CLIMATE CHANGE AND AGRICULTURE

Can market governance mechanisms reduce emissions from the food system fairly and effectively?

TARA GARNETT – 2012

SHAPING SUSTAINABLE MARKETS

iied

First published by International Institute for Environment and Development (UK) in 2012

ISBN: 978-1-84369-853-1

For further information please contact: International Institute for Environment and Development (IIED), 80–86 Gray's Inn Road, London WC1X 8NH, United Kingdom. newbooks@iied.org, www.iied.org/pubs

Citation
Garnett, T. (2012) *Climate change and agriculture: Can market governance mechanisms reduce emissions from the food system fairly and effectively?* International Institute for Environment and Development. London.

Designed by
SteersMcGillanEves
01225 465546

Laid out by
Regent Typesetting
www.regent-typesetting.co.uk

Printed by
Park Communications, UK.
www.parkcom.co.uk
Printed on 100% recycled paper.

Edited by
Fiona Hincliffe

Series Editor
Emma Blackmore

Shaping Sustainable Markets
Shaping Sustainable Markets is the flagship research project for the Sustainable Markets Group at IIED

Can markets be 'governed' to better benefit people and planet? This project explores the individual and combined impact of market governance mechanisms on sustainable development to find out what works where and why. Some of these mechanisms are well established. Others are innovative ideas yet to be tested in the real world.

We want to improve and broaden understanding of how market governance mechanisms can be designed and used to secure livelihoods and protect environments. Find out more about our work at http://shapingsustainablemarkets.iied.org.

We welcome your comments on this publication or other aspects of Shaping Sustainable Markets. Please contact emma.blackmore@iied.org.

Acknowledgements
Many thanks to Emma Blackmore and Bill Vorley for their invaluable comments and support, and to David Hebditch for additional research on market coverage.

IIED is grateful for the support of its Joint Framework donors DFID, Danida, SIDA, NORAD and Irish Aid.

About the author
Tara Garnett founded and runs the Food Climate Research Network (FCRN) – a global network of individuals from across the food industry and the NGO, government and academic sector — to share information on issues relating to food and climate change. The FCRN is funded by the Engineering and Physical Sciences Research Council and housed at the University of Surrey, where Tara is a research fellow.

ACRONYMS AND ABBREVIATIONS

AFOLU	Agriculture, forestry, and other land uses
CCBA	Climate Change, Community and Biodiversity Alliance
CCC	Committee on Climate Change
CCX	Chicago Climate Exchange
CDM	Clean Development Mechanism
CER	Certified emission reduction
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalents
ESS	Environmental Stewardship Scheme
EU	European Union
EU ETS	European Union Emissions Trading Scheme
FAO	United Nations Food and Agriculture Organization
FCPF	Forest Carbon Partnership Facility
FIP	Forest Investment Programme
GHG	Greenhouse gases
LCA	Life cycle analysis
OTC	Over the counter
MGM	Market governance mechanism
MRV	Measurement, reporting and verification
MSI	Multi-stakeholder sustainability initiatives
N_2O	Nitrous oxide
NAMA	Nationally appropriate mitigation actions
NVZ	Nitrate Vulnerable Zone
PAS 2050	Publicly available specification
PES	Payments for Ecosystem Services
REDD	Reduced Emissions from Deforestation and Degradation
RGGI	Regional Greenhouse Gas Initiative
UNFCCC	United Nations Framework Convention on Climate Change

CLIMATE CHANGE AND AGRICULTURE

Can market governance mechanisms reduce emissions
from the food system fairly and effectively?

Tara Garnett – 2012

FIGURES

BOXES

SUMMARY

The agricultural sector is a major contributor to greenhouse gas (GHG) emissions, accounting for up to 30 per cent of the global total. Agriculture is itself also affected by climate change, with overall impacts predicted to be negative, particularly in poor countries. These are likely to have serious consequences, both for food security and the livelihoods of millions of food producers worldwide. Policymakers are therefore presented with a double challenge: to reduce agricultural emissions, and to help agriculture adapt to a changing climate. This report assesses the policy scope for pursuing these objectives, focusing largely on reducing emissions (mitigation), but also considering policies that can foster adaptation.

There is growing interest by policymakers at both national and international levels in using market governance mechanisms (MGMs) – and market-based instruments in particular, such as emissions trading or payments for environmental services – as a tool for steering the global economy in less GHG-intensive directions. To date, however, most of the focus has been on sectors such as transport and the built environment; agriculture has largely been neglected. This lack of policy action reflects the fact that in being essential to our survival, agriculture transcends any purely economic function. Agriculture is also multifunctional providing food and ecosystem services, for example, and is physically, socially and economically complex.

This paper examines some of the tools that might be used to address the impact of agriculture on climate change. It covers the full spectrum of regulatory, economic, co-operative and information-related options. It assesses the potential these tools offer for (1) making food production less emissions intensive; and for (2) influencing consumers to reduce the demand for foods with a high GHG footprint (particularly meat and dairy products) and to reduce food waste.

It is clear that no single measure will be effective in achieving emissions reduction. A mixture of approaches – regulatory, economic and voluntary, as well as labelling, information and awareness-raising – are all essential and best undertaken in combination:

- Emissions related to production (agriculture) and consumption (dietary choices and waste) must be addressed together in order to reduce ‘leakage’. If this is not done, emissions will not be reduced in absolute terms but simply displaced to other countries or regions. For example, action to reduce consumption in one country can lead to increases in meat and dairy exports to another.
- Regulation, in the form of a cap on emissions, is a ‘precondition’ for other market governance measures (such as pricing) to operate effectively. In the absence of an agreed ceiling on emissions, economic, co-operative or other measures may simply improve the relative efficiency of production while failing to achieve absolute reductions.

- Economic measures have a vital part to play within this regulatory context, but care needs to be taken in the choice of instrument. Emissions trading and pricing mechanisms are likely to be more effective in reducing emissions than taxes, which can be ineffective and sometimes unfair. However, these mechanisms can achieve reductions at the expense of other environmental factors, and can ignore equity and poverty imperatives.
- There is scope for global financing mechanisms, such as the Clean Development Mechanism (CDM) and Reduced Emissions from Deforestation and Degradation (REDD), to be applied to agriculture, but they will need to be designed to benefit, rather than marginalise, small-scale farmers. So far these schemes have tended to neglect the poorest in society.
- To be effective, MGMs must be appropriate for the social, cultural and economic context within which they operate. Measures that alter farm practices need to be acceptable to farmers and they must have the capacity to implement them. Importantly, they need to be seen by farmers as beneficial, either because they raise incomes or improve yields, or both. To be equitable, issues such as land tenure and transaction costs need also to be addressed. On the consumption side, the impact of pricing strategies on lower income consumers needs to be considered, and at times disincentives need to be balanced with incentives.

FOREWORD

To achieve sustainable development multiple objectives must be met – and this is an extremely complex task. Human needs have to be balanced with environmental limits. Effective market governance mechanisms need to help achieve this balance. Nowhere is this more evident than in agricultural production – where environmental, climate and food security objectives need to be satisfied while meeting the needs of producers and consumers.

Agricultural production and the climate are inextricably linked: the climate affects agricultural production and is itself affected by agricultural emissions. Agriculture is extremely vulnerable to climate change, especially changes in precipitation and temperature, and particularly in the developing world. Agriculture is also a major driver of climate change, responsible for 30 per cent of the global total of greenhouse gas emissions. How agriculture is practised could therefore offer significant potential for mitigating climate change, for food security and for improving the livelihoods of millions of food producers worldwide.

Yet, historically agriculture has received less attention than other sectors in addressing climate change because of the major complexities – and therefore challenges – it presents. Agriculture's multifunctional role — it is essential to food production, food security, rural livelihoods and for providing ecosystem services such as biodiversity and clean water – means that millions of people can be significantly affected by mitigation efforts. The key challenge is therefore designing schemes that reach these diverse people, are appropriate to their conditions, and offer the right incentives.

There is a growing interest in the use of market governance mechanisms for tackling climate change by offering incentives to make the kinds of changes that are required. But how widely are these mechanisms being used in agriculture, and how effective are they in reducing emissions? What impact do they have on adaptation and other aspects of sustainable development? Are they able to balance the competing demands of producers and consumers, the environment and food security? How do these mechanisms interact with and build upon regulatory frameworks and mechanisms? Can they be applied fairly and in a way that does not burden the poor?

This research seeks to answer these questions. It makes a significant contribution to our knowledge of this subject by giving a comprehensive overview of the full spectrum of regulatory, economic, voluntary and information-related instruments. It explores their potential for affecting how food is produced, and also how it is consumed.

The key messages emerging from this review are that economic measures have a vital part to play within this regulatory context, but they need to be designed with care. To be effective, emissions from food production and consumption have to be addressed together. If not, emissions reduced in one region will simply be displaced elsewhere. A balance needs to be struck by applying a mix of approaches – regulatory, economic, voluntary, and information; no single measure will be effective in achieving emissions reductions on its own. 'Soft' measures, such as co-operative agreements and information have a part to play in providing an enabling context for action, but they need to be backed up by 'harder' regulatory or economic measures. Regulation, in the form of a cap on emissions, is a key prerequisite for other market governance measures to function well. Without an agreed ceiling on emissions, economic, co-operative or other measures may simply improve the relative efficiency of production while failing to achieve absolute reductions.

These findings have a vital role to play in informing key events, such as the United Nations Conference on Sustainable Development (Rio+20), to be held in June 2012 – where the focus will be on how to build a green economy that is low carbon, equitable and enhances and protects the natural resource base.

Emma Blackmore, Series Editor

ONE
INTRODUCTION

Agriculture is central to the challenge of climate change.[1] Not only is it increasingly – and often negatively – affected by rising temperatures and climatic instability, but it is itself also a major contributor, accounting for up to 30 per cent of global greenhouse gas (GHG) emissions. (Bellarby *et al.*, 2008). Emissions from the agricultural sector are determined not just by how farmers produce food, but also by what consumers choose to eat; these choices send signals to farmers through the food chain about what to produce.

This paper assesses and compares the effectiveness and fairness of different market governance mechanisms in reducing GHG emissions from agricultural production. A market governance mechanism (MGM) is defined by the Shaping Sustainable Markets research programme as a set of formal or informal rules consciously designed to change behaviour – of individuals, businesses, organisations or governments – so as to influence how markets work and their outcomes (Blackmore, 2011). MGMs operate through one or a combination of economic incentives and disincentives: regulatory measures (legal requirements or prohibitions); voluntary co-operation among stakeholders, often through partnerships; and information provision to potentially enable consumers, investors and producers to make informed and evidence-based choices (Figure 1).

This paper pays particular attention to non-regulatory (ie. market-based) measures and compares their effectiveness with regulatory approaches. In the current policy climate, market-based instruments such as carbon trading, payments for ecosystem services, voluntary industry agreements and labelling schemes are generally looked upon more favourably than 'traditional' approaches that are not market-based (e.g. regulations) or perceived to be punitive (such as taxes). It is therefore important to assess their real effectiveness and their social implications.

1.1. STRUCTURE AND METHODOLOGY

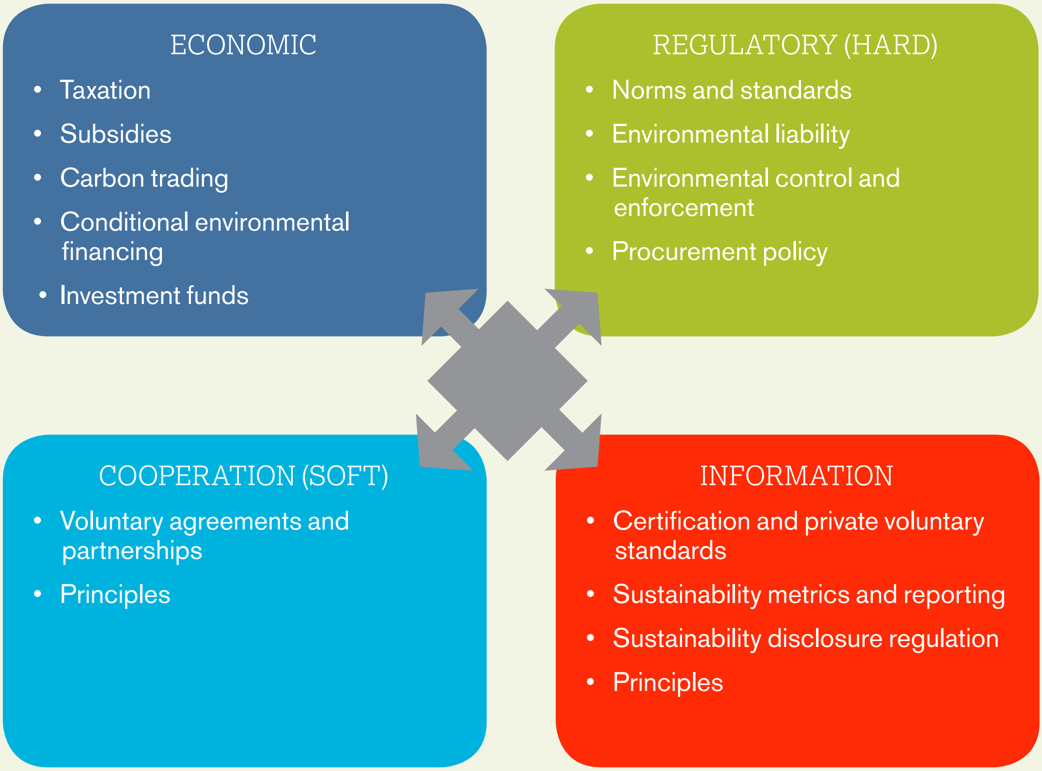
The paper is structured following the IIED typology (Figure 1). It examines the range of available economic, regulatory, co-operative and information-based measures, focusing first on those MGMs that seek to influence agricultural production (Section 3) and next on those for influencing consumption choices (Section 4).

Measures that influence food system GHG emissions beyond the farm gate, including from manufacturing, retailing and transport are not examined in detail here, except where their mention helps provide a bridge between the analysis on agriculture and on consumption. This is because many of the policies required to reduce impacts in these sub-sectors are not unique to the food system and could form part of an overall package of measures seeking to reduce energy demand and to decarbonise energy sources.

The role of agriculture in climate change has only recently been recognised; our understanding of how to reduce emissions is still developing. Thus, few MGMs are explicitly geared to reducing emissions from farming and food consumption. Nevertheless, many MGMs do seek to influence farming and consumption practices for other reasons, such as to manage nutrient pollution or promote more healthy eating patterns. While

1. The focus is on agriculture for food production, rather than agricultural production for non-food purposes such as fibres or fuels.

FIGURE 1: THE SHAPING SUSTAINABLE MARKETS MARKET GOVERNANCE MECHANISM TYPOLOGY[2]

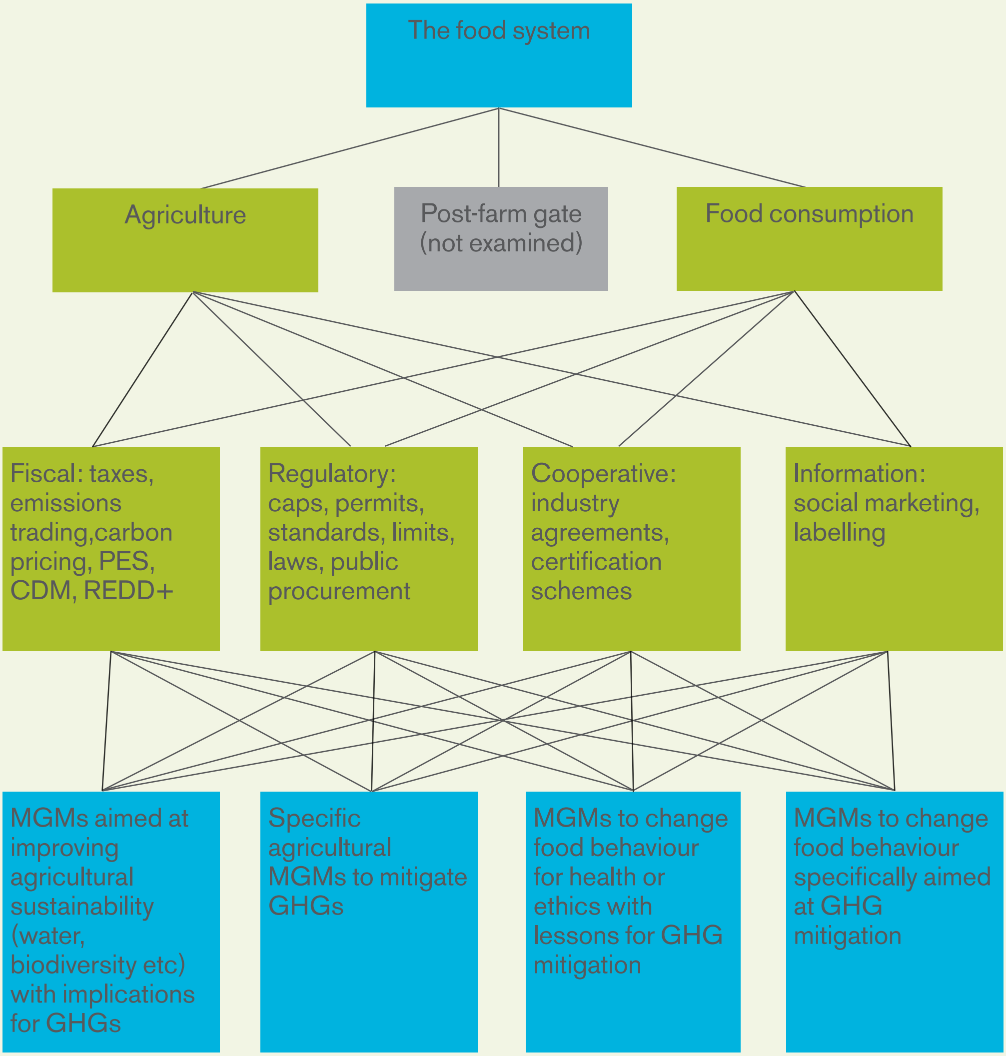


Source: Blackmore, 2011

these are not specifically intended to reduce emissions, they may still achieve this as a by-product of their primary goals. Some of these measures are examined in this paper, because they may offer insights into the effective design and implementation of MGMs that are more explicitly orientated to reducing GHGs. Figure 2 summarises the range of MGMs that are examined, or excluded from this analysis.

2. See http://shapingsustainablemarkets.iied.org for more information.

FIGURE 2: MGMS THAT AFFECT THE FOOD CHAIN AND CLIMATE CHANGE



In much of the world there has been little policy thinking and action related to agriculture

Each MGM is treated, where possible, in the following way:

- The purpose of the MGM is described (including whether GHG mitigation is a primary goal or a by-product, or whether it has no impact on emissions, but may nevertheless yield useful insights); and how it is implemented and monitored.
- Its coverage is highlighted – where and how widely it is used.
- The mechanism assessed, where possible, according to its:
  - *Effectiveness*: its proven or potential ability to make a system-wide impact and achieve measurable GHG emission reductions.
  - *Economic and institutional sustainability*: the scheme's ability to sustain itself once temporary subsidies and finance are withdrawn.
  - *Fairness*: the costs and benefits it generates for those immediately and indirectly affected (farmers, consumers), and the relative balance of impacts between rich and poor, developed and developing countries.
  - *Fit to trade policy*: its impacts on trade, trade fairness and trade distortions.
  - *Other environmental impacts*: the extent to which mitigation affects other areas of environmental concern, especially biodiversity.
  - *Social and ethical impacts*: impacts on human health (especially nutrition) and where relevant, on animal welfare.
- A summary box pulls out the main points for each mechanism.

In many cases the necessary information to provide a proper assessment of a given MGM does not exist, either because the MGM is still evolving or because no relevant research has been done. It is also important to note that some of the research identified in this analysis assesses the effectiveness of existing MGMs, while others are based on modelling studies. These models are simulations of the impacts of a hypothetical intervention rather than based on empirical evidence and will necessarily be based on a simplification of what may happen in real life. As such their findings should be treated with caution.

Finally, a word on the scope and coverage of this report: the focus is global and the intention is to cover MGMs from a range of countries, particularly in developing country settings. In practice, however, many examples of potential MGMs are drawn from the UK and Northern Europe. This reflects the fact that in much of the world there has so far been little policy thinking and action related to agriculture. What does exist, while still underdeveloped, tends to take place in European countries.

Before assessing individual MGMs in Sections 3 and 4, we review the link between the food system and greenhouse gas emissions in Section 2.

TWO
GREENHOUSE GAS EMISSIONS FROM THE FOOD SYSTEM

2.1. AGRICULTURE AND CLIMATE CHANGE

Agriculture – the production of food, fibres and fuels – is a major contributor to GHG emissions, accounting for up to 30 per cent of the global total. Of this, 10–12 per cent is emitted directly from farms, particularly methane (from ruminant animals and rice cultivation) and nitrous oxide (from soil processes, applications of inorganic fertiliser, and livestock dung and urine).

Excessive nitrogen in the soil and water system is caused by applications both of synthetic nitrogen fertiliser and of manure. These nutrient surpluses give rise to leaching and eutrophication, ammonia emissions and, as is now increasingly recognised, to emissions of nitrous oxide, a greenhouse gas. Measures to address nitrogen overload therefore have a part to play in reducing agricultural GHG emissions. Nitrogen overload has been recognised as a major concern for many European countries, particularly those in Western Europe where intensive agriculture is practised.

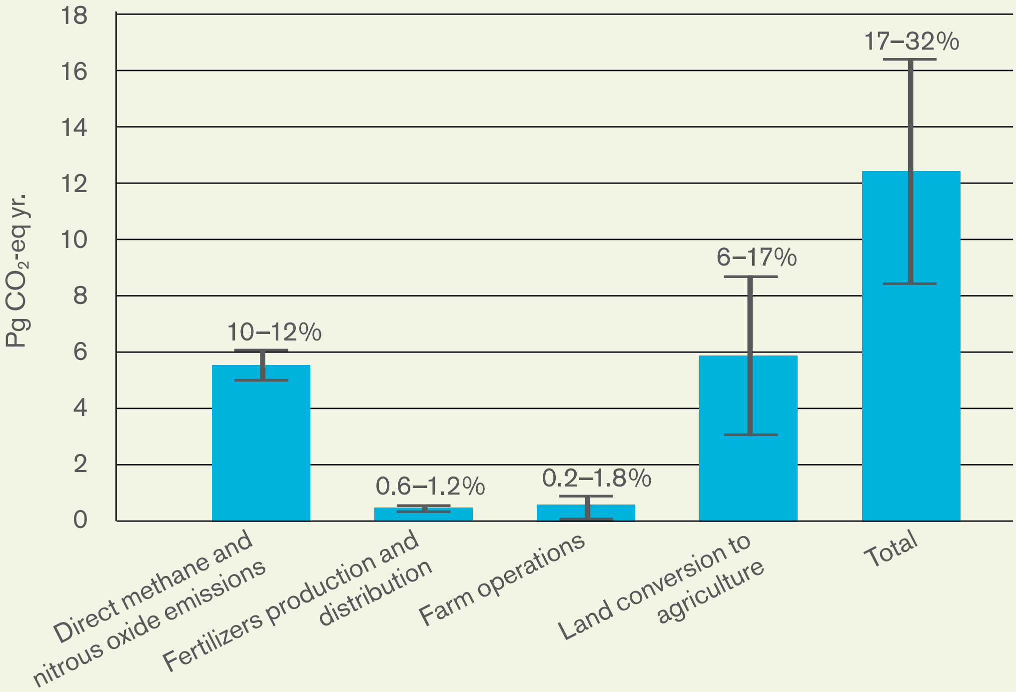
Less direct impacts (1–3 per cent) arise from the use of fossil fuel-driven farm machinery and the manufacture of inputs such as fertiliser. Most importantly, emissions also arise as a consequence of land use change: clearing forests and ploughing uncultivated land to make way for agriculture releases carbon dioxide locked in plant biomass and in soils. Land use change has been estimated to account for 6–17 per cent of global emissions, in other words a significant percentage of agriculture's overall 30 per cent contribution (Smith *et al.*, 2007; Bellarby *et al.*, 2008; see Figure 3).

