OECD Green Growth Studies

Policy Instruments to Support Green Growth in Agriculture



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BETTER POLICIES FOR BETTER LIVES

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Foreword

Green growth has been identified as an alternative global growth trajectory, and in many countries all economic sectors are being scrutinised for the extent to which they offer growth potential that is environmentally benign and socially beneficial. This report synthesises the experience of OECD countries in developing and implementing policies, programmes and initiatives related to green growth in the agricultural sector, based primarily on material provided by governments. It discusses: *i)* the overall approach that countries are taking towards establishing a green growth strategy in agriculture; *ii)* the implementation of the OECD framework for monitoring progress towards green growth in agriculture; and *iii)* the various policy instruments used. A key conclusion is that, while most countries have some policies in place that relate to the concept of green growth, the degree of ambition shows considerable variation. A wide range of instruments and a variety of "policy mixes" are currently applied across OECD countries, with the majority of countries appearing to have strategic objectives covering a wide range of subjects related to green growth, particularly in the area of improving energy efficiency and reducing the carbon footprint of agriculture.

A coherent overall policy framework that has clear objectives, sets R&D priorities, and policy measures that are targeted and implemented at the appropriate levels are essential to establish a comprehensive strategy for green growth in agriculture.

Dimitris Diakosavvas, of the Directorate for Trade and Agriculture, is the author of this report, which was declassified by the OECD Joint Working Party on Agriculture and the Environment. The report was prepared for publication by Françoise Bénicourt and Theresa Poincet.

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Executive summary

The purpose of this report is to synthesise the experience of OECD countries in developing and implementing policies, programmes and initiatives related to green growth in the agricultural sector.

The concept of green growth

- Green growth is defined as fostering economic growth and development, while sustaining the natural assets base that provides the resources and environmental services on which our well-being relies. Increasing concerns about the sustainability of current patterns of economic growth underpin the demand for a greener model of growth. A continuation of a "business-as-usual" approach to meeting the rising global demand for food, energy and infrastructure will result in using natural resources beyond their ecological carrying capacity.

- Green growth implies policies that either incrementally reduce resource use per unit of value added (*relative decoupling*) or keep resource use and environmental impacts stable or declining while the economy is growing overall (*absolute decoupling*).

Agriculture policy initiatives and policy instruments

- While the term "green growth" is currently gaining wide recognition among policy makers, the vast majority of OECD countries do not have an overall green growth strategy for their agricultural sectors. Numerous individual national policies were identified as being consistent with the concept, but most countries indicated that, so far, there is no consensus within relevant ministries on a formal strategy to develop and implement policies and encourage private initiatives on "green growth" for the agricultural sector. Several countries utilise the terms "green growth" and "sustainable development" interchangeably, whereas official objectives and targets have only been set for the latter.

- Only a small number of policy instruments and initiatives have been developed with aims consistent with those of the concept of achieving green growth in agriculture. Most of these policies were already in place before the publication of the OECD's Green Growth Strategy. For EU members, most of the green growth initiatives form part of the national Rural Development Programmes 2007-13.

- The initiatives undertaken that support green growth in agriculture cover a wide spectrum of policy areas. In several countries, most of these policy initiatives are weighted more towards the "green" dimension rather than "growth". Most countries have focused on improving energy efficiency and achieving low carbon emissions in the agricultural sector.

- Differences exist concerning the relative emphasis to be accorded different types of policies that support "green growth" (e.g. internalisation of environmental externalities, strengthening of incentives to support green innovation and technologies, etc.), but most countries underscore that core elements are: production of renewable energy, improvements to energy and material efficiency, and attainment of a low-carbon agro-food sector.

- Both strategic objectives and targets that support green growth (i.e. quantifiable policy goals with a designated timeframe) vary substantially across countries.

- Strategic objectives highlighted by several countries include: supporting a competitive business sector (including in rural areas); using agri- and forestry raw materials to contribute to renewable energy generation; promoting an open and transparent global economy, using export opportunities.

- Specific, quantifiable and time-bound targets have been mostly reported in the areas of reducing energy use, increasing the share of renewable energy in total energy use, improving energy efficiency, including that of buildings, extending the area of land under organic farming and, for a handful of countries, reducing the use of harmful pesticides.

- Most of these objectives and targets appear to be driven by international agreements or − for EU members − by EU requirements, particularly those pertaining to environmental policy and those already included in agricultural and rural development policy. More specifically, a majority of EU members report not only objectives for increasing energy efficiency, but also targets for absolute reductions in energy use, both of which are driven by EU energy policy.

- A wide range of instruments and a variety of "policy mixes" are applied across OECD countries. Policy instruments supporting green growth relate not only to traditional regulatory or "command and control" approaches, but to a much wider array of tools − such as economic, informational, co-operation and educational instruments. Caution is needed in making broad generalisations about the preferred approaches, as priorities and time paths vary across countries.

- The most common policies highlighted by countries include regulation, promotion of low-emission technologies, promotion of renewable energies, and improvement of energy efficiency. Also mentioned are support for the development of eco-industry and markets for green business, and eco-labelling.

- Very few countries have exploited the potential for green economy measures to create employment.

- There is a broad consensus that meeting the challenge of "sustainable intensification" – the "double Green Revolution" − will not be possible without considerable investment in agricultural research and development. The application of existing and new knowledge on the farms and in the food sectors can improve yield, sustainability and resource-use efficiency. Ongoing long-term investment in innovation and R&D is essential in order to improve productivity, reduce environmental impacts and increase competitiveness.

- Most OECD countries have directed greater attention towards improving their knowledge bases relating to environmental issues in agriculture over the past two decades through increased spending on agri-environmental research, often undertaken through public-private partnerships. The rise of the knowledge economy has been accompanied, inter alia, by the increased economic importance of the property rights attached to the production and commercialisation of new ideas.

- Some countries cite putting a price on pollution through economic policy instruments, such as emissions trading schemes, as one of the most effective ways of promoting a green growth.

- Although OECD countries have made a concerted effort to reduce the most environmentally harmful types of agricultural supports – those based on prices and output levels – such support still constitutes half of the total support accorded to agricultural producers. The potentially most environmentally harmful fell from 74% of the total support in 1995-97 to 50% in 2009-11, while the share of the potentially most environmentally beneficial support has risen from 5% to 8% of total support over the same period.

- A great variety of institutional settings and organisational arrangements are involved in the development and implementation of policies that support green growth. Typically, four types of ministries are involved – those addressing environment, energy, economy and agriculture. A few countries have established mechanisms to co-ordinate work, or "specialised agencies" or international research consortia to support policy development (e.g. Global Research Alliance on agricultural greenhouse gases). The involvement of regional and local-level administrations in policy making seems to be limited.

Monitoring progress

- Four OECD countries (the Czech Republic, Korea, the Netherlands and the Slovak Republic) have applied the OECD framework for measuring progress towards green growth. Although the application of the OECD framework is largely consistent, the emphasis on agriculture and the selection of agricultural-related indicators differ.

Chapter 1

Green growth and agriculture

Green growth has been identified as an alternative global growth trajectory, and in many countries economic sectors are being scrutinised for the extent to which they offer growth potential that is environmentally benign and socially beneficial. This introductory chapter provides a concise discussion of the concept of green growth and its relation to agriculture, and explains the objective of the report, which is to provide a synthesis of the policy instruments that OECD member countries have adopted in order to achieve their green growth objectives in agriculture.

Green growth has been identified as an alternative global growth trajectory, and in many countries all economic sectors are being scrutinised for the extent to which they offer growth potential that is environmentally benign and socially beneficial (OECD, 2011a, 2011b; EC, 2011a; 2011b; Hallegatte et al., 2012). Green growth policies have emerged as a central element in the policy discourse relating to the recovery from the financial and economic crisis, reflecting the idea that environmental goals can be attained while stimulating a viable and competitive economy.

The need for green growth arises because a "business-as-usual" path does not fully account for environmental limits and social concerns. Green growth focuses on the interface between the environment and the economy, and new sources of economic growth that are consistent with resilient ecosystems. The OECD's Green Growth Strategy defines an economic development path that is consistent with long-run environmental protection, using natural resources within their carrying capacity, while providing acceptable living standards and poverty reduction in all countries.

Green growth aims at combining a cleaner economy with a stronger economy. It means fostering economic growth and development, while ensuring that natural assets continue to provide the resources and environmental services on which the well-being of societies relies. Thus, a green growth strategy would yield a "double dividend" effect — higher growth with lower environmental impact — by improving the efficiency of resource use and increasing investments in natural capital to drive economic growth.[1] In that context, several sources of green growth can be distinguished (Box 1.1).

Responding partly to the global economic downturn and partly in recognition of the increasingly apparent biophysical limits to growth, including energy costs, the green growth agenda represents a renewed focus on the fundamental drivers of growth, including the re-examination of the use of factors of production, environmental innovation, and the removal of policy distortions. In contrast to the previous environment-development view – embodied, for example, in the "environmental Kuznets curve"[2] message of grow first and make environmental investments later – the green growth paradigm suggests that going green can be not only compatible with growth, but also a source of growth (OECD, 2011a).

Essentially, green growth has two implications: the requirement that existing resources are used as productively as possible but without impairing their future productive potential or provoking further environmental degradation, and preferably in ways that are consistent with reducing existing negative environmental impacts. Green growth also requires that there should be, over time, a sustained increase in the productive potential of existing resources and where possible an expansion in the total resources available for satisfying human wants.

Green growth implies policies that either incrementally reduce resource use per unit of value added (*relative decoupling*) or keep resource use and environmental impacts stable or declining while the economy is growing overall (*absolute decoupling*). Green growth has recently become an over-arching policy objective in several countries.

More specific to agriculture, an OECD report (OECD, 2011c) summarises similar elements of sector-specific green growth in terms of:

- Increased resource use efficiency − increasing production relative to inputs used
- Well-functioning markets and provision of the right pricing signals
- Establishment of well-functioning property rights.

Box 1.1. Sources of green growth

Green growth has the potential to address economic and environmental challenges and open up new sources of growth through the following channels:

- **Productivity**. Incentives for greater efficiency in the use of resources and natural assets: enhancing productivity, reducing waste and energy consumption and making resources available to highest value use.
- **Innovation**. Opportunities for innovation, spurred by policies and framework conditions that allow for new ways of addressing environmental problems.
- **New markets.** Creation of new markets by stimulating demand for green technologies, goods, and services; creating potential for new job opportunities.
- **Confidence.** Boosting investor confidence through greater predictability and stability around how governments are going to deal with major environmental issues.
- **Stability**. More balanced macroeconomic conditions, reduced resource price volatility and supporting fiscal consolidation through, for instance, reviewing the composition and efficiency of public spending and increasing revenues through the pricing of pollution.

It can also reduce risks of negative shocks to growth from:

- **Resource bottlenecks** which make investment more costly, such as the need for capital-intensive infrastructure when water supplies become scarce or their quality decreases (e.g. desalinisation equipment). In this regard, the loss of natural capital can exceed the gains generated by economic activity, undermining the ability to sustain future growth.
- **Imbalances** in natural systems also raise the risk of more profound, abrupt, highly damaging, and potentially irreversible, effects – as has happened to some fish stocks and as could happen with damage to biodiversity under unabated climate change. Attempts to identify potential thresholds suggest that in some cases – climate change, global nitrogen cycles and biodiversity loss – these have already been exceeded.

Source: OECD (2011), *Towards Green Growth*, OECD Green Growth Studies, OECD Publishing, doi: 10.1787/9789264111318-en

The agricultural sector faces challenges in adapting to an economic environment oriented towards green growth. With projected demand expected to grow strongly, agriculture has to continue to increase productivity, economise on the use of increasingly scarce resources and adapt to climate change. At the same time, it needs to be able to contribute to improving environmental quality.

A green-growth strategy for the food and agriculture sector aims to ensure that enough food is provided, efficiently and sustainably, for growing population. This means increasing production, while managing efficiently scare natural resources, such as water; reducing the carbon intensity and adverse environmental impacts throughout the food chain; enhancing the provision of environmental services, such as carbon sequestration, flood and drought control; and conserving biodiversity (OECD, 2011c).

Governments have at their disposal a wide range of instruments for achieving green growth in agriculture (Table 1.1). In general, no one instrument or type of instrument can be singled out as more appropriate or efficient. The optimal mix of policy instrument depends on the objective to be achieved, and the environmental, economic, social and political context in which the instrument will operate.

Appropriate policies for moving agriculture closer to meeting the conditions for green growth need careful design and continuous monitoring. Policies across and within the different pillars of green growth can be either mutually enhancing (synergetic) or conflicting

(trade-offs). For example, energy subsidies aimed at raising the adoption of irrigated agriculture and policies to increase charges for water use, with the aim of preventing aquifer depletion, work against each other in terms of producer incentives and result in neither policy objective being achieved. This complexity underlines the importance of policy coherence.

Table 1.1. Green growth toolkit for food and agriculture

	Green growth policies
Environmental regulations and standards	Enact and enforce controls on excessive use of agrochemicals and fertilisers in production
	Strengthen rules and standards for water, soil quality, and land management
	Improve enforcement of environmental regulations and standards and certification from the farm-gate to the retail sector
Support measures	Decouple farm support from commodity production levels and prices
	Remunerate provision of environmental public goods (such as biodiversity, carbon sequestration, and flood and drought control) beyond reference level and closely targeted to environmental outcomes[1]
	Target environmental outcomes where feasible, otherwise target production practices favourable to the environment
	Target public investments in green technologies
Economic instruments	Price inputs to reflect scarcity value of natural resources
	Impose charges/taxes on use of environmentally-damaging inputs
	Implement trading schemes for water rights and carbon emissions
	Address policy constraints (governance, etc.) in less developed economies
Trade measures	Lower tariff and non-tariff barriers on food and agriculture products bearing in mind the potential impact on environmental concerns such as biodiversity and sustainable resource use
	Eliminate export subsidies and restrictions on agricultural products
	Support well-functioning input and output markets
Research and development	Increase public research on sustainable food and agricultural systems
	Promote private agricultural R&D through grants and tax credits
	Undertake public/private partnerships for green agricultural research
Development assistance	Allocate more development aid for environmentally sustainable initiatives, in food and agriculture
	Raise profile of agriculture in Poverty Reduction Strategies
	Allocate more funding for agriculture in Aid for Trade projects
Information, education, training and advice	Increase public awareness for more sustainable patterns of consumption such as via eco-labelling and certification
	Incorporate sustainable approaches in training, education and advice programmes throughout the entire food chain

1. Reference levels define the minimum level of environmental quality that farmers are obliged to provide at their own expense and differ from country to country, depending on property rights and legal systems (OECD [2010]), *Environmental Cross-compliance in Agriculture*, OECD Publishing, Paris, oecd.org/tad/sustainableagriculture/latestdocuments/3

Source: OECD (2011), *Food and Agriculture*, OECD Green Growth Studies, OECD Publishing, doi: 10.1787/9789264107250-en

The objective of this report is to provide a synthesis of the various policy instruments used by OECD governments to achieve green growth objectives in agriculture, based primarily on material provided by governments in response to the following questions:

- Is there a consensus among policy makers in your country on a strategy to develop and implement policies and encourage private initiatives on "Green Growth" (or similar term, such as "the Green Economy") for the agro-food sector?

- What are the principal green growth-type policies applied to the agro-food sector that are currently in place in your country (such as government expenditures on green infrastructure, incentives for private investment in green agro-food sectors, targeted subsidy reform, pricing of pollution and natural resources, public procurement, education and training, environmental footprint labelling and traceability of foods)?

- To what extent have these policies been implemented as part of a specific green growth (or similar) strategy with the establishment of policy targets and monitoring mechanisms (such as for improved resource-use efficiency, reduction in greenhouse gas emissions, job creation, share of renewable energy in total energy)?

The report is structured as follows: Chapter 2 discusses the overall approach that countries are taking towards establishing a green growth strategy in agriculture, including strategic objectives (i.e. broad strategic policy goals that are neither quantifiable nor have a specific time-limit) and targets (i.e. quantifiable policy goals with a designated timeframe). It also discusses the implementation of the OECD framework for monitoring progress towards green growth in agriculture.

Chapters 3 and 4 discuss the various policy instruments used. These instruments have been grouped along the lines of the framework used in the OECD report, *A Green Growth Strategy for Food and Agriculture* OECD (2011b). It should be noted that various policy instruments often form part of a policy package and contribute to more than one aspect of green growth and they could therefore simultaneously be classified under different categories.

Chapter 5 presents a compilation of country experiences of policies and initiatives designed to achieve green growth in agriculture.

Finally, Chapter 6 offers some tentative conclusions that emerge from this discussion.

Notes

1. The double dividend effect does not apply a priori to all sectors and the effects depend on the nature of substitution between human capital and technology, and the stock of natural resources. For a discussion of the so-called "double dividend" or Porter Hypothesis see Xepapadeas and de Zeeuw (1999).
2. See, for example, Stern (2004).

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Chapter 2

Green growth strategies in agriculture in OECD countries

Chapter 2 discusses the approaches that countries are taking towards establishing green growth strategies in agriculture, including strategic objectives and targets. While most OECD countries have some policies in place relating to green growth, the degree of ambition shows considerable variation. The most commonly mentioned strategic objectives refer to energy and to greenhouse gas emissions. Some countries have objectives relating to promoting sustainable production and consumption while very few have reported objectives aimed at creating more green jobs in the agricultural sector.

This chapter also discusses the implementation of the OECD framework for monitoring progress towards green growth in agriculture.

Overall approach

Most OECD countries have some policies in place that relate to the concept of green growth, although the degree of ambition shows considerable variation (Table 2.1). Over-arching green growth strategies in agriculture have been developed and implemented by only two OECD countries: ***Denmark*** and ***Korea***.

Launched in 2009, ***Denmark***'s *Green Growth Strategy* was designed to establish a green growth economy in which the agro-food sector can improve its innovative and competitive potential. The stated purpose of the Strategy is to bring about a modern and competitive agro-food sector that is compatible with a high level of environmental, nature and climate protection. Its **c**entral aspect is that it promotes coherence between the environment and production methods through technological innovation and revision of agricultural legislation. The Strategy, prepared with the collaboration of sectoral ministries and public agencies, and with expert input from working groups, is an ambitious and long-term plan for defining environment and nature policies and the conditions of growth for the agriculture sector until 2020. A total of DKK 13.5 billion (EUR 1.8 billion), to be financed in part by the EU Rural Development Programme 2007-14, is to be invested in green growth activities until 2015 – an increase of around 50% in investments compared to previous initiatives.

Korea is at the forefront of green growth initiatives. In 2008, the *Low Carbon, Green Growth Strategy* was launched, as part of a new national development paradigm adopted in response to the challenges posed by the country's excessive energy-dependency on imported fossil fuel and the doubling of its GHG emissions over the past 15 years.[1] The main emphasis of the green growth strategy is on energy efficiency. The role of technological progress and innovations as a source of new growth momentum is highlighted. The Strategy is targeted at increasing the adoption of green technology in order to reduce carbon emissions, and also aims at strengthening Korea's international competitiveness by greening existing industries and establishing new businesses as an engine for economic growth.

In the agricultural sector, the *Low Carbon, Green Growth Strategy* emphasises the following areas: *i)* improvement in the efficient use of resources; *ii)* reduction of GHG emissions; *iii)* creation of green jobs; and *iv)* increasing the use of renewable energy in total energy. Examples of green growth policies in the agricultural sector include: public expenditure on green infrastructure (e.g. the supply and national diffusion of green technology/equipment, and the creation of low-carbon green villages); incentives for private investment in greening agro-food sectors (e.g. green technology certification systems, adoption of renewable energies using geothermal heating system and biogas generation from livestock manure); GHG trading systems (as from 2015); green education programmes for farmers; carbon labelling systems (beginning in 2013); and a traceability system for agricultural products. It is estimated that implementation of green growth policies in the agro-food sector would reduce GHG emissions by 10%, and create 420 000 green jobs over three years (Kim et al., 2011).

An evaluation of the green growth policies for the agricultural sector was undertaken by the research project "Development of Strategies for Promoting Green Growth in Agriculture and Rural Districts", conducted over 2010-11 under the auspices of the Korea Council of Economic and Social Research Institutes (Kim et al., 2011). The report shows that, although green growth measures have been correctly formulated, the development of policy programmes capable of producing tangible results and success in achieving the widespread uptake of green technologies appears to be insufficient. With regard to policy tasks for green growth in rural districts, the study recommends appropriate policy objectives and targets for green growth in the agricultural sector, which take into account local conditions.

