# Voluntary Carbon Markets: Exploring Feasibility and Acceptability

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## Abstract

In this study, we assess the acceptability and feasibility of dairy system carbon markets to accelerate the uptake of carbon mitigation measures by farmers. To this end, we employ different methods including expert interviews, a stakeholder co-design workshop, living labs and experimental auctions with farmers and consumers. This combination of methods will provide detailed insight into how voluntary carbon markets can be made operational in the agri-food sector based on real-life experience from the living labs and empirical evidence from the experimental auctions. Initial results revealed lack of knowledge, uncertainty about measurement and double counting of carbon credits are main barriers. The focus of this discussion paper is on presenting initial results and discussing how voluntary carbon markets can be implemented and tested in experimental auctions.

**Key words:** Carbon markets, climate change, dairy sector, living labs.

**JEL code:** Q12, Q13.

# 1 Introduction

Food systems are responsible for one third of global greenhouse gas (GHG) emissions (Crippa et al., 2022), with dairy production being a significant contributor to those emissions. Given projected increases in global dairy demand (OECD/FAO, 2022), there is an urgent need to reduce emissions from this sector. Therefore, a clearer understanding of the functioning and acceptability of climate-smart innovations along the dairy supply chain will contribute to achieving a climate-neutral EU continent by 2050.

One key measure to reduce food system GHG emissions is the adoption of mitigation measures by farmers (Parlasca and Qaim, 2022). However, often farmers are slow to adopt sustainable technologies (Pannell et al., 2006), which is aggravated by the fact that many farmers believe the adoption of mitigation measures will lower their profits (Läpple, 2023). Therefore, in this study, we explore the acceptability and feasibility of voluntary carbon markets among dairy farmers and food system actors in Ireland, as a way to provide market incentives to support the uptake of GHG mitigation measures by farmers.

This discussion paper provides background on the study context and then outlines how carbon markets in general work. It then presents results from expert interviews and a stakeholder co-design workshop, and how carbon markets can be tested with living labs and experimental auctions, with the aim to generate discussion to influence further research design.

# 2 Background

The Irish agricultural sector is very livestock oriented with almost 90% of farms having ruminant livestock (CSO, 2021). Of the 135,037 farms in Ireland, about 74,000 have beef cattle, approx. 15,000 farms focus on dairy production, while there are about 17,000 sheep holders (CSO, 2021). This can be explained by the Irish climate that provides good conditions to grow grass almost all year round, which makes grass based agricultural systems the dominant choice.

However, due to the strong ruminant livestock focus, GHG emissions from the Irish agricultural sector are 37.5% of national GHG emissions, which also arises due to a small industrial sector in Ireland (EPA, 2022). This is quite unique in a developed country context (with the exception of New Zealand). For example, the EU has an average of about 10% of GHG emissions arising from agriculture.

Methane from enteric fermentation and nitrous oxide from fertilizer use are particularly problematic, and have been the reason for increasing agricultural GHG emissions over the last number of years (EPA, 2022). This is due to the 2015 EU milk quota abolition that set in motion significant expansion and intensification of dairy production in Ireland. Specifically, over the last decade, milk production has increased by 69%, while dairy cow numbers have increased by 47% (CSO, 2022). However, pastures are also managed more intensively, and fertilizer use has increased, also leading to higher GHG emissions.

More broadly, Irish agriculture is pasture based, which is often associated with higher sustainability. However, over the last number of years, the sustainability of Irish agriculture has been questioned, and the development of the dairy sector is seen more critically (Balaine et al., 2022). Its further development is also compromised by clear targets by the Irish government to reduce agricultural GHG emissions by 25% by 2030 compared to 2018. This target is part of the government's Climate Action plan that implemented carbon budgets for each industry sector (Government of Ireland, 2022). One of the key strategies to achieve lower agricultural GHG emissions is the adoption of mitigation measures by farmers. This is supported by an information campaign ('Teagasc Signpost Programme') that facilitates climate action measures by farmers. In this study, we test if market based incentives are a feasible option to increase the uptake of GHG mitigation measures by farmers.

## 3 Carbon markets

Carbon markets are a type of environmental market which trades in units of reduced GHG emissions called carbon credits. Carbon credits are normally equal to a reduction of one ton of carbon dioxide or carbon dioxide equivalent emissions either from mitigation or sequestration actions. Mitigation actions prevent the release of carbon into the atmosphere, whereas sequestration measures take carbon out of the atmosphere. These credits can then be sold on the market. Carbon markets can differ in the way they are set up, and – in contrast to mandatory carbon markets – no clear guidelines have been developed for voluntary carbon markets.