In absolute terms, developing countries are the source of the bulk of agricultural GHG emissions, reflecting their higher agricultural land area, greater dependence on agricultural production relative to other GHG emitting industry sectors (such as transport), greater rate of land use change and their higher population. However, on a per capita basis, people in the developed world have a higher agricultural footprint since their diets tend to consist of a greater proportion of meat and dairy foods, the production of which emits more GHGs.

Agriculture is itself highly vulnerable to the impacts of climate change; developing countries in southern latitudes are likely to be severely affected in coming years (Easterling *et al.*, 2007).

A major proportion of agricultural GHG emissions comes from rearing livestock. In 2006, the United Nations Food and Agriculture Organization (FAO) estimated that livestock-related emissions accounted for 18 per cent of total global emissions and around 80 per cent of agricultural emissions (Steinfeld, 2006). However, this estimate is currently being revised downwards. A more recent Dutch analysis estimates that livestock account for 12 per cent of global GHG emissions (Netherlands Environmental Assessment Agency, 2009). A comprehensive European study published in 2011 finds that livestock production accounts for 9 per cent of the EU's total emissions, or 12 per cent if land use change impacts are also included (Leip *et al.*, 2010).

FIGURE 3: TOTAL GLOBAL CONTRIBUTION OF AGRICULTURE TO GREENHOUSE GAS EMISSIONS[3,4]



Source: Bellarby *et al.*, 2008

Numerous studies also draw attention to the fact that as demand for meat and dairy foods grows, this is likely not only to increase GHG emissions, but also to place pressure on scarce land and water resources, with potentially serious implications for biodiversity.

2.2. THE IMPACTS OF THE WHOLE FOOD SYSTEM

Studies show that the food system in totality – from agriculture to processing, distribution, retailing, consumption and waste disposal – is a significant contributor to global emissions.

3. The overall contribution includes direct (methane and nitrous oxide gases from agricultural practices) and indirect (carbon dioxide from fossil fuel use and land conversion to agriculture). Percentages are relative to global greenhouse gas emissions.

4. CO_2e is an indicator that converts the six greenhouse gases that exist into one carbon dioxide equivalent quantitative measure. This is the standard international way of reporting on greenhouse gas emissions. PG stands for Petajoule – an international unit of energy, work, and heat equal to 10^{15} joules.

For example, a Europe-wide analysis found that the food chain from agriculture through to consumption accounts for 31 per cent of the EU-25's total GHG impacts, with a further 9 per cent arising from the hotel and restaurant sector (EIPRO, 2006). Country-level estimates range between 15 and 28 per cent of the national total (SEPA, 2010; RACCP, 2008; Hertwich *et al.*, 2010; Neiberg, 2009; ACF, 2007; Garnett, 2008). None of these studies takes into account the indirect GHG impacts of agriculturally-induced land use change. The few studies that do include this find that the food system's GHG contribution rises considerably – from 19 to 30 per cent of the national total in the case of the UK (Audsley *et al.*, 2010). As a rule, agriculture accounts for approximately half of the food system's total GHG impacts, and around two-thirds if land use change-related emissions are considered (EIPRO, 2006; Audsley *et al.*, 2010).

2.3. WHAT POTENTIAL IS THERE TO REDUCE EMISSIONS FROM THE FOOD SYSTEM?

Much attention has focused on estimating the extent to which food system GHG emissions could be reduced. These range from global estimates to country and even farm-level studies. Here we summarise the scope for reducing emissions from agriculture, beyond the farm gate, and from consumption:

Agriculture

- *Enhancing carbon removal*: restoring degraded lands; afforestation; zero or minimum tillage; incorporating organic matter into soils; and managing aquatic plants and sediments.
- *Optimising nutrient use*: more precise dosage and timing for organic and inorganic fertilisers; incorporating nitrogen-fixing legumes into rotations; and better management of aquatic systems, including integration with agriculture.
- *Improving productivity*: increasing edible/marketable output per unit of GHG generated (accounting also for non-consumed materials); crop and animal breeding for performance; optimising nutritional content of feeds; and pest and disease management.
- *Managing and incorporating secondary outputs, including*: manure and plant biomass, wastes and byproducts from fish and other animals; product recovery, slurry and manure management; composting; and anaerobic digestion.
- *Reducing the carbon intensity of fuel and raw material inputs* through improvements in energy efficiency, selection of materials, and use of alternative fuels such as biomass, biogas, wind and solar power (Foresight, 2010; Garnett, 2011).

Most of the mitigation potential identified is in developing countries, with soil carbon sequestration dominating as the key mitigation measure in these settings (Smith *et al.*, 2007; see Box 1). This reflects the degraded state of soils in much of the developing world and hence the relatively greater gains that could be achieved through their remediation.

Beyond the farm gate

Another range of studies examines ways of reducing climate impacts from key post-farm gate sectors of the food system including transport, manufacturing, and retailing emissions (especially lighting and refrigeration).[5] These again focus on

5. See the corporate social responsibility reports of various supermarkets and food manufacturers.

measures such as improving energy efficiency, using less carbon-intensive materials, and using alternative fuels such as biomass, biogas, wind and solar power. However, as these are applicable to other industry sectors, they are beyond the scope of this research and are not discussed further.

Consumption

Finally, there is a growing body of work that highlights the mitigation potential of changing consumption practices. There are two main strands: (1) shifting diets through a reduction in the consumption of meat and dairy products (Goodland, 1997; Williams *et al.*, 2006; Weber and Matthews, 2008; Stehfest *et al.*, 2009; Garnett, 2009; Audsley *et al.*, 2010; Popp *et al.*, 2010; Pelletier *et al.*, 2010); and (2) reducing food waste. Wasted food represents a 'waste' of embedded emissions incurred during the production, processing and distribution of food – hence avoiding waste can, in theory, reduce GHG emissions (Parfitt *et al.*, 2010; Lundvquist *et al.*, 2008; UNEP, 2009).

BOX 1: SOIL CARBON SEQUESTRATION

Soil carbon sequestration involves transferring carbon dioxide from the atmosphere into the soil in a form that is not immediately re-emitted. This is achieved by incorporating carbon-rich matter in the soil, encouraging agricultural practices that 'lock' carbon into the above- and below-ground biomass, and minimising soil disturbances.

Processes and practices proposed to sequester carbon in soil include incorporation of organic matter (such as manure, biosolids, compost and crop residues); increasing fertiliser inputs to boost biomass production and hence carbon dioxide uptake; planting deep-rooted crop varieties that draw carbon further into soil; switching from annuals to perennials and/or from perennials to trees; minimum or no tillage to minimise soil disturbances (also called conservation tillage); agroforestry; restoration of peatlands and wetlands; and, as an emerging approach, biochar production.

In summary, there are three key strategic approaches possible for reducing GHG emissions in the food system:

1. Measures to reduce agricultural emissions through better farm practices such as soil carbon sequestration, nutrient use efficiency, the management of manure and other outputs, and the use of renewable energy.
2. Measures to reduce emissions beyond the farm gate through the decarbonisation of energy inputs, energy efficiency and waste management (not examined here).
3. Measures to alter patterns of consumption, and in particular to reduce demand for meat and dairy products that are highly GHG intensive, combined with measures to encourage consumers to avoid wasting food.

In all, the agricultural sector – and indeed the food chain as a whole – is a major global cause of greenhouse gas emissions. It contributes not only to carbon dioxide (through its role in land use change as well as from its use of fossil fuels) but also to methane and nitrous oxide emissions. Addressing all three interacting gases is a necessary but complex undertaking. The science of mitigation is not yet fully developed and there are still major uncertainties as to how emissions, and the effects of mitigation strategies, can be accurately measured. There are also uncertainties as to how mitigation can be achieved while also enabling vulnerable farmers to adapt to the consequences of climate change.

As discussed in the sections that follow, the task is complicated by the fact that globally there are millions of small-scale farmers who depend on agriculture for their survival, many of whom operate outside the formal market and who are often beyond the reach of policy. There are, similarly, a multitude of different types of agriculture, ranging from extensive pastoralism to agroforestry (a system of food production that incorporates trees), to highly intensive large-scale commercial production. Moreover, land is not used just for food production but also for other purposes, including for timber, fibre and now biofuels production.

The task of policymakers is to chart a course through this complexity, and to develop approaches that not only enable mitigation and adaptation to be achieved, but that do so in ways that enhance, rather than undermine, both livelihoods and food security.

THREE
MECHANISMS TO REDUCE GHG EMISSIONS FROM AGRICULTURAL PRODUCTION

This section examines in turn the spectrum of potential economic, regulatory, co-operative and information-related measures for reducing GHG emissions from agriculture, and assesses their effectiveness and their fairness.

Section 4 adopts a similar approach, but focuses on MGMs that have the potential to influence consumer behaviour.

3.1. ECONOMIC MEASURES

3.1.1. An overview: carbon markets

The UK's influential Stern Review judged carbon pricing to be one of three key elements needed (alongside technology policy and behavioural change) for the development of a global low-carbon society (Stern, 2007). Carbon pricing refers to attempts to place an economic cost on the emission of greenhouse gases into the atmosphere. It involves imposing a cost penalty on all GHGs emitted, or only on carbon dioxide (depending on how such mechanism evolves), or rewarding their avoidance. Carbon pricing takes the form of either a carbon tax, a tradeable permit (to emit a given volume of carbon/GHGs) or regulation, which by requiring action imposes a cost burden on polluters. It can have potential for reducing emissions from agriculture, though some adaptation will be required (Box 2).

BOX 2: CARBON PRICING: HOW CAN IT BE APPLIED TO AGRICULTURE?

If carbon is assigned a price, then all goods and services that rely on fossil fuels for their production or functioning are affected. This includes food. Food products are, however, a special case since emissions arise not just from fossil fuel use (mainly CO_2) but also from natural soil and animal processes (methane — CH_4 — and nitrous oxide — N_2O). To reflect the costs of food production, the definition of carbon pricing should expand to include these greenhouse gases, although quantifying and accounting for them all is more complex.

However, it has been argued that carbon pricing, even without considering CH_4 and N_2O, would have a positive effect on food system emission reductions. It would help raise the price of both fuel and chemical inputs, resulting in reduced tillage and improved residue management. These are both important approaches to reducing nitrous oxide emissions and sequestering carbon. Transport, retail and consumer use of fuel in the agri-food supply chain would also automatically internalise the environmental costs of CO_2 emissions. This would provide an incentive for emission-reducing behaviour throughout the supply chain and the wider economy (Kasterine and Vanzetti, 2011).

Two types of carbon market exist (FAO, 2010). Note that these carbon markets cover all industry sectors; agricultural schemes are few in number. These two types of market are discussed in the next section:

1 Regulated compliance markets, such as the Clean Development Mechanism (CDM; see Box 3), the EU Emissions Trading Scheme (EU ETS) and Reduced Emissions from Deforestation and Degradation (REDD+), which is still in development.

2 Voluntary markets, populated by a wide range of private players of which the most respected is perhaps the Gold Standard.[6] This standard includes sustainable development criteria and can apply to both the CDM and to voluntary markets (Godfrey-Wood, 2011).

Regulated carbon markets – including the CDM, EU ETS and the United States-based Regional Greenhouse Gas Initiative (RGGI) – are far larger than the voluntary markets. Within the regulated markets, the CDM is the second largest, transacting 94 million tonnes of CO_2 equivalents ($MtCO_2e$) in 2010 at a value of US$2,858 million. The CDM, however, is dwarfed by the EU ETS both in terms of volume and value of carbon credits transacted (Figure 4).

Other types of carbon financing are designed to give food producers and other sectors incentives to reduce GHG emissions. Carbon finance is the general term for resources provided by governments and companies to a project to purchase GHG emission reductions (GHG emissions are often called carbon for short) (World Bank, undated). Carbon pricing is the process of placing economic value on the cost of emitting carbon dioxide and as such sits within the overall carbon financing framework. One example of a system of pricing carbon can be found in Payment for Ecosystem Services schemes: these focus on paying land managers to provide a range of ecosystem benefits, including GHG mitigation through carbon sequestration.

Support for measures to improve global food security is also relevant to discussions on carbon financing in agriculture. The FAO argues that an annual US$210 billion in private and public investment in developing country agriculture is needed to achieve food security for all by 2050. Of this, it estimates that around 15 per cent can be gained through carbon finance geared towards reducing GHG emissions (FAO, 2009).

Figure 5 illustrates how these different mechanisms and initiatives overlap.

At the December 2010 United Nations climate negotiations in Cancun, Mexico, the global community agreed to create a Green Climate Fund to transfer up to US$100 billion a year by 2020 to help developing countries reduce their emissions and adapt to the adverse effects of climate change. At the time of writing a draft of the fund was being considered at the United Nations Framework Convention on Climate Change Conference (UNFCCC) of the Parties in Durban in December 2011. A portion of these funds will

6. The Gold Standard is an independent standard for creating high-quality emission reductions projects in the Clean Development Mechanism (CDM) Joint Implementation (JI) and voluntary carbon market. It was designed to ensure that carbon credits are not only real and verifiable but that they make measurable contributions to sustainable development worldwide. Its objective is to add a label to existing and new carbon credits generated by projects which can then be bought and traded by countries that have a binding legal commitment according to the Kyoto Protocol.

FIGURE 4: TRANSACTION VOLUMES AND VALUES OF CARBON MARKETS

MARKETS	VOLUME OF CARBON EQUIVALENTS TRADED ($MTCO_2E$)		ANNUAL VALUE (US$ MILLION)	
	2009	2010	2009	2010
Voluntary				
Voluntary OTC ('over the counter')[a]	55	128	354	414
Chicago Climate Exchange (CCX)	41	2	50	0.2
Other exchanges	2	2	12	10
Total voluntary markets	98	131	415	424
Regulated				
EU ETS	5510	5529	105,746	106,024
Primary CDM	135	94	2,858	1,325
Secondary CDM	889	1005	15,719	15,904
Kyoto	135	19	1,429	265
RGGI	768	45	1,890	436
Total regulated markets	7437	6692	127,642	123,954
Total global markets	7535	6823	128,057	124,378

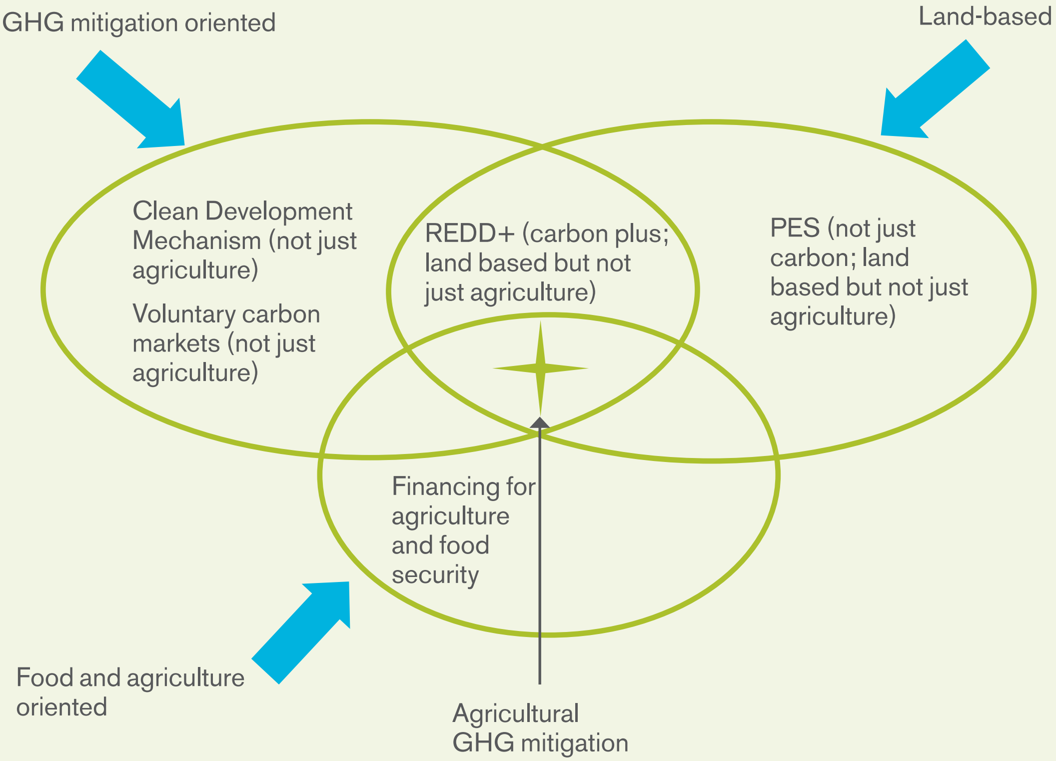
[a] 'Over the counter' is a term used to describe voluntary carbon markets. It's a market where buyers and sellers engage directly, through a broker or retail storefront.

Source: Peters-Stanley *et al.*, 2011

be directed towards agricultural adaptation and mitigation. The fund will be run by the United Nations and supervised by a board representing developed and developing countries equally. The fund includes support through technology transfer to help developing economies 'leapfrog' over carbon-intensive development and take a more sustainable path. At present it is not possible to assess how these funds will be directed, how effectively they will be targeted, or what their social effects, particularly on poor people, might be.

Some NGOs have been highly critical of the use of carbon markets in agriculture (ActionAid, 2011). They argue that, among other things, incorporating agriculture into carbon markets will benefit large farmers at the expense of small

FIGURE 5: THE ROLE OF DIFFERENT FINANCING MECHANISMS IN AGRICULTURAL GHG MITIGATION



farmers, lead to land grabs, may hinder farmers' efforts to adapt to the impacts of climate change, and represents an attempt by developed countries to shift the burden of mitigation onto low-income countries. The analysis presented in the paragraphs below examines how and if these potential concerns play out in practice.

More fundamentally, some environmental organisations disagree with the whole concept of monetarising the environment, and reject all schemes that operate through market mechanisms (*e.g.* La Via Campesina, 2011).This is a deeper issue that is not addressed further here.

3.1.2. The Clean Development Mechanism

The CDM was designed by the UNFCCC to allow projects for reducing or removing GHG emissions in developing countries to earn certified emission reduction (CER) credits. Each CER is equivalent to one tonne of CO_2 and can be traded with, sold to or used by industrialised countries to help them meet a proportion of their emission reduction targets under the Kyoto Protocol. The original aims of the CDM were to reduce GHGs and contribute to sustainable development. However, the UNFCCC did not specify what indicators should be used to measure sustainable development, and to date no international standards exist. Implementing countries have therefore adopted their own definitions, which generally cover areas such as air quality and employment generation (Olsen and Fenhamm, 2008).

All developing countries are eligible for support via the CDM, although in practice the majority of projects can be found in the rapidly industrialising economies of China (over 60 per cent), India (11 per cent) and Brazil (5 per cent) (UNFCCC, 2011).

To date, there have been very few specifically *agriculture*-related CDM projects – currently less than 4 per cent of the total (UNFCCC, 2011). Until recently there have been two routes through which agriculture could be eligible for CDM payments: through the development of biogas schemes that use manure or agricultural byproducts as feedstocks (which avoids fossil fuel use), or through practices that sequester carbon in soils. Since 2009, the UNFCCC has also approved projects that substitute biological nitrogen fixation for synthetic fertiliser. However the design of projects eligible for carbon credits through this route is still at the conceptual stage.

Biogas has had more success than carbon sequestration, since there are inherent complexities in measuring and monitoring GHG 'savings' from soil carbon sequestration, as discussed in Box 3. As a result, agricultural land use projects that reward soil carbon sequestration are scarce, even in voluntary markets outside the Kyoto Protocol, where they face fewer restrictions (Larsen *et al.,* 2011).

The technical problems relating to measuring and monitoring soil carbon sequestration are likely to be addressed over time. It has been argued that broadening carbon markets post-2012 to include agricultural carbon sequestration could enable agriculture-based countries in sub-Saharan Africa and other regions to participate in and benefit more fully from the financing available (World Development Report, 2008; Global Donor Platform on Rural Development, 2009).

In theory, farmers benefiting from carbon payments can also potentially gain in other ways. Measures to build carbon can improve soil quality and water retention, thereby increasing food productivity and enabling farmers to adapt to environmental stresses caused by climate change. In practice, however, as well as the scientific difficulties associated with measuring soil carbon, particular challenges arise when designing schemes aimed at benefiting small-scale farmers.

For owners of very little land, the increases in soil carbon that each landholding can achieve will be limited and transaction costs will be high. There can be an 'opportunity cost' in terms of foregone land for food production in some cases, and these costs will be higher for poorer farmers. Studies suggest that farmers are more likely to participate in such schemes where they perceive there to be concrete benefits, not only in terms of income but also higher yields (Perez *et al., 2007).*

Challenges for pastoralism

The challenges of designing appropriate schemes for small-scale farmers (both in the regulatory compliance and voluntary carbon markets) are particularly great in pastoral settings, although their potential for sequestering carbon (and achieving productivity co-benefits) is high. Measures for soil carbon sequestration in these settings can include reducing or avoiding land

BOX 3: SOIL CARBON SEQUESTRATION AND THE CDM: SOME PRACTICAL TECHNICAL DIFFICULTIES

Soil carbon sequestration, while offering potential for climate change mitigation (Box 1), poses a number of practical, political and accounting difficulties when including it in CDM projects:

- **CO_2 uptake can be offset by greater N_2O emissions:** The relationship between the carbon and nitrogen cycles is complex. Adding fertilisers to enhance carbon capture can increase N_2O emissions that undermine CO_2 gains (Smith *et al.*, 2001).
- **Sink saturation:** Changes in agricultural practice (for example a switch from arable to grass) will allow carbon to be sequestered in the soil and in biomass. However, after a time, a new equilibrium is reached and carbon stops accruing. Carbon sequestration is therefore greatest in the first few years of the growth and development cycle, after which gains decline and soils become saturated.
- **Permanence:** Carbon sequestration is easily reversible. Trees can be cut down and pasture ploughed up for arable cropping, releasing carbon and undoing any sequestration gains.
- **Leakage and displacement:** Measures to sequester carbon in one area can lead to agricultural production being displaced to other land, leading to no net gain in carbon sequestration
- **Measurement, reporting and verification:** Net GHG emission reductions need to be assessed relative to a baseline; however, often the baseline soil data are lacking. The ability of soils to take up carbon can vary considerably depending upon local biophysical conditions, making it more difficult for standardised measurement approaches to be used. Decades may be needed to monitor change, requiring a long-term approach to measuring and assessing impacts. There is a risk that the costs of demonstrating and verifying increases in soil carbon are greater than the carbon credit obtained – this is particularly a concern for small-scale community-based projects.
- **Other environmental uncertainties and concerns:** Impacts on biodiversity can be mixed and context-specific – often there is potential for win-wins, but sequestration promoting practices can also occur at the expense of biodiversity or sustainable water use (Smith *et al.*, 2007).
- **Effects of climate change:** The capacity of the soil to sequester carbon and the effect of climate change on its ability to do so interact dynamically; future outcomes of these interactions are uncertain and require more research (Smith, 2008).

