Age	Education	Income	Climate Concern	Impact of CC on Agriculture	CF a Good Climate Solution
Climate concern	−0.07	0.09	−0.04	X	X	X
Impact of CC on agriculture	0.02	−0.12	−0.02	−0.25	X	X
CF is a good climate solution	0.27	−0.01	0.04	−0.19	0.17	X
Only local farmer	0.03	0.07	0.01	0.05	0.12	0.29

(Correlation estimates based on CORREL-function in Excel; CF = crowdfunding, CC = climate change).

## 5. Discussion

Is there a commercially significant interest among the public to crowdfund climate measures in local agriculture (H1)? Several findings support hypothesis H1: 61% claim to have (at least adequate) knowledge of climate change in agriculture, 77% acknowledge some anthropogenic causation of worsening climate change, and one-third (33%) say they are likely to donate.

The survey respondents' stated WTP, however, is, on average, on the low side of the spectrum, from NOK 0–1000: NOK 161 (USD ~18) per measure. The WTP of the 33% segment who stated they are likely to donate, jumps to exactly double: NOK 323 (USD ~36) per campaign. To illustrate what this requires: if a typical farm wants to invest in a climate measure where NOK ~300,000 of extra funding is needed in order to trigger farmer investment decision with (some) state support, the crowdfunding campaign would then need to successfully reach around 1000 people with the attitude of "likely to donate" to this farm, or 2000 people with average contributions, for the campaign to reach its target in time. This outcome also assumes that the stated WTP would translate into actual payments. There is therefore good reason to doubt the realism of public crowdfunding providing a commercially significant investment for realizing climate measures in agriculture, all else being equal.

Social media do substantially reduce the transaction costs of outreach and a large number of transfers to the farmer and the crowdfunding platform. Still, for an average farm campaign to secure funding from up to 2000 givers is clearly a major challenge. An even more expensive measure, such as an on-site farm biogas plant, can be 10 times more expensive, with an additional NOK 3 m of funds needed to trigger investment. For one farm (or even one group of farms) to crowdfund one biogas plant, then, would require between 10,000–20,000 donors, something which—in our view—pushes the concept into the realm of the clearly infeasible for more expensive measures, an argument that weakens the overall support for hypothesis H1.

### 5.1. The Green Consumer—Is Personal Responsibility for Climate a Motivating Factor? (H2a)

Does the public perceive the consumer, the farmer, or the state to be most responsible for mitigating agricultural emissions? The question of individual vs. structural or collective responsibility for climate mitigation has been a critical issue in the climate debate for decades [12,15]. This new possibility of digital crowdfunding can in many ways bring all these threads and actors together: In the absence of ambitious top-down regulations and structural frameworks for effective mitigation, the new crowdfunding platforms can in theory engage individuals in supporting farmers through the needed private capital to match public funds, so as to realize investments in climate solutions that are otherwise too costly.

Our survey queried the informants' attitude to climate change causation, in order to tap into the public perception of human responsibility for climate change. We know from previous studies that more than 96% of the Norwegian population acknowledges the reality of climate change [37,38]. Other studies show a strong correlation between belief in anthropogenic climate change and a high degree of climate concern, sometimes referred to

as “climate attitude” [36]. There is, however, substantially more ambivalence within the Norwegian population on the issue of whether humans are the dominant cause of global warming or not, and as such, to what degree the individual assumes responsibility for mitigation efforts [37,38].

Our results do indicate a weak positive correlation between stronger attitudes to anthropogenic climate change and a higher WTP. However, there is also a very large standard deviation (typically NOK 240) relative to the average WTP (NOK 161). Hence, the correlation between WTP and “climate attitude” becomes low, at  $r = 0.09$ , with  $p < 0.02$ . This indicates that there are several other factors at work explaining green consumers’ WTP for climate measures in the agricultural sector, and that one’s climate attitude does not have a strong effect on WTP. For instance, a significant segment (19%, an equal proportion of men and women, young and old) agree that animal welfare and environmental concerns are more important than climate change in Norwegian agriculture.

Overall, these results provide some, albeit weak, support for hypothesis H2a.

### 5.2. Does Spatial Proximity to the Campaign Increase WTP? (H2b)

Our study explored to what extent respondents are more interested in participating in crowdfunding campaigns that relate to their local neighborhood. Indeed, those who state that it is likely they would contribute to a climate measure at the local level have a much higher average WTP (NOK 342, Table 4) than those who express indifference (NOK 146) as to whether measures happen locally or internationally.

From the focus groups transcripts, we learned that the farm’s being close by and local seemed to be important, but the definition of “local” is wide. Several mentioned that they would consider donating to a farmer located where they were themselves born, or somewhere where their family lives, so this is not only if the farmer is close to where they currently live. As one participant put it: “The closer and more visible it is, the simpler I think it is for you to join the common, shared contribution that this is.” However, donating to a farmer from another country, “for instance, Sweden”, was out of the question (focus-group participants).

From the survey results, there is no (strong) correlation between average WTP and attitudes to reducing emissions from agriculture in particular. Measures targeting other sectors hold as much attractiveness, and agreeing with the statement, “I will only contribute if the funds go to a local farmer”, only has a weak correlation to the average WTP ( $r = 0.17$ ,  $p < 0.001$ ).