In general, carbon markets are designed to monitor segments of the economy, multiple areas, or just one specific sector. The EU Emissions Trading System (ETS), for example, began by monitoring power generators and energy intensive industries in phase 1 of its design and has since added regulated sectors, such as aviation in phase 2, and chemical and metal production in phase 3.

Mandatory carbon markets require participation of firms in the specific economic sector. These markets are facilitated by a regulatory body; such as state governments like the California state carbon markets or economic regions like the ETS system (Michaelowa et al., 2019). These markets normally use a cap-and-trade market system, meaning the total amount of GHG emissions over the span of a specific period, usually a year, is limited below an 'emissions cap'. Functionally, this emissions limit is implemented as a limit on the number of credits available to the market in each period. Firms are only allowed to emit a level of GHG emissions equal to the number of credits they own, and firms emitting above this level will face punitive action, such as a fine. Firms who can emit below the level of credits they own can trade or sell those excess credits to firms who are not able to or cannot afford to reduce their emissions below their carbon credit limit. The initial distribution of the credits can be done in several ways. Credits can simply be endowed to regulated firms every year, either evenly across firms or via some weighted measure. Another option is that credits can be auctioned at the start of the emitting period. This method allows high emitting firms to bid for more emissions at the beginning of the period rather than purchasing credits from low emitting firms later in the period. The idea of the cap-and-trade system is to lower the cap for GHG emissions over time, thereby decreasing GHG emissions.

In some markets, like the carbon market in Alberta, Canada (Sellers et al., 2022), carbon credits can be acquired outside of the cap-and-trade system as well. The Alberta market allows for regulated emitters to choose one of four options, increase efficiency and lower emissions, purchase carbon credits from other firms who have become more efficient, purchase carbon credits from the province, or pay for carbon credits to be produced in another segment of the economy. This gives regulated firms a large array of options to meet their emissions limits.

Mandatory markets often regulate economic sectors where firms are large in size and few in number, such as the aviation sector, or where the measurement of GHG emissions is easily tracked, like the energy sector. This is due to large administrative costs or limited ability to easily monitor the emissions levels in other sectors. Emissions from power producing sectors, aviation, and other major industrial producers are more easily tracked than emissions from diffuse sources such as agricultural emissions.

Voluntary carbon markets are less established and can differ in the way they are implemented. As the name suggests, voluntary carbon markets do not require participation from all firms in the regulated industry. In these markets, participating firms engage in mitigation or sequestration activities which produce carbon credits. The carbon credits are measured,

reported, and verified after which the carbon credits are available to sell on the market. There is also no regulatory limit on the number of carbon credits which can be produced in this type of market since total GHG emissions are not regulated. Often these markets are facilitated by another firm which handles the administrative cost of measuring, verifying, and selling the carbon credits produced in exchange for a transaction or administrative fee (IndigoAg, 2023a). These facilitating firms often engage the services of an unbiased third party for verification of the carbon credits (NORI, 2023). These verification firms provide an accepted measurement protocol for carbon credits that would otherwise be hard to measure (Verra, 2019).

There are several voluntary markets already in place in the agriculture sector. NORI and IndigoAG are examples of facilitating firms which both operate soil carbon sequestration markets (IndigoAG, 2023b; NORI, 2023). Other markets include the MoorFutures program market which focuses on the rewetting of peatland in Germany (MoorFutures, 2019) and the UK Woodland Carbon Code which focuses on credits produced from afforestation (UK Woodland Carbon Code, 2019). Verification firms which have measurement protocols for livestock mitigation measures include Verra, the American Carbon Registry, and the Clean Development Mechanism (Verra, 2022). Approved mitigation measures include the addition of feed additives for dairy cattle, pasture management for livestock grazing, and reduced age at harvest for beef cattle (Verra, 2022).

## 4 Methodology

The methodology involved includes expert interviews, a stakeholder co-design workshop, living labs, and experimental auctions.

In the first step, expert interviews were conducted. These semi-structured interviews elicited main drivers and barriers of implementing a voluntary carbon market in the Irish dairy sector, and how different aspects interlink. The participants were experts in the agri-food industry comprising of one agricultural advisor, three farmers, and two industry experts with responsibility for sustainability development.