Source: Garnett, 2010.

degradation, rehabilitating degraded lands, and increasing native carbon stocks by increasing above-ground and below-ground biomass. For rangelands in Africa, while the amount of carbon that can potentially be sequestered is low when measured on a per hectare basis, the *aggregate* potential is high (Lipper *et al.*, 2010; Perez *et al.*, 2007). A major stumbling block for pastoralism is the fact that often land ownership among herders is not clearly defined and may be held in common (Roncoli *et al.*, 2007). It is far easier to pay individual farmers who have clear ownership rights and who own large tracts of land. As carbon credit payments increase the value of common property land, the risk is that powerful stakeholders will seek to curtail access by disadvantaged groups, with potentially negative impacts on their livelihoods and development (Perez *et al.*, 2007).

For example, one study notes that projects must have a clear boundary and clear tenure rights over the rangeland in order to ensure that land users implement the agreed management practices that lead to carbon sequestration (Unruh, 2008). Where land use rights have been privatised (such as in most of Latin America and China, and parts of East Africa), and where land rights holders are able to exclude other users, this can make it easier for people to claim payments. This is also the case where land use rights are communal but legally recognised (such as parts of China, or some countries in West Africa) or where rights are held at the household level.

However, if pastoralists' traditional land usage does not have legal recognition, or if pastoralists are unable to exclude others from land use, there are significant challenges for implementing carbon financing (and PES) projects. As a positive slant on this, where there is demonstrated scope for producing carbon finance flows, this may potentially aid pastoralists in lobbying for their land use rights. This socio-economic benefit may in fact prove to be the most significant one that arises from such projects in some pastoral areas (Tennigkeit and Wilkes, 2008). Additional benefits include those arising from the biophysical improvements to the soil, which can help improve grassland quality and water retention, so improving livestock productivity, and helping farmers adapt to climate change.

In addition to addressing land tenure issues, it is also essential to develop the institutional capacity to aggregate carbon credits and to ensure that payments reach individual farmers and are distributed equitably (Perez *et al.*, 2007). Government support in the form of extension services, technology transfer, subsidies and incentives are needed (Perez *et al.*, 2007). Another way of overcoming barriers for poor farmers to access climate credits is for them to participate in voluntary carbon markets (such as the Africa Biocarbon Facility), where the process of accreditation tends to be cheaper and less time consuming than the CDM. But prices – and hence benefits – to farmers tend to be lower than in the Kyoto markets.

Although the difficulties of involving small farmers in such schemes are substantial, the need to do so is increasingly being recognised. Encouragingly, this is a rapidly growing area of research and activity (Neely *et al.,* 2009; Tenningkeit and Wilkes, 2008; Reid *et al.,* 2004; World Bank 2008 and 2010). In coming years we are likely to see more attention being paid to designing schemes that are pro-poor.

CDM synergies and trade-offs between agriculture and afforestation
An even smaller number (less than 1 per cent) of all CDM projects involve afforestation/reforestation (A/R) activities. These are

mentioned here, since there are potential synergies and conflicts with food production. In addition to income opportunities, A/R projects can yield positive benefits for agriculture, including improving soils and hydrology, opportunities for technology transfer and infrastructure development, capacity building, legal recognition of property rights arising from the development of schemes, and opportunities for farmers to diversify their risks (Green and Unruh, 2010).

There can, however, also be negative impacts. These range from loss of grazing and other land access rights to environmental damage, food insecurity, involuntary resettlements and inequitable distribution of income. Unfortunately, the design of A/R schemes very rarely includes an assessment of the impacts on local agriculture. Moreover, the validation and verification processes for projects and the credits they produce currently rely heavily on host-country definitions of sustainability. These generally focus on the provision of temporary forestry employment, while other indicators, such as personal health, agricultural investment and food security are often lacking (Green and Unruh, 2010).

It is important to note that the CDM in general (not just with respect to agriculture and land use) has come in for strong criticism. Analysts have questioned the CDM's effectiveness in achieving genuine GHG reductions. In addition, many argue that the CDM has also failed to engender sustainable development co-benefits, and these are less likely to be delivered in projects that produce higher levels of reductions (Sutter and Parreño 2007; World Bank, 2010). Attempts have been made to strengthen the sustainable development element of CDMs through initiatives such as the Community Development Carbon Fund, but such efforts at this stage cover a relatively small number of projects (Nussbaumer, 2009).

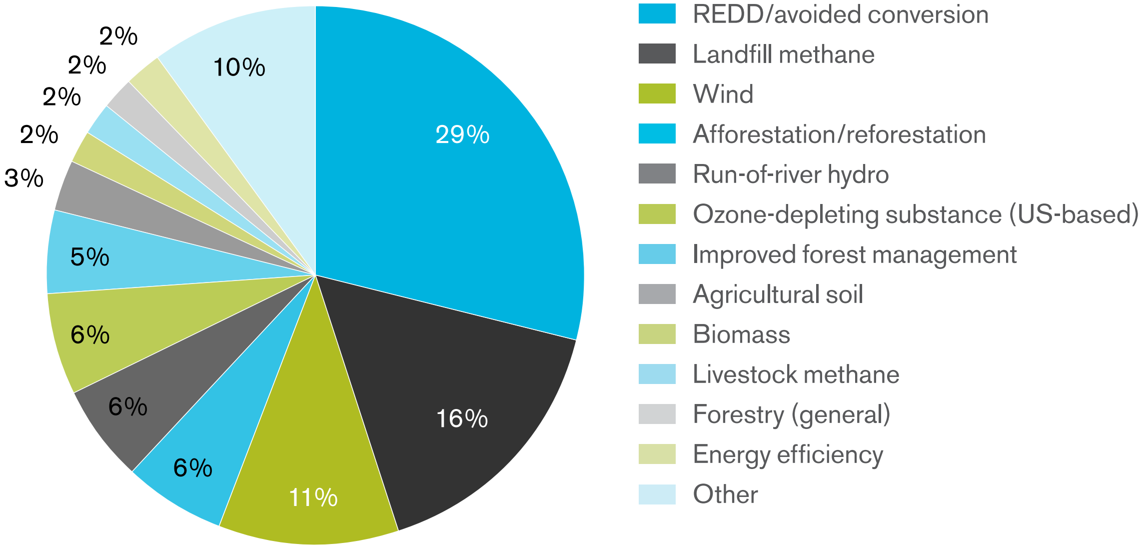
Moreover, the financial revenues that the CDM raises are modest relative to the amount of mitigation money that is needed overall (FAO, 2009). Other informal carbon credit schemes and forms of direct support will also be necessary if the potential for mitigating emissions from agriculture is to be realised.

3.1.3 Voluntary carbon markets

As in the CDM market, there are very few agriculture-related projects within the voluntary carbon markets. In 2010, agricultural soil projects made up 3 per cent of the total market, and livestock methane projects represent 2 per cent (Figure 6).

While the voluntary carbon markets are smaller than the regulated ones (the total volume of

FIGURE 6: VOLUNTARY CARBON MARKETS: TRANSACTION VOLUME BY PROJECT TYPE IN 2010



Source: Peters-Stanley *et al.*, 2011

transactions in the voluntary market in 2010 was 131 $MtCO_2e$ versus 6823 $MtCO_2e$ in the regulated markets – Figure 6), they are sources of innovation. This is true both for the types of project they include and the methodologies they use for carbon emissions reduction accounting. One example is livestock methane projects. This is also reflected in the presence of REDD-type projects in voluntary markets, whereas international policies around REDD and REDD+ are still in development (see Box 5).

However, while voluntary carbon markets potentially offer more flexibility, they vary in quality and their commitment to broader sustainable development objectives. In Gold Standard schemes where sustainable development is robustly specified, agriculture barely features (Godfrey-Wood, 2011). Therefore, while voluntary carbon markets certainly hold promise for improving farmer livelihoods, and enabling farmers to adapt to and to mitigate climate impacts, much more work is needed to ensure that agriculture is included and that schemes are designed with small-scale and marginalised farmers in mind.

SUMMARY ASSESSMENT: CDM AND VOLUNTARY CARBON MARKETS

Potential

- Well-designed agricultural CDM and informal voluntary carbon market schemes have the potential to achieve triple wins of GHG mitigation, enhanced food productivity, and income generation.
- Broadening carbon markets post-2012 to include agricultural carbon sequestration could enable agriculture-based countries in sub-Saharan Africa and other regions to participate in and benefit more fully from the financing available.

Challenges

- Small farmers are not yet well represented in the carbon market.
- Poor farmers will find it hard to get involved without tangible benefits and with high transaction cost.
- Land tenure is a major obstacle to small farmer involvement, especially pastoralists.

Future needs

- Both the CDM and informal carbon markets need to be more robust in their specification of sustainable development criteria, including the requirement that schemes benefit the livelihoods of small farmers.
- Context-specific approaches are needed to resolve tenure issues, provide subsidies to farmers where necessary and develop institutional support and capacity to provide extension services, technology transfer and engagement in measuring, reporting and verification (MRV).

PES will have implications for poor people, whether or not poverty alleviation is overtly specified

3.1.4. Payments for Ecosystem Services (PES)[7]

How do they work?

A PES has been defined (Wunder, 2005; Wunder *et al*., 2008) as a voluntary transaction where: (a) a well-defined environmental service or a land use likely to secure that service is (b) being 'bought' by a (minimum one) service buyer; (c) from a (minimum one) service provider; (d) if and only if the service provider secures service provision (conditionality). For example, in France the bottled water company Vittel has financed farmers in its water source catchment area to change their farming practices and technology so as to reduce the risk of nitrate contamination (see below). This is a clear example of a single user paying sellers for provision of a service (unpolluted water) necessary to its business.

The aim of a PES scheme is to give land managers an incentive to adopt more environmentally beneficial farming and land management practices. Sometimes social equity objectives are incorporated as well (FAO, 2007; Kelsey *et al.,* 2008; Nelson *et al*., 2008; Rasul, 2009; UNEP and IUCN, undated).

PES schemes potentially represent a more flexible and readily implementable alternative to mitigating agricultural GHG emissions than the more formal CDM. There is also potential to align GHG mitigation with other environmental goals, such as biodiversity conservation and improved water quality.

Many countries, including China, Costa Rica, Brazil and the UK, have experimented with PES, generally focusing on rewarding measures that improve water quality, protect biodiversity and sequester soil carbon. Most schemes focus on forests and only a few focus specifically on agriculture. Indeed, sometimes they involve taking environmentally sensitive land out of agricultural production, as in the case of China's Grain for Green project (People's Daily, 2000). In this case they can still have implications for agriculture. In other schemes, where the focus is on protecting existing forests or wilderness, they can also give incentives for agricultural activities that can foster biodiversity or store carbon, such as agroforestry.

PES initiatives can range from highly commercial schemes to public sector (generally government-funded) programmes. Commercial schemes tend to be user-funded – that is, they are paid for by the users of the ecosystem services provided. In practice, though, many schemes receive a mixture of funding sources.

Are PES schemes pro-poor?

On the whole, primarily user-funded schemes tend to be relatively small, and targeted at one particular ecosystem service, such as carbon sequestration or improved water quality. While poverty alleviation was not the primary purpose of a PES (FAO, 2007), government-funded schemes often want to achieve multiple environmental goals while also incorporating social objectives into their remit. Whether poverty alleviation is or is not overtly specified, there will inevitably be implications for poor people. Schemes may affect poor people directly, as potential suppliers of environmental services; or indirectly, through effects on wages, food prices or land values, particularly in large-scale programmes or in areas with limited links to external food and labour markets.

One review that compares the effectiveness of 14 government and user-led private schemes concluded in favour of user-financed programmes

7. Much of the analysis of the potential of PES as an MGM in this sub-section is based on the forestry-PES literature; however, these insights can also apply to agricultural contexts.

(Wunder *et al.*, 2008). It found that these are better targeted, more closely tailored to local conditions and needs, have better monitoring and a greater willingness to enforce conditionality, and far fewer 'confounding' side objectives than government-financed programmes. This implies that sustainable development goals (e.g. poverty alleviation) can actually hinder the effective functioning of a scheme.

Moreover, the review found that although poverty alleviation was only an explicit goal of government-funded programmes, in both types of programme poor service providers were able to access the programme and become ecosystem service sellers. Thus, regardless of whether there is pro-poor targeting, the poor normally gain access to these programmes, and their participation helps them become better off (Wunder *et al.*, 2008). This is in contrast to concerns expressed above (with respect to the CDM and carbon payments) that poor people are often excluded from participating in and benefiting from market schemes.

Other authors have noted that while many PES projects have delivered environmental benefits, the social impacts can be more mixed (Liu *et al.*, 2008; Sánchez-Azofeifa *et al.*, 2007; Hall, 2008; Perrot-Maître, 2006). For example, while Costa Rica's long standing experiments with PES forestry schemes have generally been successful from an environmental perspective, most PES payments have generally gone to wealthier farmers and private companies. This is because such individuals and farmers have larger tracts of land (reducing transaction costs), tend to be experienced in ecosystem service management, can afford to invest in research and development that can increase the project's chance of success, and are more able to deal in international markets and potential REDD+ credits (Porras, 2010).

By contrast, successful and sustainable ecosystem management may be harder to achieve where farms are small and fragmented, and where the opportunity cost to the farmer of not using the land for food production is high. Transaction costs are multiple and expensive, and many requirements are fixed costs that weigh more heavily on small properties. Attempts to reduce the entry costs for small farmers have not been entirely successful, and most small farmers still face significant barriers to participation (Porras, 2010).

The Costa Rican scheme is gradually becoming more pro-poor, partly due to allowing agroforestry to be eligible for payments, again illustrating the need for schemes to deliver 'tangible' benefits in terms of food. However, agroforestry projects still only account for 3 per cent of total PES payments in Costa Rica, and critics say that while progress is being made, more needs to be done to benefit poor people (Porras, 2010).

As noted, there are as yet very few PES schemes that focus on agriculture, and those that do relate mainly to grazing land management, or 'silvopasture'. Silvopastoralism is a practice that combines the grazing of livestock with the planting of trees and shrubs in pastures, the creation of 'living' fences from trees and shrubs and the growing of fodder plants. There are often strong barriers to uptake, including the financial costs of investment and the fact that it can take several years before benefits are seen, either in terms of income or greater productivity.

Notwithstanding these barriers, a study of a Nicaraguan silvopastoral PES project funded by the Global Environment Facility and implemented by a Nicaraguan non-governmental organisation found both environmental and social benefits (Box 4).

BOX 4: SOCIAL AND ENVIRONMENTAL BENEFITS OF PES IN NICARAGUA

The study found that participants made substantial land use changes during the project's first two years, affecting over 24 per cent of total area. Changes ranged from sowing improved grasses in degraded pastures to very substantial measures, such as planting high-density tree stands or establishing fodder banks. The area of degraded pasture was reduced by 68 per cent and that of annual crops by 52 per cent. Pastures with low tree density experienced a net increase of 19 per cent, and pastures with high tree density of 23 per cent. The area devoted to fodder banks more than doubled, and the length of live fences increased by 160 per cent. Moreover, the study notes that these net figures understate the changes for various reasons.

The Nicaragua project developed indices of biodiversity conservation and carbon sequestration under different land uses and aggregated them into a single 'environmental services' index to measure impacts as a basis for awarding payments. Land use changes were more extensive in the first year than in the second, since the project only pays for four years and so participants have an incentive to undertake land use changes as early as possible. Biodiversity — measured in terms of bird, insect and mollusc species — also improved. Measurements of the effects on soil carbon were still under way at the time of the study's publication.

The project also had social benefits. It saw considerable uptake by poorer households, even though payments were not made to participants until after they had made the required changes in practice. Indeed, not only did poorer households participate quite extensively, but by some measures they participated to a greater extent than better-off households. Nor was their participation limited to the simpler, least expensive options: poorer households tended to implement more substantial changes in land use.

The study warns that, in general, transaction costs are likely to be a bigger threat to the participation of poorer households in PES programmes then their own ability to participate. Keeping transaction costs low – in addition to being desirable in itself – is thus vital if poorer households are not to be excluded from many PES programmes. Whether the environmental benefits of the scheme continue to accrue when funding is withdrawn is a critical question that has not been followed up in the Nicaraguan context. A separate study points out that lasting, positive change will only take place if PES programmes catalyse sustainable practices desired by those providing the services (Kemkes *et al.,* 2010).

Sources: Pagiola *et al.,* 2007a; Pagiola *et al.,* 2007b

However, in contrast with findings from the Nicaraguan case, another assessment of the potential for developing carbon payments for rangelands observes that the high initial costs to farmers for undertaking carbon sequestering practices *may* require an initial subsidy (Tennigkeit and Wilkes, 2008). This suggests that households with different capital and resource endowments will have different abilities to adopt effective management practices and different potential to realise economic benefits. It also notes that carbon payment incentives vary with the market price of carbon, creating uncertainty for farmers and other participants. Efforts are being made by the FAO and others to develop low-cost systems that take account of the circumstances and needs of poor people (FAO, 2011)

In Africa, land tenure issues can present additional and significant barriers to the development of agricultural and other PES schemes, including those aimed at carbon sequestration; a point already made above.

PES in developed countries: private *versus* public sector experiences

PES schemes can also operate in developed countries, although they are often described in different terms. Some of these focus on agriculture. Within the UK, for instance, farmers undertaking environmental measures additional to cross-compliance minima are eligible for further support through the UK Government's Environmental Stewardship Scheme (ESS). Climate change mitigation is not yet a distinct goal but is likely to be so after 2013, when the reforms currently being developed come into play. One analysis of social and economic effects found that farmers participating in the ESS gained a range of cross-transferrable skills, that the local economy and employment benefited, and that social benefits arose as a result of local networks that developed (Mills *et al.,* 2010).

In France, in 1993, the bottled water company Vittel (owned by Nestlé) financed farmers in its water source catchment area to change their farming practices and technology so as to reduce the risk of nitrate contamination. This is a clear example of a single 'user' paying 'sellers' for provision of a service (unpolluted water) necessary to its business.

The scheme is widely considered to be a success. One assessment finds that the PES was a very complex undertaking requiring the consideration not just of scientific but also social, economic, political, institutional and power relationships (Perrot-Maître, 2006). The ability to maintain farmers' income levels at all times and to finance all technological changes was an important factor, but the primary reasons for the programme's success were not financial. Fundamental conditions of success were found to be trust-building through the creation of an intermediary institution (locally based and led by a 'champion' sympathetic to the farmers' cause); the development of a long-term participatory process to identify alternative practices and a mutually acceptable set of incentives; the ability to link incentives to land tenure and debt cycle issues and to substitute the old technical and social support networks with new ones. The study suggests that the Vittel PES is most likely to be replicable in places where land cannot be purchased and set aside for conservation, where the risk to business is high, while the link between ecosystem health and farming practices is well understood, and expected benefits are sufficiently high to justify the investment. Such conditions may favour industrialised countries, but could also be found in developing countries provided there is good enforceable contract law.

The Vittel PES is an example of a private scheme that has improved water quality where government agencies have failed, despite the fact that much higher sums are paid each year to improve water quality. The study notes that government institutions tend to offer technical solutions without addressing the economic, social, legal, political and communication aspects of change. Solutions and incentives tend to be short-term and do not take into account the livelihood strategies of farm families or their long-term plans. They do not start from the basic premise that in order to succeed, any change must ensure that agricultural revenues are maintained at all times, and that social, political and technical support networks are fundamental elements of farming systems and must be considered throughout the process (Perrot-Maître, 2006). It underlines the point that changing farming practices is as much a social and political challenge as a technical one. There are striking parallels between these observations of a developed world project, and the conclusions of analysts examining schemes in developing world settings.

SUMMARY ASSESSMENT: PAYMENTS FOR ECOSYSTEM SERVICES

Potential

- Experience to date suggests that PES can deliver environmental benefits.
- There is real potential for adapting PES to agricultural GHG mitigation. Existing agricultural schemes have had positive environmental and social outcomes.
- Private sector schemes can be more effective than public sector schemes, although where there is a single ecosystem service that is being provided (water quality or carbon sequestration) care needs to be taken that achieving these goals does not undermine other ecosystem services.
- The potential for a PES scheme may potentially aid pastoralists in lobbying for their land use rights.

Challenges

- While PES schemes have often delivered environmental benefits, the social impacts can be more mixed.
- Land tenure and transaction costs are the main barriers to poor people's participation.
- Lasting positive change in practices beyond the financing period will only occur where these practices give rise to benefits valued by the farming community, such as productivity gains.

Future needs

- A clear institutional model is essential to define and enforce property rights, legitimise payments and legally enforce contracts.
- As for CDM, issues relating to additionality, permanence, leakage, and saturation and proper measuring, reporting and verification processes need to be addressed – all of which will cost money.
- Local institutions can play an essential role in building trust, providing support and managing payments.

3.1.5 REDD and REDD+ and agriculture

REDD (Reducing Emissions from Deforestation and Degradation) is a system of making payments to developing countries in order to prevent climate-affecting deforestation or degradation. It is a financial mechanism proposed under the auspices of the UNFCCC. REDD was expanded to include conservation, sustainable forest management, and enhancement of carbon stocks, as listed in the Bali Action Plan, and is collectively referred to as REDD+.

It is well accepted now that mitigation of global warming will not be achieved without a halt on deforestation, and hence the inclusion of forests in an international climate regime. Funding for payments can come either from developed world offsets – where a polluter pays for the emissions-saving projects or programmes that in theory would compensate for the polluters' emissions – or through trust funds. For example, the World Bank has created a fund, the Forest Carbon Partnership Facility (FCPF). This fund is aimed at assisting developing countries in their efforts to reduce emissions from deforestation and forest degradation and foster conservation, sustainable management of forests, and enhancement of forest carbon stocks. This fund consists of a US$230 million 'readiness' fund – to support countries to prepare themselves for REDD + – and a US$205 million carbon fund to provide payments for emission reductions from REDD+ programmes in countries that have made considerable progress towards REDD+ readiness (FCPF, undated). Pilot projects have been set up in a range of developing countries to test tools for monitoring and assessing progress towards meeting REDD targets (Box 5).

As it was originally conceived, REDD and then REDD + (which takes into account broader environmental objectives) focused exclusively on the forest sector. However, it is increasingly apparent that it is not possible to address forestry issues without also considering agriculture; forests, food production and climate change, which are inextricably linked for many reasons.

