Tackling Emissions, Cultivating Change:

A Socio-Economic Approach

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Abstract

This discussion paper is a reflection on the contribution that can be made by agricultural economists in addressing a critical societal challenge. The paper focuses on the issue of climate change in the context of agriculture. In particular, the paper focuses on the need to reduce agricultural Greenhouse Gas (GHG) emissions, while at the same time facilitating the future growth in agricultural production and trade to meet the needs of a rising global population. The paper examines the varied ways in which agricultural economists can provide crucial answers to societal questions posed by the need for agricultural GHG mitigation. The paper explores how the contribution of economists can therefore assist in the reduction of GHG emissions, while supporting and enhancing agricultural growth. The audience for this paper includes the research community and particularly research funders. Within the economic research community, the purpose of the paper is to prompt a discussion on how best to enhance the status of agricultural economics as a discipline capable of contributing solutions, which could reduce agricultural GHG emissions. In the case of research funders, the function of the paper is to provide a broader appreciation of the role, which economics can play in GHG mitigation policy, particularly in the context of the allocation of funding to support associated research. Economists need to exert more influence over the decision-making processes that are involved in developing research funding calls relating to climate change, so that the topics requested in such funding calls are better aligned with the questions that economists know need to be answered.

Keywords: Agriculture, GHG emissions, Climate change

JEL Codes: Q54, Q56, Q58

1 Introduction

Significant changes in policy priorities, especially in wealthier nations, place agricultural production at a crossroads. Agriculture faces the dual challenge of meeting the escalating calorific and nutritional requirements associated with economic growth and population growth (Schneider *et al.,* 2011). Another major global challenge is the need to rapidly reduce GHG emissions (Masson-Delmotte *et al.,* 2021). While agricultural GHG emissions are generally a low share of overall GHG emission in developed economies, as GHG emissions reductions are achieved in other sectors, the share of GHG emissions produced by agriculture will increase unless the absolute level of agricultural GHG emissions is also reduced (Gernaat *et al.,* 2007). Hence, there is a need to reduce the GHG emissions generated by the agricultural sector even though food production must increase. This represents a major societal

challenge. The most commonly touted solutions tend to reflect the framing of the problem as largely a research requirement to develop more climate friendly agricultural production technologies (Oenema *et al.,* 2001). While new technologies are critical, understanding their real world potential and achieving their adoption is also vital. In this context, economists can play a valuable role by providing research to support policymaking to achieve agricultural GHG reductions.

This review looks at the various ways in which agricultural economists can help to shape a more sustainable future for agriculture. For example, economists can assist in providing a pathway towards the adoption of a suite of sustainable agricultural practices to reduce GHG emissions, without compromising agricultural production growth. Economists also have the skills to assess the competing societal, environmental and economic demands of the agricultural sector and propose ways in which they might be improved. The paper therefore highlight various ways in which agricultural economists can play a vital role in shaping policy, in facilitating behavioural change and developing strategies that support sustainable agricultural growth, while at the same time mitigating GHG emissions.

Given the continuing evolution in climate policies internationally, this discussion paper references examples from the literature, largely within the domain of economics, along with interdisciplinary studies and, in some cases, the climate sciences more generally. Using some examples, the paper discusses the contribution which economists can make across a number of key areas, including their role in informing such topics as public awareness, policy landscapes, technology adoption, behavioural incentives, social equity considerations, global trade perspectives, stakeholder engagement and communication strategies. The purpose of the paper is to emphasise the meaningful role of agricultural economists as architects of solutions that can facilitate the growth of agriculture, sustaining farm incomes and ensuring generational renewal, while addressing the sector's environmental responsibilities.

The rest of the paper is structured as follows: Section 2 examines the contribution of economists in detail. This in then followed by a discussion in Section 3 and some brief conclusions in Section 4.