Table 2.1. Selected examples of green growth policies in agriculture in the OECD area

Country	Policy
Australia	Caring for our Country Carbon Farming Initiative National Enabling Technologies Strategy
Austria	The Resource Efficiency Action Plan
Belgium	Marshall Plan 2 - Green
Canada	Growing Forward Policy Frameworks
Denmark	Green Growth Strategy
European Union	Resource Efficiency Initiative European Innovation Partnership on Agricultural Productivity and Sustainability
France	Energy Performance Plan for Farms *Grenelle de l'Environnement* and the Écophyto plan on pesticides Agro-ecological project
Ireland	Food Harvest 2020 Origin Green Programme
Japan	Strategy for the Rebirth of Japan Biomass Industrialisation Strategy
Korea	Low-Carbon Green Growth Strategy
Mexico	Sustainability of Natural Resources Programme
New Zealand	Primary Growth Partnership Emissions Trading Scheme Pastoral Greenhouse Gas Research Consortium
Netherlands	Green Deals The Dutch Enterprise Policy : Top-sector Approach
Switzerland	Action Plan on the Green Economy
United Kingdom	The Green Food Project Advice and Incentives for Farmers Project
United States	Renewable energy policies related to agriculture (e.g. programmes to support production of second- and third-generation biofuels) Sustainable Agriculture Research and Education Program

In ***Australia***, there are numerous policies that could be labelled "green growth", although policies to encourage "green initiatives" do not single out farmers, but target landholders generally. Funding for such initiatives is primarily provided through the *Caring for our Country* scheme in accordance with the objectives set down by its business plans. A range of different funding mechanisms are used, complementing those established under the *Landcare* scheme. The "growth" aspect of this is perhaps that landholders (and not solely farmers) can access a separate revenue stream that is closely targeted towards positive environmental outcomes. In the area of R&D, policy instruments used to support green growth in agriculture aim to: increase public research on sustainable food and agricultural systems; promote private agricultural R&D through grants and tax credits; and undertake public-private partnerships for green agricultural research. In particular a unique form of collaboration exists between the Australian government and industry through Research and Development Corporations, which work to increase resource use efficiency and productivity in the agricultural sector.

In ***Belgium*** there is no specific "green growth" policy, either for the economy as a whole or for the agro-food sector, but the greening of the agro-food sector is part of the overall approach to sustainable development. In the *Flemish* region, the Government is committed to a policy aimed at the application of sustainable business processes in the Flemish economy, including a sustainable consumption pattern of agricultural and fisheries production. In the *Walloon* region, one of the six priority areas of the *Priority Action Plan for the Future of Wallonia* is on competitiveness clusters and business networks, including agri-business. In the *Brussels* region, there is an overall policy to create green jobs and to boost the green economy in the Brussels Capital Region (*Green Jobs Pact*). The first economic sector to be focused on was the construction sector, while the agro-food sector was addressed in the second half of 2012, with the main objectives being: the creation of new, sustainable, green jobs and stimulation of the demand for sustainable food. Given the situation of the region (almost no production, but large food consumption), the demand-side constitutes an essential lever for transition to the green economy. The strategy focuses primarily on the area of "collective" consumption (e.g. school canteens and restaurants).

In ***Canada***, while Agriculture and Agri-Food Canada (AAFC) has no explicit department-wide "green growth" policies, it is committed to policies that support environmental sustainability actions in a manner that encourages innovation and productivity growth, increases economic returns and shares knowledge among sector participants. Emphasis is placed on improving input use efficiency, reducing environmental impacts and increasing outputs through genetic improvements. Continued investments in R&D and technology transfer are key policy activities.

The vision of the current policy framework Growing Forward (GF), which was developed jointly by federal and provincial/territorial governments, is for a profitable, innovative, competitive, market-oriented agriculture and agri-food industry. GF came into force in 2008 and is expired on 31 March 2013. The next policy framework focuses on two broad outcomes: competitiveness in domestic and international markets, and adaptability and sustainability of the sector. These outcomes are supported by policies that include innovation, market development and adaptation activities, many of which support environmental knowledge and improvements, and include environmental outcomes. AAFC also has a Departmental Sustainable Development Strategy (DSDS), which commits AAFC to supporting an economically, socially and environmentally sustainable agriculture, agri-food and agri-based products sector that ensures proper management of available natural resources and adaptability to changing environmental conditions.

No official document dealing with green growth policies in the ***Czech Republic*** has, as yet, been published, but the Ministry of Agriculture is currently preparing a *Strategy of Agriculture* and the Rural Development Programme for the period 2014-20. The latter places emphasis on: renewable resources (i.e. solar, biogas, etc.); farming, under both organic and integrated regimes; special targeted farming on high-nature value (HNV) biotopes; and land consolidation (decide land ownership and enable the development of measures to protect natural resources).

In ***Estonia*** there is no specific green growth strategy for the agricultural sector. The country's interest in green growth is mainly reflected through various government programmes concerning either renewable energies or bio-economy.

In the ***European Union*** (EU), while the key EU strategy of "Europe 2020" does not formally include the term "green growth strategy", it does share many of the features of a green growth strategy, and seeks "green" outcomes, citing "green growth" as an object of attention. A number of green growth-related initiatives have been undertaken in order to address, inter alia, issues, such as resource efficiency (including resources, such as energy, raw materials, food, water, biodiversity and land), sustainable use of natural resources, low

carbon economy, building resilience to climate change, and sustainable consumption and production patterns. The two main initiatives are: mainstreaming resource efficiency into EU legislation; and the European Innovation Partnership *Agricultural Productivity and Sustainability*. The "CAP towards 2020 Communication" COM(2010)672, of 18 November 2010, also deals with the application of the "smart, sustainable and inclusive growth" of the "Europe 2020" strategy for agriculture and acknowledges that "green growth in the agricultural sector and the rural economy is a way to enhance well-being by pursuing economic growth while preventing environmental degradation" (EC, 2010). The linkages between the CAP and the "Resource Efficiency" flagship of the Europe 2020 strategy indicate that a "green growth" type approach to the challenges of the future has been recognised in the EU policy process.

In ***France***, while many policies incorporate the objectives of "green growth", this concept is only used by a few French public actors, who instead prefer sustainable development. This mainly reflects the fact that long-term decisions on environment and sustainable development need to be made because of the consensus reached in 2007 on the occasion of the *Grenelle de l'Environnement* − a discussion based on multiparty co-operation among public authorities and different stakeholders and actors in the society. Five groups are represented: the state, local communities, NGOs, employers and employees. A debate was organised through six working groups, each containing 40 members. Each group then worked in "workshops", and summaries and reports were made available to the public. Following this, local meetings in the regions and public consultation on Internet took place. Finally, a general report was unveiled at the "round table" of the *Grenelle*, held on 24 and 25 October 2007. The 2009 *Loi Grenelle* legislation includes several policies relevant to green growth in agriculture, such as organic agriculture and the reduction in the use of pesticides. In 2012, targets for the Ecology and Energy Transition (*Transition Environnementale et Energétique*) were adopted during the Environmental Conference. In line with this, the Agro-ecological project for France (*Projet Agro-Ecologique pour la France*) was launched in December 2012. It aims to reconcile economic and environmental performances by deeply reorienting public incentives and legislation, research, training and council in the field of agronomy and agriculture.

In ***Greece***, the EU Rural Development Programme of Greece 2007-13 is the main vehicle which encourages the promotion of green growth in the agricultural sector. The most relevant measures in this area include: support to promote the use of renewable energy; support to increase the value-added of agricultural products (e.g. processing); support to promote environmentally-friendly production practices (e.g. organic agriculture, stock-farming extensification, rotation of fields previously used to grow tobacco with non-irrigated crops); and agri-environmental actions to protect water resources (e.g. protection of areas vulnerable to nitrates, and the adoption of integrated management systems in tobacco and sugar beet production).

Green growth in agriculture in ***Japan*** is primarily reflected through the following government initiatives: *i)* the *New Growth Strategy* of 2010 which aims to ensure the sustainability of the environment and the economy; *ii) The Strategy for the Rebirth of Japan* of 2011, to aid the recovery from the Great East Japan Earthquake, utilising rural area resources for producing energy;[2] and *iii)* "promotion of the greening economy and society, and green innovation" has also been addressed recently in the 4th Basic Environment Plan (Cabinet decision, 27 April 2012),[3] which is the principal Japanese environmental policy.

Hungary does not have a specific green growth strategy. The country's commitment to the green growth of the agro-food sector is primarily reflected through: *i)* the European Union's Rural Development programme of Hungary 2007-13 (i.e. building a more competitive low-carbon economy; protecting the environment and preventing biodiversity loss; developing new green technologies; introducing efficient smart electricity grids; harnessing EU-scale business networks; improving the business environment, particularly for

SMEs; and helping consumers to make well-informed choices); *ii)* the *National Environmental Technology Innovation Strategy* (NETIS), in force between 2011-20, which puts emphasis on the aspect of innovation in environmental green growth technologies; *iii)* the *National Rural Strategy*, adopted in 2012, following a broad social debate, and which will remain in effect until 2020; and *iv)* the Ignác Darányi Plan, a programme set up within the framework of the National Rural Strategy, which covers every area of agriculture and rural development.

In ***Ireland***, the 2012 Government Policy Statement on Growth and Employment in the Green Economy affirms the Government's commitment to developing the green economy (djei.ie/publications/enterprise/.../Delivering_Our_Green_Potential.pdf). The Statement identifies the opportunities in the Green Economy for sustainable economic growth and job creation, sets out how the Government is supporting the green economy and outlines new implementation structures to oversee the development of the sector. It also reaffirms the interdependencies that exist between the green economy and the Government's Sustainable Development Framework.

For agriculture, *Food Harvest 2020* provides the strategic vision for the development of the agri-food, fisheries and forestry sector for the period up to 2020. The strategy envisages a sector that can reap considerable rewards if it works and acts "smartly" so as to make the most productive use of the country's rich natural "green" resources in a way that is both economically viable and sustainable in the future. Research, development and innovation have a central role to play in the growth of the sector. Examples of elements of the strategy include: the *Agricultural Catchments Programme* (ACP) and the *Dairy Efficiency Programme & Beef Technology Adoption Programme*. Another initiative is the *Origin Green* programme – a voluntary sustainability programme launched by Bord Bia (the Irish Food Board) in 2012 on behalf of the Irish food and drinks industry. Participating organisations are asked to demonstrate their commitment to operating sustainably by focusing on a number of key areas including: greenhouse gas emissions, water management, energy conservation, waste management and recycling, animal welfare and biodiversity.

In ***Mexico***, the main policy instrument to promote green growth in the agri-food sector is the *Programme for the Sustainability of Natural Resources*, which was implemented by the Mexican Ministry of Agriculture (SAGARPA) during the 2012 fiscal year. SAGARPA's policies are also part of a general framework whose cornerstone is the *National Strategy for Climate Change*, which was introduced in 2007. The Special Program for Climate Change (SPCC) 2009-12 is the main legal instrument outlining Mexican strategy, actions, and goals to meet the challenges of climate change. It contains the main mitigation and adaptation actions, including those applying to the agricultural sector.

In the ***Netherlands***, there is no specific programme to promote green growth at the national level, and the terms "green growth strategy" or "green economy" are not used in national policy documents. However, there is a wide variety of policy programmes which address issues related to green growth. Most of the examples of policies associated with green growth relate to already existing policies under the heading of sustainable development. Long-term multi-year agreements and partnerships of government with the private sector, citizens and civil society are the main policy approaches used to encourage innovation and to improve sustainable productivity in the agro-food sector, including the horticulture sector. Much emphasis is placed on energy efficiency, renewable energy use and production and reduction of GHGs.

In ***New Zealand***, there is no formal document that outlines a strategy to apply to "green growth" as such, but there are a number of relevant policy developments. In January 2011 the government appointed a Green Growth Advisory Group (GGAG) to evaluate and advise on opportunities for green growth to contribute to an increased rate of economic growth for

New Zealand. The GGAG reported to government in December 2011. The government is responding to many aspects of the GGAG's recommendations through its Business Growth Agenda (BGA). The BGA focuses on six key "ingredients" businesses need to grow: export markets, innovation, infrastructure, skilled and safe workplaces, natural resources, and capital. Each of these has its own programme of work. "Greening Growth" is specifically presented as a cross-cutting theme spanning the BGA. Furthermore, additional actions in the natural resources, innovation and export markets reports have implications for greening growth.

Green growth in the agricultural sector in ***Norway*** is primarily reflected through the country's sustainability goals for agriculture, with the current agricultural policy, with border control measures, agricultural support and targeted environmental measures being considered essential. Research to improve agricultural productivity is also important.

The ***Slovak Republic*** does not currently have a dedicated strategy or action plan on green growth or on improving resource efficiency for the agro-food sector, but these issues are addressed primarily through: *i)* the national targets for the *Strategy Europe 2020* and *ii)* the *Biomass Action Plan* 2008-13. The *Biomass Action Plan for 2008-13* also includes targets for biomass energy utilisation in the Slovak Republic.

Sweden has not drawn up a specific national green economy strategy. Instead, work on the transition to a green, sustainable economy is reflected, for example, through legislative proposals in a number of different areas, such as transport/infrastructure, energy, forestry and agriculture, climate, and the national environmental objectives. An inter-ministerial working group exists to discuss and provide input on issues concerning the green economy.

Agricultural policy in ***Switzerland*** comprises many of the elements of a green growth policy for food and agriculture, although in official domestic policy documents its elements are not explicitly labelled as policies contributing to "green growth" or a "green economy". The Government's *Action Plan on the Green Economy* at national level, which was adopted by the Swiss Federal Council in March 2013, entails 27 measures (including food waste reduction) and mandated the Federal Department of the Environment, Transport, Energy and Communications to prepare a parliamentary amendment of the Environmental Protection Act (EPA). The salient points of the planned revision of the EPA include, inter alia, the following: definition of targets for the efficient use of natural resources; the measurement of resource use; provision of information and raising of public awareness; improvement of the resource efficiency of consumption and production; enforcing the recycling management (e.g. recovery of phosphorus out of sewage sludge for agricultural use); and strengthening of Switzerland's international commitment to the green economy.

In ***Turkey***, the *National Climate Change Action Plan* (NCCAP) (2010-20), published in July 2011, is the main policy framework to promote green growth. The NCCAP includes strategic objectives and goals on GHG emission control and adaptation to climate change over 2011-23. The overall aim of the NCCAP is to address climate change by identifying national actions for limiting GHG emissions and building resilience through managing impacts, thereby encouraging mitigation and adaptation to climate change in Turkey. The NCCAP addresses measures in priority sectors (energy, industry, waste, buildings, forestry, transportation and agriculture), specifically focusing on long term co-operation, technology development and transfer, and national and international financing mechanisms.

In the ***United Kingdom***, green growth is mainly reflected in the *Natural Environment White Paper* (NEWP) presented in 2011 (the first White Paper on the natural environment in 20 years), which outlines the Government's vision for the natural environment over the next 50 years. Sustainability is a key objective for economic growth for the UK (e.g. GHG reduction targets; carbon budgets; and waste and recycling targets). The NEWP covers the following areas: climate change, biodiversity, water, air quality and soils. Two specific

projects of the NEWP relate to agriculture: *i)* the *Green Food Project*; and *ii) Advice and Incentives for Farmers*.

The ***United States*** does not have a specific green growth strategy for agriculture, but it does have policies which aim to increase productivity in a sustainable way, including programmes to support production of second- and third-generation biofuels.

Strategic objectives and targets

The majority of countries appear to have strategic objectives covering a wide range of subjects related to green growth. Most of the reported strategic objectives are fairly general in nature and tend to express guiding principles rather than require any concrete commitments. Typical examples of these areas include ensuring sustainable agriculture; climate change; resource conservation; ensuring energy security; and reducing energy use; promoting sustainable consumption and production in the food chain; reducing fossil fuels; promoting green public procurement; and waste and recycling (Box 2.1).

The most commonly mentioned strategic objectives refer to energy (increasing the share of renewable energy; improving energy efficiency; reducing energy use) and to GHG emissions. In these two areas, several countries report absolute reductions in energy use and GHG emissions. It is worth noting that these objectives are driven primarily by international agreements (e.g. the Kyoto protocol), or regional-wide strategic goals (e.g. EU energy policy).

Although water scarcity is a priority issue for many countries, surprisingly only a couple of countries reported targets for improving their efficiency of water use (Box 2.2).

It is of interest that some countries have objectives relating to promoting sustainable production and consumption, which indicates that such countries consider green growth to be a holistic challenge encompassing the whole agro-food chain − and not just the primary sector. Only a very few countries have reported strategic objectives aimed at creating more green jobs in the agricultural sector, although several mentioned the promotion of eco-efficient technologies as a strategic objective.

Regarding consumption areas associated with high environmental impacts, several countries reported having objectives or targets specifically in the fields of livestock buildings and greenhouses (typically for energy efficiency in buildings), transport (typically for increased use of biofuels in transport and fuel efficiency standards for tractors) and food production (typically the increasing land area under organic farming). However, in most cases objectives or targets are set for efficiency improvements in technology and production rather than addressing consumption by managing demand. Two exceptions are ***Finland*** and ***France***, which have established targets for the public sector to increase consumption of organic food (e.g. in schools and hospitals).

In ***Denmark***, the *Green Growth Strategy* considers organic farming to be an important driver of green growth. It is planned to increase the area used for organic production from 6% in 2007 to 15% in 2020 through a massive effort, representing an outlay of almost DKK 350 million a year.

In ***Korea***, the **Five-Year Plan** outlines government actions for implementation of the *Low Carbon, Green Growth Strategy*, and details tasks for ministries and local governing entities, as well as specific budgets. Under the Plan, the government will spend approximately 2% of annual GDP on green growth programmes and projects. Investments will initially be geared towards infrastructure systems in order to boost the economy. In line with this, Korea has passed a USD 30.7 billion stimulus package in 2008 aimed at supporting its green objectives. This includes renewable energy resources, energy-efficient buildings, expansion of railway systems and improvement to waste management systems. Over time, the government aims for Korea to become a leading exporter in green research and technology. The strategy sets the

following policy targets: reduction of GHG emissions from their 2007 level (18.39 million tonnes); bioenergy supply: an increase from 66% in 2007, to 88% in 2013; environmentally friendly agricultural production: a rise from 3% in 2007 to 10% in 2013, and to 15% in 2020.

Box 2.1. Selected examples of strategic objectives related to green growth in agriculture

Denmark

- Become independent of fossil fuels by 2050
- Make significant increase in its resource efficiency

European Union

- Reverse the recent trend of diminishing productivity gains by 2020
- Secure soil functionality in Europe at a satisfactory level by 2020

Finland

- Create a thriving bio-economy, generating high value-added

France

- Adopt a new model of sustainable development that respects the environment, combined with lower consumption of energy, water and other natural resources

Germany

- Achieve an important increase in its energy-related use of biomass

Ireland

- Encourage efficient and environmentally sustainable production in the agro-food sector; boost the green credentials of agro-food firms

Korea

- Reduce its heavy dependence on imported energy and decrease production of GHG emissions

The Netherlands

- Meet the need for food and shelter for 9 billion people globally by 2050, while at the same time reducing the environmental impact of food production throughout the whole food chain

Slovak Republic

- Encourage utilisation of biomass energy

Slovenia

- Encourage utilisation of biomass energy

Sweden

- Recover food waste using biological treatment

Switzerland

- Reduce the consumption of resources to environmentally sustainable levels (Cleantech Masterplan)
- Improve consumer awareness, by providing information on goods that indicates the effects of their production on the environment

Turkey

- Reduction of GHG emissions and building of resilience by encouraging mitigation and adaptation to climate change

United Kingdom

- Improve the production and productivity of the agro-food sector, while at the same time increasing the environmental performance of the whole supply chain
- Reduce food waste

Box 2.2. Selected examples of targets related to green growth in agriculture

Material use

- France: In animal husbandry, reduce dependence on imported raw materials used for making animal feed
- Ireland: Achieve 75% of food and drink exports from members of the Green Origin Scheme by 2014
- Switzerland: Reduce the consumption of fossil fuel oil by 20% by 2029

Energy use and energy efficiency

- France: Achieve a minimum of 30% low-energy farms by 2013
- Netherlands: By 2020, reduce CO_2 emissions by at least 3.5Mt; produce 200 PJ per year of renewable energy from biomass; and produce about 12 PJ from wind energy on land (the Agro Covenant)

Renewable energy

- Denmark: Increase use of animal manure for green energy to 50% of total by 2020
- Korea: Increase supply of bio-energy from 66% in 2007 to 88% of total in 2013
- Slovak Republic: Achieve a 5.75% share of biofuels on total energy consumption of fuels in 2010, and a 10% share in 2020

Organic farming and certification

- Austria: Achieve a 20% increase in the share of organically farmed areas in the total agricultural area by 2010
- Denmark: Double the area under organic farming by 2020
- France: Have 6% of the total agricultural area under organic farming by 2012, and 20% by 2020
- France: Have 50% of farms applying for environmental certification

GHG emissions

- Denmark: Reduce agricultural GHG emissions by 800 000 tonnes in 2015 and achieve a further reduction in 2020

Waste

- Japan: Recycle more than 80% of biomass waste (which includes livestock manure) and utilise more than 25% of unused biomass by 2010
- Sweden: Recover at least 60% of phosphorus compounds present in wastewater for use on productive land by 2015 – at least half of this amount is to be returned to arable land

Water (pollution and efficiency)

- Canada: The target of a value between 81-100 on each of the Water and Soil Quality Agri-environmental Performance Indices to be achieved by 31 March 2030 is set for the water quality objective of the Federal Sustainable Development Strategy
- Denmark: Reduce the release of nitrogen from agriculture by 19 000 tonnes by 2015, and reduce it further by 2020; reduce the release of phosphorus from agriculture by 210 000 tonnes by 2015; reduce the release of ammonia
- Portugal: Attain, over ten years: 80% efficiency in water consumption in the urban sector; 65% of efficiency in agriculture; and 85% efficiency in the industrial sector

Pesticides

- Denmark: Reduce the impact from pesticides from 2.1 to 1.4 by the end of 2013, corresponding to a frequency in use of pesticides of 1.7
- France: Reduce consumption of pesticides by 50% within 10 years

Green public procurement

- Denmark: Commit to the 50% target for green public procurement in 2010, covering 10 product groups
- Finland: Organic, vegetable-based or seasonal food to be available in government kitchens and also provided by food services at least twice a week by 2015
- France: By the end of 2012, reach the target of 20% of products used in hospitals, schools, canteens, etc. being of organic origin
- Netherlands: Achieve sustainable public procurement for: cocoa (100% in 2025); timber (50% in 2011); and soy palm oil (100% in 2015)

In ***Canada***, AAFC has set time-bound, quantitative targets for achieving environmental outcomes that reduce the risks to soil, water and biodiversity. These targets are reported in annual federal government *Reports on Plans and Priorities*, such as "Fresh Water Quality: Achieve a value between 81-100 on each of the Water Quality and Soil Quality Agri-Environmental Performance Indices by 31 March 2030 (tbs-sct.gc.ca/rpp/2012-2013/inst/agr/agr02-eng.asp#s2.1.1).