Most importantly, agricultural expansion is a leading cause of deforestation worldwide. In the absence of a globally agreed system of monitoring and managing land use, and curbing overall agricultural expansion, restrictions on deforestation in one country may lead to pressure for agriculture production to encroach on forests in other countries, negating any mitigation effects. Even if encroachment on forests are curtailed, without curbs on agricultural expansion some analyses suggest that 50 per cent of the avoided deforestation emissions would be cancelled out by increased emissions from other natural landscapes such as the *Cerrado*[8] and other grasslands (that are converted to agriculture) (Terrestrial Carbon Group, 2010).

If agricultural expansion is successfully prevented, the result may be an increase in food prices, conflicting with national and international development goals to reduce poverty and improve food security. Alternatively, steps may be taken to increase agricultural productivity on existing land. But if this leads to greater use of nitrogen fertilisers or irrigation, there may be negative impacts on GHG emissions, on-farm biodiversity and health (IIED, undated; Ghazoul *et al.*, 2010).

Finally, and as already noted, agriculture has substantial potential to sequester – and also to

8. A vast tropical savanna ecoregion in Brazil.

BOX 5: PILOT REDD AND REDD+ PROGRAMMES

Negotiations over international REDD and REDD+ policy are still going on within the UNFCCC process. However, a number of initiatives have been launched to pilot REDD projects in so-called 'readiness' for when an international policy is agreed. For example, the UN-REDD programme was launched by Norway in 2008. It is backed by a multi-donor trust fund and is operating in nine pilot countries (Democratic Republic of Congo (DRC), Tanzania, Zambia, Indonesia, Papua New Guinea, Vietnam, Bolivia, Panama and Paraguay). In addition, funding has been given to five more: Cambodia, Ecuador, Nigeria, Philippines and the Solomon Islands, to develop national plans. Twenty-one other countries are partners on the programme and have status on the policy board.

The Forest Carbon Partnership Facility is another initiative, developed by the World Bank. It is currently funding 37 tropical and sub-tropical countries to help them develop systems and policies for REDD+ and provide them with performance-based payments for emission reductions. Another scheme, the Forest Investment Programme (FIP) also supports readiness activities and is one part of the Strategic Climate Fund set up and administered by multilateral development banks. It is currently providing US$ 587 million of support in Brazil. Burkina Faso, DRC, Ghana, Indonesia, Laos, Mexico and Peru.

While REDD has yet to be formally recognised in international climate policy, a number of innovative REDD-type projects and methodologies for counting emissions from these projects have emerged in the voluntary markets. For example, 29 per cent of the voluntary carbon market in 2010 was made up of REDD projects: *'With no existing compliance scheme yet to host transactions of REDD credits, the OTC market has been the sole home for these projects and led to the development of a host of new methodologies for crediting them'* (Peters-Stanley *et al.*, 2011: 12).

continue to emit – carbon. Carbon sequestration in agriculture can complement the goals of avoiding further carbon losses through deforestation in the forestry sector. Additionally, trees in agricultural landscapes represent a globally important carbon stock; 46 per cent of agricultural land globally has at least 10 per cent tree cover, and in Southeast Asia and Central America, 50 per cent of agricultural land has at least 30 per cent tree cover (ASB, 2009).

As a result, some organisations are now arguing that sustainable agriculture objectives need to be integrated into REDD+. The term often used for this is REDD++. Others, however, consider that since REDD+ is well advanced as a financing mechanism, incorporating agriculture could lead to its being marginalised and may simply make the scheme more complex. There are important differences between the agricultural and forestry sectors: agriculture requires consideration not just of carbon dioxide but of methane and nitrous oxide emissions, and while there is lower potential for carbon sequestration in the agricultural sector than in forestry, there are higher risks of reversibility, patchiness and variability. These factors not only heighten uncertainties when accounting for carbon, but also increase the costs. Food security and trade issues, higher transaction costs involving numerous owners and complex sectoral and supply chain incentives will all complicate the task of incorporating agriculture into REDD+ projects (FAO, 2009; Terrestrial Carbon Group, 2008).

While a global mechanism for mitigation that includes agriculture is necessary, agriculture is likely to require a broader range of financial measures and incentives than REDD+ can provide – partly because of the complexities of developing accounting systems that encompass multiple GHGs and multiple landholders, and partly because agricultural products are globally traded and their production is therefore influenced by other economic and political considerations. Some analysts are now proposing a more encompassing land-carbon initiative, in which forestry forms part of an overarching system of terrestrial carbon accounting that encompasses agriculture, forestry, and other land uses (AFOLU). Measuring and managing these total terrestrial carbon stocks would be a highly complex undertaking, but ideas have been put forward as to how it might be achieved (Terrestrial Carbon Group, 2008).

Is REDD+ pro-poor?

Certain social and ethical concerns have been raised about REDD+ that may be relevant to any future scheme incorporating agriculture. For example, questions have been raised around equity, land tenure and the rights and involvement of forest-dependent communities. There are fears that the wording of REDD+ can be interpreted to support large-scale commercial forestry while marginalising the rights of indigenous peoples (REDD-Monitor, 2010; Friends of the Earth International, 2008). Similarly there are also fears that a future REDD++ or AFOLU-type terrestrial carbon accounting scheme that incorporates agriculture could potentially be dominated by large-scale commercial agriculture at the expense of small-scale farmers.

Overall, analysis of REDD+ pilot plans so far suggests that there is generally poor consultation with and involvement from indigenous communities, and superficial treatment of land tenure and carbon ownership (Davis *et al.,* 2008). The links between REDD+ and poverty reduction in current debates appear to be inadequately framed (REDD net, 2010). Studies that examine links between REDD+ and poverty reduction find little specificity in defining the poor, with aggregate terms such as 'local communities' being commonly used. As such it is unclear what pro-poor REDD+ measures actually are and who they seek to benefit. Moreover, where poverty issues are considered, the main focus is on indigenous peoples and the forest-dependent poor. Although it is important to address such concerns, this narrow focus signals little examination of the potentially wider welfare implications of REDD+. There is scant discussion not only of how REDD+ finance will be distributed, but also of the non-financial benefits and costs (for example, power relations) that the mechanism might yield (REDD net, 2010). As such, it is evident that insufficient attention has been paid to the livelihood dimensions of REDD projects.

Nevertheless, there is certainly potential for incorporating sustainable development objectives into REDD+ schemes. The Climate Change, Community and Biodiversity Alliance (CCBA) convened by Conservation International has established voluntary social, economic and environmental standards that REDD+ projects need to meet and against which co-benefits can be measured (Negra and Wollenberg, 2011; CCBA, 2008).

There is potential for incorporating sustainable development objectives into REDD+ schemes

SUMMARY ASSESSMENT: REDD AND REDD+ AND AGRICULTURE

Potential

- REDD+ holds potential for mitigating emissions by keeping carbon 'locked' into above- and below-ground biomass, while also safeguarding biodiversity and improving livelihoods.

Challenges

- Insufficient attention has been paid to the relevance of REDD and REDD+ to agriculture.
- At present, REDD+ does not pay sufficient attention to ensuring that social equity and broader environmental objectives are promoted.
- There is still major uncertainty about how REDD+ initiatives will be funded.

Future needs

- More should be done to ensure that social equity and broader environmental objectives are included in its final form. This could also be explored through pilot schemes.
- Agricultural considerations certainly need to be included in any REDD+ project development plans.
- Further work is needed to see whether the remit of REDD+ should be expanded to formally include agriculture.
- Given the close relationship between forestry activities and agriculture, some kind of land use accounting system that includes agriculture is likely to be essential if leakage and other perverse effects (such as higher food prices) are to be avoided. Further work is needed to see how this might be achieved and where REDD+ might sit within it, taking into account not just carbon sequestration objectives but also broader social and environmental goals.

3.1.6. Emissions trading schemes

How do they work?

Emissions trading is a market-based scheme that allows parties to buy and sell permits for generating emissions, or credits for reducing them. The benefit of emissions trading is that a cap on overall emissions is set, and within this limit the market is free to make choices as to the lowest cost mitigation route to take. By setting an overall cap on emissions, an ETS possesses some of the qualities of a regulation.

The environmental regulator (for example the European Union, or a national government) first determines the total volume of emissions that can be emitted in a given time period (referred to as a cap), and then divides this total into tradeable units (often called credits or permits). These are then allocated to scheme participants. Participants that generate emissions must obtain sufficient tradeable units to compensate for them. Those who reduce emissions may have surplus units; they can sell these to others who find emission reduction more expensive or difficult. Gradually the collective allowable amount of emissions that can be produced is reduced so that the pool of credits circulating in the economy declines.

Emissions trading schemes so far only operate in the developed world, since there are as yet no obligations on developing countries to reduce their emissions. The EU Emissions Trading Scheme is the largest carbon market in the world – figures for 2010 suggest that it was responsible for 81 per cent of all carbon credits transacted worldwide (including regulatory and voluntary markets) (Peters-Stanley *et al.*, 2011).

While this is not the place for a full analysis of the EU ETS it should be noted that the scheme has been heavily criticised. Analysts note that its allocation of allowances is overly generous, which drives down the price of carbon. Moreover, since participating companies can purchase offsets by investing in projects in the developing world, this reduces the incentive to improve the efficiency of European practices (note that, recognising this risk, offsets will not be permitted in Phase Three).

What scope does it offer for reducing agricultural emissions?

At present the EU ETS does not include agriculture (although large food manufacturing plants are included), nor are there plans to include agriculture in the third phase of the scheme, starting in 2013. By contrast, an emissions trading scheme currently being developed in New Zealand (NZ ETS), will include agriculture. While agriculture will not be fully incorporated until 2015, compulsory reporting of agricultural emissions begins in 2012 – voluntary reporting began in 2011. With some exceptions, agricultural participants are meat and dairy processors, exporters of live animals, fertiliser importers and manufacturers, and egg producers. Emissions are calculated based on the quantity of products processed, manufactured or imported, multiplied by an emission factor for that product, which is based on estimates of the emissions generated in its production. Farmers and growers are unable to register and participate directly in the NZ ETS since that would be a form of double counting: their emissions are accounted for in the allocations made to processors. Agricultural participants will receive a 'free' allocation of emission units from the New Zealand government from 2015 to reduce the cost of participation in the NZ ETS, based on output intensity; these allocations will decline over time.

So far there has been little analysis of the potential effects of the NZ ETS on agriculture. However, one draft report assesses its possible impacts on farmer incomes and agricultural emissions under a range of scenarios (Saunders and Saunders, 2011). The assessment uses a partial equilibrium model that forecasts international trade and the domestic production and consumption of agricultural commodities. The scenarios developed revolve around several dimensions:

- The presence or absence of climate change (that is, scenarios that assume no change in agricultural productivity and scenarios that assume climate change will affect productivity).
- The presence or absence of global policies in place to curb GHG emissions (which directly or indirectly put a price on carbon)
- The deployment or non-deployment of technological mitigation options in the agricultural sector.

The study finds that the ETS on its own is unlikely to have much effect on agricultural GHG emissions, but if combined with the active deployment of mitigation technologies, emissions could fall by nearly 20 per cent by 2020. The impacts on farm incomes are likely to be negative, however, representing for sheep and beef, dairy, and arable producers losses of 33 per cent, 11 per cent and 4 per cent of farm incomes respectively by 2050.

But this negative scenario assumes no international action on climate change. Where international action on climate change is incorporated, the effects on farm incomes are found to be positive, since the price of meat and dairy products is assumed to rise. In addition, scenarios that factor in the physical impacts of climate change on productivity find that New Zealand growers do better still since they have a climatic advantage. While New Zealand productivity will be negatively affected by the scheme, it will not be as badly hit as other countries and so producers will benefit relative to those in other countries (Saunders and Saunders, 2011). Clearly a hypothetical ETS for agriculture developed in another part of the world is likely to see farmers doing less well, relative to other countries.

The USA-based Chicago Climate Exchange (CCX) was, until its closure at the end of 2010, an example of a private cap-and-trade scheme that focused on providing payments for GHG (not just CO_2) mitigation. The scheme covered a range of sectors, including agriculture, and totalled around 400 participants, who were required to sign legally binding emission reduction agreements. Members could comply by cutting their emissions internally, trading emission allowances with other CCX members, or purchasing offsets generated under the CCX offset programme. There was a 50 per cent limit on the use of offsets to meet compliance standards (CORE, undated). Agricultural practices eligible for emissions reduction credits included sustainable rangeland management, minimum- or no-tillage and grassland plantings.

Although initially welcomed by environmental organisations, from its early days the CCX was beset by controversy.[9] The agricultural practices eligible for credits came in for particular criticism since in many cases no-till techniques had been practised before the CCX came into being (ClimateLab, undated; Kirkland, 2010).

Other criticisms of the scheme included its lack of transparency — as it operated as a private for-profit entity it was perceived to lack credibility and trustworthiness. Added to this, the inclusion of offsets in the system meant that participants did not need to purchase allowances or take steps to reduce their emissions to meet their commitments. The offsets flooded the system, causing a steep drop in the price of carbon, which fell to less than 10 cents a tonne of CO_2 by November 2010 (Kirkland, 2010; Stumhofer, 2010; Gronewold, 2011). In principle these are problems that other, better designed, schemes could potentially avoid. Broader problems, not specific to the scheme itself, included scepticism about global warming among the American public and the general failure of the US government to drive through climate legislation.

The CCX as a trading scheme is no longer operational, but it still continues to function as a carbon offset registry. In a parallel development,

9. Since the closure of the CCX is fairly recent, published assessments of the factors contributing to its failure are not yet forthcoming, and so this sub-section relies largely on media and internet analysis, most of which reports are largely consistent and in agreement with one another.

the state of California is pressing ahead with plans for its own emissions trading scheme, although agriculture will not be included.

Finally, several modelling studies have compared the effectiveness of emissions trading with other economic and regulatory instruments in the context of agriculture. These are modelling exercises only and as such are not evidence-based. However, they do suggest that emissions trading schemes may (in theory) be able to achieve emission reductions at a lower cost to farmers than taxation. A fuller discussion can be found in Section 3.2.4 on model comparisons.

SUMMARY ASSESSMENT: EMISSIONS TRADING SCHEMES

Potential

- With the right policy framework, including concerted global action to address emissions, farmers in favourable climates could potentially benefit from emissions trading scheme. The problems of 'leakage' (where emissions are displaced to other countries) are also potentially less than for other fiscal measures.
- Emissions trading schemes may be able to achieve emission reductions at a lower cost to farmers than taxation.

Challenges

- Since agricultural production gives rise to three greenhouse gases – CO2, methane and nitrous oxide – the design of such schemes is inherently more complex than those based on carbon dioxide alone.
- There are no successfully operating agricultural ETS schemes at present.

Future needs

- Broader issues to do with the number of allowances issued, the role of offsets, and transparency and trust, all need to be resolved for emissions trading schemes to operate effectively.

Taxes have often proved ineffective – because they often target inputs rather than outputs and are set too low

3.1.7. Taxes

How do they work?

A tax on emission-generating inputs to the agricultural process (such as fertilisers or manure) is one way of discouraging their overuse. In addition to input-based taxes, it is also possible to tax the outputs from the agricultural process – such as livestock, or more specifically the GHG emissions themselves.

Experience to date suggests that taxes have often proved ineffective. This is because they often target inputs (fertilisers, livestock) rather than outputs (such as greenhouse gases, or nitrogen surpluses) and are set too low to have a substantial impact.

For example, a number of European member states, including Sweden, Denmark and the Netherlands, have experimented in the past with various charges and taxes on fertiliser use. However, as a whole these have met with limited success (Söderholm and Christiernsson, 2008) although mineral fertiliser use has been reduced to some extent. The specifics vary by country, but some consistent insights into design and implementation have emerged.

For a start, the tax is often set too low, perhaps reflecting political caution, and so its effectiveness is undermined. If the cost of fertiliser falls, through greater efficiencies in fertiliser manufacturing plants, then the impact of the tax is reduced further.

More fundamentally, a tax on inputs can be a blunt instrument, since the relationship between inputs and impacts is not always straightforward. One kilogram of nitrogen applied on one field or at one time of year will have different impacts on leaching and N_2O emissions than if applied in another field, or at another time of year, due to differences in biophysical conditions such as soil type, rainfall patterns and so forth. These biophysical and temporal variations can mean that the tax can be unfair on some farmers. For example, where there are nitrogen deficits, fertiliser requirements will be higher than in an area where soils are rich in nitrogen, but farmers in the former regions may have to pay more in fertiliser taxes than those in the latter even where their negative impacts (in terms of leaching and so forth) are lower.

Moreover, a reduction in mineral nitrogen to avoid a synthetic fertiliser tax can be compensated for with manure – and where this is not taxed, and applied inappropriately, nitrogen pollution still occurs. A tax on synthetic fertilisers but not manure (or vice versa) can, therefore, simply shift the pollution source without addressing the problem of excessive nutrient applications. Where input taxes consider both organic and mineral nitrogen sources they may be more effective than a focus on one of them alone.

Taxes can also be unpopular and perceived as unfair. This perception can be mitigated somewhat if revenues are ring-fenced and invested in research and development in the sector. There has been little analysis of the effects of taxation on social equity outcomes.

Another ‘input’ tax option might be to place a tax on livestock production. Livestock are, as noted, a major source of nitrogen overload (which can give rise to nitrous oxide emissions) as well as of methane, and hence a significant contributor to global GHGs. At present such a tax has not been implemented but its potential environmental and economic impacts have been modelled (see Section 3.2.4). They suggest that the tax could be fairly damaging to farmers, while at the same time it would be less effective in reducing emissions than other fiscal instruments. The problem of leakage (discussed below) is also fairly substantial. However, a livestock tax could potentially address more than one environmental concern (for example biodiversity as well as GHG emissions), in contrast with other approaches.

One study suggests that regulation can represent a more effective approach to managing nitrogen emissions than taxes. The study compared the existing situation in Ireland, where regulation is in place, with a hypothetical situation in which mineral nitrogen is taxed. It found that although regulations limiting nitrogen led to some loss of income for farms (where yields were lower) a tax set at a rate to achieve the same outcomes imposed a far greater compliance cost burden (Lally *et al.,* 2009). Its findings indicated that the tax would also be inequitable, as farms already in compliance with the Action Programme would incur substantial losses in family farm income.

The targeting of outputs (e.g. nitrogen surpluses) rather than inputs will be more effective and more cost efficient for farmers and is also perceived to be fairer. But it is more complex and expensive to measure and monitor outputs than it is for inputs, and is therefore less popular with policymakers.

SUMMARY ASSESSMENT: TAXATION

Potential

- An input tax can target multiple environmental concerns, such as GHGs, water pollution or ammonia emissions.
- Taxes covering both organic and mineral nitrogen sources may be more effective than a tax on only one.
- Taxing outputs rather than inputs will be more effective and more cost efficient for farmers and is also perceived to be fairer.

Challenges

- Input taxes are often ineffective because they are set too low to have a substantial impact.
- Taxes can be unpopular and perceived as unfair.

Future needs

- Taxes could be made more acceptable if revenues were ring-fenced and used to fund research and development in the agricultural sector.
- There is some research to suggest that regulation imposes lower economic costs on farmers than taxation.

3.2. REGULATORY MEASURES

This section examines a range of regulatory instruments (from within and outside the EU) that either directly seeks to regulate emissions of GHGs, or that, in targeting other environmental concerns, may have indirect impacts upon them.

3.2.1. European-wide legislation

In the European Union, a number of legislative measures seek to influence how agriculture is practised and to control some of its negative effects. Examples include the Water Framework Directive, the Nitrates Directive, the EU Biodiversity Strategy and, oldest of all, the Common Agricultural Policy (Box 6). All of these in some way have an indirect bearing on GHG emissions, and some, such as the Water Framework and Nitrates Directives, are closely interlinked.

This section focuses on the Nitrates Directive, as an example of a regional, legislation-based MGM.

The EU Nitrates Directive

The Nitrates Directive is an example of a regulatory market governance mechanism. The directive is applicable to land across all 27 EU member states and it currently covers nearly 40 per cent of EU territory (EC, 2010). It was not originally designed to reduce GHG emissions; nonetheless, the management of nitrogen has a major influence on the overall balance of GHGs.

The main aim of the directive is to prevent the nitrogen loading of water bodies from agricultural waste and the use of fertilisers. It sets a cap on the

BOX 6: THE COMMON AGRICULTURAL POLICY AND CLIMATE CHANGE

The CAP was first implemented in Europe in the 1950s. Its original purpose was to improve European agricultural productivity following the Second World War. Since then its purpose has changed following several revisions. The CAP represents a significant proportion (34 per cent) of the total EU budget, paying out EUR 55 billion per year (EC, undated).

In its current form the explicit link to production has now virtually been severed, with greater emphasis placed on rural development and the environment. Climate change is an 'overarching theme' of the Common Agricultural Policy but there are no specific elements in the CAP's support structure to address emissions.

However, the CAP is currently undergoing further reforms, which are due to be complete by 2013. Although details are lacking, climate change will feature much more strongly than at present (EC, 2011).

A report by the UK's Committee on Climate Change (CCC, 2011) briefly explores how the CAP's mitigatory role could be strengthened (see Section 3.2.2). It argues that actions need to be taken to increase uptake of zero- or negative-cost abatement policies – those that don't cost anything to implement or may even save farmers money – and to incentivise those that require some investment and support. It also notes that a Europe-wide policy for achieving mitigation would reduce the risks of 'carbon leakage' (where measures taken to reduce emissions in one country lead to increases in emissions in another). However, the risk of emissions leakage to non-EU countries is not necessarily addressed.

amount of manure that can be applied to soils (representing a nitrogen content of 170kg N/ha). This in theory places limits on livestock stocking density, although in practice if manure is transported to other regions, these limits can be overridden. There are no restrictions on the use of synthetic fertiliser applications. However, in Nitrate Vulnerable Zones (NVZ) – areas designated as being especially sensitive to nitrogen overload — there may be restrictions on total nitrogen applications (both organic and inorganic). In some member states the entire country has been designated as an NVZ, but this is not the case for all.

Of course, the effectiveness of any regulation will depend upon how, and to what extent, it is implemented and regulated, and what the penalties are for non-compliance. There have also been criticisms that the Nitrates Directive, as implemented in many European countries, lacks coherence. NVZs are not always in place in areas where they may be needed, an example being the west of England. The UK government's Committee on Climate Change (see Section 3.2.3) has stated that if the entire UK was a Nitrate Vulnerable Zones there could be significant incentives to reduce manure and fertiliser related emissions (CCC, 2011).

Is it working?

One analysis of emissions per unit of agricultural land does show a decline in N_2O from soils among EU member states that have implemented the directive. However, similar reductions in emissions have been achieved in those member states that have not implemented the directive, suggesting that there are other influences on agricultural production too (AEA *et al.,* 2009).

Denmark has had particular success in managing nitrogen using regulatory measures. Nitrogen mineral fertiliser consumption halved between 1990 and 2003 (compared with a 12 per cent decline on average across the EU 15), driven by the directive and by national governmental commitment. Nitrogen surplus was reduced by 34 per cent (as compared with 16 per cent for the EU 15). This was achieved through an integrated regulatory approach that addressed the point sources of pollution (waste water plants), area-based measures (for example, establishing wetlands) and integrated nutrient measures applying both to mineral fertiliser and to manure. This was matched with effective monitoring, the use of indicators and intensive research efforts. A forward-looking farming community is also considered to have been a factor in achieving success (Kronvang *et al.,* 2008). This echoes observations made about PES and the CDM of the need to consider social and cultural factors when designing MGMs.