2 Climate change: a role for economics

When research funders consider the issue of GHG mitigation in agriculture, there has been a tendency to focus research resources on technical solutions. Such research is largely natural science based and reflective of work that takes place in a laboratory or research farm, with a focusing on physical, chemical and biological solutions (Lui et al, 2019). Reflecting the flow of research funding, much of the research output has centred on developing and assessing the capacity of technologies in terms of their effectiveness in reducing agricultural GHG emissions. Such research is set largely under the controlled conditions that are associated with experiments in the natural sciences that is necessary to produce research, which meets the requirements of the peer review process.

Of course, the development of a technology which addresses a problem is only part of the challenge that arises in actually solving the problem (Overland and Sovacool, 2020; Castree, 2016; Grundman, 2016). The implementation of technical solutions at farm level requires firstly, that a problem is recognised and understood, that secondly, there is awareness on the part of the farmer of the technical solution and that thirdly, the farmer deems that adoption of the technical solution is feasible and affordable (Pannell *et al.,* 2006). In this context GHG mitigation in agriculture can be interpreted as a form of technology adoption.

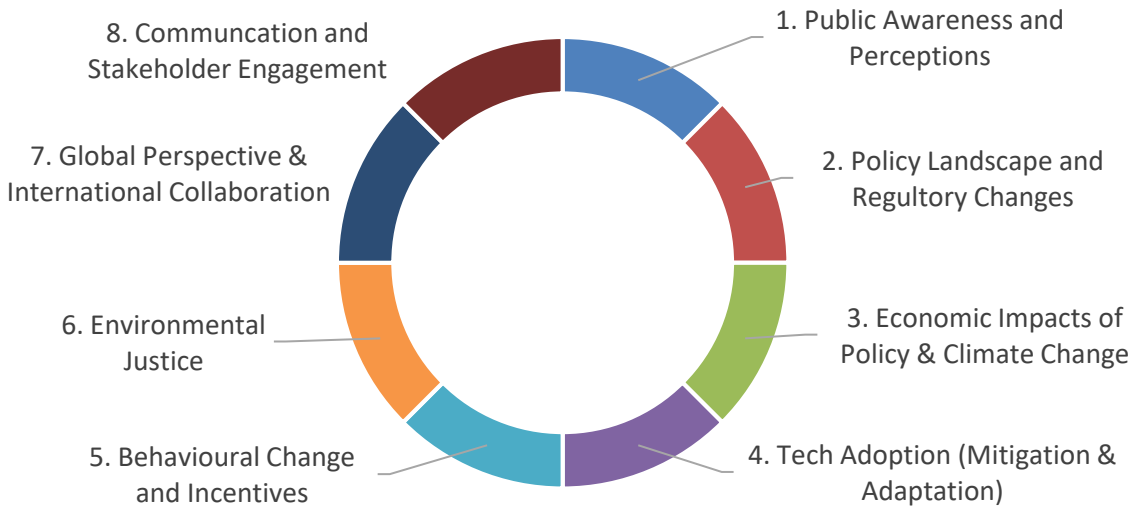
Natural science oriented research which explores the development of technical solutions to GHG emissions does not tend to examine how the technology might be adopted, the obstacles to adoption, such as costs, the means to promote adoption and the aggregate impact of the adoption of the technology. Understanding the aggregate impact is critical given that these GHG solutions in agriculture are necessary to contribute to sectoral and national GHG reduction targets. Where the aggregate impact of these technologies in reducing agricultural GHG emission is insufficient, the likelihood of agricultural production being constrained as a means to achieve GHG emission reduction targets potentially increases, unless other sectors of the economy can take up the slack by reducing emissions in those other sectors. Therefore understanding the true potential of mitigation technologies is vital.

Natural science based projects focussed on agricultural GHG emission reductions, which take place in the laboratory or research farm typically present their results in the context of an impact per hectare, an impact per animal or an impact per unit of agricultural product (Stewart et al, 2009). Often the research does not consider the potential aggregate impact, the costs that might be incurred in the adoption of the technology, the likelihood of adoption or pace of adoption. Even when there is an attempt to include these questions as part of the research, the methodology used may be inadequate, as the researchers with expertise in the technology at farm scale may lack the skill set to properly assess the technology's likely aggregate impact.