In ***France***, implementation of the EU Rural Development Programme 2007-13 contributes to the green growth of French agriculture. For example, the *Plan de modernisation des Bâtiments d'Elevage et le Plan Végétal pour l'environnement*, that encourage and subsidise modern and environmentally friendly investments. Regarding the agro-food industries, the following programmes can be mentioned: *i)* the "energy and industry" chapter from the *Plan national d'adaptation au changement climatique* (PNACC), released in July 2001, which defines the priority actions for the agro-food sector, such as the use of more efficient cooling equipment or of renewable energy; *ii)* the *Plans régionaux de l'agriculture durable (PRAD),* created by the law for the modernisation of agriculture and fisheries (LMAP), which set the broad regional guidelines of agricultural, agro-food and agro-industrial policy. The PRAD offer a reflection on the vision of sustainable agriculture, combining economic efficiency and environmental performance, shared by all partners and, in particular, by the processing industry for agricultural products.

Nevertheless, the main current devices and programmes related to the environment are those originating from the discussions held during the *Grenelle* of the environment on sustainable agriculture:

- The *Environmental Certification of Farms*, which is a voluntary process accessible to all sectors, and builds around the themes of biodiversity, fertiliser management and management of water resources.
- The *Plan for Energy Performance of Farms (La plan de performance énergétique des exploitations agricoles),* which aims at improving the overall energy efficiency of farms. The latter is based on a broad development of the diagnosis of the energy and greenhouse gas emissions from farms. It seeks to identify potential improvements in terms of energy saving, changes in agricultural practices, and the appropriate production of renewable energy. The practices that make possible reductions of direct energy consumption (tractor settings, efficient driving, etc.) and also indirect energy consumption (e.g. changes in fertilisation methods, for feed, etc.) are encouraged. Equipment that uses less energy is promoted (especially in livestock buildings and greenhouses), as is some equipment which allows the production of renewable energy.
- The *Écophyto plan 2018 on pesticides* aims to reduce the use of pesticides by 50% by 2018 if possible, while maintaining a high level of production and preserving the quality of agricultural products. It is led by the Ministry of Agriculture, Agro-food and Forestry, together with the participation of the major actors concerned – farmers, technical institutes and researchers.
- The *Plan Agribio 2012,* which has, as an objective, an increase in the share of organically farmed area in total agricultural area from 2% to 6%.

In ***Hungary***, the National Rural Strategy, which considers organic production as a high priority, has set the following targets: the area for organic production to be increased from 133 000 ha in 2012 to 350 000 ha in 2020 (a 163% increase).

In the ***Netherlands***, targets are set for various agro-food sectors in order to achieve the goals set by the EU for 2020, concerning energy efficiency and renewable energy across the

whole food chain. For example, 20% of livestock farms are to be 100% reliant on electricity from sustainable sources by 2020.

Monitoring progress towards green growth in agriculture

Governments in several OECD countries are increasingly aware of the importance of monitoring and evaluating their agricultural policies and are devoting considerable efforts to strengthening their monitoring and evaluation approaches. For example, evaluation of the EU's rural development programmes, which also include agro-environmental programmes − is required by legislation within an established framework which also comprises quantitative indicators. Less formal approaches are used by other member countries, which also use quantitative indicators (OECD, 2009). Also, in their responses to the questionnaire, several countries pointed out that they regularly monitor environmental outcomes in compliance with established environmental targets (e.g. reduction of CO_2 emissions). In the European Union, for example, as part of its Resource Efficiency Strategy, is developing indicators for monitoring progress on the path to the 2050 resource efficiency vision (ec.europa.eu/environment/resource_efficiency/news/up-to-date_news/12122012_en.htm).

As part of its *Green Growth Strategy*, the OECD has developed a conceptual framework and a set of indicators to help governments monitor progress towards green growth.[4] The framework draws on four interrelated-groups of indicators which capture major aspects of green growth. Particular attention is paid to efficiency and productivity issues. The focus is on the environmental performance of production and consumption, and on drivers of green growth, such as policy instruments and innovation activity.

The ***Netherlands*** was the first country to publish a green growth indicator report based on the OECD framework (Statistics Netherlands, 2011), followed by the ***Czech Republic***, ***Korea*** and the **Slovak Republic**[5] (Czech Statistical Office, 2011; Statistics Korea, 2012).[6] Although these three reports are largely consistent, there are differences when it comes to indicator selection, as indicators were selected to best reflect national circumstances and data availability. For example, indicators of the natural asset base were focused on coal and water for the ***Czech Republic***, and on natural gas and fish for the ***Netherlands***). Indicators of policy responses and economic opportunities emphasise expenditure on R&D in the ***Czech Republic*** and ***Korea,*** while in the ***Netherlands*** the issue of carbon emission trading is highlighted).

The emphasis on agriculture and the selection of agriculture-related indicators also differ (Table 2.2): the ***Czech Republic***'s report includes three agriculture-related indicators (nutrient balances; structure of land cover change; farmland birds); the ***Korean*** report, which selected and analysed 23 green growth indicators applicable to Korea, includes two agriculture-related indicators (consumption of chemical fertilisers and annual rainfall per capita); whereas in the ***Dutch*** report, which studied 35 indicators, only five were related to agriculture (domestic biomass consumption, nutrient surpluses, farm bird index, land cover conversion to built-up land and nitrate concentration in groundwater).[7] For the ***Slovak Republic***, three out of the 33 indicators included individual refer to agriculture.

In the next phase of the work on green growth, the OECD green growth measurement framework will be developed for the agricultural sector and applied to selected OECD countries.[8]

Table 2.2. Agriculture-related indicators used by the Czech Republic, Korea, the Netherlands and the Slovak Republic

	Environmental and resource productivity	Natural resource base	Environmental quality of life	Economic opportunities and policy responses
Czech Republic	**Nutrient balances** *i)* Nitrogen *ii)* Phosphorus	**Land cover change** *i)* Agricultural land, pastures and meadows *ii)* Urban areas and infrastructure *iii)* Semi-natural habitats **Farmland birds**		
Korea	**Consumption of chemical fertilisers**	**Annual rainfall per capita**		
Netherlands	**Energy efficiency** *i)* Agriculture and fisheries *ii)* Manufacturing *iii)* Transport *iv)* Other services **Share of renewable energy in total** *i)* Biomass *ii)* Wind *iii)* Other **Nutrient balances** *i)* Nitrogen *ii)* Phosphorus	**Land conversion into built-up land** *i)* Agriculture *ii)* Nature *iii)* Forest *iv)* Built-up		
Slovak Republic	**Nutrient balances**	*i)* Land use *ii)* Agricultural land area affected by water and wind erosion, by class of erosion		

Notes

1. Korea is one of the highest per capita energy-consuming countries in the world and imports 97% of its gross energy consumption.
2. Strategy for the Rebirth of Japan (English) npu.go.jp/policy/pdf/20120127/20120127_en1.pdf
3. The Fourth Basic Environment Plan (English Summary): env.go.jp/policy/kihon_keikaku/plan/plan_4/attach/pamph_en-1.pdf; env.go.jp/policy/kihon_keikaku/plan/plan_4/attach/pamph_en-2.pdf
4. The measurement framework is described in detail OECD (2011), *Towards Green Growth: Monitoring Progress: OECD Indicators*, OECD Green Growth Studies, OECD Publishing. doi: 10.1787/9789264111356-en
5. The creation of the green growth indicators follows the conclusions of a national workshop on green growth held in 2011, the recommendations of the *OECD Environmental Performance Review: Slovak Republic* (2011), as well as the recommendations of the *OECD Economic Survey of Slovak Republic* (2012). In 2012, the working group on green growth indicators was established by the Slovak Environmental Agency and the Ministry of Environment (enviroportal.sk/indikatory/schema.php?schema=124).
6. In Germany a set of green growth indicators following the OECD framework was also published by the Statistical office (in German only): *Test des OECD-indikatorensets green growth in deutschland*, destatis.de/DE/Publikationen/Thematisch/UmweltoekonomischeGesamtrechnungen/Umweltindikatoren/IndikatorensetsOECD5850015129004.pdf?__blob=publicationFile
7. The list of indicators for the Netherlands was revised in 2012 and the 35 indicators selected were based on the following criteria: relevance to the Dutch situation, coverage (all themes of green growth must be covered), interpretability, data quality; and consistency with other sets of indicators.
8. A similar exercise was performed jointly by the OECD and the International Energy Agency for the energy sector, where a set of indicators was proposed (OECD, 2012).

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Chapter 3

Policies for improving productivity and resource efficiency in the context of green growth

Innovation, together with market-based incentives and appropriate regulation and taxation, can accelerate the transition to greener growth and help decouple environmental degradation from economic growth. New technologies realised through R&D have the potential to reduce the load of known toxins in agricultural production, substitute safer alternatives, protect ground or surface waters, conserve natural habitats, reduce nutrient loads in soils, lower gaseous nitrogen loss and reduce the amount of non-renewable energy used in the cropping cycle. This chapter discusses policies for improving productivity and resource efficiency in the context of promoting green growth, paying particular attention to R&D, technology and innovations.

Note: The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

R&D, technology and innovation

The capacity of the agricultural sector to produce adequate supplies of food, feed, and non-food uses in an environmentally sound manner is closely linked to the level of technological development and innovation. Production improvements have been brought about mainly through R&D in the areas of biology (e.g. crop and plant varieties, and animal breeds), mechanics (e.g. farm equipment) and management (e.g. integrated pest management). On the consumption side, the diffusion of scientific information concerning food safety, nutrition and environmental quality is important to consumers.

The strong growth in agricultural productivity experienced since the post-war period has been driven largely by technological advances and the rapid adoption and diffusion of new technologies. Scientific developments in agriculture brought about rapidly rising productivity growth, the development of new crop varieties, and increased yields in many countries through the "Green Revolution."[1]

Innovation plays a key role in fostering greening growth. One of the main messages of the OECD Green Growth Strategy is that innovation, together with market-based incentives and appropriate regulation and taxation, can accelerate the transition to greener growth and help decouple environmental degradation from economic growth. OECD analysis shows that significant innovation, such as the creation of new products, processes and technologies, as well as their diffusion and application will be required to achieve the decoupling of growth from environmental pressures in the most efficient manner.

Fostering greener growth through R&D and innovation has received greater attention from governments in recent years across the OECD area. For example, the ***European Union***'s Growth Strategy for 2020 and ***Korea***'s National Strategy and five-year plan for green growth, consider green innovation to be the crucial impetus to build competitive and sustainable economies.

Technological innovation through advances in information and communication technologies, engineering and biotechnology can improve the economic and environmental performance of farming systems and can provide an important impetus to green growth across the OECD area. New technologies realised through R&D can contribute to improving environmental performance and achieving green growth targets by replacing resource-intensive and polluting activities, or by making them more eco-efficient. They have the potential to reduce the load of known toxins in agricultural production, substitute safer alternatives, protect ground or surface waters, conserve natural habitats, reduce nutrient loads in soils, lower gaseous nitrogen loss and reduce the amount of non-renewable energy used in the cropping cycle.

Adopting these innovations will entail changes to current farming practices and the implementation of new technologies to enhance resource productivity and eco-efficiency. Green growth can provide a new paradigm for agricultural research, placing the emphasis simultaneously on environmental and economic requirements, with the aim of enhancing productivity without compromising the natural resource capital.

But adopting technologies for fostering green growth farming systems involves uncertainty and trade-offs. Technologies that can contribute to an economically efficient farm sector and provide financial viability for farmers, while at the same time improving environmental performance in a way that is acceptable to society, will provide "triple dividends" to green growth. Moreover, the aims are "moving targets" which must address new issues and changing priorities. Technological developments are rapidly evolving and information on the costs and benefits of adopting technologies in agriculture is often imperfect. Thus, the choice of technology adoption is made in a climate of uncertainty, with a

large element of "trial and error" in its application, and the speed and extent of adoption varies considerably among farmers.

In addition, there may well be substantial challenges, both technical and social, in promoting innovation and adoption of new technologies in the food system. One particularly contentious area is the role of new technologies, including biotechnology and nanotechnology, in addressing future food needs (Box 3.1).

The "enabling" environment for the development and uptake of green technology and innovation

The rationale for policy actions to foster green innovation rests on several well-known market failures and is what is usually referred to as the "double externality" problem (OECD, 2011a). The first concerns the under-investment in the production of new knowledge by the private sector due to knowledge externalities and the disincentives provided by free riding. The second argument stems from the negative externalities associated with the environment – such as climate change – and has implications for both the creation and diffusion of technologies. For example, because GHG emissions are not priced by the market, incentives to reduce them through technology development are limited. Similarly, there is less diffusion and adaptation (once green technologies are available) if market signals regarding the environmental benefits of such technologies are weak.

In addition, other market failures and barriers, such as institutional failures, dominant patterns in energy and transport markets – which can create entry barriers for new technologies and competitors due to, for example, the high fixed costs of developing new infrastructures – uncertainty about future success, long timescales for infrastructure replacement and development, and a lack of options for product differentiation may be unique to, or more prevalent in, markets for green innovation (UK Committee on Climate Change, 2010).

Unleashing green innovation will require a comprehensive strategy that considers the full spectrum of policies to create, diffuse and apply knowledge, covering both supply and demand-side policies as postulated in the OECD's 2010 Innovation Strategy and re-stated in its study on fostering innovation for green growth (OECD, 2011b). A policy environment based on core "framework conditions" – sound macroeconomic policy, competition, openness to international trade and investment, tax and financial systems – is a fundamental building block of green growth strategies and allows innovation to thrive.

In addition to the above over-arching policy framework for green innovation, the "enabling environment" for fostering innovation for green growth in agriculture encompasses several agriculture-specific factors. R&D efforts in the sector; adequate levels of education and training among farmers; access to advice and credit (especially those that require a larger scale of operations and where the initial investment costs required are high); quicker and cheaper means of disseminating and sharing information, and pressures from the civil society are all contributing towards facilitating the adoption of farm technologies which are benign to green growth. Moreover, policies should also be conducive to non-technological innovations, including those pertaining to organisational and behavioural changes because such innovations play an important role in fostering green growth (OECD, 2011a).

Box 3.1. Technological breakthroughs contributing to green innovation in the agro-food sector: The case of nanotechnologies

Nanotechnology, which involves the manipulation of material measuring between 1-100 nanometres in at least one dimension, is leading to the development of potentially revolutionary technologies in a variety of industries, including agriculture and food. By increasing productivity and resource use, reducing postharvest loss, improving product quality, increasing the competitiveness of agricultural producers, advances in nanotechnology may present new opportunities to foster green growth, if the multiple challenges to their use can be overcome. Investment in several OECD countries (e.g. Australia, Canada, Chile, European Union, Japan, Korea, New Zealand, Mexico, Switzerland and the United States) has been growing and a wide range of nanotechnology applications are currently being developed and commercialised, with goals ranging from improved food safety to reduced agricultural inputs, improved processing and nutrition, and enhanced packaging.

Agricultural nanotechnology applications include: sensors in many applications (bacteria in food, plant health monitoring, soil quality and pollution identification), filtration/purification for air/water applications, energy storage and photovoltaic, fibre production, soil stabilisation, slow-release nanofertilisers and encapsulated pesticides. In agriculture, nanotechnology R&D has mostly focused on improving input use and delivery, from water to nutrients, nanopesticides and nanoherbicides. Interesting applications include the use of nanoporous zeolites to slow the release and increase the efficiency of fertilisers; nanosensors to measure soil quality; smart delivery mechanisms for herbicides. There has also been significant R&D on food and water safety, with the development of nanosilver or nanoclay products to improve water filtration, and nanosensors to detect and help track food pathogens. The most important area of development, however, has been in the field of nutritional supplements and packaging and storage.

Nanotechnology can potentially benefit the agro-food sector in several key areas, including sustainable production, plant and animal health, food processing and packaging, as well as in reducing the environmental impact of agricultural operations. For example, nanotechnology can contribute to enhancing agricultural productivity in a sustainable manner, using agricultural inputs more effectively, and reducing by-products that can harm the environment or human health. Nanotechnology-based biosensors deployed in crop fields and in plants to monitor soil conditions, growth and disease vectors, can expand the concept of precision farming in which productivity can be optimised, while providing inputs (i.e. fertiliser, pesticide, irrigation, etc.) and conditions (i.e. temperature, solar radiation) in the precise levels necessary. Similarly to nanomedicine applications, pesticides and herbicides can be formulated with nanoparticles to enhance the effectiveness of active ingredients and allow targeted delivery and release, thereby requiring less dosage per application and minimising run-off of excess chemicals. Nanotechnology can help in the diagnosis, treatment and monitoring of crop and livestock diseases, and ensure timely intervention. Moreover, developments in nanobioprocessing have the potential to convert agricultural waste into energy and other useful by-products, thereby transforming waste that can adversely impact the environment into a valuable resource.

A major challenge facing the sector is how to maintain growth and move towards commercialisation. Sustained funding can be difficult to obtain because of the length of the time required to establish the results of research, the high cost of equipment and the uncertainty of the findings. Another major challenge relates to health and environmental risks.[1] Various issues and concerns have been raised, concerning, in particular, the lack of full understanding of the impact of nanomaterials on health and the environment, as well as the inadequacy of current regulations to cope with rapid advances in nanotechnology. In the context of green growth, these policy challenges highlight the importance of assessing the impact of nanotechnology from a life-cycle perspective that considers the full range of economic, environmental and societal implications.

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1. Nanotechnologies could, in themselves, constitute a specific source of pollution, which may be more difficult to treat than conventional ones. A study on nanopesticides used in the treatment of pears found that they entered the fruits more easily than standard pesticides (Zhang et al. [2012],) "Detection of Engineered Silver Nanoparticle Contamination in Pears", *Journal of Agricultural Food Chemistry*, Vol. 60, No. 43.

Sources: Gruère, G. (2012), "Implications of nanotechnology growth in food and agriculture in OECD countries", *Food Policy,* Vol. 37, pp. 191-198; Gruère, G., C. Narrod and L. Abbot (2011), "Agriculture, Food and Water Nanotechnologies for the Poor: Opportunities and Constraints", *IFPRI Policy Brief* 19, June.

Farmers will invest in and implement green technologies and farm practices if they expect the investment will be profitable, if they have the appropriate skills, information and motivation, and if government policies provide appropriate incentives, or at least avoid creating dis-incentives. Where the environmental benefits from employing sustainable technologies are not expected to accrue to farmers, but to people outside agriculture, and where there are no markets for the benefits, levels of adoption could be sub-optimal from a societal perspective. Equally, where the costs of the environmental effects caused by current farming activities are paid by other sectors, farmers will have no incentive to adopt environmentally sustainable technologies.

Agricultural policies can also be particularly important for agricultural innovation as they can alter the prices facing farmers for their inputs and outputs, which in turn will influence their decisions on investment. Some measures may also influence farmers' choice of product and farming practices.

Agricultural policies are frequently giving conflicting signals which hinder the uptake of technology. For example, some agricultural policies encourage the expansion of agriculture on environmentally fragile land, leading to the over-exploitation of natural resources, and make no requirement to farmers to take into account environmental spill-overs into other sectors. Moreover, many agricultural support policies get capitalised into the value of land, encouraging a greater intensity of production and influencing the kind of technologies that are adopted.

The combination of the many different economic, structural, behavioural and policy factors in a wide range of different situations means that there is no simple or unique explanation as to what leads farmers to adopt new technologies and that there is no single factor or policy that will drive green innovation. A comprehensive strategy for boosting green innovation will require policy actions on several fronts, including clear and stable market signals (e.g. carbon pricing or other market instruments that address the externalities associated with environmental challenges). Such signals will enhance the incentives for farmers to adopt green innovations, and would also indicate a clear policy commitment on the part of governments to move towards greener growth.

If green growth is to be achieved in the agricultural sector, the overall policy framework needs to be consistent and coherent, particularly in the context of agricultural policy reform, trade liberalisation and multilateral environmental agreements. This will require a more integrated approach in terms of setting objectives for green growth in agriculture, defining research and development priorities, and targeting and implementing policy measures at the appropriate level. Improving the innovative capacity of the farm sector would involve identifying obstacles to innovation; revisiting policies that hamper innovation, structural change and the functioning of output and input markets; and implementing measures to foster innovation and competitiveness (OECD, 2013a). However, in practice it is a considerable challenge to achieve policy coherence across a range of government, ministries and other institutions.

