Executive Summary

This report considers some of the salient issues that underpin the economics of addressing climate change impacts in the agricultural sector; specifically, projected impacts of climate change on agricultural systems, adaptation responses to these scenarios, and the mitigation of sector greenhouse gas emissions. The report first describes current knowledge on the impacts of climate change on agriculture and related resources. It then examines the limits of the knowledge on the mechanisms that translate climate change into potentially serious impacts on food production, water stress, and ultimately food security. The report highlights remaining uncertainties in relation to impact categories and in terms of unequal global coverage of existing information.

This discussion is used to consider the options for climate change action. Recent reports, including *The Fourth Assessment Report of the Intergovernmental Panel on Climate Change* (IPCC, 2007b) and the *Stern Review* (Stern, 2006), highlight the importance of immediate action to address climate change, both in terms of reducing greenhouse gas (GHG) emissions to avoid the worst impacts of climate change in the future, and with regard to adapting our systems to cope with the unavoidable changes. Types of adaptations are discussed, together with their timing and responsibility. The link to policy intervention is addressed by distinguishing between private responsibility and public roles. Private responsibility is equated with autonomous or spontaneous actions undertaken by producers responding gradually, largely in response to market signals. This is distinct from public adaptations that may be necessary where private adaptations lead to unanticipated adverse public good outcomes, or where information failures or other barriers are manifest in terms of how to adapt. The paper provides examples of adaptation actions in agriculture currently underway in a variety of arable and livestock contexts.

On the basis of this discussion, the report suggests that there are three roles for public policy intervention to promote adaptation in the agricultural sector: reducing the vulnerability of those least able to adapt; provision of information to stimulate widespread adoption of adaptation techniques and opportunities; and an enhanced role for provision of public goods associated

with agriculture. The report then suggests that successful adaptation should take account of effectiveness, efficiency and the equity and legitimacy of adaptation actions and policies.

Beyond adaptation, agriculture is also major source of global greenhouse emissions, accounting for an estimated emission of 5.1 to 6.1 giga tonnes (Gt) of CO_2-eq/yr in 2005. This represents 10-12% of total global anthropogenic emissions of greenhouse gases (Smith *et al.,* 2007), although scientific uncertainty also suggests this could be as high as 18-31%. Methane (CH_4), mainly from enteric fermentation, rice cultivation and manure handling, contributes 3.3 Gt CO_2-eq/yr:[1] nitrous oxide (N_2O) from a range of soil and land management practices contributes 2.8 Gt CO_2-eq/yr. Of global anthropogenic emissions agriculture is estimated to account for about 60% of N_2O and about 50% of CH_4.

Sector emissions are coming under increasing scrutiny as part of efforts to allocate emissions reductions implied by external obligations. However, even though they are largely outside the global agreements that are binding on other sectors, an important consideration is the assessment of the efficiency of reducing these emissions relative to the cost of reductions in other sectors of the economy. Such an assessment requires a better understanding of the abatement potential offered by a variety of agricultural mitigation measures, and the cost of implementing these measures in viable farm systems. This information can be depicted in the form of a marginal abatement cost curve (MACC), which shows the order in which measures can be implemented and the relative cost of mitigation measures.

Emerging MACC analysis suggests that many agricultural measures can mitigate emissions at low cost (USD per tonne of CO_2-equivalent) relative to benchmark costs provided by the cost of emissions permits or the notional shadow price of carbon. Importantly, the research suggests significant win-win potential where some measures can actually save input costs and reduce emissions. Such measures include the more accurate application of nitrogen fertilizer and manures.

Further abatement cost evidence is required for the variety of global farming systems. But marginal abatement cost curves can be a useful basis for identifying efficient emissions budgets, which in turn require appropriate policy instruments for delivery. A range of policy options are available to the sector. In the first instance the non-adoption of win-win mitigation

[1] Methane and nitrous oxide can be converted to carbon dioxide equivalents (CO_2-eq) by multiplying by their global warming potentials of 21 and 310, respectively.

measures suggests that more attention needs to be directed at existing information and behavioural barriers that are handicapping voluntary mitigation. Beyond the potential of voluntary approaches, market-based approaches are being considered for parts of the sector. But specific problems exist in their application in agriculture, an industry that is characterised by many small producers operating in biologically complex systems.

It has been suggested that incentive mechanisms can be applied both at the supply and the demand side. This report does not consider demand-side measures; however, we do note that a move beyond the farm-gate opens up a range of complications in relation to the role of other actors in the food chain and the correct apportionment of life-cycle emissions associated with food production.

Finally, implementation of any emissions budget will need to be consistent with longer-term adaptation planning. This report concludes with recommendations for the OECD and more general research requirements.

A number of first steps can guide policy makers in the design of a rational economic response to climate change. The first and most obvious is to understand impacts and their associated costs. This economic picture provides an indication of the value at risk and therefore the basis of an economically efficient investment response to adaptation. This clearly requires some mapping of downscaled climate projections and their effect on vulnerable sectors of the economy. The second is to consider the range of adaptation responses, their associated costs and whether these fall within the categories of public or private responsibility. The latter includes a range of less tangible interventions, such as information barriers that should be addressed to facilitate private adaptation. The third first step is to design an efficient mitigation policy. Whatever the adaptation response, most countries are now party to international obligations on emissions reductions and these should be designed at least cost. The agriculture and land-use sector offers significant mitigation potential at low cost and countries should develop a sector emissions budget by concentrating on the identification of these low-cost measures. Once this budget is determined, a range of voluntary and/or market-based approaches can be used to provide incentives for their deployment in the sector.