Beyond the research farm or laboratory, the process of real world GHG emissions mitigation in agriculture is complex. Economists are armed with the skills to explore a range of issues relevant to GHG mitigation, which go beyond the development of technical solutions to GHG emissions, the research question that dominates the natural sciences.

Figure 2.1 presents a summary of various areas in which economists can usefully contribute research input to help to address GHG mitigation in agriculture.

Figure 2-1: A selection of agricultural GHG related research topics for economists



Source: Author's own elaboration

Issues, which economists can address, include such topics as policy design, cost benefit analysis, the use of carbon market mechanisms, efficient resource allocation, behavioural change and international

collaboration. Economists can assess the level of emissions produced by different farms along with the associated farm income. In turn, they can investigate how people adopt technologies, the cost of technology adoption and the role of incentives in facilitating technology adoption. In addition, economists can interrogate these issues, not only in terms of the present circumstances, but also in terms of future scenarios.

Economists understand that the policy framework facing agriculture can differ across the world, be it in terms of the level of support or regulation in the sector. Economists can therefore seek to understand the implications of different GHG mitigation policies in different countries. This is especially important given that international trade in agricultural goods is significant. Finally, there is a role for economists in shaping the messaging around GHG mitigation to make policies more effective. In the rest of this section, each of these eight areas is described in more detail. Of course, this list should not be considered as exhaustive.

2.1 Public Awareness and Perceptions

We are living in a period of rapid climate policy change at the European and national level (Burns et *al.,* 2020). There is now greater public and political awareness of climate change than there was even a decade ago. For example, the annual United Nations Conference of the Parties (COP), which seeks to negotiate future climate commitments from the world's governments, has now become a major international event, with extensive mainstream media coverage (Carrattini *et al.,* 2021).

While public concern in Europe with respect to climate change is growing, in some cases it is motivated by a moral imperative to comply with climate policy targets given the historical role of developed economies in creating the circumstances for climate change. It is less clear that the avoidance of adverse climate outcomes in evident in the day-to-day decision making of the wider population. A considerable portion of the population disagree that man-made emissions are the source of climate change. There is confusion between the causes of climate change and the factors that lead to the depletion of the ozone layer. Also there is confusion among the public about which of their actions can deliver more significant emissions mitigation benefits (Capstick *et al.,* 2015; Watson *et al.,* 2016; O'Mahony *et al.,* 2024).

A further complication is that many do not understand that actions which might improve the carbon footprint of an activity might not reduce emissions if more of that activity then takes place (Ellerman and Wing, 2003; Garnett *et al.,* 2017). For example, a farmer might select cows, which individually produce fewer emissions, but might also increase the number of cows in the herd. The important distinction between carbon footprint measures, such as those used in life cycle analysis, and the measurement of territorial emissions which is required in national GHG emissions inventories is too complex, and perhaps uninteresting, for many citizens to engage with. Given the need to understand what farmers know and think about climate change and the need to improve that knowledge, there is a role for economists in identifying farmer misconceptions and their basis and to determine how understanding could be improved.

2.2 Policy Landscape and Regulatory Changes

Across the EU national GHG reduction targets have been set, while some EU member states have also set sectoral GHG reduction targets, including targets for the agriculture sector. One of the challenges with respect to agriculture is that efficiencies in emissions per unit of agricultural output can be offset

by increase in emissions due to higher volumes of output over time. For example, the removal of the EU milk quota system in 2015 led to an increase in EU milk production, which has tended of offset efficiencies in emissions per unit output. There is a role therefore for economists in modelling the implications of agricultural and trade policy to determine how agricultural activity might evolve in future years. This work can be aligned with the development of marginal abatement costs curves (MACCs) for the agriculture sector, discussed further in section 2.4.