On this topic, we find significant differences related to age. We see that the older population (50+) places a greater emphasis on the tradition and cultural landscape in their image of agriculture in Norway than on climate. Thus, the oldest age bracket (50+) is willing to give more to a local campaign than is the middle-aged bracket (35–49). In addition, a larger share of older people (50+) than young people (18–34) will only give if the funds go to a local farmer (9% over 5%).

Weighing the evidence above, particularly the fact that we do see the highest average WTP among those who indicate that they are likely to donate for local measures vs. international, it seems that H2b is moderately well supported.

### 5.3. The Characteristics of Climate Measures in Agriculture—Comprehension and Salience (H2c)

Most WTP studies explore the respondents’ stated preferences for climate mitigation by finding ranges in the variable USD/tCO<sub>2e</sub>; however, the uncertainty of agricultural emissions measures in (Nordic/Norwegian) agriculture makes it challenging to calculate the exact impact of investments in climate measures on the tons of GHG emissions from a specific farm per year.

From the focus groups, we learned that most of the participants know about solar panels and have heard about farmers investing in such technology, but almost none of the focus group participants knew about the other measures presented (biogas/drag hose/biochar). They expressed the opinion that they have little knowledge of whether

these measures would actually help. Few participants were aware of their personal climate footprint in tons per year. The positive feedback on the solar panels also had to do with them being able to see the actual installation when passing by the farm or visiting. Most of them expressed interest in more information about the measures even if they had never heard about them before. As one participant expressed it: “I think that if it is an engaging measure, then one will give more. If one holds no opinion or have never heard of it, then one will disregard it” (from focus groups convened between November 2018 and September 2019).

The WTP results per measure reflect this order of comprehension and salience, in that solar panels were given the highest average at NOK 187, biogas, NOK 177, drag hoses, NOK 142, and biochar, NOK 141. Both drag hoses and biochar are more “invisible” results, as the impacts are mainly in the soil, and hence seem to evoke bewilderment and disengagement. As one participant put it: “I think it is smarter when you can actually see the results {of the measure}, so that you don’t just pay a sum and it ends up in something very vague”. The lack of information and experience, the novelty of the measures, with little previous government or media attention, seem to result in a low comprehension of and trust in the measure, which in turn impacts the WTP negatively.

Both the focus group and survey results indicate that comprehensibility, high visibility and salience have large impacts on WTP, strongly supporting H2c.

#### 5.4. Other Factors: The Importance of Familiarity with Crowdfunding and Storytelling

Despite being introduced in the survey as “crowdfunding climate measures”, other factors have a stronger correlation than climate concerns: age ( $r = -0.30$ ) and, in particular, their attitude to CF as a good climate solution ( $r = 0.42$ ). As researchers, we were surprised by the magnitude of the impact that familiarity with crowdfunding campaigns and platforms has on WTP.

The majority of participants in the focus groups mentioned the importance of getting to know the farmer “behind the campaign”, seeing pictures and reading a story, but also seeing pictures of the farm, animals, and nature, framing the campaign with real-life images. None of the focus group participants, nor the survey participants, queried the exact mitigation efficiency of the measure, as measured in USD/tCO<sub>2e</sub>.

## 6. Conclusions

In conclusion, we find supportive attitudes in the Norwegian population for crowdfunding climate measures, especially in local agriculture. However, the level of support as expressed in WTP may not be sufficient to trigger larger investments at the farm level. The WTP is somewhat higher among those that perceive climate change as mainly anthropogenic, and when the measures are at a local farm, relative to international measures, but these correlations are generally weak ( $r = 0.09$  and  $0.17$ , respectively). We found a higher WTP for measures that are easily comprehensible, visible and well-known, such as a solar panel (USD ~20) relative to those where the results are hard to grasp, invisible, or unknown, such as dribble-bars and biochar (USD ~15), irrespective of that measure’s climate mitigation potential. A surprising finding, to us, was that there is a much stronger correlation of WTP to attitudes and knowledge about crowdfunding as such, and particularly to crowdfunding as an enabler of climate solutions, than to factors such as climate concern, proximity, or mitigation potential.

The rational actor would only put his money on the measure with the best “bang for their buck”, measured in tCO<sub>2e</sub>/USD, but the real, human, consumer seems more motivated by norms and status concerns, and more persuaded by visible salience, stories about the farmer and the farm, animal welfare, and trust in the crowdfunding mechanism itself. In order to keep long-term trust and reliability, the campaigns would ideally be equipped with “carbon certificates”, where the exact mitigation effect per measure and effect per USD is specified for each farm. The current state of knowledge does not permit this, due to the variety of conditions under which farms operate, and the lack of low-cost

monitoring systems for emissions and carbon in soil levels per farm. More research could possibly meet these shortcomings by providing verifiable mitigation numbers in the future.

The implications for any crowdfunding campaigns of additional agricultural measures are that one should prioritize those measures that do not require too many small-level gift contributions to reach the investment threshold, with a high climate potential (such as dribble bars), and to dedicate considerable efforts to communicating the crowdfunding mechanisms, storytelling about the farmer, as well as visualizing how such measures work in order to maximize the WTP.

**Supplementary Materials:** The following are available online at <https://www.mdpi.com/article/10.3390/su13169227/s1>, Supplements 1–5 to Table 2 Estimated annual on-farm emissions reductions for four agricultural measures. Supplements 6 Survey form as distributed. Supplements 7: Survey raw data.

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