3.2.2. Emission caps: the case of the UK

The UK was the first nation in the world to enact a law committing it to reduce its greenhouse gas emissions by 80 per cent on 1990 levels by 2050 and its targets are still the most ambitious and far-reaching. To meet this goal, the government has set indicative targets for all industry sectors, specifying levels of emission reductions by 2020. The target for the English agricultural sector is to reduce emissions by 3 million tonnes CO_2-equivalent (Mt CO_2e) during the third carbon budget period (2018–2022). A carbon budget is a cap on the total amount of GHG emissions that are emitted over a five-year period and they are set in law (DECC, undated).

The Committee on Climate Change — a statutory body set up to monitor progress in achieving emissions reductions and to provide advice to government — found that agricultural emissions

There are major uncertainties in measuring agricultural emissions and developing strategies to reduce them; the evidence base needs to be improved

fell by around 1 per cent in 2009, and as such the sector is broadly on track for the 3 per cent reduction (relative to 2007 levels) required (CCC, 2011). Interestingly, it attributes some of this reduction to a decline in meat consumption, which has fallen by around 3 per cent since 2003 and 5 per cent since 2007. The decline since 2007 coincided with significant price increases for all food products.

But the report also notes that substantial issues need to be resolved if agriculture is to play its part in driving down the UK's emissions. There are major uncertainties as regards measuring agricultural emissions and in developing strategies to reduce them; the evidence base needs to be improved so that future targets can be set. Significantly it points out that the level of ambition in the industry-led emission-reduction roadmaps is weak (see Section 3.3) and this in turn reflects the modesty of the government's own targets for the industry. The CCC's own analysis suggests that more substantial levels of reduction are possible. This would require strengthening incentives at UK and EU levels, and in the long run addressing dietary patterns, particularly meat and dairy consumption and the amount of food that is wasted (CCC, 2011).

Hence, although there are signs that the indicative target, driven by UK legal requirements, has led to some mitigation, it remains to be seen how effective government targets are in triggering the more radical cuts in agricultural emissions that will be needed in the future.

3.2.3. Nationally appropriate mitigation actions

Under the terms of the UNFCCC 2007 Bali Action Plan, developed nations agreed to pursue new 'quantified emission limitation and reduction objectives'. Developing nations agreed to undertake 'nationally appropriate mitigation actions' (NAMAs) in the context of sustainable development (UNFCCC, 2008), with financial support from developed country partners. While NAMAs are not MGMs, they provide an overarching policy framework for developing nations within which a mixture of MGMs (regulatory and market-based) can be deployed to achieve mitigation objectives.

In theory, and as the FAO advocates (FAO, 2009), agricultural mitigation can be part of a country's NAMA. However, at present, much uncertainty surrounds their shape and form. For example, the relationship between NAMAs and other mechanisms such as REDD+ is unclear. One possibility is that REDD + activities can form part of a country's NAMA. At present, little more can be said about NAMAs, other than that there is a need to keep a close watch on how they evolve.

3.2.4. Modelled comparisons of different economic and regulatory instruments

Most of the analysis presented so far has been of existing fiscal instruments, or those that are being developed. However, as interest in agricultural GHG mitigation grows, research is increasingly exploring hypothetical agricultural mitigation policy instruments. Although these theoretical models are necessarily simplistic, they may nevertheless offer some insights for policymakers. Some relevant studies are summarised here.

European Commission evaluation: livestock sector's contribution to EU greenhouse gas emissions

This study examined different scenarios for achieving a 20 per cent reduction in agricultural emissions in Europe by 2020 (Leip, *et al.*, 2010). It considered four main policy options – two regulatory and two fiscal – and compared them against a reference scenario:

- *Emission Standard Scenario (STD)*: this scenario is based on an emissions cap, with equal reductions specified for all member states.
- *Emission Standard Scenario according to a specific Effort Sharing Agreement for Agriculture (ESAA)*: this scenario is also based on an emissions cap but the burden of mitigation is distributed differently among different member states.
- *Tradable Emission Permits Scenario according to an Emission Trading Scheme for Agriculture (ETSA)*: this scenario is linked to a regionally homogenous emission cap set on total GHG emissions in member states (all states have to reduce emissions by the same degree). According to this cap, tradable emission permits are issued to farmers and trade of emission permits is allowed at the regional and EU-wide level.
- *Livestock Tax Scenario (LTAX)*: this introduces regionally homogenous taxes for ruminants – at euro 300 per tonne of CO_2e emissions from ruminants and euro 160 tonne for non-ruminants.[10]

The study finds that all four scenarios could achieve reductions approaching 20 per cent, and in all cases the biggest decreases in agricultural activities occur in the beef sector (Figure 7). However, when emission leakage is included in the calculation, the reductions in EU emissions are partially offset by emissions increases in the rest of the world, mainly as a result of higher net imports of feed and animal products. In other words, while EU livestock production is reduced, demand for meat and dairy products is assumed to be relatively inelastic and so not affected to the same extent; hence production overseas for import to the EU increases.

The model finds that the emissions trading scheme scenario leads to the least leakage, because emission cuts are made where they cost least to achieve. The livestock tax policy is found to be the most inefficient, because it does not discriminate according to the potential for cutting emissions and loads the cost onto just one production factor – livestock. But leakage is substantial. The tax leads to fewer livestock per land area (extensification) but since consumption habits are not affected, the shortfall in meat supply is met through greater imports. The model finds that meat imports into EU-27 would increase by 49 per cent for meat and 7 per cent for dairy products. Exports would be decreased by 9 per cent for meat and 8 per cent for dairy products.

This leakage effect is absolutely critical and needs to be borne in mind when considering the effects of measures geared at achieving greater extensification – that is, on lower productivity for a given area of land.

As regards economic impacts, the Emissions Standard Scenario and the Effort Sharing Standard Scenario would both reduce production, lead to more extensive farming, and increase prices. The livestock sector would be particularly affected by declines in production. The model indicates that this would raise farmer incomes (since demand is assumed to be fairly inelastic) but would also increase prices for

10. Following personal discussion with the authors it appears that this different attribution of costs per tonne CO_2e is an error since clearly a tonne of CO_2e is the same whatever its source. A new version of the report will be published that penalises ruminants and non-ruminants equally per tonne of CO_2 eq emitted.

FIGURE 7: AGRICULTURAL EMISSIONS REDUCTIONS UNDER A RANGE OF SCENARIOS

	BAS	REF	STD	ESAA	ETSA	LTAX
Total GHG emissions EU27	476.1	443.5	382.7	385.1	384.0	385.1
% reduction to BAS (2003–2005)		–6.8%	–19.6%	–19.1%	–19.3%	–19.1%
Net increase in emissions in rest of the world due to emission leakage		0.0	9.2	8.4	6.0	19.9
% reduction to BAS (2004)		–6.8%	–17.7%	–17.3%	–18.1%	–14.9%

Key: BAS – Baseline today; REF – situation in 2020 in the absence of additional policy measures; STD – emission standard scenario; ESAA – effort-sharing emission standard scenario; ETSA – emission trading scenario; LTAX – livestock tax

Source: Leip *et al.*, 2010

consumers. Different regions of the EU would be differently affected.

In the ETSA scenario the economic effects across activities are more homogeneous, with beef meat activities less affected and arable crops more affected. Farmer incomes are expected to rise (for the reasons already highlighted). Those member states already on track to achieve a 20 per cent GHG emission reduction, even without additional policy measures, could most clearly benefit from an emission permit trading scheme.

In the LTAX scenario the beef and dairy sector are most substantially, and negatively, affected. The model assumes that no tax revenue is redistributed to the farmer and that the tax is part of the variable cost of production; this leads to an average farmer income reduction in the EU-27 of –18.3 per cent.

Note that the study does not consider the impacts on soil carbon or other areas of concern (such as biodiversity) which may influence the effectiveness of the different types of taxes. However it notes that a livestock tax may yield relatively greater benefits for biodiversity protection and for soil carbon sequestration than some of other measures. Moreover, a measure of GHG impact that also includes carbon sequestration might lead to a different ranking of the relative merits of different schemes.

Overall, it is hard to draw strong conclusions as to the effectiveness of one measure over another. All appear to trigger some form of mitigation. But robust judgements are not possible since the important role of soil carbon (as well as other environmental impacts) is not considered in detail, and there are also errors in the study's relative costing of GHG emissions from monogastrics *versus* ruminants (see footnote above). The most important observation is that unless MGMs address production and consumption together, then at least some of the emissions are simply displaced to other regions.

Mitigation strategies for greenhouse gas emissions from agriculture: a study from Germany

This smaller comparative study focuses on the German federal state of Baden-Württemberg. It couples an economic farm model with a biophysical model to estimate the possible environmental and economic impacts of four different mitigation policies: an emissions tax, emissions cap, nitrogen tax, and a process of livestock extensification, for typical farming systems in the region (Neufeldt and Schäfer, 2008). It finds that:

- For the entire region, GHG emission abatements could amount to between 8 and 12 per cent and income loss from 2 to 10 per cent, depending on the policy instrument.
- The emissions cap represents the cheapest option for farmers, but would impose high additional administrative costs for policymakers, owing to the complexity of accounting for emissions.
- The emissions tax would impose highest costs both on farmers (since they pay a tax) and on government administration, due to accounting complexities.
- The nitrogen tax and livestock extensification options are judged to be economically less efficient, but provide greater additional environmental services (for example by reducing nitrate loading of aquifers, and by enhancing landscape quality) and give rise to lower administrative costs, as information on nitrogen fertilisers and livestock is readily available from agricultural statistics.

Importantly, the study does not consider leakage effects – for example the possibility that reductions in agricultural output could increase imports from outside the region, in response to consumer demand.

Lessons from modelling studies

Bearing in mind that these findings are based on models, which can be simplistic and based on assumptions that turn out not to be valid in a real world context, several observations can be made:

1 More effective measures are likely to incur higher costs for government. Governments and farmers may have conflicting views on the burdens a particular measure imposes – often measures that are expensive for farmers are cheaper for governments to administer and vice versa.

2 Attempts to compare regulation and fiscal instruments are not especially helpful since fiscal instruments are most effective in the context of an overall regulatory cap on emissions (as in the case of emissions trading). In general, trading schemes appear to be a more effective route to reducing GHG emissions (and comparable in efficacy to regulation) than taxes.

3 The effectiveness of a particular policy instrument is likely to be viewed differently depending upon whether GHG mitigation alone or other environmental and social impacts are being measured. A broader definition of sustainability might judge taxes more favourably than narrower GHG-only metrics.

4 It is vital that leakage risks ('exporting the problem') are considered and addressed. From a global climate perspective, if agricultural mitigation in one country is achieved at the expense of increased emissions in another, then there has been no net benefit. Hence, consumption and production side issues need to be addressed in tandem; an analysis of consumption-oriented measures is given in Section 4.

SUMMARY ASSESSMENT: REGULATION

Potential

- Regulation, particularly in combination with pricing measures, could have an important part to play in agricultural GHG mitigation but its potential has so far been under-explored.
- They can operate effectively in conjunction with fiscal mechanisms, such as emission trading schemes.

Challenges

- Ensuring that measures implemented in one country do not have perverse or contradictory consequences in another (the 'leakage' effect).

Future needs

- To be effective, regulations need to be flexible and thus able to address an issue from multiple angles.
- They need to be backed up by ongoing investment in research (to ensure regulations are targeted appropriately) and by robust measurement and monitoring measures.
- Consideration of the social dimension is also important; participants (i.e. farmers) need to be informed and supportive if schemes are to succeed.

3.3. CO-OPERATIVE MEASURES

This sub-section assesses the effectiveness of voluntary global measures implemented at an international level by industry bodies; initiatives developed by industry organisations at the national level; and voluntary commitments by individual companies.

3.3.1 Global co-operative agreements

One of the few global industry agreements focusing on reducing GHG emissions from agriculture is the Global Dairy Agenda for Action on Climate Change, co-ordinated by the International Dairy Federation. This statement of commitment by the dairy supply chain to take action to address climate change was launched in 2009 and endorsed by regional dairy industry representative bodies from across the world. Signatories agree to promote the development of a standard carbon footprinting methodology; promote practices that reduce GHG emissions, foster efficient technologies and optimised economic, social and environmental outcomes; promote the development of tools for measuring and monitoring progress; foster improved farmer understanding; and encourage the sharing of information and research. The emphasis is on 'promoting' – no quantitative commitments are specified (International Dairy Federation, 2009). The major achievement to date has been to develop infrastructure for measuring GHG emissions from the livestock sector. The Agenda has published an international life cycle analysis methodology and also worked on tools applicable to different stages in the supply chain; and it has worked on sharing best practice for mitigation through its green paper website. However, no mention is made of any collective, industry-wide quantitative reduction targets (International Dairy Federation, 2011).

Looking beyond GHG emissions, the global agricultural and food sector does have some experience in developing other collective environmental agreements. Examples include the roundtables on Responsible Soy (RTRS), and Sustainable Palm Oil (RSPO), the Forest Stewardship Council, the Marine Stewardship Council, GlobalGap and SEDEX. Many of these will have a bearing on GHG emissions, particularly in relation to deforestation and land use change. Some issues that these schemes raise are explored here since they may have relevance when considering the potential of co-operative agreements targeting GHGs.

The RSPO could potentially have a significant positive role to play in addressing the environmental impacts of palm oil production, since its members together account for around 35 per cent of the global production of palm oil. The RSPO has developed 39 sustainability criteria, organised under eight principles (Laurence *et al.*, 2010; RSPO, 2007). Those relevant to GHG emissions include actions to address land degradation and improve soil quality, and the requirement that new plantings (since November 2005) do not replace primary forest or any area required to maintain or enhance one or more high conservation values (a concept developed by the Forest Stewardship Council to denote areas with high biodiversity or other important ecosystem attributes). The criteria also include the commitment to develop plans to reduce and monitor pollution and emissions, including of greenhouse gases.

The RSPO has set up a GHG working group to develop tools for accounting for GHG emissions from palm oil production and processing, taking account of land use change, and developing best practice guidelines (RSPO, undated). This work is still in process and as yet there are no evaluations of progress on the ground.

Companies producing palm oil to RSPO-approved standards register a given quantity with Greenpalm in return for a certificate. Manufacturers and retailers can then purchase these certificates on-line, in order to claim that they are supporting sustainable palm oil production. In other words, while the complexity of the palm oil supply chain makes it virtually impossible to verify that the actual palm oil purchased is sustainable, it is possible to confirm that the purchase of these certificates have supported methods of production that would not otherwise have been incentivised (Greenpalm, undated).

Many environmental organisations have criticised the RSPO for weak criteria and because tropical deforestation is continuing. This includes peat swamps, which are major carbon sinks. Their destruction and degradation constitutes a major source of CO_2 emissions (Wetlands International, 2010). There is as yet no blanket ban on destruction of peat forests and one analyst notes that the RSPO 'appears to be in denial about the alarming pace of peat-forest destruction' (Laurence *et al.,* 2010). The analysis highlights other, fairly considerable shortcomings:

- It is industry dominated and lacks sufficient representation by NGOs and outside experts.
- Given its weak approach to halting deforestation and peat swamp destruction it is likely to be ineffective in addressing deforestation related GHG emissions.

Multi-stakeholder sustainability initiatives need to be one part of a policy mix

- There is significant non-compliance among members.
- It is too easy to join – companies can join even if they are not certified producers of sustainable palm oil.
- Monitoring processes are weak and the industry rejects remote sensing, which would effectively assess patterns of deforestation.
- There is weak global demand for certified palm oil, especially from the world's largest buyers, China and India, meaning that market incentives are lacking.[11]
- While the principle of certification may be sound, the sustainability criteria themselves are weak, meaning its effectiveness in driving real change is open to question.

The study recommends strengthening the RSPO by addressing the industry imbalance; bringing in remote sensing; taking a stronger stand on destruction of forests and peat swamps; and establishing an independent watchdog to monitor effectiveness and progress (Laurence *et al.*, 2010). These, if implemented, would have the affect of curbing deforestation-related emissions and protecting biodiversity.

A WWF study of a range of multi-stakeholder sustainability initiatives (MSIs) like those discussed here finds that while positive environmental impacts have been recorded, there has been little *quantitative* assessment of their effects (WWF, 2010). Social impacts are mixed; positive impacts on workers and local communities are reported, but there is limited evidence of direct poverty-related effects, such as improved food security and livelihoods. In addition, the cost of certification can be a barrier and MSIs tend to favour large-scale over smaller operators. The effects on businesses themselves can be positive: MSIs can help re-orient business thinking and decision-making on corporate social responsibility, and this in turn can lead to positive commercial impacts.

The report makes the following recommendations for increasing the impact of MSIs:

- MSIs need to be one part of a policy mix that includes national legislation, public procurement policies, tax incentives and tax relief, and start-up grants. These mechanisms are not only important in themselves, but can also strengthen the uptake of MSIs. Financial institutions can play an important role in supporting and enabling MSIs.
- Monitoring and evaluation capacity needs to be strengthened and sharpened. These activities should be systematically conducted on a regular basis to obtain comparable, benchmarking data.
- MSI-market interactions need to be better understood; information is needed on who drives demand at different points in the supply chain, and particularly on how demand is evolving in large developing country markets.
- More monitoring and assessment of the social impacts of MSIs is needed.
- How MSIs operate needs to be improved, including through the development of robust business plans.

---

11. While sales of certified palm oil have increased since the scheme's launch, there is still a considerable gap between supply and demand of certified palm oil. The latest market figures, for 2011, find that supply is equal to 2.7 million tonnes (approximately 9 per cent of the world's total palm oil production) while sales of certified palm oil are 1.2 million tonnes – approximately 46 per cent of supply (RSPO, 2011).

3.3.2. National co-operative agreements: the case of the UK

At the country level, some sectors of the agricultural industry have agreed targets for reducing emissions. The UK is one of the very few countries taking action in this area. For example, in 2008, the UK dairy industry published an environmental 'roadmap' setting out its ambition to reduce GHG emissions by 20–30 per cent by 2020 relative to a 1990 baseline, and to address other environmental issues such as water use (DairyCo, 2008). It sets out a number of targets for dairy producers and processors – for example, entering into Environmental Stewardship Schemes (Defra, undated *a*) or piloting anaerobic digestion.

The dairy industry's latest progress report finds that all except one of its targets have been met (DairyCo 2011). Yet there is no quantitative assessment of the effects of meeting these measures on overall dairy-sector GHG emissions so it is not possible to ascertain what tangible impacts on emissions the roadmap has had. The roadmap's effects on other economic and social factors such as farm profitability are not assessed either.

The UK's beef and sheep sector, led by its representative body, the English Beef and Lamb Executive, has also published a roadmap (EBLEX, 2009). This sets out its plans as to how the sector can reduce its emissions by 11 per cent per kg of meat produced by 2020 in line with the UK government's target for the agricultural sector (see above).

The English pig sector's roadmap aims to reduce emissions per kilogram of pork by 17 per cent by 2020. Measures include more efficient use of feed, breeding for greater productivity, and manure management (BPEX, 2011). Note that both the beef and sheep, and the pork industry targets are relative, not absolute.

3.3.3. Company-defined targets

Some international food retailers and manufacturers, including the chocolate manufacturer Cadbury and the retailer Tesco, are also taking steps to work with their dairy suppliers in benchmarking and reducing emissions.

These actions tend to be part of a broader commitment to reduce the carbon footprint of products. For example, Tesco has promised to reduce the GHG intensity of all its products by 30 per cent by 2020. This commitment will require it to promote reductions at all stages of the life cycle of each product, including from agriculture. Unilever, a company with global reach, is committed to halving the environmental (including carbon) footprint of making and using its products. This includes the consumer stage – for example, in the case of laundry powder it will include reductions in the temperature at which people wash their clothes (Unilever, 2005). These are recent targets and so far their effectiveness has not been analysed.

SUMMARY ASSESSMENT:
CO-OPERATIVE MEASURES

Potential

- The development of co-operative initiatives, such as roundtables, signals some recognition by industry that there a need for action.
- Targets set by individual companies can stretch them, perhaps reflecting a sense that in coming years, carbon-readiness will prove to be a market advantage.
- Co-operative measures may be important for catalysing industry to become engaged in climate change mitigation.

Challenges

- Often these roundtables and co-operative agreements lack ambition: targets tend to reflect a 'lowest common denominator' position and are about process rather than measurable outcomes.
- Co-operative measure are not, on their own, sufficiently effective for tackling emissions reductions.

Future needs

- To achieve real progress, co-operative initiatives need to accept the scrutiny of independent measurement, monitoring and evaluation processes.

3.4 INFORMATION PROVISION

Agricultural extension services are the key route through which farmers receive information on GHG-reducing agricultural practices. The UK's Farming Futures project is a developed world example. The initiative is a partnership between agricultural industries, agricultural trade associations and countryside charities. Farming Futures has produced a series of factsheets, case studies and short films and videos with information to farmers about the science of climate change, and how different agricultural sectors (arable, livestock and so forth) can adapt to climate impacts and mitigate their on-farm GHG emissions. It also runs events across the country on GHG-relevant issues ranging from anaerobic digestion to the impacts of climate change on the arable sector.[12]

The effects of the initiative are difficult to gauge. According to the findings of the Farming Future's annual survey, the proportion of farmers who claim to be taking action to reduce greenhouse gas emissions has stayed more or less the same since 2008, when the project was launched. This suggests that information provision is not in itself sufficient to stimulate measurable changes in practice.

To our knowledge, there has been no research into whether this approach has been adopted in developing countries.

SUMMARY ASSESSMENT:
INFORMATION

There is little evidence of GHG-targeted information provision for the agricultural sector. On its own, it is unlikely to achieve measurable reductions in emissions.

12. See the Farming Futures website at www.farmingfutures.org.uk.

FOUR
MECHANISMS FOR INFLUENCING CONSUMERS

Section 3 has examined MGMs that potentially influence GHG emissions from agricultural production. Changes in what, and how, people consume can also influence production-related emissions, in affecting what is produced and how. There is a relationship between consumer waste behaviour and GHG emissions: wasted food represents a waste of all the emissions generated during the course of its production, processing, distribution and so forth.

Much of the analysis presented so far recognises that production and consumption should not be separated. Nevertheless, while it is increasingly well established that reductions in meat and dairy consumption and in food waste can play a major role in reducing agricultural emissions, very few MGMs seek to influence consumption behaviour. There is also a real lack of research examining *how* behaviour might be changed, and what an appropriate mix of consumption-oriented MGMs might be.

Therefore, in this section we are forced to look laterally at MGMs (or models of MGMs) that have been designed to influence behaviour for other reasons, such as to promote health, or to encourage greater uptake of foods produced to higher ethical standards (relating to animal welfare or working conditions). The main focus is on the developed world, partly because this is where the bulk of analysis can be found, and partly because the challenges in low-income settings are malnutrition and hunger, rather than the reduction in demand for any food type. However, in coming years, dietary shift is likely to emerge as an issue for high meat consuming populations in transition economies.