More generally, economic approaches to emissions mitigation in agriculture have remained relatively unexplored. For example, little consideration has been given to carbon pricing in the context of achieving carbon targets in agriculture. Instead, the emphasis has been on the adoption of technological solutions to achieve emissions reductions. Perhaps this is because the debate on emissions reduction strategies tends to be driven by engineers and scientists whose expertise is in technology rather than in people. Economists work to project (model) what will happen in the future but there are very large uncertainties involved, especially over longer time horizon.

2.3 Economic Impacts of Policy and Climate Change

There is a role for economists in demonstrating to other researchers and to wider society that dynamic approaches to the modelling of the impact of climate change on agriculture are preferable to static analyses. Climate change (and climate policy) will have an impact on a country's agricultural production conditions, output prices and production costs. However, climate change (and climate policy) will also impact on agricultural production internationally. This is particularly important in the context of the interconnected world of agricultural markets. So, ultimately, the impact of climate change (or climate policy) on agriculture in a country will be determined in part by factors external to that country.

There is a significant role therefore for economists in assessing the implications of climate change for the competitiveness of a country's agriculture. Equally, an assessment of the implications of national climate policies on agriculture is required. Implications for international supply and demand and the impact on commodity prices, production, consumption and trade at the global scale needs to be understood. One of the issues that economists might consider is whether for some countries agriculture climate policy (agricultural GHG emissions reduction targets) might have greater implications for agricultural activity than the impact of climate change itself.

While the focus of this paper is largely on research relating to GHG emissions mitigation, climate change adaptation is also relevant. However, fewer economic research studies have been undertaken on agricultural adaptation, for example which types of farms would be effected to the greatest extent (McCarl *et al.,* 2016; Holzkämper, 2017). In part the focus on mitigation rather than adaptation may be because adaptation is perceived as a more distant concern in socio-economic research prioritisation, a sort of fall back strategy to be pursed if GHG mitigation fails to limit climate change.

Again, there is potentially a significant role for economists in assessing adaptation from an economic perspective. Some adaptation studies indicate that due to the adverse impact of climate yields for certain crops would decline or that product costs would rise rendering production "uneconomic". But such studies are sometimes lacking in terms of economic insights and may assume static production or static output prices in arriving at their conclusions (Vermonet *et al.,* 2010). It is possible to use economic modelling to try to take this type of complexity into consideration, such as the implications

of a change in production or trade for output prices. There is also potential to examine the interplay between climate change mitigation and adaptation actions (Rozensweig *et al.,* 2007)

2.4 Technology Adoption (Mitigation and Adaptation)

Much work has been undertaken in some countries to assess the potential of mitigation technologies and the associated cost of their implementation. Agricultural sector level marginal abatement cost curves (MACCs) are a very useful tool in this regard (Moran *et al.,* 2011; Schulte *et al.,* 2012). The development of agricultural MACCs are however a challenging undertaking, ideally requiring input from a range of disciplines. MACCs also need to be revisited periodically as new technologies emerge or are refined, since this can impact on the efficacy of the technology, its associated cost and the extent to which it might be adopted.

The most common form of agricultural MACC examines the cost and potential of technologies for the agricultural sector in aggregate. However, given that aggregate sectoral MACCs implicitly treat the agricultural sector as a single national farm they are less well suited for the assessment of costs and potential for mitigation technologies for a particular farm system type or for an individual farm. This means that in an aggregate level agricultural MACC the applicability of a technology for a particular farm type is not obvious, nor is the associated cost of using the technology. However, the cost of applying measures and the efficacy differs across farms (Beach *et al.,* 2008). This necessitates the production of more specific MACCs for different farm types (Jones *et al.,* 2015).

There is a significant role for economists in developing MACCs, be they at an aggregate sector level or for particular farm types. Economists can assess the cost of technologies, or the rate of their adoption. Given that MACCs ideally should be forward looking, they also need to consider how the agricultural sector in the country to which they relate might evolve in future years.