Next, a stakeholder co-design workshop was conducted to discuss how carbon markets could be implemented in the Irish agri-food sector, with the goal to have a clear plan on how to implement carbon markets in practice. Participating stakeholders included industry leaders from food companies and industry groups, governmental ministry and banking representatives, as well as farmers. The workshop was structured following the backcasting technique (Hines et al., 2019) that is based on the idea to present participants with the end result (i.e., a

functioning carbon market) and ask them to trace back all necessary steps to get to this end result. The use of this method allows participants to visualize the goal they are trying to achieve and aids in focusing the conversation. This also included identifying all barriers that prevent the implementation of the market and solutions to these barriers.

Based on these findings, living labs with 10 dairy farmers will be created to get real-life experience with voluntary carbon trading. Following Potters et. al. (2022) living labs can be defined as '*An open innovation process bringing together public and private users and stakeholders to co-create, validate and test new services, business ideas, markets and technologies in real-life contexts'.* In our living labs, participants will engage in real carbon trading on a small scale. At the end, semi-structured interviews with all living lab participants to evaluate the economic, environmental and social sustainability of voluntary carbon trading are conducted.

As a last step, we will conduct experimental auctions with farmers and consumers. The experimental auctions will follow standard procedures where participants bid for carbon credits to be exchanged. We will run two auctions. First, consumers and farmers will be asked to state a price at which they are willing to buy carbon credits. A random price is then presented and if the participant's bid exceeds the price, the participant will buy the carbon credit. Otherwise, the participant will keep the money and no carbon credit is bought. The second auction includes dairy farmers only. Here, farmers will be asked to state a price to sell carbon credits in exchange for implementing climate-smart technologies on their farm. This price will reflect each farmer's cost of implementing the measure. A random price is then presented and if the farmer's bid is below the price, carbon credits are sold. Otherwise, the farmer will keep the carbon credits.

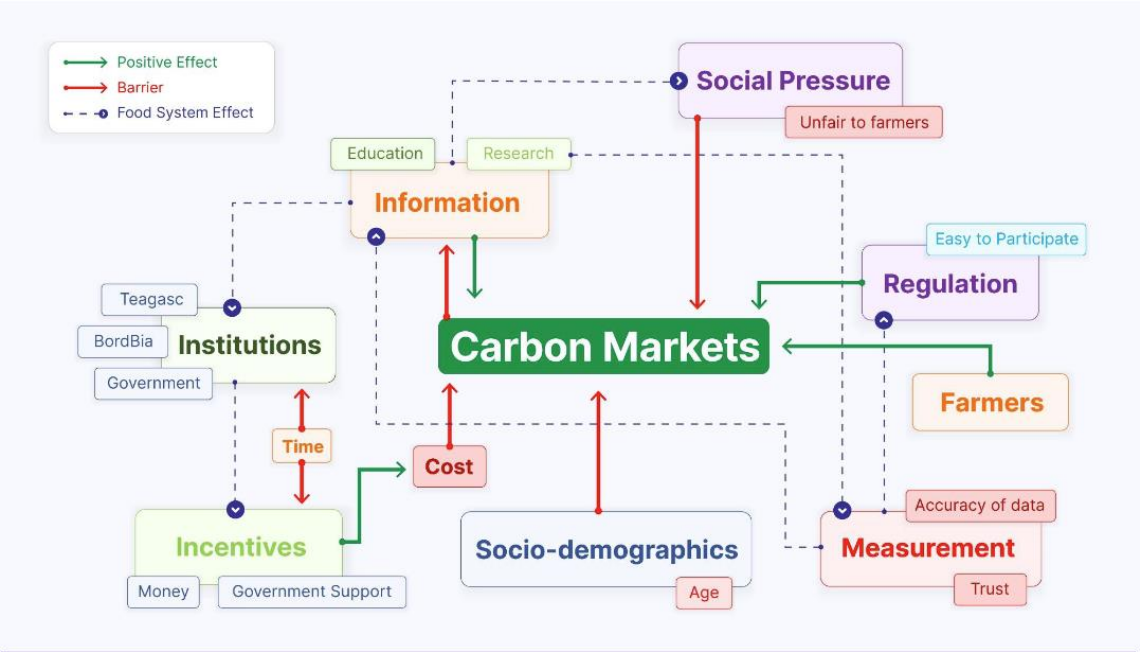
## 5 Results and Discussion

### *5.1 Expert Interviews*

Key themes arising from the expert interviews are summarized in Figure 1. Similar to a word cloud, the size of the font in the figure relates to the frequency how often a theme was mentioned. The arrows imply positive effects (green), barriers (red) or links between different themes (dashed). As can be seen, information, regulation, social pressure, measurement, socio-demographics, incentives and institutions emerged as key themes. For example, lack of information was seen as a key barrier. This is connected to institutions that organize the market, resolving GHG mitigation measurement, and can be overcome by more research and education on the topic. In addition, experts connected closer to agricultural production (i.e. farmers and