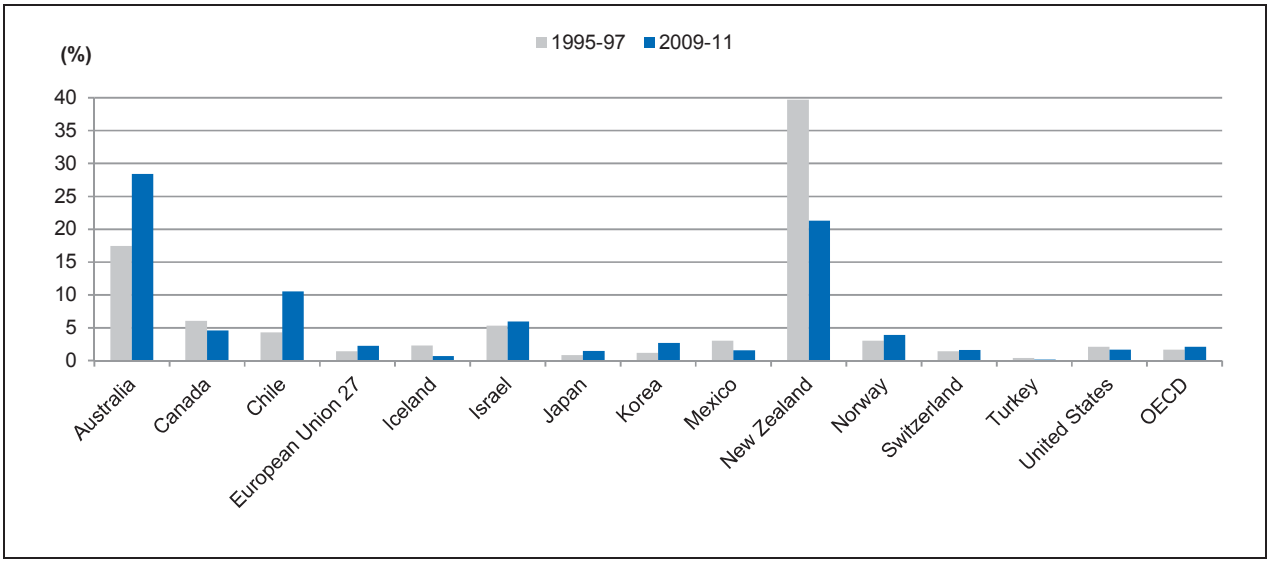
Fostering innovation for green growth – Research and Development (R&D)

While technology can continue to be a key driver for productivity and yield increases in OECD agriculture, maintaining this level of performance will largely depend on research and technologies to enhance the ability of the agricultural sector to increase eco-efficiency, improve sustainable resource use, and respond to climate change. The productivity of agricultural production can be enhanced through appropriate technology and management techniques for farms, resources and land which do not harm the environment.

Estimates of the rates of return to agricultural R&D suggest a very high social value of agricultural R&D, indicating considerable under-investment in agricultural research systems.[2]

Yet, and despite the importance of the agricultural sector to food security, about only 4% of public and private R&D spending in OECD countries is oriented towards agriculture. Moreover, even though government funding for R&D is permitted under international trade agreements, it accounts for just a small share of total support to agriculture – around 2% in the OECD area in 2009-11 (Figure 3.1). Public spending on agricultural research as a proportion of total support to agriculture is very high in ***Australia*** and ***New Zealand*** only (28% and 21% in 2009-11, respectively).[3]

Figure 3.1. Share of government expenditures on agricultural R&D in total support to agriculture



Source: OECD PSE/CSE database, 2012.

Public investment in basic and long-term research plays an important role in innovation. Such research has a public-goods character and is therefore unlikely to be undertaken by the private sector. It helps address fundamental scientific challenges and fosters technologies that are considered too risky, uncertain or long-gestating for the private sector.

In the context of green growth, public research will need to cover many areas, including, for example, both mitigation and adaptation technologies to climate change and water management; it will need to be well designed, and able to complement private investment in research; it should be neutral with respect to specific technologies, as innovations may emerge from a wide range of fields; and it should be targeted to areas in which social returns and spill-over effects are potentially the greatest.

Because of the high costs involved, the management of research systems will assume increasing importance. One of the conclusions of the 2012 OECD conference on improving Agricultural Knowledge and Innovation Systems (AKS) was that the budget austerity currently facing many countries is heightening the need to improve the effectiveness of these systems and to reinforce multidisciplinary co-operation at national and global level (OECD, 2012a).

Moreover, because of the long lead time in research activities, the timely identification of future research problems carries a substantial premium. In the context of green growth, for example, one area which warrants increased attention is research into lower-input farming systems geared to developing economically viable methods of cultivation and husbandry, while also producing beneficial effects for the environment (e.g. lower agro-chemical input per unit of output) and on the use of land (extensive methods).

Governments can encourage R&D using a variety of financial and non-financial incentives (Box 3.2). They can promote business R&D investments in agriculture through targeted supports, tax credits and public/private partnerships, which have a multiplier effect on public research funding. As one way of trying to increase resource efficiency, some governments have increased the use of contracts or competitive research grants, but further analysis of the factors which determine the efficiency of research systems is required.

Box 3.2. Types of incentives to promote R&D

Financial incentives

Direct financing: The government can directly finance R&D undertaken at public scientific bodies such as universities, government research institutes and science parks.

Grants: The government can directly fund private R&D initiatives through awarding financial grants (both for-profit and not-for-profit). Grants allow the government to target the projects with high social returns.

Tax incentives: Tax incentives represent an indirect form of support to private R&D efforts by providing tax relief that lowers costs. This measure gives more autonomy to the private sector, but makes it difficult to target projects.

Removing subsidies: The government can also remove subsidies for environmentally harmful products (e.g. fossil fuels) in order to create a level playing field for R&D on resource-efficient technologies.

Long-term investments: The government can provide R&D for resource-efficient technologies with long-term, low-rate investment in companies, or loans by venture capital and other financial organisations.

Non-financial incentives

Protection of intellectual property rights: The creation of a legal environment that protects patents and relaxes anti-trust activities can increase the likelihood of generating an acceptable return from R&D investment.

Demonstration projects: It is essential that trials are conducted to prove the technical viability at a commercial scale of those new technologies that do not readily attract private sector financing. Demonstration projects are also needed to tailor developed technologies to fit specific contexts.

Human resources development: The availability of university graduates influences the potential number of research scientists and engineers. Education policies lead to a match with the requirements of industry.

Industrial standards: The provision of standardisation in products and processes can not only reduce the costs of production by providing clearly specified requirements, but also speed up competition for upgrading of products.

Co-ordination bodies: The creation of co-ordinating agencies or advisory councils can improve the flow of information between government departments, research organisations and industry, fostering learning processes, indigenous innovation and technological diffusion.

International collaboration: The government can facilitate the formation of international joint ventures and other international collaborative efforts to encourage resource-efficient technology transfer and innovation.

Source: de Serres, A., F. Murtin and G. Nicoletti (2010), "A Framework for Assessing Green Growth Policies", *OECD Economics Department Working Papers,* No. 774, OECD Publishing, http://dx.doi.org/10.1787/5kmfj2xvcmkf-en

Success of R&D policy depends on a variety of factors including: *i)* balanced protection of intellectual property rights (i.e. enabling "reasonable' returns so as to encourage private investment while simultaneously enabling widespread diffusion of benefits); *ii)* define performance (e.g. the development of resource-efficient technologies would be encouraged by setting clear goals that specify efficiency and emission characteristics of technologies); *iii)* clearly define the role of each partner in public-private partnerships (de Serres et al., 2010).

At least 21 OECD countries stimulate private sector research through the provision of R&D tax credits which provide firms with tax benefits that are related to the costs of undertaking specific innovation activities (Stevens, 2011). ***Canada***, for example, offers a broad-based R&D tax credit of up to 35% of total expenses for experimental development, basic and applied research, and related supporting activities. The ***United States*** is now proposing to simplify, increase and permanently extend its R&D tax credit.

In ***Australia***, through the R&D Tax Incentive, which was introduced in July 2011, the government is encouraging investment in rural R&D across the economy through tax credits. In particular, the R&D Tax Incentive is a targeted tax offset designed to encourage more national companies to engage in R&D. It aims to: boost competitiveness and improve productivity across the economy; encourage industry to conduct R&D activities that may not otherwise have been conducted; provide business with more predictable, less complex support; and improve the incentive for smaller firms to engage in R&D. The R&D Tax Incentive is open to firms of all sizes in all sectors who are conducting eligible R&D activities. There are two components to the incentive, a 45% refundable tax offset for entities with a turnover less than AUD 20 million, and a non-refundable 40% tax offset for the rest.

Accelerated depreciation schemes for research-related capital expenditures and reduced labour taxes on scientists and researchers provide incentives to expand research and innovation. Some countries lower the corporate tax rate for innovation-related profits, such as those resulting from royalties or the sale of patents. Other countries target the tax credit to specific sectors and outcomes, including environmental research. For example, as stipulated by the *Framework Act on Low Carbon Green Growth*, the ***Korean*** Government revised the Restriction of Special Taxation Act in order to provide tax breaks for green finance as from January 2010. Skilfully harnessing the tax system offers a means for increasing R&D expenditures to advance Green Growth in agriculture and other sectors.

Regulations affect innovation in several ways. Although regulation can encourage green innovation, its impact is not straightforward and varies across sectors, industries and technologies. The design of regulations is also important: they should be sufficiently stringent to encourage innovation; stable enough to provide investor confidence; flexible enough to foster genuinely novel solutions; closely targeted on the policy goal; and provide incentives for innovation (OECD, 2011a). Poorly designed regulations, in terms of stringency, stability; flexibility and closely targeted on the policy goal may impede innovation.

A number of regulatory issues are of particular importance for agricultural innovations, including property rights protection (Box 3.3), environmental regulations (Chapter 4), health and food safety regulations, and bio-based regulations. In the ***European Union***, smarter regulations aim to simplify existing EU legislation to spur innovation and reduce the administrative burden for operators. Independent evaluations have been commissioned on several legislative areas, including Genetically Modified Organisms (GMOs), animal health, plant health and seeds. Furthermore, impact assessment is now required for any regulatory proposals, including those involving contributions to sustainable development and innovation. In terms of innovation, impact assessment takes into consideration, *inter alia*, whether the proposal: hinders or stimulates R&D; promotes greater productivity or resource efficiency; and affects intellectual property rights.

Box 3.3. What are property rights?

Property rights define the rules determining who may control or benefit from designated assets. These assets may be tangible (physical) or intangible (virtual, or conceptual). Hence, property rights can be assigned in relation to a wide range of assets: natural resources found on, above or below ground on specified tracts of land; buildings and land; industrial processes; property existing only in digital form; physical works of art; intangible artistic creations (such as music, literature and design) and so on. Property rights are legally enforceable and may be vested in individuals or groups of individuals, or in legal entities (e.g. corporations).

Property rights usually confer a bundle of specific benefits and privileges that regulate the relationship between the rights-owner and the asset. Rights do not necessarily imply full ownership nor the sole authority to use and dispose of a resource; different individuals, families, groups, or even the state often hold overlapping use and decision making rights. To be secure, rights should be of sufficient duration to allow one to reap the rewards of investment and should be backed by an effective, socially sanctioned enforcement institution. This institution might be the government, local communities or other institutions (Bromley, 1991).

The composition and precise form of the bundle of rights can vary depending on the type of asset. In general, the property rights bundle can be broken down into user rights (including the exclusive claim to the income derived from the use of the asset), transfer rights (control over the sale, gift or bequest of the asset) and transformation rights (unconstrained modification or destruction of the asset).

Not all these rights are relevant for every type of asset. Moreover, the legal definition and attribution of property rights in particular cases may explicitly limit or withhold one or more of these components of the bundle, or some of potential rights may be ruled out by over-riding general legislation. Furthermore, different elements of the bundle may be allocated to different beneficiaries. For example, landownership may confer user rights and transfer rights to landowners, although user rights may be constrained by general environmental and safety legislation and access rights to parts of the land may reside with the general public.

Property rights are not absolute or unchanging (Bromley, 1991). Three particular factors which can trigger change include: technological change (which can make access to resources feasible for the first time; reduced costs of obtaining or processing information or reduce the cost of defining and enforcing rights); new markets (due to technology, reduced trade protection, political shifts); changes in relative factor scarcity; and state intervention to define and enforce property rights in exchange for revenue (Furubotn and Pejovich, 1972).

Sources: Bromley, D. (1991), *Environment and Economy: Property Rights and Public Policy,* Oxford, Basil Blackwell; Furubotn, E.G. and S. Pejovich (1972), "Property Rights and Economic Theory: A Survey of Recent Literature", *Journal of Economic Literature,* Vol. 10, No. 4, pp. 1137-1162.

Fostering innovation for green growth: Property rights to knowledge-based capital

Naturally occurring resources are in finite physical supply and so their expansion cannot be a strong driver of growth over the long term.[4] However, their productivity can be enhanced by combining them with new inputs, with other (renewable) inputs whose productive potential is continuously being upgraded (e.g. a better-educated workforce), with more productive man-made capital or with existing inputs but in new ways. This kind of productivity-enhancing innovation is essentially limited only by human ingenuity. Thus, it is expansion of the non-physical productive resources (knowledge, know-how, "intellectual capital") that is expected to be the main driver of green growth in the longer term. It follows that the question of how the property rights relating to these resources are specified and in whom they are vested is potentially of major importance in the green growth context. Lack of an adequate system of property rights that would enable those responsible for developing new intellectual capital to fully appropriate a commercially-based economic return for it could be seen as a major constraint on research and innovation processes.

The OECD (2011c) study on tools for delivering on green growth identifies low appropriability of returns to innovation and investment as one of the factors holding back green growth, although the diagnosis can be applied more generally to any kind of growth-oriented innovation and investment. A causal factor in this low appropriability is ascribed in part to an incomplete system of property rights, which is categorised as an aspect of government failure.

A number of other government and market failures are also responsible for low appropriability of returns. For example, other barriers to innovation may emerge from systematic failures that hinder the flow of knowledge and technology, such as: *i)* capability failure (e.g. lack of managerial capacity); *ii)* institutional failure (e.g. universities, research institutions); *iii)* network failures (e.g. weak links between actors of innovation systems); and *iv)* framework failures (e.g. deficiency in regulatory frameworks, cultural and social values) (OECD, 2011a).

The traditional means for protecting new intellectual property in productive processes has been the patent system (OECD, 2011a). Patents have emerged as the central institution for asserting intellectual property rights in many crucial fields of science and technology, including agriculture.[5] The rapid progress of modern agricultural biotechnology has led to an increased awareness of the patenting of agricultural plants, and the number of plant biotechnology patents granted by governments (e.g. the United States) has grown exponentially over the last two decades. This period coincided with fundamental revolutions in the ways in which agricultural technologies were developed. As agricultural technology has become more science-based, patents on platform and enabling biotechnologies, transformation and gene-transfer techniques and methods for genomics research have strongly influenced the development of new technologies.

Patents have helped private enterprise develop new technologies and disseminate knowledge. Without patent protection, private companies might not be able to recover development costs of new technologies that improve the performance of tractors, irrigation equipment, pesticides, storage facilities and other inputs. By endowing discoverers with property rights over the results of their efforts, patents affect the incentive to innovate and are likely to lead to an increase in the flow of innovations. Patents can also help to improve the dissemination of knowledge, technology transfer and commercialisation.

However, intellectual property licensing is a challenging topic for policy makers. Notwithstanding the aforementioned beneficial effects, licensing agreements can also have the effect of cartelizing an industry, or of increasing the market power of a single licensor. The challenge for policy makers is to determine whether a particular agreement is likely to facilitate or hurt competition. In other words, the system of patents and licensing should provide incentives for private investment in innovation, without compromising the sharing of knowledge and further spread of innovation (Box 3.4).

The effectiveness of the IPR regime relies on effective institutions. IPRs should be well protected and appropriately enforced to provide strong incentives for innovation but also lead to the public benefits that flow from dissemination of knowledge in the marketplace. Competition authorities play an important role in ensuring that patents are not used anti-competitively. A number of OECD governments have made efforts to encourage firms to learn about the patent system and apply for green patents. These include expedited examination of patent applications relating to green technologies. In the ***United Kingdom***, the UK Intellectual Property Office has developed a strategy specifically to facilitate the protection, management and appropriate exploitation of intellectual property connected with low-carbon technologies.

Box 3.4. Main economic arguments for and against patents

In the academic literature the usual argument in favour of intellectual property protection — as it appears in the seminal works of Arrow (1962), Nordhaus (1969) and Romer (1990) — is that innovation amounts to knowledge production, and as knowledge is inherently non-rival there is a market failure and insufficient incentives to innovate. The non-rival character of knowledge implies that once an invention is known, everyone can use it with no additional R&D cost. Patents provide incentives to R&D and to disclose information, but at the social costs of reducing the invention's use during the validity of the patent.

More recent academic research has called into question this conventional view and, consequently, the effectiveness of patents as a tool for stimulating innovation (Hall and Harhoff, 2012; Jaffe and Lerner, 2011; Langinier and Moschini, 2002). In situations where imitating is as costly as inventing, or where firms have the economic and technical means for protecting their inventions, there is no need for further legal protection. Under these circumstances, patents may simply become a source of market distortion and facilitate rent-seeking or strategic behaviour by patent holders. The theoretical literature shows that when research is sequential and builds upon previous discoveries, stronger patents increase the costs of subsequent innovators, especially when innovators need to combine inventions from several different sources. In this case, the enhanced ability to enforce patents may *impede* rather than *promote* innovation, contrary to conventional belief. Finally, transaction costs and contracting problems associated with proliferation of patents may also adversely impact on innovation (Mueller et al., 2013).

Sources: Arrow, K.J. (1962), "Economic Welfare and the Allocation of Resources for Invention", in *The Rate and Direction of Economic Activity: Economic and Social Factors,* Universities-National Bureau, nber.org/chapters/c2144; Nordhaus, W. (1969), *Invention, growth and welfare*, MIT Press, Cambridge, MA; Romer, P. (1990), "Endogenous technical change", *Journal of Political Economy*, Vol. 94, No. 5, pp. 71-102; Hall, B.H. and D. Harhoff (2012), "Recent research on the economics of patents", *Working Paper* 17773, National Bureau of Economic Research, nber.org/papers/w17773; Jaffe, A. and J. Lerner (2011), *Innovation and its discontents: How our broken patent system is endangering innovation and progress, and what to do about it,* Princeton University Press; Langinier, C. and G. Moschini (2002), "The Economics of Patents: An Overview", *Working Paper 02-WP 293,* Center for Agricultural and Rural Development, Iowa State University, Ames, Iowa; Mueller, E., I. Cockburn and M. MacGarvie (2013), "Access to intellectual property for innovation: Evidence on problems and coping strategies from German firms", *Research Policy*, Vol. 42, Issue 2.

A commonly held view is that basic research, which may feed into a variety of new applications and products, is best undertaken in the public sphere, or at least financed from public funds, and should be made available to all as a common resource. By contrast, near-market research and development of specific techniques, which may draw on the common pool of basic research, but which can be marketed to end-users, is best left to the private sector, since the private sector is better placed to foresee specific market demands and is able to fund its development activities out of market returns. However, with the increasing importance of PPPs and other forms of collaborative research, the distinction between public versus private funds is blurred. Under US law, basic research per se cannot be patented.[6] Likewise, in Europe, it is not straightforward for basic research to qualify as patentable.[7]

This situation raises questions as to the destination of the rent from the basic research. When much basic research is so complex and esoteric that only large corporations have the resources to understand and exploit it for an end-use, in what sense can it be said that this knowledge belongs to society as a whole, and to what extent if any is society able to capture the benefits of ownership if it becomes available only when embodied in products and services marketed by private sector companies? If universities and public research organisations were able to recoup more of the market returns from their basic research, this would allow a larger share of self-funding of new basic research and would help guarantee the continuity of basic research programmes in times of budget stringency.[8]

The trend towards funding of on-campus research laboratories and programmes by large companies does not necessarily solve the problem. Even if it is correct to interpret this trend as a recycling of some of the market returns from basic research back to the institutions that generated the basic research, it is not necessarily a perfect substitute for income that is directly appropriable by universities. Indeed, corporate funding of university research arouses mild concern in some quarters about potential loss of scientific independence and research autonomy in these public institutions.

Finally, since the benefits to research and innovation with respect to environmental conservation and enhancement do not – for the most part – pass via markets and are essentially "non-appropriable", it can be expected that this kind of knowledge creation to fall to the public sector, although much of it will not qualify as "basic research" at all. In fact, the coupling of "green" and "growth" has increased total demands and expectations directed towards the research establishment, and this has to be borne in mind by governments that might be tempted to reduce research funding due to over-stretched budgetary resources.

Fostering innovation for green growth: Public-private partnerships

Public-Private Partnerships – that is joint agreements with agro-food industry or other stakeholders (e.g. producer organisations, universities, environmental groups, etc.) – are gaining importance in several OECD countries. For example, ***Australia*** and ***New Zealand*** have created special research institutes jointly funded by government and industry, with a focus on specialised agricultural research. Similar co-operative research programmes are in place in ***Canada***, ***Denmark***, the ***Netherlands***, the ***United Kingdom*** and the ***United States***.

In its Green Growth Strategy, one of the aims of the ***Danish*** Government is the efficient organisation of agricultural R&D, to be brought about through a green development and demonstration programme, aimed at increasing the co-ordination between research, innovation and demonstration in the agro- and aquaculture and food sectors.