In the context of a MACC, changes in the composition of agricultural activity can be a factor which would affect the potential of a mitigation technology, potentially increasing or decreasing its applicability. Again, economists a well placed to assess this complexity, using scenario analysis to project the potential development of different parts of the agricultural sector (Lanigan et al, 2018). .

Advice and training on mitigation technology is available, but barriers to technology adoption need to be better understood (Long *et al.,* 2016). Economists can explore how policy makers might incentivise technology adoption e.g the choice between the implementation of a mitigation technology through regulation - making the technology a legal requirement - versus financial incentives -providing financial support to farmers to defray the costs of adopting the mitigation technology (Piñeiro *et al.,* 2020).

If efforts to curtail emissions in agriculture through mitigation actions are unsuccessful, a question that then arises is whether adaptation will even be necessary in some parts of agriculture. The possibility exists that if technologies cannot deliver emission reductions then, the level of agricultural activity could be constrained, meaning that farms could be forced to exit agriculture. Farmers operating farms that might no longer exist in the future might have no need to learn about the adaptation requirements associated with climate change This is referred to in the literature as transformational adaptation, where changing economic, environmental or social circumstances make the system of production untenable (Wheeler *et al.,* 2013).

2.5 Behavioural Change and Incentives

In recent years, an increasing number of problems have been subject to analysis using behavioural economics. A particular concern of behavioural economics is understanding the biases that influence the behaviour of individuals. The discipline advocates the use of nudges, an intervention that changes the way in which individuals perceive choices. Ideally, the process of nudging aims to guide individuals towards making decisions that are in their best interest (Ilberly, 1978).

In the context of climate change, economists can investigate different incentive mechanisms, such as rewards and penalties, to better understand their effectiveness (Thomas *et al.,* 2019). Related to this is the need to understand the decision-making processes of farmers and the importance of the influence of peers and of role that can be played by peer to peer learning. However, a question that then arises is how effective nudging can be in the context of GHG mitigation, especially if the change required is substantial and the required time scale for the change to be implemented is short.

Aside from the potential to motivate changed behaviour, which will help to address climate change, there is also the need to provide evidence of that behavioural change, so that it can be quantified and credited to agriculture in national GHG inventories and to also understand the basis for behavioural change (Thompson *et al.,* 2021). This is just one aspect of a more general role for economists in measuring and understanding the change in sustainability of agricultural activity, not just in an environmental sense, but also in an economic and social context. In fact, the importance of having data to measure sustainability in agriculture is evident in the transition that will soon occur in the European Union (EU) Farm Accountancy Network (FADN), which will soon become the EU Farm Sustainability Network (FSDN).

While FADN has largely focused on economic and farm technical performance, FSDN will take a much wider view of sustainability (Turchetti *et al.,* 2021). The sustainability data gathered via FSDN will allow economists to assess the sustainability of agriculture in a way that will provide independent recognition of the efforts of farmers to address environmental sustainability. The datasets it will provide can also provide datasets to facilitate the more targeted use of policy to deliver more effective environmental outcomes in agriculture, including GHG mitigation. Coupled with modelling capacity, economists can even project how the sustainability of different farm types might change in the future under various market and policy based scenarios.

In addition to delivering desirable changes in behaviour, there is also a need to explore whether there are risks that such changes in behaviour will remain permanent. In other words, is there a risk that behavioural change may be temporary rather than permanent? Is there a risk, for example, that farmers will lose interest in GHG mitigation actions, which they have taken, especially if the media messaging about agriculture's interaction with the environment is negative. This requires an assessment of how such changes can be made culturally sustainable (Burton and Paragahawewa, 2011).

2.6 Social Equity and Environmental Justice

Economists can undertake research to identify which farms or which farmers are likely to be more vulnerable in the face of policies implemented to address agriculture's impact on the climate. This is an important question in the area of climate justice. The concept of environmental justice recognises that climate policy will affect certain members of society more than others (Timmermann, 2021).