4.1. ECONOMIC MEASURES

4.1.1. Taxes on meat and dairy products

One model-based study investigates the effects on demand and GHG emissions of changing the price of EU meat and dairy purchases (Wirsenius *et al.,* 2010). The model assumes a tax on animal food products corresponding to 60 euros per tonne CO_2 eq. It finds that the associated decline in consumption could lead to a GHG reduction of approximately 32 million tonnes of CO_2e – equivalent to a 7 per cent reduction in emissions from EU agriculture. Additionally, 11 million hectares of permanent pasture and 4 million hectares of crop land would be made available for alternative uses. If this land were used to grow lignocellulosic energy crops,[13] as a substitute for fossil fuels, then the GHG reduction would be six times higher than the direct savings in livestock emissions, and would represent a 5 per cent cut in the EU's total burden of GHG emissions (not just from agriculture).

These reductions would require very minor changes in consumption; ruminant meat consumption in this model would fall by 15 per cent, while pork and poultry consumption would increase by 1 per cent and 7 per cent respectively, due to substitution between meat categories (pig and poultry meat is, broadly speaking, less GHG-intensive than that of ruminants). In total, food consumption would be reduced by 1 per cent in energy terms, taking into account substitution effects. Overall, the study concludes that consumption taxes on animal food could be a cost-effective policy to abate agricultural GHG emissions.

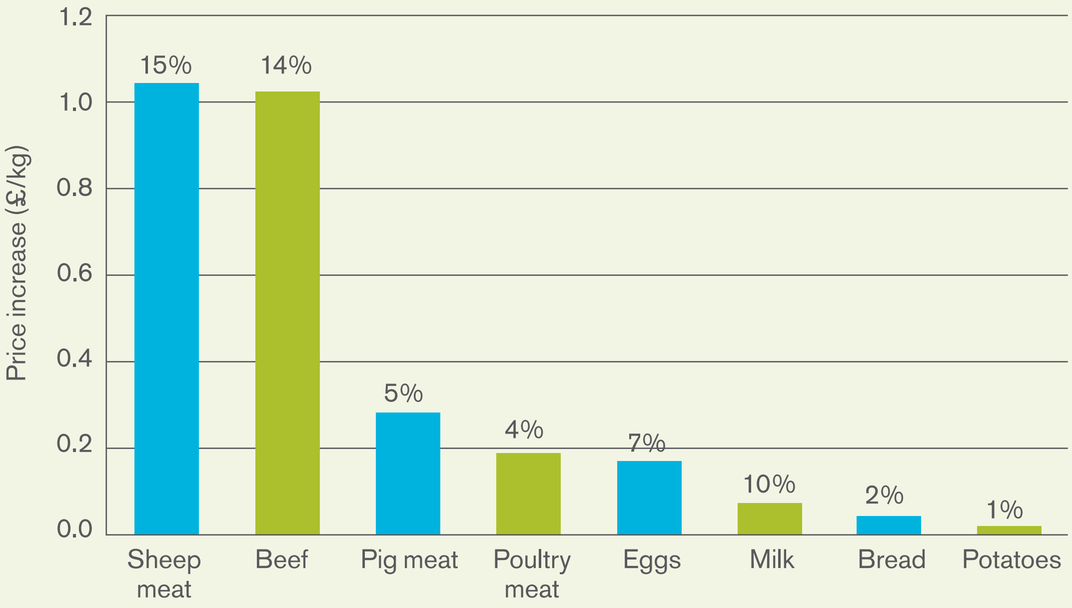
13. Perennials such as willow and miscanthus; sometimes known as second generation biofuels.

Clearly much in this model depends on its assumptions about elasticity of demand. In this case they were based on data on average short-run price elasticities from the UK, France and Greece. It is also important to note that the study taxes *consumption*, not *production* (in contrast to the Livestock Tax Scenario discussed in 3.2.4 above). This avoids encouraging production, and emissions, to shift overseas. On the other hand, it would not necessarily reduce EU livestock production and associated emissions. For example, one response by livestock farmers to reduced domestic consumption might be to increase export efforts. As discussed in the context of the livestock tax, both production- and consumption-related emissions therefore need to be addressed together to bring about absolute emissions reductions.

While the study does not assess the effects on equity and health, a reduction in meat consumption could yield health benefits. Another study found that in the UK a 30 per cent reduction in animal food (meat and dairy products) intake could reduce the burden of ischaemic heart disease by about 15 per cent (Friel *et al.,* 2009). Levels of meat consumption do not differ significantly by socio-economic group in the UK, and hunger is not an issue for the vast majority of the UK public, at least by developing world standards. Nevertheless the tax is likely to have a greater impact on low-income consumers. It may need to be balanced with incentives for consumers to increase their intake of other nutrient-rich foods, such as fruit and vegetables.

Another brief and very high level analysis of the tax effects on consumption has been undertaken by the UK's Committee on Climate Change (CCC, 2010).This considers the impact of a tax of 70 pounds sterling per tonne of CO_2e in 2030 on the price of key food commodities. Note that this tax is higher than the euro 60/tonne CO_2e assumed in the study described above (Wirsenius *et al.*, 2010) and is designed to affect certain non-livestock products too (see Figure 8). The study finds that a price rise of this magnitude could reduce GHG emissions by around 1.3

FIGURE 8: POTENTIAL INCREASES IN FOOD PRICES AS A RESULT OF A CARBON TAX BASED ON AVERAGE EMISSIONS PER KG OF FOOD, 2030



Source: CCC, 2010

million tonnes CO_2e, or a 6 per cent reduction in emissions from these foods. The impact of substitution effects – that is, the GHG consequences of people shifting their diets towards consumption of non-taxed foods – are not considered.

Interestingly, these reductions are a very small percentage of what the CCC identifies as possible through dietary shift: it estimates that public shift in consumption away from red meat and dairy produce could potentially reduce emissions by up to 15 $MtCO_2$e, while maintaining nutritional balance, improving health and freeing up land. This represents a reduction of around one-third of the UK's current agricultural emissions (CCC, 2011). It does not, however, discuss what policies might be needed to achieve these changes in diets.

4.1.2. Can price changes promote healthy eating?

There is a vast literature on eating behaviour and what influences it. Many factors shape what people consume, including personal taste and cultural identity, planning legislation and retail structures. Much research suggests that in the developed world at least, nutritional and environmental health can broadly be aligned (Barilla Center, 2010; Macdiarmid *et al*., 2011). Thus, policy approaches that are successful in improving the public's nutritional well-being may also deliver GHG reductions. A large body of research, summarised here, investigates the extent to which changes in *price* can encourage healthier eating patterns.

Several studies that examined the effect of price reductions on healthy foods found that uptake of healthier foods increased. These studies conclude that price reductions are an effective strategy to increase the purchase of healthier foods in community-based settings and among lower socio-economic groups (French, 2003; Powell *et al*., 2009). However, increases in fruit and vegetable uptake (driven by lower prices) may not lead to a corresponding decline in meat and dairy products. Hence, while there may be health benefits, the environmental gains are uncertain.

The effect of a 'fat tax'

A model-based UK study has investigated the effect of a tax on saturated fats, with the income from the 'fat tax' used to subsidise the cost of fruit and vegetables (Arnoult *et al.,* 2008; Tiffin and Arnoult, 2011). The model found that the tax reduced the consumption of fatty foods to the benefit of fruit and vegetable consumption. There was no analysis of the implications for the rural economy or the environment, but since the main source of saturated fats in the diet are livestock products, it is likely that this shift in consumption would also reduce GHG emissions. It is important to note, however, that the relationship between saturated fat and GHG emissions from livestock is not totally straightforward. Manufacturers can remove fat from meat and dairy products, as in the case of skimmed milk, or low-fat sausages and lean mince. How this waste fat is used affects whether there are overall reductions of GHG emissions. For example, it is common practice to use waste fat as an energy feedstock in rendering plants.

The study concluded that a fat tax should be one component of a suite of instruments for tackling poor diets, rather than being implemented on its own. Fat taxes could make marginal changes in the diets of large numbers of people, with a significant impact on the incidence of disease across the population. However, more complex polices targeting specific socio-economic groups are likely to be more effective in addressing severe chronic dietary diseases affecting some groups. An integrated mix of measures is also likely to be required to bring about pro-environmental behaviour change, and by targeting especially GHG-intensive population groups.

The Danish government has introduced a tax on saturated fat at a rate of 16 Danish Krone (around £1.90 or 2.15 euros) per kg of of saturated fat. The tax must be paid by companies that produce or import food with a saturated fat content of over 2.3 per cent – particularly meat, dairy products, margarine and oil. The tax has been criticised as an income-generating exercise and it has been argued that if the government were serious about improving public health then the tax revenues should be used to subsidise fruit and vegetable prices – which is not the case.

4.1.3. Can price strategies reduce waste?

A handful of municipalities in the US and continental Europe have put in place waste management schemes in which householders pay according to the amount of waste they throw away (Waste Watch, undated), rather than being charged a flat rate for waste collection (usually as part of a package of other council charges). This gives householders a clear fiscal incentive to waste less, either by reducing the amount of food and packaging they throw away or by recycling. The counterpart to pay-as-you-throw schemes, are those where rewards are given to householders who waste less, rather than penalising them for producing waste.

Evidence from the US suggests that pay-as-you-throw schemes can be very effective in reducing the amount of waste going to landfill (MSW Management, 2006). But they can be unpopular and have been voted out by some communities, despite their environmental success. The current UK Conservative-Liberal Democrat coalition government, for example, has scrapped the previous government's plans for introducing pay-as-you-throw, preferring to develop more incentive-based initiatives instead (BBC News 2010). Schemes are more likely to be publicly acceptable if accompanied by education and awareness-raising activities (MSW Management, 2006).

SUMMARY ASSESSMENT: ECONOMIC MEASURES

Potential

- Research into the relationship between price and dietary behaviour suggests that pricing can promote more healthy behaviour.
- Pricing measures may hold potential for shifting behaviour in less GHG-intensive directions, but so far the evidence is model-based only.
- Pricing measures are not sufficient by themselves – a mix of policies is needed both to achieve the desired changes and to ensure public acceptability.

Challenges

- While price changes aimed at fostering healthy diets may reduce GHG emissions, this may be more likely when accompanied by both a tax on livestock products and subsidies for fruit and vegetables.

Future needs

- The economic impacts – on farmers and on consumers – must be examined to ensure there are no regressive impacts. Taxes may have to be matched by economic incentives to minimise negative social impact.

4.2. REGULATORY MEASURES

There are currently no regulatory policies anywhere in the world geared to orienting diets towards greater sustainability; neither do there appear to be any plans to implement any. In any democratic, free-market economy, it is difficult to envisage access to certain foods being banned or rationed except in times of extreme stress – such as during a war. Legal specifications of the environmental credentials of foods (including GHG intensity) are an option but would contravene current World Trade Organisation agreements. The main route for regulation at present is via public procurement, which is the subject of this section.

4.2.1. Public procurement

Public procurement potentially has a strong part to play in influencing the foods consumed in many settings, from schools and hospitals to prisons and work canteens. In practice, however, most governments across the world have done little or nothing to use public procurement for improving the sustainability of diets.

In the UK, for example, despite the government's stated interest in the role of public procurement to foster greener product choices (Defra, undated *b*), the only relevant requirement is that cooking and storage equipment such as fridges and freezers meet 'A'-rated energy efficiency standards. These standards for food are unlikely to have much impact on GHG emissions.

As for the section on economic measures above, we need to extrapolate from the impact of procurement policies on nutritional health to get a sense of whether public interventions could reduce GHG emissions. For example, in the EU there are school-based schemes to raise children's consumption of fruit and vegetables and to instil healthy eating habits. One EU-wide systematic review found that these schemes have been effective in increasing both intake and positive knowledge and attitudes to fruit and vegetables (de Sa and Lock, 2007). A later study of the UK found a more mixed, although still fairly positive, picture: while fruit and vegetable consumption in 2008 was higher than at the beginning of the scheme in 2004, boys' consumption peaked in 2006 and has since fallen. It also suggests that the overall higher levels of consumption are likely due to wider changes to school food, including school dinners, than to the fruit scheme alone (Teeman *et al.,* 2010). Both studies conclude that public sector interventions can help shift behaviour, but that single-solution approaches may not be sufficient – a multi-stranded approach is likely to be needed.

A number of non-governmental organisations are also running public procurement projects; they include Sustain's Good Food on the Public Plate and the Soil Association's Food for Life Project. These are not government mandated schemes, but they do give an indication of what might be achieved if such schemes were rolled out nationally and enshrined in law (Box 7).

There are currently no regulatory policies anywhere in the world geared to orienting diets towards greater sustainability

BOX 7: NGOS: LEADING THE WAY IN SUSTAINABLE FOOD PROCUREMENT

Sustain's Good Food on the Public Plate project is fully funded by the Greater London Authority (GLA) and was launched in its current form in 2006. It aims to increase the proportion of healthy and sustainable food in the meals served by the public sector. Current activities centre on London and the southeast of England. By the end of December 2009, contracts to the value of 1.5 million pounds sterling per year had been signed to procure sustainable produce for a number of public organisations in and around the capital (Sustainweb, 2011a).

The Food for Life Partnership is a collaborative effort of four charities – the Soil Association, Focus on Food Campaign, Health Education Trust and Garden Organic – and is funded from the National Lottery. It awards bronze, silver and gold awards to schools that provide meals which meet certain health and sustainability criteria, and who develop school food-growing projects, children's cooking classes and so forth. In 2010 over 3000 schools were enrolled across the UK (Food for Life Partnership, 2010).

A recent assessment of the Food for Life Scheme found that the social, health and educational impacts have been positive, although the environmental effects were not examined (Orme *et al.,* 2011):

- Ofsted ratings[14] improved following schools' participation in the scheme (37.2 per cent compared to 17.3 per cent pre-enrolment rated as 'outstanding').
- Headteachers reported a positive impact on pupil behaviour, attention and attainment.
- The proportion of primary school children eating five or more portions of fruit or vegetables a day rose by 5 percentage points to 21 per cent (those eating four or more portions rose by 12 percentage points to 49 per cent). Forty five per cent of parents said the family is eating more vegetables.
- Disadvantaged pupils are benefiting: over a two-year period, free school meal take-up went up 13 percentage points on average in partnership schools; uptake was highest at 20.9 per cent in secondary schools, and 21 per cent across the board in schools achieving the Silver or Gold award.
- 67 per cent of participating schools felt the programme had a clear impact on their Ofsted report in terms of pupils' personal development and well-being.

SUMMARY ASSESSMENT: REGULATION

Potential

- Public procurement policy can be effective in changing consumption patterns, but only as part of a package of measures rather than as a stand-alone intervention.

Challenges

- More stringent forms of regulation, such as rationing or bans are unlikely to be politically acceptable at this time.

Further needs

- There needs to be greater political will to examine the scope for public procurement to foster pro-environmental changes in diets.

14. UK government school inspections that rate the schools academic, social and other performance.

4.3. CO-OPERATIVE MEASURES

Recent years have seen the development of industry-wide agreements set up to tackle energy use, water use and waste in the food supply chain. For example, in the UK the Waste Resources Action Programme is a government-funded initiative to improve resource efficiency across the UK economy, including from the food sector. Twenty-nine retailers and manufacturers are signatories to the Waste Resources Action Programme's (WRAP) 'Courtauld Commitment 2'. They have agreed to specific targets on packaging, and to reduce household food and drink waste by 4 per cent by 2012 (from 2009 levels) (WRAP, 2010b). Actions by signatory companies have included technical changes (resizing portions, and developing packaging that keeps food fresh for longer), information and awareness raising, and switching from 'Buy one, get one free' promotions to offering half prices on products (so that people do not buy more than they need) (WRAP, 2010b).

Although progress in the Courtauld Commitment's second phase has not yet been assessed, the results of the first phase show that a total of 670,000 tonnes of food waste and 520,000 tonnes of packaging were avoided across the UK between 2005 and 2009 (WRAP, 2010a).

It is unclear how much of this success is likely to be attributable to the commitment alone, since it forms part of a larger overarching 'Love Food, Hate Waste' campaign by WRAP to reduce household food waste, which has been taken up and promoted widely by NGOs and the media. Furthermore, the data on avoided food waste are based on local authority household waste data, but it has not been possible to ascertain whether the avoided food waste is of the kind sold or produced by Courtauld signatory companies or by other non-participating sources. The impact of the global economic downturn in stimulating more frugal behaviour, including efforts to reduce food waste, also needs to be taken into account, although there has been no assessment of its effects so far.

One of the world's largest food service providers, Sodexo, has signed up to 'Meatless Mondays', in which it provides a meat-free option to customers in 2,000 of its corporate and government client locations (Sodexo, 2011). Since the scheme has only just started, there has been no evaluation of its success. At present, there are no plans to roll the scheme out to its locations in other countries.

SUMMARY ASSESSMENT: CO-OPERATIVE MEASURES

Potential

- Experience from the waste sector suggests that co-operative measures may yield results, although it is hard to untangle the success of the initiatives themselves from the impact of global economic recession (which will itself influence consumer behaviour) and from synergistic public awareness-raising activities.

Challenges and future needs

- There is a need for co-operative measures that focus on addressing dietary patterns and in particular consumption of resource-intensive meat and dairy products. This is likely to be controversial for many in the food industry.
- More analysis is needed to assess the extent to which co-operative measures deliver success when viewed in isolation from other supporting initiatives.

4.4. INFORMATION PROVISION

4.4.1. Life cycle analysis, carbon footprinting and labelling

Recent years have seen the development of a number of tools that seek to quantify the environmental impacts of food and non-food products so that producers can identify environmental 'hotspots' in the supply chain, and seek to mitigate them. Life cycle analysis (LCA) is perhaps the most sophisticated of these approaches. It quantifies impacts in a range of environmental categories, including GHG emissions. The growing focus on carbon has led to the development of narrower carbon footprinting approaches, which assess GHG impacts only. Many countries are now developing standardised methodologies to quantify and assess a product's carbon footprint or GHG emissions throughout its life cycle; the UK's PAS (Publicly Available Specification) 2050 is one such example (British Standards Institute, undated).

Companies that wish to communicate their findings to the public can publish the carbon footprint on food packages alongside nutritional and other information (Figure 9), provided their assessment approach complies with PAS 2050 methodological standards.

The largest scheme to date has been the PAS 2050-compliant Carbon Trust Carbon Reduction Label (Figure 9). This originated in the UK but the label is now seen on products across Europe, North America, Asia and Australasia. To date approximately 5,400 products have been labelled, with more expected as the scheme matures. As of October 2010, products bearing the carbon label represent £2bn worth of sales and this is predicted to expand to £15bn by 2015 (Bamfield, 2010). The UK's leading supermarket retailer has already carbon footprinted over 500 of its food and non-food products (Tesco Plc, 2010).

Other examples of environmental labels include Marks & Spencer's 'by air' logo, as well as those certifying that a product is organic (the Soil Association logo) or produced to certain environmental specifications (the Rainforest Alliance and LEAF marques). There is also a host of non-environmental labels highlighting a product's ethical credentials such as the free range, 'freedom foods' (animal welfare) and the Fairtrade logo. Nutrition labelling has, of course, been standard practice for some time in many developed world countries.

What is their impact?

It is unclear how effective such labels are in driving behaviour change. For example, there is a sense that the growing multitude of different labels could benefit from being streamlined and integrated, in order to avoid confusing consumers and placing unnecessary burdens on the producers who have to comply. It has been suggested that an 'omni label' would ideally provide easy-to-understand information on a number of ethical and environmental issues in a simple format, to enable consumers to make informed decisions. In response to this uncertainty, the UK government commissioned research to (1) investigate the practicality and effectiveness of environmental labelling of food to promote behavioural change; and (2) to compare the pros and cons (including costs) of different labelling formats, including omni-labels (Defra, 2010).

The study concluded that the science is not yet sufficiently robust to justify the development of an environmentally broad omni-label. It recommended that the main role for government

FIGURE 9: EXAMPLE OF A CARBON FOOTPRINT LABEL

Source: Carbon Trust, undated

should instead be to harmonise and improve existing schemes. Importantly, the study also found a lack of evidence on how effective labels actually are as a tool to stimulate change. It concluded that while there is a role for environmental labelling, efforts to reduce the environmental impacts of food should not focus solely or primarily on this approach. Labelling should be part of an integrated suite of initiatives, including government regulation and industry schemes.

Other studies endorse this general conclusion, but are a little more positive about the role of labelling. Van den Bergh *et al.,* (2011) argue that while it is not reasonable to expect labelling to solve a complex problem by radically shifting the behaviour of most or all consumers, labelling may improve a consumer's ability to make choices and may induce firms to change the mix of products offered to consumers. It points to health evidence showing that although nutritional labelling has not eliminated diet-related health problems, it does influence product selection and consumption in some cases (Roberto *et al.,* 2010). Van den Bergh *et al.*'s (2011) report also cites evidence suggesting that consumers have modified purchasing behaviour in response to non-nutritional labels such as 'dolphin-safe' tuna labels (Teisl *et al*., 2002). It emphasises that more work is needed to clarify the impact of labels outside laboratory settings and of labels that provide information on a collective good, such as climate, rather than a private good, such as personal health. Importantly, the purchase of low-carbon products may give rise to contradictory follow-on consequences: people who purchase them may be motivated to take additional 'green' actions – alternatively, however, their 'virtuous' behaviour may give them a sense that they are licensed to increase carbon emissions through other activities (Jacobson *et al.,* 2010).

One potential benefit of carbon labelling is that the process of quantifying the impacts of a certain product increases company understanding of how it might be able to take steps to reduce them. Hence, although carbon labelling may not yet influence consumer behaviour, its presence is a sign that there are footprinting activities underpinning it – signalling industry's growing desire to understand and thereby reduce emissions in their supply chain.

The UK-based international supermarket chain Tesco has a target to reduce emissions in its entire supply chain by 30 per cent by 2020 – a major task that is predicated on the availability of carbon footprinting measurements. The natural next step of a company taking action is to communicate to customers that such an action is taking place – and whether or not the public understands the details of the label itself, the public can appreciate that efforts are taking place.

Other researchers are very critical of carbon labelling, warning that some countries may be negatively affected by any changes in behaviour that result from the introduction of carbon labels (Kasterine and Vanzetti, 2011; Edwards-Jones *et al*., 2008). Countries that are 'highly vulnerable' include those that rely on:

- Crops that are air-freighted and possibly substitutable such as green beans from Kenya.
- Crops with a favourable carbon footprint for only a few months in the year such as apples imported into Europe from Argentina or New Zealand.
- Crops with a higher carbon footprint than EU production and which are vulnerable to technological advances in the EU agricultural sector, such as onions from New Zealand.

On the other hand, traditional tropical commodity crops such as coffee, cocoa, tea and bananas are not vulnerable because there is no local substitution in temperate countries. Kasterine and Vanzetti (2011) warn that setting carbon requirements would increase costs for exporting countries, although the extent of the likely impact will depend upon factors such as the degree of product substitution; consumer reactions to embedded carbon approaches; retailers' demands in the supply chain; and how far embedded carbon approaches are implemented into standard setting.