advisors) highlighted the need for clear incentives for farmers to avoid additional costs, which was seen as a barrier, as indicated by the red arrow. Other themes worth mentioning are socio-demographic characteristics of farmers and social pressure. Experts felt that older farmers may be less open to carbon markets, while social pressure can also have negative implications on farmers' willingness to participate as the market may be perceived as unfair to farmers. Overall, the consensus from all interviews was that several major barriers must be overcome before carbon markets can be implemented.

*Figure 1: Overview of expert interview findings*




## *5.2 Stakeholder workshop*

The following five key themes arose from the stakeholder co-design workshop: information and incentives to wait; establishing a baseline; eligible farm practices; monitoring, reporting and verifying; and trading platform.

Lack of information is a key barrier to establishing voluntary carbon markets in Ireland. Without clear information about the structure of the market and how to participate farmers cannot make informed decisions, this is further complicated by the fact that dairy system stakeholders are also unsure on how to establish this market.

Another theme that arose was how to establish a baseline. This may create issues of fairness as farmers starting with a higher baseline of emissions – due to low GHG mitigation effort- can

more easily produce carbon credits. As such, if the baseline is taken from a time prior to adoption of a specific mitigation technology, adopters prior to the baseline would be penalized for early adoption. Emissions baselines also need to be updated periodically to incentivize continual GHG reduction and prevent the resale of credits from previous reductions. Without baseline updates, the market will act as a subsidy for mitigation measures already adopted rather than incentivizing the adoption of more GHG mitigation measures.

Determining which farm practices will be eligible as GHG mitigation measures in the market was another theme that emerged during the workshop discussions. However, all stakeholders agreed that additionality is key to a successful carbon market. Additionality requires all produced carbon credits to result from newly adopted emissions reduction measures. However, some practices, like the use of low emissions slurry spreading equipment, are becoming mandatory under Irish governmental regulation (DAFM, 2022). It was discussed that such practices may no longer be eligible for a carbon market.

In relation to the theme monitoring, reporting and verification, many farm GHG mitigation measurements may be good possibilities for emissions reductions but their effect is impossible to measure accurately. Given the diffuse nature of emissions from agriculture, reliance on estimated emissions reductions is often used. In addition, monitoring of the market and proper implementation of mitigation measures will require additional resources. This is especially true for mitigation measures which may be hard to measure or monitor from single site visits or with data. Where these monitoring resources will come from is currently unclear. How to report emissions reductions from voluntary carbon markets to national inventories and the possibility of double counting of credits was also a part of the workshop discussion. If a credit producing farmer and the company who purchases the credits both count the same credits as reductions, the same credit is counted twice. This double counting can lead to greenwashing and hinder the achievement of environmental goals. The verification of credits produced from livestock emissions reductions is a third aspect of this barrier. There is a possible solution to the barrier, the use of verification firms and measurement protocol, but it is limited to the types of measurement protocol available. The hardship of the barrier is also the financial cost of verification, and who should bear it.

Lastly, a feasible voluntary market will need a trading platform. This trading platform would allow registered farmers to market and sell their carbon credits to interested buyers. The logistics of how and by whom the platform would be managed was discussed. The trading platform would also need to be able to facilitate financial transactions for the buying and selling

of carbon credits, provide a registry of participants and their mitigation actions, which would increase trust in the market due to higher transparency.

### *5.3 Living labs*

Living labs provide an opportunity to test possible solutions. With the semi-structured interviews at the end of the period, they are also a good way to get direct feedback as to how carbon markets were perceived by all involved and how they can be improved for future implementation.

As a first step, information sheets are being designed to recruit farmer participants. These sheets will explain how the voluntary carbon market works, what mitigation measures are included, and how the farmer can participate. Also included in this information is the additionality requirement. The living labs will allow us to see how farmers will react to this information and if the information provided is sufficient to overcome this barrier.