Environmental justice argues that there is an obligation on government to mitigate the financial impact of policies which are in the broader interest, but which fall disproportionately on a particular sector of society. An example of this would be climate policy in the agricultural sector. In the context of climate change mitigation policy, there is a risk that, relative to others in society, farmers may be subject to a disproportionate share of the adjustment required to deliver climate change.

Committing to the effective implementation of climate policy in an effective way require an understanding of the costs incurred by citizens in meeting climate obligations. Economists can make such a cost assessment (Chapman, 2020). Easing the adjustment process for those greatest impacted by climate policy can be achieved by supporting the climate transition for certain sectors of society via training, capacity building and targeted financial supports. This then empowers farmers to engage in emissions mitigation (NESC, 2023).

However, appropriate policy design may require an inclusive approach to policy making which allows farmers to point to the challenges they face in meeting climate obligations. These challenges may differ across the farming population. The financial and human capacity of different categories of farmers to address the impact of climate policy may vary greatly and economists can explore this issue. For example, it is possible to explore the impact of climate policy on the operators of small farms versus larger farms or younger farmers versus older farmers or livestock farmers versus crop farmers.

There is a role for economists also in helping to tailor targeted communication and information campaigns to explain the motivation for reducing emissions and to explain the mitigation techniques that are available. Overall, environmental justice points to the need for collaboration across society. This should involve government departments, state agencies, researchers (including economists) and the farmers directly affected.

2.7 Global Perspectives and International Collaboration

There is a substantial role for economists in highlighting the value of international collaboration with respect to climate policy in agriculture leading to policy integration (Schmidt, 2020). In particular, the transboundary impacts of GHG policy is relevant. Economists can show that the impact and the effectiveness of climate mitigation policies can vary depending on whether those policies are implemented by governments unilaterally, or in a co-ordinated multilateral way.

This allows the exploration of such issues as carbon leakage, where reductions in GHG emissions in one country due to a reduction in economic activity (such as a reduction in agricultural production) are simply offset by an increase in GHG emissions due to an increase in activity (an increase in agricultural production) in another country (Arvanitopoulos,et al 2021).

The traditional analysis of potential trade agreements by economists has focused on the economic impact, examining how such agreements might affect production and trade. However, there is now also a need to assess such potential agreements from an environmental perspective, examining how potential changes in production and trade might impact on global agricultural emissions (Balogh, Jámbor, 2020).

The challenge here perhaps is that agriculture is not yet a major focus of attention in terms of GHG mitigation in many parts of the world, making it more difficult to conceive of mechanisms that could lead to co-ordinated multilateral implementation of climate policies in agriculture.

2.8 Communication and Stakeholder Engagement

Economists can explore the effectiveness of different communication strategies relating to agriculture that are directed at farmers. This can provide insights for policy makers as to how such messaging can be improved to make it more effective. The complexity of GHG mitigation in agriculture makes this communication issue challenging. Communications may need to be tailored to different audiences. Economist can investigate whether communication strategies that works well with a general audience work as well with a farmer audience, which in turn can lead to research exploring how more successful communication with farmers can be achieved. For example, there is a considerable literature on the importance of two-way communication between experts and farmers to obtain feedback from farmers and better understand their concerns relating to mitigation technologies (Burbi, 2014).

There is also a need to understand how farmers interpret the information provided to them, which is part will be influenced by their existing beliefs. Understanding those beliefs can itself produced insights that can inform the messages to be communicated and how those messages are communicated (Robertson *et al.,* 2016).

Economists can also use their knowledge of policy and agriculture more generally to play a facilitation role between farmers and other stakeholders, such as environmental NGOs, around climate policy (Mitter *et al.,* 2019). This can help to help foster trust between these differing interests, leading to more successful dialogue and better progress in achieving desirable outcomes.

3 Discussion

The various examples presented in this paper underscore the potentially significant role of agricultural economists in addressing the complex interplay between mitigating GHG emissions and sustaining agricultural growth.