4.4.2. Social health marketing campaigns

It is possible that government health marketing campaigns, which promote healthy lifestyles, may also have an effect on environmental purchasing behaviour (Box 8). However, they are unlikely to be sufficient in themselves.

BOX 8: CHANGE4LIFE: A UK CAMPAIGN

In 2009 the UK government launched its flagship Change4Life campaign, which aims to encourage people to lead healthier lives, using the slogan 'eat well, move more, live longer'. The campaign involves over 200 partners drawn from the voluntary sector, businesses, local government and health charities, and over 50,000 local community groups.

The campaign is showing signs of success. Awareness of it and its messages is high and there is some evidence that it is influencing purchasing behaviour. However, so far much of the evaluation has focused on assessing brand recognition and 'claimed' rather than actual change (Department for Health, 2010). Moreover, the food industry's involvement in the Change4Life scheme has attracted the criticism of public health campaigners, who fear that it amounts to little more than a marketing exercise (Sustainweb, 2011b).

The UK's House of Lords examined the effectiveness of current UK government approaches to achieving public changes in behaviour across a range of areas from smoking cessation to energy efficiency (House of Lords, 2011). It focused in particular on the government's approaches to addressing obesity and reducing private car use. The report concludes that *'the evidence supports the conclusion that non-regulatory or regulatory measures used in isolation are often not likely to be effective and that usually the most effective means of changing behaviour at a population level is to use a range of policy tools, both regulatory and non-regulatory' (House of Lords, 2011).*

In relation to food health labelling, the report finds that while well-designed labels can increase the reach of health messages, there is still little understanding of the link between knowledge and purchasing patterns and behaviours.

SUMMARY ASSESSMENT: INFORMATION PROVISION

Potential

- Information provision and awareness-raising activities are likely to be a useful, and even necessary, accompaniment to 'harder' measures, but are unlikely to be effective on their own.
- Labelling schemes are often the public face of more substantial efforts taken by industry to understand and manage their life cycle GHG emissions and as such they can be seen as a 'byproduct' of positive action rather than as an end goal in themselves.

Challenges and future needs

- The key challenge is for policymakers to recognise the limitations of information provision. Information provision needs to be seen as part of a package of measures but not as a stand-alone solution itself.

FIVE
CONCLUSIONS: WHICH MGMS COULD WORK, AND HOW?

This review indicates clear potential for well-designed MGM schemes to achieve the triple wins of GHG mitigation, enhanced food productivity, and income generation. These gains could be particularly of benefit to farmers in the developing world who depend upon the land for their survival.

Here we distil our recommendations for designing specific MGMs that can help reduce GHGs without negative consequences for equity and poverty. We then look at some overarching recommendations for ensuring an optimal mix of MGMs.

5.1 ECONOMIC MGMS

Our review suggests that economic instruments such as pricing schemes, emissions trading schemes, and charges and taxes have the potential to reduce emissions from agriculture and the food system. To date few such GHG mitigation schemes currently include agriculture; this should be changed, but their design needs careful attention.

Emissions trading: Modelling work from New Zealand suggests that within the right policy framework, emissions trading could potentially yield benefits for farmers as well as for the environment.

Recommendations:

- Implement fiscal and regulatory measures alongside each other. Fiscal instruments, such as emissions trading schemes, will only reduce emissions significantly if accompanied by a legally required cap on emissions.
- Put measures in place to provide farmers with technological support for abatement.
- Ensure schemes operate in a context of concerted global action to address emissions.

Pricing schemes: The CDM and REDD+ are currently more accessible to larger and better-organised farmers. High transaction costs and complex land tenure arrangements are preventing small-scale farmers from participating or benefiting. Evidence from PES schemes indicates that where small-scale farmers can participate they can benefit, whether or not social goals are explicitly included in schemes.

Recommendations:

- Ensure win-wins between mitigation and enhanced productivity.
- Provide support from agricultural extension services.
- Build local social and institutional capacity.
- Develop context-specific approaches to overcome land use and tenure obstacles.
- Ensure that fiscal incentives (e.g. subsidies) and/or benefits to farmers (in terms of greater productivity, for instance) are sufficiently high for them to want to continue.

Taxes: Taxes can be ineffective and inequitable if they are not well targeted – i.e. if they penalise a certain practice (for example fertiliser use or livestock rearing) rather than the output (greenhouse gas emissions); if they are too low; or if they penalise poorer farmers. They can also encourage leakage – for example, taxing livestock production in the EU may simply encourage production elsewhere and increase imports, unless consumption habits change in tandem. However, such taxes can potentially yield other environmental benefits, such as biodiversity protection.

Consumption-oriented taxation, such as a tax on livestock products, could yield health co-benefits by reducing consumption *and* could reduce GHG emissions. However, if badly designed they may harm poorer consumers, as well as the farming community.

Recommendations

- Ensure that taxes are fair: Taxes on environmental 'bads' (such as emissions) are more likely to be perceived to be fair than taxes on inputs (such as fertiliser). Acceptability can be improved if tax revenues are ring-fenced and used to fund research and development in the agricultural sector.
- Set taxes at a sufficiently high level so they can be effective; this makes it all the more important that they are considered fair.
- Ensure when taxing consumption that a tax on 'bads' (such as meat and dairy products) is matched by subsidies on 'goods', such as fruit and vegetables.
- Back up waste charging schemes — such as *Pay as you Throw* – which can be effective – with community support and awareness-raising activities.

5.2 REGULATORY MGMS

Regulation has an important role to play in reducing emissions, and can be less costly to implement than taxes. Modelling studies suggest that an overall cap on emissions could be a highly effective way of reducing emissions, possibly implemented in combination with some kind of a pricing mechanism (e.g. emission trading schemes). To be effective, compliance with an emission cap requires measuring and monitoring, which is administratively costly. On the positive side, the costs to farmers will be less than for taxation.

Regulation for changing consumer behaviour, such as rationing or bans, is unlikely to be politically acceptable at this time. However, public procurement policy can be effective in changing consumption patterns. There is a need to further examine the scope for public procurement to foster pro-environmental changes in diets, but at the moment there seems to be little political will to do so. Note that public procurement is likely only to be effective as part of a package of measures rather than as a stand-alone intervention.

Recommendations

- Ensure that participants (i.e. farmers) are informed and supportive when implementing regulations. Denmark's positive experience with implementing the EU Nitrates Directive suggests the need for a flexible, multi-faceted approach to implementation, backed up by research and a forward-looking farming community.
- A cap on emissions is a 'precondition' within which other market governance measures (such as pricing) can operate.
- Consider the value of public procurement standards that meet environmental and/or health objectives.

5.3 CO-OPERATIVE MEASURES

Co-operative, voluntary measures are often most acceptable to industry and to governments who seek to adopt a light regulatory touch, but they may be weak and ineffective. Often quantitative targets are not set and difficult issues are avoided. In general, the larger the number of stakeholders, the less challenging the goals. Individual companies tend to be bolder in their adoption of absolute targets than of multi-stakeholder 'lowest common denominator' initiatives. This may reflect their sense that carbon-readiness will prove to be a market advantage.

Recommendations

- Consider backing up co-operative measures with at least the threat of regulation to increase their effectiveness.
- Use co-operative measures for engaging industry and in raising awareness of a concern to be addressed.

5.4 INFORMATION

Labelling and information provision are popular approaches with government and industry alike, but their impact on changing practices is weak.

On the other hand, labelling schemes are often the public face of more substantial efforts taken by industry to understand and manage their life cycle GHG emissions. Thus they can be seen as a 'byproduct' of positive action rather than as an end goal in themselves.

Experience from the waste sector suggests that public information campaigns aimed at reducing food waste can yield results, but their effectiveness needs to be seen in the context of the recent global economic recession, which in itself will have had effects on people's behaviour.

Recommendations

- Implement information provision, labelling and awareness-raising activities as a useful accompaniment to 'harder' measures.

5.5 DESIGNING A MIX OF MGMS FOR THE FOOD AND AGRICULTURE SECTOR

From the above it is clear that one single approach will not 'do the job.' A well-designed and flexible mix of fiscal, regulatory, co-operative and information-providing MGMs will be needed. Furthermore, the social and economic context must not be ignored. To be effective and equitable, MGMs need to consider the social, cultural and economic context within which they operate. Measures aimed at altering farm practices need to be acceptable to farmers and within their capacity to implement. Importantly, they need to be seen by farmers as beneficial, either because they raise incomes or improve yields, or both. To be equitable, issues such as land tenure and transaction costs need to be addressed. On the consumption side, the impact of pricing strategies on lower income consumers need to be considered, and at times disincentives need to be balanced with incentives. The table below summarises the considerations needed to come up with the right mix of instruments for the agricultural sector and for changing consumption (Table 1).

Finally, the science is still uncertain: more research is needed to understand how deep cuts in emissions can be achieved, and in particular into the interplay between the three main GHG emissions – carbon dioxide, methane and nitrous oxide. There is also a real need for empirical research into how consumers might be directed towards less GHG-intensive patterns of food consumption and waste management.

TABLE 1: A FRAMEWORK FOR AN EFFECTIVE MIX OF MGMS FOR REDUCING AGRICULTURAL GHG EMISSIONS

DESIGN CONSIDERATIONS	• **Implement fiscal and regulatory measures hand in hand:** Fiscal instruments, such as emissions trading schemes, will only reduce emissions significantly if accompanied by a legally required cap on emissions. • Back up 'softer' co-operative industry agreements, and information and awareness-raising activities, with 'harder' regulatory or economic measures. • **Avoid 'leakage' risks:** Emissions related to production (agricultural) and consumption (dietary choices) need to be tackled together in order to reduce 'leakage'. If this is not done, emissions are not reduced in absolute terms but simply displaced to other countries or regions. This is a particular problem where mitigation reduces food productivity or overall outputs • **Target outcomes over inputs:** Some MGMs target the inputs to agricultural production (such as fertiliser use) while others target the outputs or outcomes (emissions). In general the latter are more effective in delivering GHG mitigation, but they generate higher measurement, monitoring and evaluation costs. • **Ensure synergies with other environmental concerns:** It is important that measures to reduce GHG emissions do not exacerbate problems in other areas. When designing MGMs it is necessary to balance a range of environmental risks and considerations. Some MGMs, such as emissions charges or trading, may be more effective in delivering mitigation than an 'input' measure such as a livestock tax, but less effective in improving sustainability in other respects, such as biodiversity protection. • Explore pricing instruments that marry health with environmental objectives, although taxation is not necessarily the only option here.
SOCIAL CONSIDERATIONS	• **Clarify land tenure:** This is a major obstacle to the successful and equitable implementation of market-based initiatives such as the CDM, REDD+ and PES schemes. Unless schemes are sensitive to, and work with, land tenure and land use agreements that are often informal, they will fail or will marginalise poorer people. On the other hand, the development of a climate financing scheme can potentially serve as a lobbying tool for poor land users to assert and define their land rights. • **Minimise transaction costs:** Generally the more effective and equitable the scheme the more expensive it is. Effective measurement, reporting and verification (MRV), and the transaction costs associated with involving many small farmers, all demand substantial resources. A decision is needed over who pays for the scheme: generally taxes incur costs to farmers, whereas caps and emissions trading schemes place them on regulators and administrators. • **Consider the impacts on social justice and sustainable development:** Where schemes successfully involve poor people they can increase equity. However, experience from CDM, REDD+ and some PES schemes suggests that large-scale initiatives can often marginalise poorer people. This is partly because of the cost and complexity of involving small land holders in schemes.

SOCIAL CONSIDERATIONS (CONT.)	• **Ensure farmers see tangible benefits:** Schemes are most likely to engage poor farmers and their mitigation objectives where there are other tangible benefits, such as higher yields, incomes or both. • **Provide social and institutional capacity building:** Institutional support and capacity to provide extension services, technology transfer and to engage in the process of MRV is essential, backed by government financial support, and where necessary subsidies and other incentives. Local institutional involvement is particularly important. • **Ensure continuity:** If schemes are to continue to deliver reductions, then they either need to deliver advantages (such as higher yields) that are significant enough to motivate farmers to continue with them, or funding needs to be long-term.
PARTICIPATION CONSIDERATIONS	• **Encourage involvement by the private sector:** Private sector initiatives can often be more effective in achieving their goals than public sector initiatives and can also benefit poor people. However, where there is a single ecosystem service being provided (water quality or carbon sequestration) care needs to be taken to ensure that achieving these goals does not undermine other ecosystem services.
ASSESSMENT CONSIDERATIONS	• **Independent measurement, reporting and verification is essential** whether the MGM is fiscal, regulatory or a co-operative agreement. It is essential not only to ensure that progress is actually being made but also to establish wider trust in the scheme. However, technical difficulties relating to the difficulty of measuring, monitoring and verifying emissions, avoiding leakage and dealing with the issue of permanence increase the complexity and cost of mitigation-oriented MGMs. These costs can make it harder for small farmers to participate in and benefit from schemes. • **Decide what is being measured:** When designing an MGM it is necessary to consider whether GHG mitigation is the only goal, or one of a linked set of objectives (improved soil and water quality, biodiversity protection). • **Establish some kind of land use accounting system that includes agriculture:** This is likely to be essential if leakage and other perverse effects (such as higher food prices) are to be avoided. Further work is needed to see how this might be achieved and where REDD+ might sit within it, taking into account not just carbon sequestration objectives but also broader social and environmental goals.

REFERENCES

ACF (2007). Consuming Australia: Main Findings. Australian Conservation Foundation, based on data collected and analysed by the Centre for Integrated Sustainability Analysis at the University of Sydney. See: www.acfonline.org.au

ActionAid (2011). Agriculture: From Durban to the World http://www.actionaid.org/2011/12/agriculture-durban-world, accessed Dec 2011.

AEA, Ecofys and Fraunhofer ISI (2009). *Quantification of the Effects on Greenhouse Gas Emissions of Policies and Measures. Final report to the European Commission.*

Arnoult M.H., Tiffin R. & Traill W.B. (2008). *Models of Nutrient Demand, Tax Policy & Public Health Impact, RELU* Workpackage No. 1 Report No. 03, University of Reading and Research Councils UK.

ASB (2009). *Reducing Emissions from All Land Uses: The case for a whole landscape approach*, Policy Brief 13. ASB Partnership for the Tropical Forest Margins.

Audsley, E., Brander, M., Chatterton, J. Murphy-Bokern, D., Webster, C., Williams, A. (2010) *How low can we go? An assessment of greenhouse gas emissions from the UK food system and the scope for reducing them by 2050. FCRN and WWF-UK, Godalming, UK. See: http://assets.wwf.org.uk/downloads/how_low_report_1.pdf*

Bamfield, J. (2010). Audit of the Carbon Reduction Label. The Carbon Trust. *Green Retail Trends, Research Report,* CRR, Nottingham.

Barilla Center (2010). *Double Pyramid: Healthy food for people, sustainable food for the planet. Barilla Center for Food and Nutrition, Parma, Italy.* http://www.barillacfn.com/uploads/file/72/1277905159_PositionPaper_BarillaCFN_Double-Pyramid.pdf

BBC News (2010). *Government Rules Out 'Pay As You Throw' Waste Charges, 7 June. See* http://www.bbc.co.uk/news/10251696, accessed 16 February 2012.

Bellarby, J., Foereid, B, Hastings, A. and Smith, P. (2008). *Cool Farming: Climate impacts of agriculture and mitigation potential*. Greenpeace, Amsterdam.

Blackmore, E. (2011). *Shaping Sustainable Markets: A research prospectus*. International Institute for Environment and Development, London. See http://shapingsustainablemarkets.iied.org

BPEX (The British Pig Executive) (2011). *Advancing Together: A roadmap for the English pig industry. BPEX, Warwickshire.*

British Standards Institute (undated). *PAS2050.* http://www.bsigroup.com/Standards-and-Publications/How-we-can-help-you/Professional-Standards-Service/PAS-2050, accessed 10 April 2012.

Carbon Trust (undated). *Home.* http://www.carbontrust.com/. accessed 10 December 2011.

CCC (Committee on Climate Change). (2011). *Meeting Carbon Budgets – 3rd Progress Report to Parliament*, Committee on Climate Change, London.

CCC (2010). Chapter 7: Reducing emissions from agriculture and land use, land-use change and forestry, in *The Fourth Carbon Budget – Reducing emissions through the 2020s*.

ClimateLab (Undated). *Chicago Climate Exchange*. http://climatelab.org/Chicago_Climate_Exchange. accessed 14 January 2011.

CORE (Undated). *Chicago Climate Exchange. See* http://www.co2offsetresearch.org/policy/CCX.html, accessed 8 July 2011.

DairyCo (2008). *The Milk Roadmap*. Dairy Supply Chain Forum's Sustainable Consumption and Production Taskforce. DairyCo, Kenilworth, UK.

DairyCo (2011). *Dairy Roadmap: Our route towards environmental success. Dairy Supply Chain Forum's Sustainable Consumption and Production Taskforce. DairyCo, Kenilworth, UK.*

Davis, C. Daviet, F. Nakhooda, S. and Thuault, A. (2008). A Review of 25 Readiness Plan Idea Notes from the World Bank Forest Carbon Partnership Facility. *WRI WorkingPaper*. World Resources Institute, Washington DC.

DECC (Department for Energy and Climate Change) (Undated). *Carbon Budgets.* http://www.decc.gov.uk/en/content/cms/emissions/carbon_budgets/carbon_budgets.aspx

Defra (UK Department for the Environment, Food and Rural Affairs) (2010). *Effective Approaches to Environmental Labelling of Food Products.* Defra Project FO0419. Defra, London.

Defra (Undated a). *Environmental Stewardship. Defra, London.* http://www.defra.gov.uk/food-farm/land-manage/stewardship/, accessed 16 February 2012.

Defra (Undated b*). Sustainable Public Purchasing. Defra, London.* http://www.defra.gov.uk/environment/economy/purchasing/, accessed 3 December 2011.

Department for Health (2010). *Change4Life One Year On.* UK Department for Health, London.

De Sa, J. and Lock, K. (2007). *School-based Fruit and Vegetable Schemes: A review of the evidence.* London School of Hygiene and Tropical Medicine, London.

Easterling, W.E. *et al.* (2007). *Food, Fibre and Forest Products. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* (eds. M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson). Cambridge University Press, Cambridge, UK.

EBLEX (English Beef and Lamb Executive). (2009). *Change in the Air: The English beef and sheep production roadmap.* English Beef and Lamb Executive, UK.

EC (European Commission) (2010). *The EU Nitrates Directive. EC, Brussels.* http://ec.europa.eu/environment/pubs/pdf/factsheets/nitrates.pdf

EC (2011). *The CAP Towards 2020: Meeting the food, natural resources and territorial challenges of the future. Communication from the Commission to the European Parliament, The Council, The European Economic and Social Committee and the Committee of the Regions. European Commission 18.11.2010 COM(2010) 672 final, Brussels.*

EC (Undated). *The Common Agricultural Policy Explained.* EC, Brussels. http://ec.europa.eu/agriculture/publi/capexplained/cap_en.pdf

Edwards-Jones, G., Plassmann, K., York, E.H., Hounsome, B., Jones D.L., Mila i Canals, L. (2008). Vulnerability of exporting nations to the development of a carbon label in the United Kingdom, *Environmental Science and Policy 12(4): 479-90.*

EIPRO (Environmental Impact of Products) (2006). Analysis of the Life Cycle Environmental Impacts Related to the Total Final Consumption of the EU-25. *European Commission Technical Report EUR 22284 EN, May 2006, EC, Brussels.*

FAO (UN Food and Agriculture Organization) (2007). *The State of Food and Agriculture 2007. Paying Farmers for Environmental Services. FAO, Rome.*

FAO (2009). *Food Security and Agricultural Mitigation in Developing Countries: Options for capturing synergies.* FAO, Rome.

FAO (2010). *Carbon Finance Possibilities for Agriculture, Forestry and other Land Use Projects in a Smallholder Context. Natural Resources Management and Environment Department, FAO, Rome.*

FAO (2011). *Methodology for Sustainable Grassland Management (SGM)*, Version 01. FAO, Rome.

Food for Life Partnership (2010). *Our Work in 2010*. Food for Life Partnership, Bristol.

http://www.foodforlife.org.uk/LinkClick.aspx?fileticket=gQYgQJL-smY%3d&tabid=179

Foresight (2011). *The Future of Food and Farming. Final Project Report*. The Government Office for Science, London.

Forest Carbon Partnership Facility (FCPF). (undated). *Introduction.* See http://www.forestcarbonpartnership.org/fcp/node/12, accessed 25 April 2012.

French, S. A. (2003). Pricing Effects on Food Choices, *Journal of Nutrition 133(3): 841S–843S.*

Friel, S., Dangour, A., Garnett, T., Lock, K., Butler, A., Butler, C.D., Chalabi, Z., Roberts, I., Waage, J., McMichael, A.J., Haines, A. (2009). Public health benefits of strategies to reduce greenhouse-gas emissions: food and agriculture, *The Lancet* 374: 2016–25.

Friends of the Earth International (2008). *REDD Myths: A critical review of proposed mechanisms to reduce emissions from deforestation and degradation in developing countries. Friends of Earth International, The Netherlands.*

Garnett, T. (2008). *Cooking up a Storm: Food, greenhouse gas emissions and our changing climate. Food Climate Research Network, Centre for Environmental Strategy, University of Surrey, UK.*

Garnett, T. (2009). Livestock-related greenhouse gas emissions: impacts and options for policy makers, *Environmental Science & Policy* 12(4): 491–503.

Garnett, T. (2010). *Soil Carbon Sequestration Workshop: Summary of discussion.* Food Climate Research Network, Centre for Environmental Strategy, University of Surrey, UK.

Garnett, T. (2011). Where are the best opportunities for reducing greenhouse gas emissions in the food system (including the food chain)?, *Food Policy 36: S23–S32.*

Ghazoul, J., Koh, L.P. and Butler, R.A. (2010). A REDD light for wildlife-friendly farming, *Conservation Biology 24(3): 644–48.*

Global Donor Platform on Rural Development (2009). Agriculture and Climate Change: Why and how to include agriculture in a post-2012 agreement. *Platform Issue Paper* No. 4. Global Donor Platform on Rural Development, Bonn.

Godfrey-Wood, R. (2011). Carbon Finance and Pro-poor Co-benefits: The Gold Standard and Climate, Community and Biodiversity Standards, *Sustainable Markets Discussion Paper 4. International Institute for Environment and Development, London.*

Goodland, R. (1997). Environmental Sustainability in Agriculture: Diet matters. *Ecological Economics* 23: 189–200.

Green, A.G. and Unruh, J.D. (2010). Clean Development Mechanism Afforestation and Reforestation Projects: Implications for local agriculture. *CAB Reviews: Perspectives in Agriculture, Veterinary Science, Nutrition and Natural Resources 5, No. 057.*

Greenpalm (undated). *Welcome to Greenpalm.* http://www.greenpalm.org/, accessed 11 August 2011.

Gronewold, N. (2011).Chicago Climate Exchange Closes Nation's First Cap-And-Trade System but Keeps Eye to the Future, *New York Times, 3 January.* http://www.nytimes.com/cwire/2011/01/03/03climatewire-chicago-climate-exchange-closes-but-keeps-ey-78598.html, accessed 16 February 2012.