In ***Korea***'s green-certified firms are given prioritised access to public funding for R&D programmes, including eco-friendly agriculture and food, renewable energy. The criteria for the award of certificates are the ability to demonstrate that the technology adopted has reached 70% of the most advanced level in the same line of technologies. The list of candidates is renewed every year to reflect related technological advancement and social change.

In ***Australia***, the national rural R&D priorities aim to foster innovation and guide R&D effort in the face of continuing economic, environmental and social change. There are collectively five national rural R&D priorities: productivity and adding value, supply chain and markets, natural resource management, climate variability and climate change and bio-security. Through the rural Research and Development Corporations (RDCs) model, the *National Enabling Technologies Strategy*, Australia has increased public research on sustainable food and agricultural systems and undertakes public/private partnerships for green agricultural research.

The RDC model is a key contributor to increases in public research on sustainable food and agricultural systems. It is estimated that in 2012-13 the Australian Government will match industry levies on production of about AUD 235.9 million. RDCs are a public/private partnership between the Australian Government and industry, which includes "green agricultural research". Through the RDCs, the Government and industry share the funding and strategic direction setting for primary industry R&D. The RDCs account for a significant proportion of Australian's rural R&D. Of the 15 RDCs, six are statutory authorities funding only R&D, and nine are industry-owned companies that fund industry service provision, including R&D and marketing. As evidenced by its productivity performance, whereas rural

productivity is increasing at more than twice the rate of other industries in the economy in recent decades, the rural RDC model has been successful.

The *National Enabling Technologies Strategy* provides a framework to support the responsible development of enabling technologies, such as nanotechnology, biotechnology and other emerging technologies. With funding of AUD 38.2 million over four years, it aims to help industries capitalise on growth opportunities and ensure that the country benefits from enabling technologies, while ensuring that processes are in place to identify, monitor and mitigate any associated risks. The Strategy also provides a central point for policy co-ordination and community engagement at the Federal, State and territorial level.

More specifically, the expected outcomes from the Strategy are: timely and accurate information that informs policy makers' decisions on the impacts, opportunities and challenges of enabling technologies; increased competitiveness through uptake of nanotechnology-based products, processes and services; effective regulatory frameworks to manage the impacts of enabling technologies on public health, safety and the environment, but which do not unreasonably inhibit or prohibit their uptake; and an understanding amongst government, researchers and industry of public interests with regard to enabling technologies.

In ***France***, one of the actions of the *Écophyto* plan on pesticides is to encourage innovation in the design and development of low pesticide input practices and cropping systems. The research and development effort within the *Écophyto* plan seeks to develop new Integrated Pest Management solutions that can contribute to sustainable agriculture while preserving the competitiveness of French agriculture. Toward this end, the Ministries of Agriculture and Environment have requested that the *Institut National de la Recherche Agronomique (INRA)* launch the research which is mobilising a hundred experts from over 30 organisations and is focusing on four main crop sub-sectors: arable crops, fruit arboriculture; viticulture; and vegetable crops. For each of these sub-sectors different strategies for limiting the use of pesticides are being analysed.

In ***New Zealand***, the *Primary Growth Partnership (PGP)* provides investment in research and innovation to boost productivity, economic growth and sustainability across New Zealand's primary, forestry and food sectors. PGP funding must be matched by co-investors from industry. A key programme under the PGP is the establishment of the Centre for Agricultural Greenhouse Gas Research. The *Sustainable Farming Fund* (SFF) supports rural communities to undertake applied research and extension projects to tackle a shared problem or to develop a new opportunity. SFF projects are led by rural landowners and managers, often with the support of industry organisations, agribusiness, researchers or consultants. The *Pastoral Greenhouse Gas Research Consortium* (PGGRC) is a partnership, formed in 2002, between the Government and the dairy and fertiliser industries, to provide livestock farmers with the information and means to mitigate their GHG emissions. The scope of the programme is broad, and includes research into improvement of the production efficiency of ruminant animals. The PGGRC target is to decrease emissions by 10% per unit of output by 2013 over business as usual benchmark, relative to 2005 (estimated to be 4 million tonnes).

Launched in 2007 and administered by the Ministry of Agriculture and Forestry (MAF), the *Sustainable Land Management and Climate Change Plan of Action* (SLMACC), is a five-year programme for the land-based sectors, running in partnership with the land management sectors, local government and Maori. Key work streams include: the impacts of climate change and adapting to climate change; reducing New Zealand's GHG emissions and enhancing carbon sinks; research; and a technology transfer programme. Priority research topic areas and funding are identified through consultation with stakeholders. Research programmes have been carried out in the following areas: farm-level GHG reporting using the Overseer nutrient budget model; bioenergy and biochar R&D; national nitrification inhibitor

research; national agriculture and forestry inventory development; and life-cycle analysis for a number of industry sectors and products.

In the *Building Innovation* theme of the *Business Growth Agenda* a number of actions are envisaged: strengthening research institutions (where there are several actions to reposition public education and research institutions to develop more effective links between the business sector and CRIs and universities); public science investment (where the action to develop the Statement of Science Investment Priorities will consider the potential for green research); international knowledge transfer (where the work to establish mutually beneficial science investment opportunities with Singapore and the actions on science that are part of the New Zealand strategies will support the transfer, adaptation and adoption of existing and new technologies).

The *Enterprise Policy – Top Sector Approach* government initiative in the ***Netherlands*** aims to boost growth and innovation in nine sectors: agro-food; horticulture and propagating stock; high tech; energy; logistics; creative industries; life sciences; chemicals; and water. The core of the top sector approach is collaboration among researchers, entrepreneurs and government (the "golden triangle"). *Top-sector Agro-Food* focuses on further sustainable food supply chains where there is a continuous challenge of improving resource efficiency.

In the ***United Kingdom***, the *Green Food Project* is a is a joint initiative between government and stakeholders (industry and environmental partners) to reconcile the competing demands of producing more food and improving the environmental performance of the whole supply chain (e.g. lowering GHGs, reducing levels of waste and water use, and improving biodiversity and soil quality). Among the questions to be addressed will be how competing pressures on land use and on natural resources can be managed, how new technologies should be embraced, the implications of changing consumer behaviour, the potential to innovate. In particular, it will examine how production and consumption could change in the future in five different sectors – wheat, dairy, bread, curry, and geographical areas. The initial conclusions of the project, which were published in July 2012, address a range of topics, primarily R&D, knowledge exchange, future workforce in the food industry, investment, building effective structures, valuing ecosystem services, land management, consumption and waste.

In the ***United States***, the 2008 Farm Bill, which contains the major provisions dealing with federally supported and United States Department of Agriculture (USDA)-administered agricultural research, education and extension services, authorised the creation of several new research activities related to specialty crops, organic agriculture, bio-energy, nutrition and pollinators. An increasing emphasis is placed on competitive grant funding. The 2008 Farm Bill also raised funding authorisation for "1890 institutions" and broadened eligibility for federal grants for agricultural research, education and extension, particularly for Hispanic-serving institutions.

Fostering innovation for green growth: International co-operation

Although much of the policy emphasis on achieving green growth objectives is inevitably domestic in nature, there is also an important role for international collaboration in several areas. In particular, the sharing of the results of R&D and new knowledge that contributes to the greening of agriculture is important. There is considerable potential for taking advantage of spillovers at the international level from the development of new production methods in agriculture.

The Global Research Alliance

The *Global Research Alliance* (GRA) *on Agricultural Greenhouse Gases,* which was launched in December 2009 and now has more than 30 member countries from all regions of the world, is a voluntary network set up to increase international co-operation, collaboration and investment in agricultural GHG research.[9] The focus of the GRA is on R&D and the extension of technologies and practices that will help deliver ways to grow more food (and produce more climate-resilient food systems) without increasing GHG emissions at a global level. It aims to deepen and broaden existing mitigation research efforts across the agricultural sub-sectors of paddy rice, cropping and livestock. This includes the cross-cutting themes of soil carbon and nitrogen cycle and inventories and measurement issues.

A key initial task includes conducting a stocktaking of research activities to guide the development of research activities. The Alliance promotes an active exchange of data, people and research to help improve the ways in which agricultural greenhouse gas research is conducted and to enhance the scientific capability of participating countries. For example, the New Zealand Government sponsors the Global Research Alliance Senior Scientist Award, which provides support to scientists from New Zealand and other Alliance countries who undertake exchanges on research projects on agricultural GHG mitigation. Likewise, the United States, through the 2012 United States Department of Agriculture Global Research Alliance Fellowships, will support scientists from Columbia, Ghana, Indonesia, Malaysia, Mexico, Peru, the Philippines and Vietnam to work side-by-side with US scientists on climate change mitigation research.

As of March 2012, an Alliance Council and five scientific groups have been formed: the Paddy Rice Research Group; the Livestock Group; the Croplands Group; the Soil Carbon and Nitrogen Cycling Cross-Cutting Group; and the Inventory and Measurement Cross-Cutting Group. These Groups have developed work plans that bring countries and other partners together to collaborate in research, as well as to share knowledge and best practices, build capacity and capability amongst scientists and other practitioners, and work towards breakthrough solutions to addressing agricultural GHG emissions.

The Paddy Rice Research Group (co-chaired by Japan and Uruguay) is focused on emissions from paddy rice cultivation systems. The Group is working to find ways to reduce the emissions intensity of paddy rice cultivation systems, while improving its overall production efficiency. Trade-offs with emissions of nitrous oxide and changes of the quantity of carbon stored in paddy soils are also being considered. The Group's work will help improve countries' national inventories of greenhouse gas emissions from paddy rice cultivation systems. It will also provide knowledge of source and sink extents and mitigation options to paddy rice farmers, land managers and policy makers, by looking at the impacts of water management, organic matter and fertilisers and cultivar selection.

Specifically, the Paddy Rice Research Group is working on the standardisation of measurement techniques, identifying good practice and gaps in current knowledge, and developing improved country-specific emission factors and mitigation options. Relevant literature is being pulled together into a database. Over time, the Group will look at how to scale up results across countries and extrapolate solutions to the long term.

The Livestock Group (co-chaired by New Zealand and the Netherlands) is looking at emissions from ruminant and non-ruminant livestock systems. Key emissions covered are methane from enteric fermentation and waste management, nitrous oxide from animal wastes and fertilisers, and soil carbon. The Group's work will help catalogue available mitigation options and improve understanding of the ways of managing livestock emissions and improving efficiency of production. Immediate goals for the Livestock Group include:

- Collecting, collating and analysing information in livestock emissions research.
- Developing best practice guidance and standardised methodologies for measuring emissions from livestock production and making training and development opportunities available.
- Establishing networks and databases on key areas of activity, e.g. microbial genetics, manure management, etc.
- Fostering research collaboration between member countries and with key partner organisations (e.g. the CGIAR Climate Change Agriculture and Food Security programme, the EU Joint Programming Initiative, the International Livestock Research Institute).

The Croplands Group (co-chaired by the US and Brazil) is focused on reducing GHG intensity and improving overall production efficiency of cropland systems. The Group is looking at ways to limit the losses of carbon and nitrogen from crops and soils to the atmosphere, and transferring that knowledge and technologies to croplands farmers, land managers and policy makers around the world.

The main GHG emissions studied by the Group are nitrous oxide and soil carbon. Different techniques are being applied to understand the croplands production pathway: from soil condition, to tillage or no-till systems, climatic effects and crop varieties for low GHG emitting production. There is also a strong emphasis on working with farmers to apply new technologies and management practices in the field. The Croplands Group has been set the specific goals of:

- Taking stock of key scientific projects and personnel involved in GHG emissions and soil carbon sequestration of cropping systems.
- Developing a searchable literature database relevant to croplands emissions and soil carbon sequestration.
- Assembling protocols, guidelines, and methods for determining soil carbon, GHG fluxes, and assessing temporal and spatial variations among measurements.
- Developing sub-groups looking specifically at GHG emissions and changes in soil carbon in agricultural peatlands and wetlands; using simple and complex models to evaluate carbon and nitrogen emissions; and assessing net GHG emissions and soil carbon sequestration with cropland management practices.
- Identifying funding opportunities for cross-national research collaboration.
- Cataloguing best management options and recommendations for different croplands environments.
- Over time, and adopting a consistent international approach, the Croplands Group aims to build a global network of GHG emission and soil carbon sequestration data from specific management approaches (for example, the GRACEnet approach used by the USDA Agricultural Research Service).

The Soil Carbon and Nitrogen Cycling Cross-Cutting Group (co-chaired by Australia and France) aims to improve models and methodologies related to soil carbon and nitrogen, and related mitigation opportunities as they affect the production systems covered by GRA (livestock, croplands and paddy rice). It focuses on three major research areas: *i)* technical workshops; *ii)* identifying models; *iii)* testing and comparison of models. The Group, which

has 27 countries participate in its work, has developed a work plan around the following issues:

- The identification of available data sets (on soil carbon, GHG emissions, soil-plant-atmosphere balance for nitrogen or carbon) and models.
- The definition of criteria for model applicability, particularly for mitigation options.
- Options to fill data gaps, particularly for some climatic/agricultural areas, through collaboration.
- Selecting key models and core datasets for *i)* inter-comparison, *ii)* benchmarking and *iii)* improvement of models for coverage, predictive capability and reliability, especially for mitigation options.

The Inventories and Measurement Cross-cutting Group (co-chaired by Canada and the Netherlands) focuses on two major research areas: *i)* improved GHG quantification methodologies (this deals with all inventories including formal country submissions) and *ii)* Guidance for GHG measurements, such as validation of models and identification of existing mitigation opportunities. Seventeen countries participate in the work of the Group.

International Knowledge-Based Bio-Economy Forum

The International Knowledge-Based Bio-Economy (KBBE) Forum is a partnership between the ***EC***, ***Australia***, ***Canada*** and ***New Zealand*** launched in September 2010. It aims to share knowledge on policy strategies and actions, create new knowledge to address societal challenges related to the bio-economy, and to foster collaboration and joint activities that will promote innovation in bio-economy sectors. It promotes co-operation in the bio-economy through policy dialogue and scientific co-operation between the partners. The Forum also acts as a think-tank for identifying future trends and challenges in the bio-economy.

Four themes were identified for KBBE focus:

- Bio-based Materials (led by Canada in 2010-11);
- Food & Health (led by Australia in 2010-11);
- Fisheries & Aquaculture (led by the EC in 2010-11); and
- Sustainable Agriculture (led by New Zealand in 2010-11).

Energy efficiency: Renewable energy

Across the OECD area energy use is a critical component in the ability of the agricultural sector to achieve competitiveness and sustainability. Agriculture plays a double role in relation to energy, being both a consumer and producer. Energy is consumed at a variety of points in the food chain and accounts for as much as 20% of total energy use in some OECD countries. Moreover, agriculture has the potential to be an important source of clean, renewable energy.

Many policy makers view the development of agriculture-based biofuels as both a catalyst for rural economic development and as a response to the problem of countries' growing dependence on imported energy: a range of policy measures have been put in place in order to promote biofuel production and use, the principal ones being subsidies of various types and production or consumption mandates.

However, the use of agricultural crops for biofuel production is a controversial issue. Concerns have been raised about the implications for food prices and resource use in

agriculture – particularly in countries where land previously used by wildlife or forest is to be used for the production of biofuel feedstocks, and where the magnitude of the net contribution of first-generation biofuels to reducing GHG emissions is a subject of current debate. A number of studies suggest that biofuels policies provide significant subsidies to agricultural producers, which can create trade distortions.[10] The OECD's own work in this area suggests that biofuel policies lead to higher and more volatile world prices for crops, such as maize and oilseeds, which provide first-generation feedstocks (OECD, 2008).

In terms of green growth, increasing the yield of existing crops and introducing the use of new agricultural crops (e.g. jatropha) in order to promote biofuel production will pose certain challenges. The combination of the consequent demand that would be placed on available land and the pressure likely to be exerted on other inputs may make it difficult to improve environmental quality in agriculture.

The development of second-generation feedstocks such as woody biomass may also place additional demands on land and other natural resources and have detrimental effects on the environment, unless appropriate steps are taken. However, other potential benefits of the increased use of biofuels, such as reduced reliance on fossil fuels, need to be taken into consideration when evaluating the future direction of biofuels policy.

Apart from the use of biofuels, there exists a range of interventions designed to reduce energy use, involving the more efficient use of machinery and heating in order to reduce direct energy demand at all stages of the supply chain (including household appliances). At the farm-gate, indirect demand can be reduced by changing production systems (e.g. switching crop types and expanding organic farming); a more targeted use of inputs; and better management of animal health. Some interventions are win-win, offering the potential to lower the costs associated with energy use and to reduce the greenhouse gas emissions associated with inputs. Overcoming information failures and behavioural barriers is the key to realising these changes.

Although technological developments, changes in crop management and renewable energy use are of critical importance in increasing the energy efficiency of agriculture, due consideration should also be given to the relative cost-effectiveness and challenges of changing production behaviour, versus that of inducing changes on the consumption side.

In 2007, the ***European Union*** set the ambitious goal of achieving a 20% share of renewable energy (and a 10% share of renewable energy in transport) by 2020. The renewable energy goal is a headline target of the Europe 2020 strategy for smart, sustainable and inclusive growth. To achieve the 20% target, the *Renewable Energy Directive* has introduced a legislative framework laying down individual mandatory targets for each member state's share of renewable energy in final energy consumption (member states are to make independent decisions on the most cost-efficient technology path and support schemes necessary for achieving those targets). On 17 October 2012, the European Commission published a proposal to limit global land conversion for biofuel production and raise the climate change benefits of biofuels used in the EU. The use of food-based biofuels to meet the 10% renewable energey target of the *Renewable Energy Directive* will be limited to 5%. The European Commission is also proposing to enhance the incentives for the best-performing biofuels, to improve the GHG savings of the overall biofuel mix — compared to fossil fuels — used in the EU by 2020, and thereby to reduce the impact on the potential increase in food prices.

In ***Austria***, the *2007 Energy Efficiency Action Plan* covers energy efficiency measures in private households and public and private services, as well as the agricultural and transport sectors. It also includes cross-sectoral measures. The action plan includes a number of detailed initiatives.

In ***Canada***, the 2006 Government's renewable fuels strategy has four key objectives and corresponding sets of policy instruments aimed at supporting the development of a domestic biofuels industry in Canada: *i)* reducing GHG emissions resulting from fuel use by increasing the retail availability of renewable fuels through regulation; *ii)* supporting the expansion of production of renewable fuels through incentives to production to biofuel producers; *iii)* helping farmers capture new opportunities in this sector through the provision of capital incentives for the construction or expansion of biofuels facilities that include new equity investment from farmers of at least 5% of eligible project costs; and *iv)* accelerating the commercialisation of new technologies through support for the construction of large-scale demonstration facilities for the production of next-generation renewable fuels, such as cellulosic ethanol made from agricultural residues and waste products.

In ***Denmark***, a central element in the country's *Green Growth Strategy* is the emphasis placed on the development of renewable energy in the agricultural sector. In particular, the role of the agricultural sector as a supplier of green energy is to be strengthened, with up to 15% of arable land to be used for energy crops − which represents a 16-fold increase in energy production coming from agriculture − and the share of farm animal manure to be used for green energy is to be increased from 5% to 50% by 2020.[11] Policy initiatives to help in reaching these targets include annual financial support for starting investments in biogas and a grant scheme for planting perennial crops. The grant scheme for perennial crops will be assessed in 2012.

In ***Finland***, within the scope of the country's energy-related targets, agricultural investment support is granted to on-farm boiler houses and biogas plants using renewable energy sources. The purpose of the investment support is to promote the increased use of renewable energy sources, the more efficient use of energy (and energy saving), the adoption of new energy technologies and the reduction of environmental damage from energy production and use. Production and use of biogas are promoted through investment and support to research and training and communications projects to assist in the establishment of bio-energy production plants, as well as through pilot projects applying new research data and technologies. A particular objective of the support is to promote the construction of biogas plants in areas with large farm animal populations and consequent environmental impacts.

In ***France***, promotion of renewable energies is mainly through the *Energy Performance Plan* (*PPE) for Farms, 2009-13* programme, which aims to increase awareness of energy consumption on farms through: reducing energy consumption; enhancing energy efficiency in agriculture; producing renewable energies; and improving farmers' competitiveness. It includes a number of actions to be conducted at the farm level, with particular emphasis on "energy diagnosis". In addition, a new plan targeting "Methane Energy and Nitrogen Autonomy" has been launched in March 2013 as part of the Agro-ecological Project. The plan has a dual aim: *i)* to develop renewable energy in the framework of French energy transition; and *ii)* to support the substitution of mineral nitrogen by nitrogen from livestock manure.

In ***Japan***, the *Basic Promotion Plan for Biomass Utilisation*, endorsed by the Cabinet in 2010, promotes the utilisation of biomass as an alternative energy source. It aims to support the creation of an autonomous, distributed system of energy supply in local regions through the use of biomass. The Basic Plan established targets to be achieved by 2020, and set out guidelines and a technical "road map" for achieving these targets. The "Biomass Industrialisation Strategy" was announced in September 2012. Several ministries participated in formulating the strategy, including the Ministry of Agriculture, Forestry and Fisheries, the Ministry of the Environment and the Ministry of Economy, Trade and Industry.