Economists can play a crucial role in shaping climate policies for agriculture by leveraging their expertise in agricultural policy, production, trade, and at farm level. They can facilitate the uptake of GHG mitigation actions by understanding technology adoption costs and by signalling how to overcome adoption barriers. While sector level GHG mitigation cost curves for agriculture are important, they may not adequately address farm-specific needs, necessitating GHG mitigation costs curves that have deeper granularity tailored for individual farm types. Economists can propose market-based solutions such as carbon pricing to incentivise technology adoption, but effective implementation of carbon pricing requires may require accurate GHG emission measurement at the farm level, which can itself be challenging. Without proper measurement of farm level GHG emissions, the incentives for farmers to adopt GHG mitigation actions are not clear.

The capacity of economists to understand and even quantify the trade-offs and synergies involved in GHG mitigation and agricultural productivity is important for farmers, policy makers and other stakeholders. In addition, there is the potential to look at the synergies and trade-offs between agricultural GHG emissions and other environmental goals. Cost benefit analysis in this area can identify strategies that deliver desirable outcomes. By facilitating dialogue between farmers and other stakeholders, this can be a means to deliver collective action to address GHG mitigation.

More climate change related socio-economic research could be undertaken if the funding were made available. Economics and other social sciences appear to be at the back of the queue when it comes

to funding provision. However, it may be difficult to secure more climate related funding for the social sciences if an argument is made that existing funding for the natural sciences should be reallocated to the social sciences, since this will not be seen favourably by natural scientists. Instead greater climate related funding for social science could be provided by increasing the overall funding made available for climate change related research. There is an obligation however on economists to demonstrate where the funding gaps exists. This in turn may require specific studies to identify key challenges tht need to be addressed. Lessons could probably also be learnt from the natural sciences which have been successful in co-ordinating international funding mechanisms to support climate research in their research fields.

At the level of the funding bodies themselves, a key issue may lie in the framing of the research themes to be investigated. If these are formulated, primarily as natural science research questions, then the capacity of economists to address such research questions will be by definition constrained. Therefore, part of the solution lies in reframing the research themes that needs to be addressed through climate funding mechanisms, so that a broader range of themes emerges, including specific research questions that are more directly relevant to economists. This is turn requires that there is greater involvement of decisions makers with economic expertise in the identification of research themes.

4 Conclusion

The role of agricultural economists in addressing the challenge of mitigating GHG emissions while allowing for continued growth in agriculture is clear. This review has highlighted the various ways in which economists can contribute to shaping a more sustainable future for agriculture.

Economists can provide insights into the adoption of sustainable agricultural practices aimed at reducing GHG emissions in a way that does not compromise agricultural productivity. Expertise in assessing societal, environmental, and economic objectives is required and economists are equipped to advice on strategies that would address all three of these goals.

In the climate space, economists can contribute to policy design, undertake cost-benefit analysis, and assist with the implementation of a carbon market based solutions. By evaluating the economic impacts of climate change and policy interventions, economists can contribute useful insights to inform decision-making processes at both national and international levels.

Behavioural economics may also have a role in the context of climate changes mitigation measures, offering the possibility of a better understanding of biases and incentives that influence farmer decision-making. Through the design of effective communication strategies incorporating insights on behavioural change, economists can help to improve the rate of adoption of climate mitigation technologies and promote sustainable practices in farming.

Issues of social equity and environmental justice are also of interest to economists who can play a useful role in identifying vulnerable farm households whose needs should be taken into account when devising policy objectives. There is a role for economists in supporting the dialogue that is necessary between stakeholders so that a consensus approach to climate action can be fostered, which in turn can lead to more successful delivery of GHG mitigation goals.

In addressing climate change, economists can bring valuable skills to the table, helping to chart a path towards a more sustainable and resilient agricultural sector, taking account of the need to find a good balance between the objectives of environmental, economic and social sustainability.

However, much of the above relies on the provision of resources. The economics community must therefore find a way to influence the decision making process that surrounds the allocation of research funding relating to climate change.

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