A solution to measurement of mitigation measures is being tested using an app designed by a project partner. This app requires specific farm information input from the participating farmer, but will also use additional data supplied by other sources to reduce the reporting demand. The living labs will test if the app can be used to measure and report GHG mitigation practices. Currently due to measurement protocol constraints with the app, only mitigation, not sequestration, measures will be considered for participation. The living lab will also test the user friendliness of the app and provide feedback for improvement.

One key limiting aspect of the living lab carbon markets is that carbon credits cannot be used as offsets. This implies that participating agri-food firms will buy the credits for marketing purposes or their corporate social responsibility reporting, however they cannot be used for the company's net zero goals. This requirement avoids the possibility of double counting since these credits cannot be counted towards national inventories, as otherwise a corresponding adjustment would be required, which is outside the reach of a voluntary market. As such, the living lab will be able to test the demand for a carbon market where credit buyers cannot use credits as an offset for their own emissions. The living labs will also implement a trading platform. A financial project partner will act as a facilitating entity and buy credits from participating farmers to resell to participating companies and stakeholders. Overall, the living labs provide an opportunity to test several possible solutions to increase feasibility and acceptability of voluntary carbon markets.

### *5.4 Experimental auctions*

The last step of this study will be to conduct experimental auctions with both farmers and consumers. These auctions will likely use the Becker–DeGroot–Marschak (BDM) auction mechanism (Becker et al., 1964), as this auction can be administered on an individual basis. Specifically, participants will be asked to record a bid for a carbon credit, and once all observations are collected a random price is generated. If the participant's bid for the carbon credit is over the generated price the bid is binding, and the participant purchases the carbon credit at the randomly generated price. If the bid is below the generated price no sale is made. The possible binding nature of the bid makes the mechanism incentive compatible as participants' optimal strategy is to bid their exact willingness to pay for the good (Lusk, 2004). Given the individual and single round nature of the bid placement, there is a lack of market feedback with this mechanism as participants. This also prevents participants from skewing bids of other participants.

The study will use two sets of BDM auctions. One involving consumers and farmers where the willingness to pay for a carbon credit is observed. The second auction will involve only farmers and will test their willingness to sell a carbon credit. Farmers in this auction will be asked to list a price at which they would be willing to sell a carbon credit in exchange for the price and the actual implementation of the carbon credit generating climate smart practice. If their bid is below the randomly generated price the offer becomes binding, and they will be paid the generated price and be required to implement the practice. If their bid is above the generated price no exchange takes place.

## 6 Conclusion

The pressure to reduce GHG emissions from the dairy industry, especially in large dairy producing regions like Ireland, is high. The adoption of GHG emission mitigation technologies in agricultural production is essential to meet these reductions. Voluntary carbon credit markets are a possible solution to the financial barrier preventing technology adoption.

This study explores the acceptability and feasibility of a voluntary carbon credit market in the Irish dairy sector through a series of assessments including expert interviews, a stakeholder co-design workshop, the development of living labs and experimental auctions with farmers and consumers.

A number of barriers and opportunities to the implementation of a voluntary carbon market have been identified through discussion with experts and stakeholders. Barriers and opportunities will be tested through real-life carbon trading in living labs and quantitative data collection with farmers and consumers on carbon trading. While the research is currently ongoing, two key themes have emerged.

First, it appears that there is a clear lack of knowledge in relation to carbon markets. On the producer side, this relates to a general lack of understanding what these markets entail and how they work. Clear communication and campaigns are likely to overcome this barrier. However, our stakeholder workshop also revealed that there is considerable uncertainty among key agri-food stakeholders on how carbon markets could be made operational. The implementation of carbon trading in our living labs are likely to produce answers to many open questions.

Second, double counting is a key issue that prevented the establishment of voluntary carbon markets to date. Whether carbon markets that rely on companies financing carbon removal projects without any offsetting claim ('result-based financing') or certificates to demonstrate a contribution to national targets ('contribution claims') (EC, 2022) will create sufficient participation, remains to be seen. In this instance, the potential for double counting is being avoided as credits from the living labs will not be allowable for use as offset credits.

Barriers still without solutions include establishment of a baseline for a long running programme, how to avoid double counting when credits can be used as offsets, and the addition of measurement protocols for a larger suite of eligible GHG mitigation measures. The possibility of a carbon sequestration market are also left to be explored.

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