In ***Greece***, the Ministry of Environment, Energy and Climate Change implemented a law in May 2010 which permits farmers to construct solar photovoltaic installations on their land, in order to produce electricity, either for personal use or for sale to the Public Enterprise of

Electricity, thus offering farmers a potential source of additional income. According to the legislation, the area of farmland used for such photovoltaic installations cannot exceed 1% of the total farmland in each prefecture. This measure has as a goal the promotion of renewable energy systems and, in the long term, the mitigation of climate change. These measures serve not only as a tool for "greening" agricultural growth by implementing environmentally friendly policies, but also aim to create "green" jobs.

The agricultural sector is a large energy user in the ***Netherlands***, mainly because of the use of heated greenhouses in its large horticulture sector. The *Clean and Efficient Agro Sectors* programme (launched in 2008) is a public-private partnership with the government that sets out how the agro-food sector can help achieve the national targets for GHG emissions to which the country has committed internationally and in the European framework.

For the greenhouse horticulture sector, the government, through the "*Glasshouses as Energy Providers"* innovation programme, is working, in public-private partnership with the industry and knowledge institutes, to ensure that new greenhouses become independent of fossil energy by 2020. Improvement in energy efficiency is mainly sought through more efficient methods of cultivation and investments in energy-saving technologies. The national government and the greenhouse horticulture sector have also agreed to set up a CO_2 emissions trading scheme in return for lower energy taxes in greenhouses horticulture.

Multi-year agreements are also being made with other agricultural sectors, such as livestock farming, open cultivation, bulb cultivation and the forestry and timber sector, with a view to achieving energy efficiency improvements averaging 2% per year in the period up to 2020, and to introduce the production of renewable energy in 2020.

For the livestock sector, the development of manure policy is recognised to be closely linked to the achievement of targets in the field of sustainable energy and, in particular, reducing other GHGs. By 2020 energy-intensive livestock farming (poultry, pigs and calves) aims for a complete switch-over on 20% of holdings to the use of sustainable electricity (e.g. biomass, solar water heaters for heat and/or small windmills and solar panels for their own electricity consumption). By the same date, the dairy sector aims to achieve the lowest emissions of GHGs per litre of milk in the European Union; the dairy and pig sectors aim to separate 25% of their manure, reducing the need for artificial fertiliser and achieving a reduction (of 15%) in methane emissions from manure storage; and the poultry sector aims to incinerate ⅔ of its manure.

A number of programmes are also in place to realise the EU's 2020 goals of renewable energy across the whole food chain. For example, within the *Sustainable Logistics Innovation Programme*, industry and government shall work together to reduce energy consumption in the logistics chain.

The ***Netherlands*** also considers that research in the field of genetics (both Genetically Modified Organisms − GMOs − and ordinary genetics) is necessary in order to give higher energy value to energy crops and to adapt them to demanding growing conditions. In addition, government involvement may be necessary in GMO approvals for the non-food sector. The Dutch Government, together with Wageningen University and Research Centre and the European Association for Bio-industry (EuropaBio), is preparing to carry out an initial analysis of the current situation.

In the ***United States***, interest in renewable energy has developed rapidly, due in large part to a strong rise in domestic and international petroleum prices and a dramatic acceleration in the production of domestic biofuels (primarily maize-based ethanol).[12] A number of programmes are in place, focusing on: energy efficiency and conservation of domestic resources; research programmes that target the development of renewable sources of energy;

and the creation of new industries and new jobs. These programmes are aimed at a variety of beneficiaries, including farmers, the private sector and academia.

Although many of the programmes have their roots in the 1970s, several major energy laws have been enacted since 2005: the Energy Policy Act of 2005; the Energy Independence and Security Act of 2007; the Energy Improvement and Extension Act; and the American Reinvestment and Recovery Act. Each of these laws established, expanded, or modified energy efficiency and renewable energy research, development, demonstration and deployment programmes.

Until recently, ethanol and biodiesel – the two most widely used biofuels – received significant government support under federal law in the form of mandated fuel use, tax incentives, loan and grant programmes, and certain regulatory requirements. While the mandate remains in place, several key biofuel programmes expired at the end of 2011 (e.g. a tariff on ethanol imported from most countries, as well as tax credits for ethanol).

The *Renewable Fuel Standard* (RFS) mandate requires that the nation's fuel supply contain a specified amount of blended biofuel. The RFS sets a minimum of the biofuel to be used in the United States and it also mandates maximum lifecycle GHG emissions from each type of biofuel contributing to the mandate. The mandate is enforced by a credit-trading scheme that ties together biofuel producers with refiners, exporters and blenders of oil-based gasoline (EPA, 2010). With the termination of tax incentives and import duty on ethanol, and the more ambitious targets being mandated, the RFS mandate has become the main policy instrument in the US for promoting the use of biofuels.

Moreover, with the more ambitious targets being mandated, the RFS could, in future, become binding (OECD, 2011b). Current technological developments seem to suggest that the targets of the cellulosic biofuel mandate, as currently regulated by the EPA, are unlikely to be met by 2022. Binding mandates mean more consumption of biofuel than would otherwise occur, leading to higher domestic production or imports. The EPA has the authority to waive the total volume of renewable fuel mandated by the RFS, as well as the specific requirements for cellulosic biofuel and biomass-based diesel fuel, should domestic supply be inadequate to meet the mandate, or were the implementation of the requirements deemed to have severe economic or environmental effects. The *OECD/FAO Agricultural Outlook 2012-21* provides a detailed analysis of uncertainties surrounding the implementation of the mandate and the impacts of three alternative options (OECD/FAO, 2012b).

Federal support for the development of agriculture-based systems of renewable energy production is also provided in the form of loans, grants and loan guarantees; research, development and demonstration assistance; educational programme assistance; and procurement preferences. Also, several states have already established their own incentives, regulations and programmes to support renewable fuel research, production and consumption, that supplement (or exceed) federal incentives.

Most of the federal programmes are administered by five separate agencies and departments (the Environmental Protection Agency, the USDA, the Department of Energy, the Internal Revenue Service and Customs and Border Protection).[13] However, as renewable energy production has been considered primarily a concern of energy, tax and environmental policy (rather than agricultural policy), most of the federal programmes that support renewable energy production in general, and agriculture-based energy production in particular, are outside the domain of the Farm Acts.

The USDA – and in particular the Rural Business and Co-operative Programmes – operate a wide array of programmes aimed at achieving the goal of 80% of America's electricity coming from clean sources (including wind, solar, nuclear, clean coal and natural gas) by 2035, and ensuring America's energy independence from imports.[14] These

programmes provide grants, guaranteed loans and payments for a wide range of purposes, including: support for rural energy efficiency and self-sufficiency; research, development, deployment and production of advanced biofuels (especially cellulosic); realisation of energy efficiency improvements (e.g. providing aid for conversion of older heating sources to cleaner technologies); installation of renewable energy systems (e.g. installation of flexible fuel pumps, solar panels and building bio-refineries); completion of energy audits and feasibility studies; encouragement of federal procurement of bio-based products; and creation of educational programmes to increase understanding of biodiesel and promote its use.

The 2002 Farm Act was the first omnibus Farm Act to explicitly include energy. Under the 2008 Farm Act (The Food, Conservation, and Energy Act of 2008), renewable energy policy built on the programmes initiated under the 2002 Farm Act, by amending or establishing various biofuels incentives, including lowering the value of the ethanol excise tax credit, establishing a tax credit for cellulosic biofuel production, extending import duties on fuel ethanol, and introducing several new grant and loan programmes (all of which are set to expire at the end of FY2012) (OECD, 2011b).

The 2008 Farm Act authorised USD 1.1 billion in mandatory funding for FY2008 through to FY2012, compared with USD 800 million under the 2002 Farm Act (FY2002-07), with most of the increase mandated for the Biorefinery Assistance Program, which aims at promoting the development of advanced biofuel refining capacity.

US policy to expand the production of agriculture-based renewable energy – especially biofuels and wind power – has significant implications for agriculture and resource use. The production of maize-based ethanol – and consequently the overall production of maize – has expanded dramatically over the past several years. The effect on agricultural commodity markets has been national, but commodity production adjustments and the resulting environmental outcome, vary across regions (Malcolm, Aillery and Weinberg, 2009). Changes in the crop sector have also affected the cost of feed for livestock producers. Most notably, since 2006 the escalating demand for maize as a component of feed in ethanol production was one of the factors contributed to the sharp increases in driven grain and oilseed prices. As commodity price inflation has accelerated both in the United States and globally, the "food versus fuel" debate has come to the fore of the policy agenda.

Waste

A considerable amount of "waste" can be generated by the food and agriculture sector system, which not only adds to pressure on the land and water resources used by the system, but also represents an untapped resource. As noted earlier, the food and agricultural system has become increasingly energy intensive. The growth in the production of "convenience" foods and changes in the presentation of foods to consumers (e.g. vegetables that have been washed and packaged rather than sold in their relatively unprocessed state) not only increases energy usage, but also generates a higher waste stream in the form of excess packaging.

The standards set by retailers (e.g. requirements on the size and appearance of fruit and vegetables) can also add to the amount of material entering the waste stream, as products that do not meet those requirements are unable to find a market.

Green growth in agriculture and the food system will require participants in the system to examine product life-cycles and governments will need to evaluate what they can do to help reduce energy usage and product waste. This is already beginning to happen. For example, food retailers in some OECD countries are beginning to reduce the amount of plastic packaging they use and various initiatives are being taken to promote the recycling of packaging materials.

Many of the supply-side initiatives involve the creation of networks, platforms or partnerships with participation from industry and other stakeholders. Governments can assist through the use of conventional measures, such as funding research, education and demonstrations of green technologies. They can also promote greater efficiency in the use of energy and of food and raw material production in the sector by modifying existing regulations (e.g. those relating to product standards, or the use of waste products in feeding livestock.

In 2010, the ***European Union*** adopted a communication on bio-waste and the topic of waste is receiving increasing attention in the European policy agenda. A strategy for food waste reduction is being developed, as indicated in the road map on *Resource Efficiency*.

In the ***United Kingdom***, there are initiatives to reducing waste in food chains. The *Waste Resources and Action Programme* (WRAP) initiative entails government collaboration with businesses, individuals and communities to reduce food waste. Household food and drink waste represents GBP 12 billion in lost value and 20 million tonnes of CO_2-equivalent in emissions each year. Research by WRAP focuses on ways to cut down the amount of food thrown away by consumers and covers consumer habits, attitudes and behaviour patterns, appropriate ways of communicating to priority audiences and retail innovation. In partnership with WRAP, the grocery sector has instigated changes to make it easier for consumers to buy the right amount of food, and to optimise freshness and value, as well as to implement large-scale consumer campaigns. As a result, 670 000 tonnes of food waste have been diverted from landfills, saving GBP 600 million a year.

In ***Austria***, the *Waste Prevention Programme* was set up in mid-2011 by the Ministry of Environment, as part of the Federal Waste Management Plan 2011. It targets: the construction sector; industry and households in general; the food sectors (notably the food industry, retail and large-scale catering establishments); and the re-use sector (including repair networks).

Water

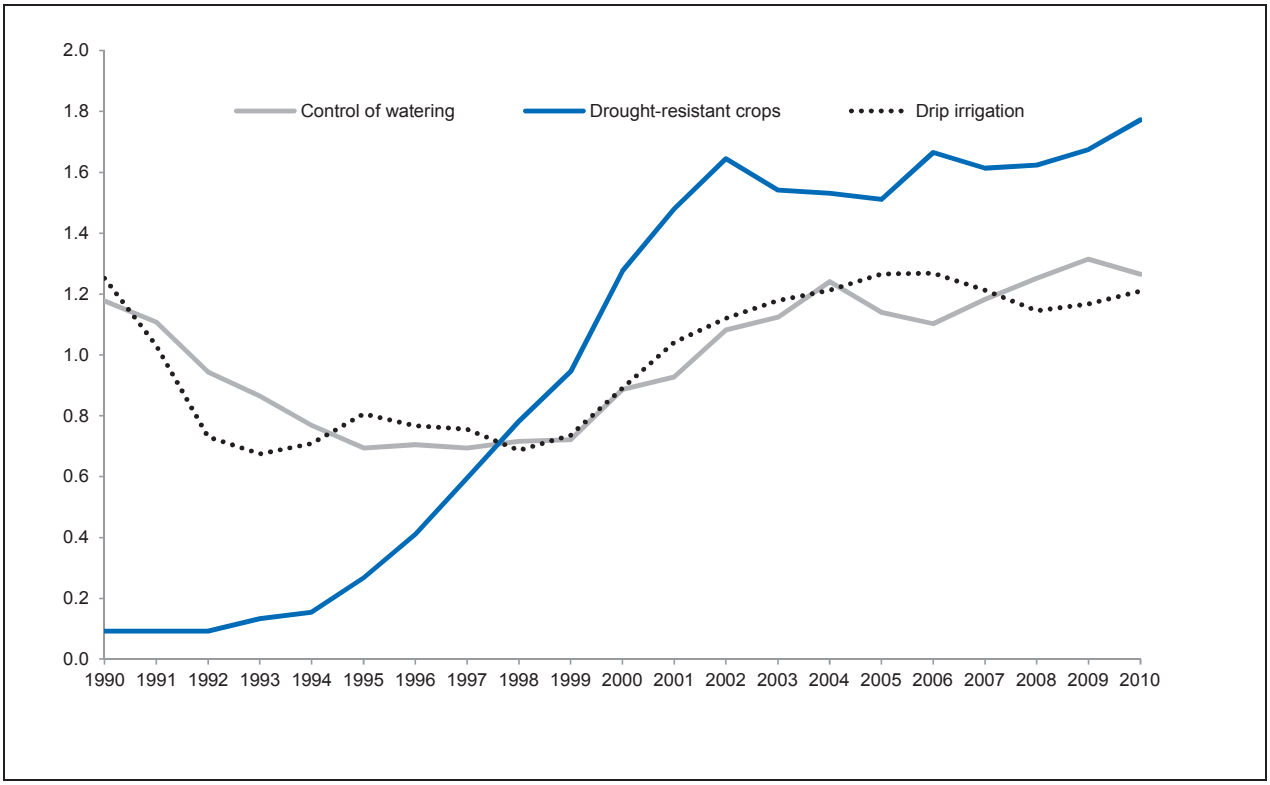
New OECD work is analysing trends and patterns of innovation in water and conservation technologies.[15] As shown in Figure 3.2, innovations (as measured by patents) in water-related agricultural technologies, such as drip irrigation, drought-resistant crops and controlled watering have grown steadily over the last decades.[16] Drought-resistant crop technologies experienced the highest rate of growth, with very high growth at the end of the 1990s and the beginning of the 2000s, before flattening towards the end of the period. There was a peak in this field at the end of the 1990s, when inventions were filed in six different patent offices.

Innovation in water-related technologies appears to be concentrated in a handful of countries. World-wide, the ***United States*** is by far the front runner in innovations in agricultural water technologies, while certain countries have achieved strong positions in specific fields (Table 3.1). For example, ***Italy*** is the third-most innovative country in the world for control of watering; ***China*** is the third-most innovative country in the development of drought-resistant crops; and ***Israel*** is the second-largest inventor country in the area of drip irrigation. The top-20 inventor countries in each agricultural water-related technology are presented in Table 3.1.

Interestingly, the development of more than half of inventions in the development of drought-resistant crop technologies has been through international collaboration. On the other hand, the rate of international co-invented patents for drip irrigation and control of watering inventions is rather small, amounting to only 5%.

Concerning policy approaches, it should be noted that, as water issues are mainstreamed in the activities of the Organisation, the present document includes only those countries which have provided information on their water policies.

Figure 3.2. Trends of water-related innovations in agriculture



Note: The series have been normalised by their own average, to make them comparable.
Source: Dechezleprêtre, Haščič and Johnstone, "Invention and International Diffusion of Water-related Adoption Technologies: Evidence from Patent Data", in OECD (2013), *International Cooperation for Climate Innovation: A Problem Shared is a Problem Halved*, OECD Publishing (forthcoming).

Only a few countries reported policies aimed at improving efficiency of water use in agriculture.[17] In ***Australia***, the *National Water Market* provides incentives for the efficient use of water resources. It is composed of several separate water markets, differentiated by water systems or administrative boundaries. The scale of Australia's water markets varies greatly, from small, unconnected water markets to extensive connected systems such as the Murray-Darling Basin, the largest water-trading area in Australia. Water trading provides opportunities for water resources to be allocated between competing uses. Each state and territory maintains responsibility for the legislative and administrative arrangements for water rights and water trading. The water market has a number of participants, including: users and owners (e.g. irrigators, farmers, rural water utilities, irrigation infrastructure operators, industry, urban water utilities and environmental groups); intermediaries (e.g. brokers, solicitors, banks); researchers (e.g. environmentalists, scientists, economists and hydrologists); government (e.g. the Australian Government, state and local government and trade approval authorities; and public (e.g. investors, community groups and the general public).

In ***Germany***, the 2007 amendment to the Fertiliser Act set: a minimum distance to be respected in between water bodies and sites where fertiliser application may be carried out; limited the application of animal-based fertilisers (to 170 kg of nitrogen/ha/year); set area-related upper limits for the application of nutrients from farm manure of animal origin; and set requirements on the application of fertilisers. The 2010 *Federal Water Act* specified further requirements for buffer zones for the use of pesticides and fertilisers near river banks.

Table 3.1. Top-20 inventor countries by technology in water efficiency and conservation technologies for agriculture (2000-10)

	Controlled watering		Drought-resistant crops		Drip irrigation	
Rank	Country	Share of world's high-value inventions (%)	Country	Share of world's high-value inventions (%)	Country	Share of world's high-value inventions (%)
1	United States	40.3	United States	44.7	United States	29.2
2	Germany	7.6	Japan	9.0	Israel	10.9
3	Italy	7.1	China	6.7	Japan	7.6
4	Australia	5.9	Korea	4.5	Germany	7.4
5	Canada	4.4	Germany	4.4	Korea	5.9
6	Israel	4.2	Canada	3.8	China	5.9
7	Chinese Tapei	4.2	Spain	3.5	Switzerland	3.9
8	Japan	4.0	Israel	3.2	Chinese Tapei	3.7
9	United Kingdom	3.8	India	3.2	Australia	3.5
10	Switzerland	3.0	France	2.8	United Kingdom	3.1
11	France	2.3	United Kingdom	2.6	Italy	3.1
12	Spain	2.3	Belgium	2.5	Spain	2.7
13	Korea	1.5	Australia	2.4	Canada	2.7
14	China	1.2	Netherlands	1.2	France	1.8
15	New Zealand	1.2	Italy	0.8	Greece	1.7
16	Netherlands	1.2	Austria	0.7	Austria	1.2
17	Denmark	0.8	Switzerland	0.5	Sweden	0.8
18	Norway	0.8	Hungary	0.5	Mexico	0.8
19	Brazil	0.6	Chinese Tapei	0.5	Brazil	0.6
20	Sweden	0.4	Hong Kong, China	0.4	Belgium	0.4

Source: Dechezleprêtre, A., I. Haščič and N. Johnstone, "Invention and International Diffusion of Water-related Adoption Technologies: Evidence from Patent Data", in OECD, 2013, *International Co-operation for Climate Innovation: A Problem Shared is a Problem Halved*, OECD Publishing (forthcoming).

In ***Greece***, according to the requirements of Directive 91/676/EEC (introduced into the national legislation with JMD 161890/1335/1997), eight vulnerable zones (with respect to nitrogen pollution from agricultural run-off) have been identified and suitable action programmes have been put in place. The adoption of sound agricultural practices, obligatory for all farmers operating in vulnerable zones, is a key element of these programmes.

In addition, a *National Plan of Action* has been developed in the context of implementing the 2009/128/EC Directive aiming to protect the human health and the environment (based on a Joint Ministerial Decision [JMD]). The newly developed legislative framework aims to protect the aquatic environment and freshwater from the impacts of pesticide use. For this purpose, a number of special areas have been set up, where the use of pesticides is either restricted or forbidden.

In March 2011, a JMD regulating waste water management was signed, that includes, among other things, the re-use of treated wastewater for irrigation purposes. This measure has been designed to save water resources and to promote the use of treated wastewater (i.e. minimising the use of freshwater in irrigation, industry, etc.). A JMD was passed in June 2011, requiring farmers and cattle breeders to declare their irrigation bores by the end of the year. This measure is aimed at monitoring the abstraction of groundwater being used for irrigation reasons; controlling the unreasonable use of water resources; and defining the water rights of farming areas.

In ***Ireland***, the objective of the Rainwater Harvesting Scheme is to conserve water by maximising the use of rainfall run-off and thus reduce water costs on farms. Grant-aid support is provided for rainwater harvesting facilities and equipment. The scheme has been targeted initially at young trained dairy farmers.

In ***New Zealand***, the primary purpose of the *Irrigation Acceleration Fund* is to support: *i)* investments for regional-scale rural water infrastructure; *ii)* funding for strategic water management studies; and *iii)* funding for community irrigation schemes.

Water management and property rights

The OECD work on water management in agriculture points out that the shift in water resource policies, with a greater accent on demand rather than supply management, has brought reforms to the institutional and property right structures in many countries (OECD, 2010a). But the progress and path of water policy reforms has been mixed across countries. Poorly defined property rights, including problems over separating land from water entitlements found to be one of the key impediments to water market formation and further strengthening of property rights and institutions for water management in agriculture is advocated.