Hall, A. (2008). Better RED than Dead: Paying the people for environmental services in Amazonia. *Philos Trans R Soc Lond B Biol Sci. 27; 363(1498): 1925–932.*

Hertwich, E., van der Voet, E., Suh, S., Tukker, A., Huijbregts M., Kazmierczyk, P., Lenzen, M., McNeely, J. And Moriguchi, Y. (2010). *Assessing the Environmental Impacts of Consumption and Production: Priority Products and Materials. A Report of the Working Group on the Environmental Impacts of Products and Materials to the International Panel for Sustainable Resource Management*. United Nations Environment Programme, Nairobi.

House of Lords (2011). *Behaviour Change. 2nd Report of Session 2010–12*. House of Lords Science and Technology Select Committee, HL Paper 179. House of Lords, London.

IIED (International Institute for Environment and Development). (Undated). *The interface Between Forests, Agriculture And Climate Change: Understanding the implications for REDD. IIED, London.* http://www.iied.org/sustainable-markets/key-issues/environmental-economics/interface-between-forests-agriculture-and-cli, accessed 17 February 2012.

International Dairy Federation (2009). *A Global Dairy Agenda for Action – Climate Change. International Dairy Federation, Brussels.* http://www.dairy-sustainability-initiative.org

International Dairy Federation (2011). *The Global Dairy Agenda for Action on Climate Change: Progress report 2009-2011. International Dairy Federation, Brussels.*

Jacobson, G., Kotchen, M. J. & Vandenbergh, M. P. (2010). *The Behavioral Response to Voluntary Provision of an Environmental Public Good: Evidence from Residential Electricity Demand. National Bureau of Economic Research, Cambridge, MA.*

Kasterine, A. and Vanzetti, D. (2011). *The Effectiveness, Efficiency and Equity of Market-based and Voluntary Measures to Mitigate Greenhouse Gas Emissions from the Agri-food Sector*. UNCTAD, New York.

Kelsey, B.J, Kousky, C. and Sims, K.R.E. (2008). Designing payments for ecosystem services: lessons from previous experience with incentive-based mechanisms, *Proc Natl Acad Sci USA 105(28): 9465–470.*

Kemkes, R.J, Farley, J. and Koliba, C.J. (2010). Determining when payments are an effective policy approach to ecosystem service provision, *Ecological Economics 69:2069–074.*

Kirkland, J. (2010). *Sale of Chicago Climate Exchange to ICE Reinforces Weak Carbon Market. New York Times, 3 May.* http://www.nytimes.com/cwire/2010/05/03/03climatewire-sale-of-chicago-climate-exchange-to-ice-reinfo-362.html, accessed 16 February 2012.

Kronvang, B., Andersen, H.E., Børgesen, C. Dalgaard, T., Larsen, S.E., Bøgestrand, J. and Blicher-Mathiasen, G. (2008). Effects of policy measures implemented in Denmark on nitrogen pollution of the aquatic environment, *Environmental Science & Policy* 11(2): 144–52.

La Via Campesina. (2011). *La Vía Campesina Declaration in Cancun*, 14 January. La Via Campesina, Jakarta. http://www.viacampesina.org/en/index.php?option=com_content&view=article&id=1018:la-via-campesina-declaration-in-cancun&catid=48:-climate-change-and-agrofuels&Itemid=75, accessed 17 February 2012.

Lally, B., Riordan, B. and van Rensburg, T. (2009). Controlling agricultural emissions of nitrates: regulations versus taxes, *Journal of Farm Management* 13(8): 557–73.

Larsen, D.F, Dinar, A. and Frisbie, J.A. (2011). *Agriculture and the Clean Development Mechanism*, Policy Research Working Paper. Development Research Group, Agriculture and Rural Development Team, World Bank, Washington DC.

Laurence, WF, Koh, L.P, Butler, R. Sodhi, N.S., Bradshaw, C.J.A., Neidel, J.D., Consunji, H. and Vega, J.M. (2010). Improving the performance of the Roundtable on Sustainable Palm Oil for Nature Conservation, *Conservation Practice and Policy 24(2): 377–81.*

Leip A., Weiss, F., Wassenaar, T., Perez, I., Fellmann, T., Loudjani, P., Tubiello, F., Grandgirard, D., Monni, S. and Biala, K. (2010). *Evaluation of the Livestock Sector's Contribution to the EU Greenhouse Gas Emissions (GGELS) – Final report. European Commission, Joint Research Centre, Brussels.*

Lipper L, Dutilly-Diane C, McCarthy N (2010). Supplying carbon sequestration from West African rangelands: opportunities and barriers, *Rangeland Ecology Management* 63:155–66.

Liu, J., Li, S., Ouyang, Z., Tam, C. and Chen, X. (2008). Ecological and socioeconomic effects of China's policies for ecosystem services, *Proc Natl Acad Sci USA105(28): 9477–82.*

Lundqvist, J., de Fraiture, C. and Molden D. (2008). *Saving Water: From Field to Fork – Curbing Losses and Wastage in the Food Chain. SIWI Policy Brief. Stockholm International Water Institute, Stockholm.*

Macdiarmid, J., Kyle, J., Horgan, G., Loe, L., Fyfe, C., Johnston, A. and McNeill, G. (2011). *Livewell -– A Balance of Healthy and Sustainable Food Choices.* WWF-UK, Godalming, UK.

Mills, J., Courtney, P., Gaskell, P., Reed, M. and Ingram, J. (2010). *Estimating the Incidental Socio-economic Benefits of Environmental Stewardship Schemes: Final Report. Countryside and Community Research Institute, Gloucestershire.*

MSW Management (2006). The rise and . . . rise of pay-as-you-throw, *Elements* 15:4. MSW Management. http://www.mswmanagement.com/MSW/Articles/The_Rise_and_Rise_of_PayAsYouThrow_1520.aspx, accessed 12 April 2012.

Neely, C., Bunning, S. and Wilkes, A. (eds) (2009). Review of Evidence on Drylands Pastoral Systems and Climate Change: Implications and opportunities for mitigation and adaptation. Land Tenure and Management Unit (NRLA), *Land and Water Discussion Paper 8. FAO, Rome.*

Negra, C. and Wollenberg, E. (2011). *Lessons from REDD+ for Agriculture*. CCAFS Report 4. The CGIAR Research Program, Climate Change, Agriculture and Food Security (CCAFS). Copenhagen, Denmark. Available online at: www.ccafs.cgiar.org

Nelson, E., Polasky, S., Lewis, D.J., Plantinga, A.J., Londsdorf, E., White, D., Bael, D. and Lawler, J.J. (2008). Efficiency of incentives to jointly increase carbon sequestration and species conservation on a landscape, *Proc Natl Acad Sci USA105(28): 9471–476, 15 Jul.*

Netherlands Environmental Assessment Agency (PBL) (2009). *Environmental Balance: Summary*. Netherlands Environmental Assessment Agency (PBL), Bilthoven.

Neufeldt, H. and Schäfer, M. (2008). Mitigation strategies for greenhouse gas emissions from agriculture using a regional economic-ecosystem model, *Agriculture, Ecosystems and Environment* 123: 305–16.

Nieberg, H. (2009). Auf den Nahrungskonsum zuzüchzuführende TGH-Emissionen. Chapter 4 in B. Osterburg, H. Nieberg, S, Rüter *et al*. Erfassung, Bewertung und Minderung von

Triebhausgasemissionen des deutschen Agrar- und Ernährungssektors. Arbeitsberichte aus der vTI – Agrarökonomie.

Nussbaumer, P. (2009). On the contribution of labelled certified emission reductions to sustainable development: a multi-criteria evaluation of CDM projects, *Energy Policy 37: 91–101.*

Olsen, K.H and Fenhamm, J. (2008). Sustainable development benefits of clean development mechanism projects: a new methodology for sustainability assessment based on text analysis of the project design documents, submitted for validation, *Energy Policy* 36: 2819–830.

Orme, J., Jones, M., Kimberlee, R., Weitkamp, E., Salmon, D., Dailami, N., Morley, A. and Morgan, K. (2011). *Food for life Partnership Evaluation: Full report.* Project Report. University of the West of England, Bristol.

Pagiola, S., Ramírez, E., de Haan, C., Ibrahim, M., Murgueitiod, E. and Ruíza, J.P. (2007a). Paying for the Environmental Services Of Silvopastoral Practices in Nicaragua. *Ecological Economics 64: 374–85.*

Pagiola, S., Rios, A.R. and Arcenas, A. (2007b). *Can the Poor Participate in Payments for Environmental Services? Lessons from the Silvopastoral Project in Nicaragua. World Bank, Washington DC.*

Parfitt, J., Barthe, I.M. and Macnaughton, S. (2010). Food waste within food supply chains: quantification and potential for change to 2050, *Phil. Trans. R. Soc*. B 365: 3065–081.

Pelletier, N., Pirog, R. and Rasmussen, R. (2010). Comparative life cycle environmental impacts of three beef production strategies in the upper midwestern united states, *Agricultural Systems* 103: 380–89.

People's Daily (2000).Grain-for-Green project takes off in West China. http://english.people.com.cn/english/200004/17/eng20000417_39061.html, accessed January 2012.

Perez, C., Roncoli, C., Neely, C. and Steiner, J.L. (2007). Can carbon sequestration markets benefit low-income producers in semi-arid Africa? Potentials and challenges, *Agricultural Systems 94: 2–12.*

Perrot-Maître, D. (2006) *The Vittel Payments for Ecosystem Services: A 'perfect' PES case?* International Institute for Environment and Development, London.

Peters-Stanley, M., Hamilton, K., Marcello, T. and Sjardin, M. (2011). *Back to the Future. State of the Voluntary Carbon Markets 2011.* Ecosystem Marketplace/Forest Trends, Washington DC and Bloomberg New Energy Finance.

Popp, A., Lotze-Campen, H. and Bodirsky, B. (2010). Food consumption, diet shifts and associated non-co_2 greenhouse gases from agricultural production, *Global Environmental Change* 20: 451–62.

Porras, I. (2010). *Fair and Green? Social impacts of payments for environmental services in Costa Rica.* International Institute for Environment and Development, London.

Powell, L.M, Zhao, Z. and Wang, Y. (2009). Food prices and fruit and vegetable consumption among young american adults, *health and place* 15(4):1064–70.

RACCP (Regional Activity Centre for Cleaner Production) (2008). *Sustainable Consumption and Production in the Mediterranean, Annual Technical Publication. Regional Activity Centre for Cleaner Production, Barcelona.*

Rasul, G. (2009). Ecosystem services and agricultural land-use practices: a case study of the Chittagong Hill Tracts of Bangladesh, *Sustainability: Science, Practice and Policy 5(2).*

REDD-Monitor (2010). *REDD: An introduction. http://www.redd-monitor.org/redd-an-introduction/ accessed 21 October.*

REDD net (2010). *The Impact of REDD+ on Poverty Reduction. http://redd-net.org/resource-library/taking-stock-of-redd+-what-do-we-know-in-2010, accessed 17 February 2011.*

Reid, R.S, Thornton, P.K., McCrabb, G.J., Kruska, R.L., Atieno, F. and Jones, P.G. (2004). Is it possible to mitigate greenhouse gas emissions in pastoral ecosystems of the tropics?, *Environment, Development and Sustainability 6: 1–2.*

Roberto, C. A., Larsen, P. D., Agnew, H., Baik, J. & Brownell K. D. (2010). Evaluating the Impact of menu labeling on food choices and intake, *Am. J. Public Health* 100: 312–18.

Roncoli, C., Jost, C., Perez, C., Moore, K., Ballo, A., Cissé, S. and Ouattara, K. (2007). Carbon sequestration from common property resources: lessons from community-based sustainable pasture management in north-central Mali, *Agricultural Systems 94: 97–109.*

RSPO (Roundtable on Sustainable Palm Oil) (2007). *RSPO Principles and Criteria for Sustainable Palm Oil Production. Roundtable on Sustainable Palm Oil, Kuala Lumpur.* http://www.rspo.org/files/resource_centre/RSPO%20Principles%20&%20Criteria%20Document.pdf

RSPO (undated). *GreenHouse Gas Working Group 2 (GHG WG2)* http://www.rspo.org/?q=page/532, accessed 11 August 2011.

RSPO (2011). *RSPO Trademark: Next Phase in Transformation to Sustainable Palm Oil*. Roundtable on Sustainable Palm Oil, Kuala Lumpur. http://www.rspo.org/?q=content/rspo-trademark-next-phase-transformation-sustainable-palm-oil, accessed November 2011.

RTRS (Round Table on Responsible Soy Association) (2011). *Round Table on Responsible Soy Association*. www.responsiblesoy.org, accessed November 2011.

Sánchez-Azofeifa, G.A., Pfaff, A., Robalino, J.A. and Boomhower, J.P. (2007). Costa Rica's payment for environmental services program: intention, implementation, and impact, *Conserv Biol. 5:1165–73.*

Saunders, C. and Saunders, J. (2011). *The Impacts of the New Zealand Emissions Trading Scheme on Economic and Environmental Factors. Draft.* Agribusiness and Economics Research Unit, Lincoln University, New Zealand.

SEPA (Swedish Environmental Protection Agency) (2010).*The Climate Impact of Swedish Consumption, Report 5992. Swedish Environmental Protection Agency, Stockholm. http://www.naturvardsverket.se/Documents/publikationer/978-91-620-5992-7.pdf*

Smith P. (2008). Land Use change and soil organic carbon dynamics,,*Nutr Cycl Agroecosyst*. 81:169–78.

Smith, P., Goulding, K.W., Smith, K.A., Powlson, D.S., Smith, J.U., Falloon, P. and Coleman, K. (2001). Enhancing the carbon sink in European agricultural soils: including trace gas fluxes in estimates of carbon mitigation potential, *Nutr Cycl Agroecosyst 60: 237–52.*

Smith, P., D. Martino, Z. Cai, D. Gwary, H. Janzen, P. Kumar, B. McCarl, S. Ogle, F. O'Mara, C. Rice, B. Scholes and O. Sirotenko. (2007). *Agriculture.* In B. Metz, O.R. Davidson, P.R. Bosch, R. Dave and L.A. Meyer (eds). *Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge.

Söderholm, P. and Christiernsson, A. (2008). Policy effectiveness and acceptance in the taxation of environmentally damaging chemical compounds, *Environmental Science and Policy* 22: 240–52.

Sodexo (2011). *Sodexo More Than Triples Reach of Its Meatless Monday Offer. News release 18 April. Sodexo, Gaithersburg, MD.*

Stehfest, E., Bouwman, L., van Vuuren, D.P., den Elzen, M.G.J., Eickhout, B. and Kabat, P. (2009). Climate benefits of changing diet, *Climatic Change* 95: 83–102.

Steinfeld, H. (2006). *Livestock's Long Shadow. Food and Agriculture Organisation, Rome.*

Stern, N. (2007). *The Economics of Climate Change: The Stern Review. Cambridge University Press, Cambridge, UK.*

Stumhofer, T. (2010). The Chicago Climate Exchange Closure, a Vote for Robust GHG MRV? GHG Management Institute, Silver Spring, US. http://ghginstitute.org/2010/11/10/the-chicago-climate-exchange-closure-a-vote-for-robust-ghg-mrv/, accessed 17 February 2012.

Sustainweb (2011a). *About the Project.* http://www.sustainweb.org/goodfoodpublicplate/about/, accessed November 2011.

Sustainweb (2011b). *Children's Food Campaign Response to Change4Life 'Great Swapathon'* 05/01/2011. http://www.sustainweb.org/news/jan11_swapathon_response/, accessed 2 December 2011.

Sutter, C. and Parreño, J.C. (2007). Does the Current Clean Development Mechanism (CDM) Deliver its Sustainable Development Claim? An analysis of officially registered CDM projects. *Climatic Change 84:75–90.*

Teeman, D., Lynch, S., White, K. *et al.* (2010). *The Third Evaluation of the School Fruit and Vegetable Scheme*. National Foundation for Educational Research and University of Leeds, UK.

Teisl, M.F., Roe, B. & Hicks, R.L. (2002). Can eco-labels tune a market? Evidence from Dolphin-Safe labeling, J. *Environ. Econ. Manag* 43: 339–59.

Tennigkeit, T. and Wilkes, A. (2008). *Carbon Finance in Rangelands: An assessment of potential in communal rangelands*. World Agroforestry Centre, Kunming, China.

Terrestrial Carbon Group (2008). *How to Include Terrestrial Carbon in Developing Nations in the Overall Climate Change Solution. The Terrestrial Carbon Group, July (Update 1 with corrections August 2008).*

Terrestrial Carbon Group (2010). *Agricultural Expansion and REDD+: An Assessment of Risks and Considerations to Inform REDD+ and Land Use Policy Design, Policy Brief. Terrestrial Carbon Group.*

Tesco Plc (2010). *Tesco Corporate Responsibility Report 2010. Tesco Plc, Cheshunt, UK.*

Tiffin, R. and Arnoult, M. (2011). The public health impacts of a fat tax, *European Journal of Clinical Nutrition* 65: *European Journal of Clinical Nutrition* 65, 427-433.

UNEP (United Nations Environment Programme). (2009). *The Environmental Food Crisis: The environment's role in averting future food crises.* United Nations Environment Programme, Nairobi.

UNEP and IUCN (Undated). *Developing International Payments for Ecosystem Services: Towards a greener world economy.* United Nations Environment Programme (Nairobi) and International Union for the Conservation of Nature,Gland.

UNFCCC (2011). *Expected annual CERs from registered projects by host party.* http://cdm.unfccc.int/Statistics/Registration/AmountOfReductRegisteredProjPieChart.html, accessed 12 April 2012

UNFCCC (United Nations Framework Convention on Climate Change). (2008). *Expected Annual CERs from Registered Projects by Host Party*. UNFCCC statistics, available at http://cdm.unfccc.int/Statistics/Registration/RegisteredProjByScopePieChart.html

Unilever (2010). *Unilever Sustainable Living Plan.* Unilever, London. http://www.unilever.com/images/UnileverSustainableLivingPlan_tcm13-239379.pdf

Unruh, J.D. (2008). Carbon Sequestration in Africa: The land tenure problem, *Global Environmental Change* 18: 700–70.

Van den Bergh M P, Dietz T and Stern P C. (2011). Time to try carbon labelling, *Nature Climate Change 1: 4–6.*

Waste Watch (Undated). *Pay As You Throw.* http://www.wastewatch.org.uk/pages/pay-as-you-throw.html, accessed 3 December 2011.

Weber, C. and Matthews, H. (2008). Food-miles and the relative climate impacts of food choices in the United States, *Environmental Science & Technology* 42(10): 3508–513.

Wetlands International (2010). *The Global Peatland CO_2 Picture. Peatland status and drainage related emissions in all countries of the world.* Wetlands International, Wageningen.

Williams, A.G., Audsley, E. and Sandars, D.L. (2006). *Determining the Environmental Burdens and Resource Use in the Production of Agricultural and Horticultural Commodities*. Main Report. Defra Research Project IS0205. Cranfield University, Bedford, and Defra, London.

Wirsenius, S., Hedenus, F. and Mohlin, K. (2010). Greenhouse Gas Taxes on Animal Food Products: Rationale, tax scheme and climate mitigation effects. *Climatic Change,* Springer Science DOI 10.1007/s10584-010-9971-x, available at www.smmi.nu/GHG_taxes_on_animal_food.pdf

World Bank (Undated). *Catalyzing Markets for Climate Protection and Sustainable Development. The World Bank, Washington DC.* http://wbcarbonfinance.org/Router.cfm?Page=FAQ&ItemID=24677#4, accessed 5 July 2011.

World Development Report (2008). *Agriculture for Development. World Bank, Washington DC.*

World Development Report (2010). *Development and Climate Change.* World Bank, Washington DC.

WRAP (Waste Resources Action Programme) (2010a). *Courtauld Commitment 1 (2005–2010): Examples of household packaging optimisation and food waste. Waste Resources Action Programme, Banbury.*

WRAP (2010b). *Courtauld Commitment 2. Waste Resources Action Programme, Banbury.* http://www.wrap.org.uk/retail_supply_chain/voluntary_agreements/courtauld_commitment/, accessed 24 May 2011.

WRAP (2010c). *One Million Tonnes of Waste Prevented through Courtauld Success.* News Release: Waste Resources Action Programme, 23 September. WRAP. http://www.wrap.org.uk/media_centre/press_releases/one_million_tonnes.html

Wunder, S. (2005). Payments for Environmental Services: Some nuts and bolts. *CIFOR Occasional Paper No. 42. CIFOR, Bogor.*

Wunder, S., Engel, S. and Pagiola, S. (2008). Taking stock: a comparative analysis of payments for environmental services programs in developed and developing countries, *Ecological Economics 65: 834–52.*

WWF (Worldwide Fund for Nature) (2010). *Certification and Roundtables: Do they work? WWF review of multi-stakeholder sustainability initiatives. WWF, Gland.*

CLIMATE CHANGE AND AGRICULTURE

CAN MARKET GOVERNANCE MECHANISMS REDUCE EMISSIONS FROM THE FOOD SYSTEM FAIRLY AND EFFECTIVELY?

Climate and agriculture are inextricably linked: the climate affects agricultural production and is itself affected by agricultural emissions. Agriculture is responsible for 30 per cent of global greenhouse gas emissions. How agriculture is practised therefore has significant potential for mitigating climate change, for providing food security and for improving the livelihoods of millions of food producers worldwide.

There is growing interest in the use of market governance mechanisms for tackling climate change by giving the financial incentives to make the kinds of changes that are required. But how widely are these mechanisms being used in agriculture, and are they effective in reducing emissions? What impact do they have on adaptation and other aspects of sustainable development? Are they able to balance the competing demands of producers and consumers, the environment and food security?

This study seeks to answer these questions. It gives a comprehensive overview of the full spectrum of regulatory, economic, voluntary and information-related instruments. It explores their potential for affecting how food is produced, and also how it is consumed.

The key messages emerging from this study are that economic measures have a vital part to play within this regulatory context, but they need to be designed with care. To be effective, emissions from food production and consumption must be addressed together. If not, emissions reduced in one region will simply be displaced elsewhere. A balance needs to be struck by applying a mix of approaches – regulatory, economic, voluntary, and information: no single measure will be effective in achieving emissions reductions on its own. 'Soft' measures, such as voluntary agreements and information have a part to play in providing an enabling context for action, but they must be backed up by 'harder' regulatory or economic measures. Regulation, in the form of a cap on emissions, is a prerequisite for other market governance measures to function well. To be effective, MGMs need to consider the social, cultural and economic context within which they operate.

iied

The International Institute for Environment and Development is one of the world's top policy research organisations working in the field of sustainable development. With its broadbased network of partners, IIED is helping to tackle the biggest issues of our times – from climate change and cities to the pressures on natural resources and the forces shaping global markets.

International Institute for Environment and Development
80–86 Gray's Inn Road
London, England
WC1X 8NH
Tel: +44 (0)20 3463 7399
Fax: +44 (0)20 3514 9055
email: info@iied.org
www.iied.org