In most OECD countries, water property rights – in terms of access – involve a complex set of rules, where water is often allocated in terms of *quantities* rather than *prices,* between users and for environmental needs. As pressures build up to reallocate water between different users and to meet environmental demands there is a need for water property rights to become more flexible, where these rights exist and for supporting institutions to be more robust to ensure an economically efficient and environmentally effective allocation of water.

Regimes for groundwater rights are generally less developed compared to surface water (see the OECD questionnaire at oecd.org/water). User right systems are also frequently uncoordinated between groundwater and surface water. Typically the landowner (farmer) is given the exclusive right to extract from groundwater beneath his/her property, although most countries have introduced regulations to limit private extraction from commonly shared groundwater resources and landowners will normally require consent from a government agency prior to making extractions. Some states in ***Australia*** have more advanced water rights regimes for groundwater, involving water entitlement licences (which might only be issued for 5- to 10-year periods), annual allocations and trading in groundwater (Box 3.5).

Box 3.5. Water policy reforms and property rights: The Australian experience

Australia has embraced the idea of competition and markets as a paradigm for water management. A nationally consistent water entitlement and trading system has been established to provide security to both water users and the environment. Water trading allows scarce water resources to be transferred to their most efficient and productive uses, and is being delivered through a range of State and National initiatives. The result has been the generation of significant opportunities to achieve sustainable and efficient water use. The development of water markets is seen as a key mechanism, along with planning and appropriate regulation, to address over allocation of water resources whilst optimising the economic, social and environmental outcomes in Australia. This integrated approach will also assist to adapt to changing water availability in the face of a climate change.

Underpinning the Australian experience is a suite of institutional and property right reforms that have made it easier to set up viable water markets. The general model is one that has involved development of a water entitlement regime that allows people to own the right to use water. State governments' legislation makes it clear that water is controlled by the State on behalf of the general public. Water users may only acquire or hold an entitlement to use water that is available according to a statutory water plan. Moreover, it is the role of governments rather than the courts to determine how much water is available for use. The result is a property right regime that is conducive to the development of efficient markets. In general the rights to use water is "unbundled" into a three-part structure:

- The ***entitlement*** is a proportionate share of water as specified in a water plan. This entitlement is separate from any land title and may be traded among any willing purchasers. These are referred to as permanent trades.
- Decisions on ***volumetric allocations*** are made on an ongoing basis throughout a water year. The allocation is made to an entitlement and recorded in the water account associated with the entitlement. Allocation trades, or temporary trades as they are called in Australia, can then be made by debiting one account and crediting another. Allocations are not linked to land titles. These annual allocations may be traded among willing purchasers.
- ***Use approvals*** then set out the rules for applying water to a nominated area of land and deducting the amount used from a water account associated with the use approval. Site use approvals are not generally tradable as the conditions relate specifically to a piece of land.

In the face of worsening climatic conditions in eastern and southern Australia and difficulties in rebalancing the amount of water in the environment pool versus the consumptive pool and addressing institutional weaknesses, the Federal Government announced Water for the Future in 2008. Water for the Future is a AUD 12.9 billion investment over 10 years with over-arching objectives to take action on climate change, use water wisely, secure water supplies and support healthy rivers and waterways. Investment is being mainly used to purchase water entitlements for the environment and infrastructure upgrades and reconfiguration, with water savings being returned to the environment on a shared basis.

Source: Adapted from OECD (2010), *Sustainable Management of Water Resources in Agriculture*, OECD Studies on Water, OECD Publishing, doi: 10.1787/9789264083578-en

Notes

1. Fuglie (2010) found that raising real R&D spending by 1% per year would increase US agricultural output by 83% by 2050.
2. Annual internal rates of return of investments on agricultural R&D estimated in the literature range between 20-80% (Alston, 2010).
3. It should be noted that these figures do not include private agricultural research, which in some countries is significant (e.g. in the United States, private agricultural research accounts for more than 60%). While government focuses mainly on public-goods research (as the results benefit society as a whole), the private sector focuses mainly on R&D related to marketable goods (e.g. research in biology, microbiology and computing).
4. It could be argued that finding ways of accessing or exploiting natural resources that were previously not used (e.g. shale gas reserves) amounts to an expansion of the natural resource base, and a demonstration that it should not be considered as finite. However, by definition these resources are not renewable and over the medium to long term they will in principle be exhausted.
5. Of particular importance for agricultural productivity, the WTO Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) provides that patents shall be available – with a few exceptions – in all fields of technology for inventions that are new, non-obvious and useful. An exception concerns plant varieties, which may be excluded and protected via a sui generis system such as the one provided under the convention of the International Union for the Protection of New Varieties of Plants, or by any combination of those two options. In addition, in some cases, national law and regional or international accords afford IPR protection beyond the TRIPS minimum standards (e.g. availability of protection for new plant cultivars via patents and plant variety protection laws).
6. An interpretation confirmed by the recent ruling in the case Ariad Pharmaceuticals, Inc. v. Eli Lilly and Co., No. 08-1248, slip op. at 2 (Fed. Cir. Mar. 22, 2010) (en banc).
7. The European Patents Convention lists four requirements to be met by a patentable invention: there must be an invention; if there is an invention, it must satisfy the criteria of novelty, of being an "inventive step", and of having industrial applicability (WIPO).
8. This case is argued strongly in Arai (2000).
9. As of April 2012, there were 33 member countries: Argentina, Australia, Brazil, Canada, Chile, China, Colombia, Costa Rica, Denmark, Finland, France, Germany, Ghana, Indonesia, Italy, Ireland, Japan, Malaysia, Mexico, the Netherlands, New Zealand, Norway, Peru, the Philippines, the Republic of Korea, Spain, Sweden, Switzerland, Thailand, the United Kingdom, the United States, Uruguay and Vietnam.
10. See, for example, Moschini, Cui and Lapan (2012) for an overview of the literature.
11. According to the Danish Energy Agency, in order to meet this requirement, 130 biogas plants would have to be constructed by 2020.

12. US biofuel production is dominated by ethanol, 98% of which is produced from maize; biodiesel comes primarily from soybean oil (around 60%). About one-third of US maize production is devoted to ethanol production.

13. The Department of Energy operates the greatest number of efficiency and renewable energy incentive federal programmes; the Department of the Treasury and the Department of Agriculture operate several programmes; a few programmes are also conducted by the Departments of Transportation, Labor, and Housing and Urban Development. For more details discussion, see Yacobucci (2012) and OECD (2011b).

14. In addition to these programmes, there are several conservation programmes which significantly reduce fuel and other energy-related costs, such as the Conservation Security Program, the Environmental Quality Incentive Program, Conservation Technical Assistance, etc.

15. This OECD work provides the first descriptive analysis of innovation in water-related adaptation technologies and of their international diffusion at the global level (Dechezleprêtre, Haščič and Johnstone, 2013). The analysis is based on a unique data set comprised of over 50 000 patents filed in 83 patent offices, between 1990 and 2010, and covers a wide range of technologies that may either increase the supply of water in drought conditions (e.g. rainwater collection, groundwater collection, water storage, desalination, etc., or decrease water consumption (e.g. water control in agriculture, drought-resistant crops, drip irrigation, water efficiency technologies in power production, domestic water recycling, efficient water distribution systems, etc.).

16. These three water-related technologies are defined as follows: Drought-resistant crops: mutation or genetic engineering; DNA or RNA concerning genetic engineering, vectors (e.g. plasmids, or their isolation, preparation or purification for drought, cold, or salt resistance). Drip irrigation: watering arrangements located above the soil which make use of perforated pipe-lines or pipe-lines with dispensing fittings; and controlled watering: watering arrangements making use of perforated pipe-lines located under soil level.

17. The OECD series on water provides policy analysis and guidance on the economics, financial and governance aspects of water management. The OECD (2012c) report examines the linkages between agriculture and water quality, including recent policy experiences in OECD countries in addressing water quality issues in agriculture.

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Chapter 4

Policies oriented towards improving the environment

A central issue in achieving green growth is to ensure that all the costs associated with economic activity are reflected in production and consumption decisions. Market-based instruments (such as environmental-related taxes and charges and tradable permit systems) and non-market approaches (regulatory requirements or voluntary agreements) each have their own participation advantages and disadvantages.

One of the central issues in achieving green growth is to ensure that all the costs associated with economic activity are reflected in production and consumption decisions (i.e. that they are internalised either through prices or via some other mechanism). In terms of market-based instruments, two major approaches have long been identified – one based on the use of taxes and subsidies (Pigou, 1932) and the other based on the attribution of property rights (Coase, 1960). An alternative approach is the use of various non-market instruments, including regulations.

Market-based instruments aim at addressing market failures mainly through price signals. This category includes environmentally-related taxes, charges and fees, tradable permits, and subsidies for reducing pollution. Non-market approaches can be divided into separate categories – one covering direct environmental regulations, and the other covering voluntary approaches, including information-based instruments.

Each of these approaches has its own participation advantages and disadvantages and none is universally superior to the others. Efficacy and efficiency depend on a range of factors including the nature of the issue to be addressed, the institutional environment, and the technical limitations and constraints associated with the use of particular policy instruments.

The OECD *Green Growth Policy Toolkit* (Table 1.1) promotes a shift away from more environmentally harmful supports, towards environmentally beneficial payments and requirements. Adoption of these adjustments would enhance the productivity of environmental investments and make farm support measures a more effective vehicle for green growth. It would also increase the effectiveness of environmental regulations in agriculture due to a decrease in the negative ecological impacts of farm support. Such a shift in the composition of agricultural support would result in an overall reduction in the cost of achieving environmental objectives, and lead to increased eco-efficiency.

Market-based instruments

In several sectors, market-based instruments – primarily taxes and charges and tradable permit systems – are used as a means of discouraging practices that are damaging to the environment by raising the cost of these activities to producers. The role of these economic instruments in promoting Green Growth in agriculture is not, however, as significant as in other sectors (e.g. transport). Due to both the nature of property rights systems and difficulties in identifying sources of pollution, taxes are relatively ineffective for dealing with negative environmental externalities in agriculture, which tend to be location-specific and diffuse in nature. In many cases, regulations and payments have proved easier to implement than taxes in encouraging greener activities among agricultural producers.

Payments

Governments provide supports to farmers and agri-businesses to manage the supply of agricultural commodities, influence their cost, supplement producers' income and achieve other social and environmental aims. This support to farmers, which was estimated to total USD 248 billion (EUR 181 billion) in 2009-11 in terms of the OECD Producer Support Estimates (PSE) (or 20% of farm gross receipts), can be ranked according to its potential impacts on the environment (Table 4.1).

Market price support mechanisms and payments based on output are potentially the most harmful for the environment because of the production incentives they create, whereas payments based on cropped land, animal numbers, historical entitlements or overall farming income are likely to be more neutral in environmental terms, as they place limits on the level of production supported and constitute a form of decoupled support (Box 4.1).

Payments based on non-commodity criteria and payments for input use linked to constraints on resource use are generally beneficial because they are usually designed to help reduce agricultural pressures on the environment. These include supports given to farming systems and practices that preserve environmentally sensitive land and biodiversity; maintain flood, drought or soil erosion control; and provide sinks for greenhouse gases and carbon storage. However, the level of green supports to farming are far outweighed by variable input- and production-linked support policies that have damaging environmental effects.

Table 4.1. Share of PSE supports in the OECD area by category, ranked by potential environmental impact (%)

Potential environmental impact	Type of support measure	1995-97	2009-11
Potentially most harmful	Market price support	67	43
	Payments based on commodity output, without imposing environmental constraints on farming practices	3	2
	Payments based on variable input use, without imposing environmental constraints on farming practices	4	5
	Total	**74**	**50**
Potentially less harmful	Payments based on current cropped area/number of animals/receipts or income, without imposing environmental constraints on farming practices	10	5
	Payments based on historical entitlements/receipts or income, without imposing environmental constraints on farming practices	1	2
	Payments based on fixed capital formation, without imposing environmental constraints on farming practices	3	3
	Payments based on on-farm services, without imposing environmental constraints on farming practices	2	3
	Total	**16**	**14**
Potentially more beneficial	Payments subject to environmental cross-compliance[1]	**5**	**28**
Potentially most beneficial	Payments based on non-commodity criteria that impose environmental constraints on farming practices	1	2
	Payments based on fixed capital formation that impose environmental constraints on farming practices	1	1
	Payments based on on-farm services that impose environmental constraints on farming practices	0	0
	Payments based on variable input use that impose environmental constraints on farming practices	0	0
	Payments based on current cropped area/number of animals/receipts or income that impose environmental constraints on farming practices	3	4
	Payments based on historical entitlements/receipts or income that impose environmental constraints on farming practices	0	1
	Payments based on commodity output that impose environmental constraints on farming practices	0	0
	Total	**5**	**8**

1. Includes payments from various PSE categories which are subject to environmental cross-compliance.

Source: OECD Secretariat calculations based on OECD PSE/CSE database, 2012.

Box 4.1. Relative potential impacts of support measures to producers on the environment

Since the mid-1980s, as part of its work on monitoring and evaluating agricultural policy developments, the OECD Secretariat has measured, on an annual basis, the level and composition of support (monetary transfers) associated with agricultural policies in OECD countries (and, to an increasing extent, also for non-OECD countries), using a standard methodology. The classification of support into different categories is based on how policies are actually implemented and not on the objectives or impacts of those policies. The categories of the support to producers, as measured by the Producer Support Estimate (PSE), reveal the transfer basis for support (based on commodity output, input, area/animal numbers/receipts/income or non-commodity output); whether the support is based on a current or historical (fixed) basis and whether production is required in order to receive support. Each policy measure is also labelled with supplementary implementation details, which for example, show whether the policy measure is provided with or without production limits; whether or not it involves constraints on input use or farming practices (i.e. specific requirements concerning farming practices related to the programme in terms of reduction, replacement or withdrawal, in the use of inputs, or a restriction of farming practices). Moreover, the payments that require input restrictions are further broken down into payments that are conditional on compliance with basic, mandatory requirements (e.g. cross-compliance) and payments that require specific practices going beyond basic requirements and are voluntary. Payments requiring voluntary input constraints are further disaggregated into payments requiring practices related to: *i)* environmental issues (i.e. agri-environmental programmes); *ii)* animal welfare; and *iii)* other specified practices. OECD 2009, Box 2.2, discusses how agri-environmental payments are classified in the various PSE categories.

The PSE classification of categories of policy measures, although based on implementation criteria, has the potential to show the degree of flexibility in production choice that farmers have and, thus, how different policies could influence farmers' decisions to produce commodities and non-commodity outputs using farm resources. OECD work on monitoring and evaluation has demonstrated that, in general, the more a policy measure provides incentives to increase the production of specific agricultural commodities, the greater is the incentive towards monoculture, intensification (greater yields), or bringing marginal (environmentally sensitive) land into production, and the higher is the pressure on the environment. On the other hand, the more a policy measure can be targeted to a specific environmental goal, the greater is its potential effectiveness in achieving that goal (OECD, 2001a; 2001b; 2004; 2006; 2010).

Ranking agricultural policy measures according to their potential relative impacts on production shows that, all other things being equal, market price support, output payments (per output unit produced) and variable input subsidies (such as those that apply to fertilisers, pesticides, water and energy) provide the greatest potential incentive to increase commodity production, although this effect is weakened when constraints on output produced or inputs used are in place. Policy measures that are designed to deliver support based on current parameters, such as area or animal numbers and that require commodity production, have a potentially somewhat weaker influence on production incentives. Policy measures providing support based on historical parameters, such as the overall farm area or income of the farmer, have potentially far less influence on production incentives, while those that provide support based on non-commodity criteria (such as the provision of trees, stone walls and hedges), have potentially the least influence on production and can be targeted to specific environmental objectives.

It should be emphasised that neither the total PSE nor its composition in terms of different categories of policies can be interpreted as indicating the actual impact of policy on production and markets. Clearly, the actual impacts (*ex post*) will depend on the many factors that determine the aggregate degree of responsiveness of farmers to policy changes – including any constraints on production. For example, while it is true that market price support mechanisms and payments based on output are potentially the most harmful for the environment, whether they actually are harmful depends on a host of other factors, including whether production quotas are attached to them and whether they incorporate strong cross-compliance requirements, or are constrained by agri-environmental regulations independent of the support payments. Similarly, payments based on area, animal numbers, farm receipts or income, and historical entitlements are only potentially neutral in their effects on the environment, but may be harmful − or even beneficial − depending on specific programme designs and other regulations.

Note: Annex Box 1 of the OECD (2005) study provides a more detailed discussion on the potential impacts of the various PSE categories on the environment; while the OECD (2009) study provides an extensive discussion of the potential impacts of PSE categories on different types of farmland management.

Sources: OECD (2001a), *Market Effects of Crop Support Measures*, OECD Publishing, doi: 10.1787/9789264195011-en; OECD (2001b), *Improving the Environmental Performance of Agriculture: Policy Options and Market Approaches*, OECD Publishing, doi: 10.1787/9789264033801-en; OECD (2004*), Agriculture and the Environment: Lessons Learned from a Decade of OECD Work,* OECD Publishing, oecd.org/dataoecd/15/28/33913449.pdf; OECD (2005), "Case Study on Agriculture", in *Environmentally Harmful Subsidies – Challenges for Reform*, OECD Publishing; OECD (2006), "Decoupling: Policy Implications", *OECD Papers*, Vol. 5/11. doi: 10.1787/oecd_papers-v5-art38-en; OECD (2009), *Agricultural Policies in OECD Countries 2009: Monitoring and Evaluation*, OECD Publishing, doi: 10.1787/agr_oecd-2009-en; OECD (2010), *Environmental Cross-compliance in Agriculture*, OECD Publishing, oecd.org/tad/sustainableagriculture/latestdocuments/3 /

OECD countries have made a concerted effort to reduce the most environmentally harmful types of agricultural supports – those based on prices and output levels – and have achieved a decrease from over 74% of the total in 1995-97 to 50% in 2009-11. About 96% of payments in this category take the form of market price support. Price support for agricultural commodities masks market signals to producers and encourages intensification of production, entailing higher levels of fertiliser and pesticide use and subsequent adverse effects on the environment, soil quality and biodiversity. While some countries have taken clear steps to decouple support from output and price levels, other countries have not yet begun to address the problem.

Payments based on levels of input use have increased as a share of PSE in this time period (from 1995/97-2009/11) from 10% to 13% of PSE. There are three main targets of supports for input use: *i)* support for the (unconstrained) use of variable inputs such as credit, fertilisers, fuel or water; *ii)* support for fixed capital formation or on-farm investments; and *iii)* support for on-farm services including pest and disease control and seed and soil testing. The first category has by far the most negative environmental impacts. Support to input use in OECD countries is evenly divided across these three approaches, although there are wide variations among countries.

Domestic price supports have been largely replaced in this decade by direct payments based on past entitlement levels or farm income, and which may or may not require production. Payments that do not require production and are based on factors other than output (e.g. area, animals, receipts or income) now account for over a third of total support to producers in the OECD area. These supports are mostly aimed at increasing farm income, with less production-distorting and potentially less environmentally damaging effects than those requiring commodity production.

Payments based on non-commodity criteria (i.e. mainly agri-environmental schemes) continue to increase their share of total PSE, but still account for only 2% of agricultural support in OECD countries. Payments are made to agricultural producers to adopt specific farming practices, such as retiring environmentally fragile land from production, planting trees, or changing tillage practices in a way that can contribute to alleviating climate change or flood risk. Payments are also made to farmers to provide public goods such as landscape elements, biodiversity preservation and wetland conservation.

In some countries, it is possible to make supports conditional on producers following specified production practices in pursuit of broader environmental objectives. Environmental cross-compliance may be required, with the policy acting as compensation or incentivise to meet regulatory requirements. Payments subject to environmental cross-compliance requirements have increased to apply to 28% of total PSE in the period 2000-11 (as compared to 5% in 1995-97). Among OECD countries, the ***European Union***, ***Switzerland*** and the ***United States*** provide more than 50% of their agricultural supports with some constraints linked to environmental protection and other objectives (OECD, 2010; Claassen, 2012). In the EU, environmental cross-compliance is applied to over 95% of commercial farms.

Other things being equal, with respect to furthering environmental objectives, targeted measures are likely to be more efficient and cost effective in achieving specific environmental aims than cross-compliance approaches. Under cross-compliance, the distribution of income support payments is unlikely to correspond to the distribution of environmental costs or benefits of agricultural production. Income support payments are typically linked to current or historical production, whereas it is often the case that the volume of production from farms in areas of high environmental value is relatively low. In that case, high levels of payments to farms in relatively productive areas under cross-compliance conditions are likely to generate relatively modest environmental returns per unit of expenditure.[1]

That being said, cross-compliance is clearly preferable to price support measures that provide an income transfer to farmers without any environmental conditions. More generally, however, price and income support that is directly linked to current output is likely to intensify production, which may work against the aim of reducing the stress that farming places on the environment. Given the likelihood that public funds will be increasingly scarce in the future, there is a strong argument for shifting expenditure from relatively untargeted measures for improving environmental quality to more targeted measures, such as those under environmental programmes.

In reality, many environmental programmes are composed of a mixture of measures – such as implicit taxes imposed by rules and regulations and subsidies – designed to reduce negative externalities (e.g. such as water pollution), and measures designed to increase positive externalities (e.g. such as an increase in wildlife populations). The advantage of such programmes is that, if designed appropriately, they can address environmental issues at a much finer geographical scale than other programmes, can be targeted to achieving specific environmental outcomes, and can achieve these outcomes at lower cost than untargeted measures.

Finally, the use of payments to achieve environmental aims can confront problems of conflicting objectives. For example, in order to maintain a particular wildlife ecosystem (e.g. one created by the grazing of hill land by ruminants) there may be a trade-off in terms of providing an incentive for the maintenance of particular production systems. Grazing animals may increase the nutrient loading in water supplies and add to GHG emissions at the same time as protecting wildlife habitat. A choice may have to be made between ecosystem preservation and other environmental objectives in such situations.

Environmental taxes

Only a few countries have levied taxes and charges on farm inputs as a way of addressing environmental issues in agriculture. These have mostly been applied to environmentally-damaging chemicals, such as those associated with fertiliser and pesticide use.

In ***Denmark,*** the law on the restructured pesticide tax, which was due to be submitted in the autumn of 2009, came into force in January 2012. A key element of the tax is that smaller or specialised crops, such as potatoes and lettuce, should not be so heavily taxed that their production would be outsourced. In addition to the new tax, a new national target was set for the use of pesticides based on environmental impact, and several measures were passed to support the greater use of Integrated Pest Management (IPM), according to EU Directive 2009/128/EC. One of the objectives is to provide subsidised advice in the clearance of IPM.

Carbon taxes in agriculture have not been seriously considered even though farming can be a very-energy intensive sector. Farmers use carbon-based fuels directly in vehicles and machinery and indirectly in the form of carbon-based fertilisers and pesticides and fuel-intensive inputs. While a tax could be introduced in order to encourage use if more energy-efficient systems of production, proponents of carbon taxes have generally sought to exclude the agricultural sector, since emitters are not easily identifiable and it is often difficult to monitor the amount of emissions.[2]

Moreover, the application of taxes designed to reduce GHG emissions in agriculture could conflict with other environmental objectives. For example, there may be a desire to maintain grazing animals in order to preserve certain types of landscapes and grazing-dependent ecosystems. If the effect of a GHG tax were to cause farmers to reduce stocking rates or to abandon livestock farming this could have a negative impact on such ecosystems. There could also be a conflict with other types of policies – for example, the provision of subsidies under agri-environmental programmes to encourage certain types of land-use systems.

More generally, taxes are difficult to apply when non-point-source pollution is involved and this tends to be the case throughout much of the agricultural sector. In the water quality area, for example, it can often be difficult to determine the source of the pollution of water bodies – and, specifically how much a particular farm contributes to the problem. Where the amount of nutrients generated can be monitored – for example, in concentrated feeding operations – it is somewhat easier to monitor the externality and to address it.

There may be wider scope for the application of taxes and charges to promote the internalisation of environmental costs in agricultural production decisions, but this would require clearer definitions of property rights. In the agricultural sector, different types of rights – access and use rights, control rights and transfer rights – co-exist and are attached to various types of land ownership (FAO, 2011).

Tradable rights

As with taxes, tradable rights based on environmental quotas, permits and restrictions do not yet appear to play a significant role in agri-environmental policy, despite the growing use of such measures for environmental policy design in other sectors. Tradable rights have been used mainly in the area of water management (e.g. ***Australia*** and the ***United States***) and agricultural nutrients (e.g. Ontario in ***Canada***, the ***Netherlands*** and the ***United States***).

Australia and ***New Zealand*** designed tradable permits to address the concern of GHGs from agriculture. ***Australia***'s *Carbon Farming Initiative* (CFI), which is the world's first national scheme aimed at reducing carbon emissions from farming and forestry, was enacted in August 2011 and is part of a suite of land sector measures under the wider *Clean Energy Future* package, which is the Government's climate change initiative for primary industries. Potential participants in the CFI include farmers, landholders, foresters, community groups, businesses and local governments.

In ***New Zealand***, the *Emissions Trading Scheme* (ETS), a price-based mechanism for GHGs, is a key policy instrument and represents one of the Government's efforts to meet its international commitments on climate change and move towards a low carbon economy: it will fully cover agriculture as of 2015. However – with some exemptions – the emissions trading system sets the point of obligation for agriculture emissions at processor level (i.e. meat and dairy processors, and fertiliser companies), rather than at farm-level, in order to reduce regulatory and transactions costs.

Non-market (regulatory) instruments

A Green Growth strategy in agriculture entails strengthened regulations and standards to ensure that agricultural producers internalise environmental costs to a greater extent. For example, the discharge of dangerous substances into agricultural land, groundwater and waterways could be better controlled and/or prohibited. Reductions in GHG emissions from agriculture could be achieved through regulations covering land, soil and nutrient management aimed at lowering emissions from soil decomposition. Livestock management regulations have been shown to be effective in greatly reducing methane emissions. Stricter health and safety standards for food commodities could reduce problems arising from the use of polluting agro-chemicals (e.g. nitrogen and phosphorus loading). Fines and penalties for breaching environmental laws in agriculture are the usual means of enforcement, although they are not always adequately applied.

Regulatory requirements have long been applied in the agricultural sector to prevent negative impacts on the environment from agricultural activities and all OECD countries impose a complex set of regulations. Regulatory measures can meet agri-environmental objectives in a variety of different ways, imposing differing degrees of restrictiveness on

landowners. These regulatory requirements range from outright prohibitions, to very prescriptive details about farm management practices and resource-use requirements. Most of the regulations in force in OECD countries are related to the use (storage, handling, plant and animal application) of agricultural inputs (pesticides, industrial fertilisers, manure) which have the potential to cause negative environmental effects (in terms of soil, water and air pollution) (Table 4.2).

Table 4.2. Matrix of environmental regulations in agriculture

Regulation	Purpose	Form
Water quality	Maintain chemical, physical and biological integrity of water by addressing point and non-point sources of pollution	Groundwater controls Pollutant discharge permits Animal feeding restrictions Irrigation rules
Air quality	Maintain and improve the quality of air to protect human health and the environment by controlling emissions	Emission standards for air pollutants (e.g. nitrous oxide) Standards for particulate matter Air quality permits
Land use	Preserve the quality of land through limiting production intensity and the over-use of chemicals	Chemical use permits Limits on waste disposal Soil removal and placement rules
Pesticides	Control use of chemicals which may pose a risk to human health and the environment	Pesticide registration and labelling Pesticide use restrictions Food and feed residue limits
Natural habitats	Maintain or restore the natural habitats and populations of species of wild fauna and flora	Land development restrictions Protection of endangered species Agricultural habitat rules
Machinery and equipment	Maintain farm machinery and equipment in good working order and prevent environmental damage	Emission controls Noise limitations Diesel fuel restrictions
Food safety and quality	Safeguard the health and well-being of consumers	Animal welfare provisions Storage and handling regulations Food labelling requirements

There are also requirements concerning the use of land (including buffer strips and green coverage requirements) and the maintenance of water quality (including controls on groundwater, irrigation, silage and slurry operations) and protection of valuable wildlife and habitats. Stricter regulations tend to be applied in areas with higher environmental or resource conservation values. Some of these requirements are specific only to agriculture, while others are part of broader national environmental legislation affecting many sectors, including agriculture. Over time, OECD regulatory requirements for agricultural production have broadened in scope and have become increasingly stringent.

Some countries provide financial assistance to farmers (generally in the form of investment subsidies) to comply with stricter environmental regulations where this is consistent with the allocation of property rights between farmers and society. An increasing number of regulatory requirements also derive from state, provincial, regional or local

measures under the framework of over-arching national regulatory policy and law, in order to accommodate the local nature of many environmental concerns.

Voluntary agreements

In a number of countries, farmers and landowners (often grouped in local initiatives) are involved in voluntary agreements to facilitate group activities aiming to improve the productivity and environmental sustainability of the agricultural sector.

Voluntary agreements range from initiatives under which participating parties set their own targets (and often conduct their own monitoring and reporting), to initiatives where a contract is made between a private party and a public body, or stakeholder groups such as local communities and/or non-governmental or environmental groups. By making public such commitments, voluntary agreements are expected to improve the resource efficiency and environmental performance of the sector concerned beyond the level required by the existing environmental legislation and regulations.

Voluntary agreements provide greater flexibility than regulations and can offer more ambitious goals, while lowering administrative and enforcement costs and enabling faster implementation. Moreover, they improve dialogue and trust between industry and stakeholders. However, voluntary agreements are difficult to apply in areas in which the sector does not have a business interest in voluntarily changing its behaviour; they are unable to incite all companies to invest in environmental protection; and they cannot, on their own, deal with negligent or consistently poor performers (existence of "free riders") (OECD, 2003).

Despite their voluntary nature, the level of enforcement of such agreements can be diverse and the targets set in the agreements can be either general, qualitative goals (e.g. continuous improvement) or specific quantitative targets relative to previous performance (e.g. reduction of material usage) or absolute targets (e.g. zero emissions).

Voluntary agreements also include instruments such as eco-labelling standards that seek to improve consumer awareness about the environmental impact of products and/or practices. In particular, in order to enable customers to distinguish products grown without chemical fertilisers or pesticides from conventionally produced agricultural products, a number of OECD countries have established standards for "eco-labels" and have set up bodies to certify their authenticity, particularly in relation to organic or integrated agricultural production processes, which influence production practices at farm level. As such, they could be an important instrument in stimulating the environmental dialogue aiming to achieve sustainable consumption and production.

One example is the *Environmental Certification for Farms* scheme of the 2010 *Grenelle 2* environmental law in ***France*** that enshrined environmental certification in the French code of rural law. It also created a new value statement for products, both processed and unprocessed, from farms certified as having "high environmental value". The scheme was designed by all of the partners in the *Grenelle* consultation process (i.e. the farming industry, environmental organisations, consumer bodies, representatives from downstream industries and relevant official bodies); it is voluntary and open to all sectors of the industry. It is built around four themes: biodiversity, plant protection strategy, management of fertiliser use and management of water.

It also includes so-called voluntary agreements, which are negotiated agreements between the government and particular agricultural sector(s) to address a specific environmental concern. For example, in the ***Netherlands***, *Green Deals*, launched by the government in 2011, aims to promote and accelerate the transition to a green economy by encouraging the private sector, NGOs and citizens to develop and implement projects for achieving a more sustainable

economy. Through partnerships and the exchange of information, they work to remove harmful regulations and to make *Green Deals* effective. For example, the government has set targets for the Dutch Dairy Organisation and the Dutch Agricultural and Horticultural organisation to achieve zero-carbon emissions in dairy chains by 2020. By removing harmful regulations, *Green Deals* aims to strengthen private initiatives.

Voluntary agreements can also be concluded with local communities. They involve government support to community-based groups implementing collective projects to improve environmental quality in agriculture. Since the 1980s, a number of countries, including ***Australia***, ***Canada***, and ***New Zealand*** place emphasis on the use of community-based approaches to resource management in rural regions, through collective action to address environmental issues. Much emphasis is placed on improving the flow of information and using peer pressure to attain results (OECD, 2009).

In ***Australia***, *Landcare* is a uniquely Australian partnership between the government, the community and business to address environmental issues in local communities. Landcare Australia Limited (LAL) was formed by the Commonwealth Government in 1989 as a private non-profit company with the aim of encouraging community groups to develop a self-help attitude and capacity in planning, promoting and using sustainable land, water and vegetation management practices. Its role is to raise awareness about *Landcare* in the broader community and to raise funds for *Landcare* and Coastcare projects on the ground. LAL works with its business partners to help deliver triple-bottom line results for each corporate sponsor. Its aim is to assist partners in improving their own economic, environmental and social outcomes. LAL receives funds from governments, corporate organisations and private donations.

In **Ireland**, Bord Bia (the Irish Food Board) launched the *Origin Green* programme in 2012. This voluntary sustainability development programme involves manufacturers setting targets in areas such as energy, waste, water, biodiversity, thereby minimising their overall carbon footprint and lessening their impact on the environment. The programme is also expected to result in increasing the industry's overall efficiency and competitiveness. The objective is to have 75% of Irish food and drink exports sourced from Origin Green members by the end of 2014, and to increase membership levels in the future. The ultimate aim is the creation of a significant point of differentiation for the Irish food and drinks industry around the area of sustainability. Full membership requires each participant to propose a plan containing specific actions to achieve to achieve quantifiable targets of improved sustainability performance.

In ***New Zealand***, a number of farmer-based *Landcare* groups, some of which receive administrative or financial support from regional authorities, have also formed over the past decade to address issues connected with sustainable agriculture. In addition, the *Sustainable Management Fund*, which was launched in 1994, provides cost-share support for community-oriented projects promoting environmental management, while the *Sustainable Farming Fund*, launched in 2000, provides funding on a similar basis towards projects aimed at improving the financial and environmental performance of the land-based sectors. These programmes encourage the transfer of information and technology from technical experts to communities, including farmers.

In the ***United Kingdom***, there are initiatives to improve the environmental footprint of food systems through the mobilisation of public-private partnerships. The Climate Change Act of 2008 commits the United Kingdom to an 80% economy-wide reduction in GHG emissions from 1990 levels by 2050. The agriculture industry's ambitious Greenhouse Gas Action Plan (GHGAP) aims to reduce annual emissions by 3 million tonnes of CO_2 equivalent by 2018-22 through strategic delivery of messages, technical advice and information to agricultural producers in all farming systems. GHGAP builds on existing initiatives (for

example, the Dairy Roadmap) and brings together whole supply chains, to encourage the adoption of farm practices that are more efficient and to reduce GHG emissions while enabling cost savings per unit of production and enhancing landscapes and biodiversity.

Technical assistance and institutional measures

Advisory and institutional measures include collective projects to address environmental issues and measures to improve information flows to promote environmental objectives. This information can be provided to both producers, in the form of technical assistance and extension, and to consumers, via labelling.

As noted earlier, greater emphasis has also generally been placed on communicating information to farmers on environmental issues via technical assistance and extension, in order to induce voluntary changes in farming practices and improved environmental outcomes. Such measures feature an increasingly comprehensive array of information, and now employ a wide range of communication tools, such as the Internet.

Demand-side measures, such as green public procurement are also receiving increasing attention, as governments acknowledge that insufficiently developed markets are often the key constraint for eco-innovation. Many governments are substantial purchasers of food – for the military, for the prison population, and for food assistance programmes. Such purchases can be used to promote the greening of the agricultural sector.

The ***Danish*** Green Growth Strategy also introduced changes to modernise legislation and harness structural development in order to provide farmers with better opportunities for growth, improve their the financial viability and increase the competitiveness of the agricultural sector. The limit on the number of animals on a farm and the requirement that a farmer must have a certain amount of land in relation to the number of animals on his/her farm has been removed.

The legislative changes introduced permit farmers, for the first time, to form shareholding corporations for the ownership of land for farming purposes. The previous legislation required individual ownership and management, and a maximum of four farms owned per farmer, or a maximum of 400 ha. The stated motivation for these changes was to avoid the closure of one-quarter of Denmark's 13 000 farms that had been forecast to take place within five years.

In the ***United Kingdom***, focus of the *Advice and Incentives for Farmers Project*, which is still at the development stage, is on the provision of targeted advice to farmers. The aim of the project is to better integrate advice for environmental outcomes and economic performance.

The performance of these "soft" agri-environmental measures will be examined in a separate project during the 2013-14 PWB. In particular, it is envisaged to assess the extent to which such measures contribute towards: *i)* improving: the economic viability of a farm, skills, employment creation and productivity improvement (including on-farm innovation and technology transfer); *ii)* the adoption of environmentally benign farming practices; and *iii)* the extent to which such measures are coherent with other support measures.

Notes

1. The econometric study by Bokusheva, Kumbhakar and Lehmann (2010) found that in Switzerland environmental cross-compliance increased the productivity of single inputs in milk farms, but decreased it in crop farms.

2. Levying such taxes on agricultural output has the disadvantage that there is no incentive for farmers to reduce the level of emissions in the production process. For example, were a tax to be applied per head of livestock, there would be an incentive to maximise the sales weight of the animal in order to lower the rate of tax per kilo. The higher use of feed that this would involve could weaken the effectiveness of the tax in reducing emissions.

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Chapter 5

Policy approaches, by country

Chapter 5 presents a compilation of country experiences of policies and initiatives designed to achieve green growth in agriculture, by country, in the OECD area.

Australia

Caring for our country

The *Caring for our Country* initiative, which came into force in 2008, is one of several government initiatives seeking to improve the protection and restoration of land and seascape functions. It supports projects that increase the capacity of farmers to adopt sustainable practices through monitoring, information development, demonstration sites and piloting innovative practices. Over the next phase of the initiative (2013-18), a further AUD 2 billion will be provided by the government to continue its focus on protecting ecosystems and biodiversity, particularly through improving integration and planning across the different sectors involved in natural resource management.

The strategic objectives will be focused under two streams – a *sustainable environment stream* and a *sustainable agriculture stream*. The sustainable environment stream will complement investments in biodiverse carbon plantings and water planning, and continue to contribute to the National Reserve System, by focusing on Indigenous Protected Areas and marine reserves. This will not exclude contributing to the recovery of threatened species. The sustainable agriculture stream will focus on increasing the sustainability of agricultural production and recognise the contribution made by communities towards managing and improving these landscapes.

A range of different funding mechanisms is used to encourage landholders to adopt sustainable land management practices to build farm productivity and improve the quality of ecosystem services delivered to the broader community from their land, whilst building their resilience to climate change. Supported activities include pilots, demonstrations, and trials to adapt practices and systems to regional conditions, the development of industry guidelines and codes of practice, and the dissemination of information through extension activities, including training, workshops, demonstration sites and field days. Moreover, in the area of R&D, a unique form of collaboration exists between the Australian government and industry through Research and Development Corporations, which work to increase resource-use efficiency and productivity in the agricultural sector.

Monitoring undertaken over the first five years of Caring for our Country has shown that farmers have adopted many of the practices that will contribute to better production outcomes, build resilience to climate change and provide community benefits by improving the quality of ecosystem services from agricultural lands. The practice changes that have occurred are improving soil condition, mainly by reducing wind and water erosion. Over the next five years Caring for our Country will focus on food security, managing natural resources sustainably and address key threats that impact on agricultural production such as weeds and pest animals.

Climate change policies

Carbon Farming Initiative

Australia's *Carbon Farming Initiative* (CFI) is a voluntary carbon offset scheme designed and implemented by the Australian government. It is a market-based mechanism designed to will support green growth in Australian agriculture by encouraging activities that reduce greenhouse gas (GHG) emissions while improving production efficiency and sustainable resource use in agriculture. The CFI allows land holders and managers to generate and sell carbon credits by undertaking projects that reduce GHG emissions, or to sequester carbon from the atmosphere in vegetation and soil. These credits can be sold into domestic and international carbon markets, providing an additional and diversified source of income for agricultural producers.

Potential participants in the CFI include farmers, landholders, community groups, businesses and local governments. Farmers, landholders, community groups and local governments will be able to carry out activities that generate carbon offsets. Businesses, such as agents or carbon trading companies, may assist those wishing to carry out projects to participate in the scheme.

The CFI covers a range of land sector abatement activities including the reduction of methane emissions from livestock, manure management or rice cultivation; changes to the burning regimes of savannahs and grasslands; reduction of nitrous oxide emissions through more efficient farm and fertiliser management practices; and the sequestration of carbon in vegetation and soils. Examples of potential CFI activities, including additional green growth benefits from these activities, are described below.

- Management practices to reduce methane emissions in the beef and dairy industries may lead to improvements in production efficiency, in addition to achieving abatement outcomes. For example, optimising cattle breeding and stocking rates, achieving faster turn-off of sale cattle or improving the quality of diet can increase production efficiency in beef and dairy systems.
- Management practices to reduce GHG emissions from savannah fires could lead to biodiversity benefits and new employment and economic opportunities for indigenous land managers. For example, carrying out controlled burning earlier in the dry season reduces the severity of fires and increases habitat diversity in savannah landscapes.
- Management practices to reduce GHG emissions from manure in intensive livestock installations can result in reduced input costs for businesses. For example, the capture and flaring of methane emissions from piggery manure ponds can be used to produce heat and electricity.
- Management practices to reduce nitrous oxide emissions associated with nitrogen fertilisers may improve production efficiency. For example, lowering fertiliser use by synchronising the application of fertilisers with plant needs, or by using lower-emission nitrogen-inhibitor fertilisers can result in the same level of plant growth as that associated with higher fertiliser inputs.
- Management practices to increase carbon stored in vegetation and soils can lead to a range of production and environmental benefits. For example, integrating trees into agricultural systems can improve water quality, protect soils, prevent erosion and increase habitat, while also protecting livestock from wind and heat and thereby potentially increasing survival rates and increasing milk, wool and meat production.

The CFI will provide important benefits for landholders, regional communities and the environment. First, the CFI will help Australia meet its international obligations to reduce its GHG emissions under the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol. Second, the scheme will create incentives for people to invest in land sector abatement projects and provide land holders with an additional and diversified source of income. Third, the CFI will help land holders to adopt management practices that will improve their ability to adapt to the impacts of climate change. Fourth, the CFI has the potential to protect biodiversity, improve natural resource management and support regional communities.

In order to participate in the CFI, land holders and indigenous land managers must use an approved methodology. This ensures that projects satisfy internationally recognised offset integrity standards, such as additionality and permanence. Moreover, estimation methods must be consistent with the methods applied in compiling Australia's National Greenhouse Accounts for reporting under the UNFCCC. Methodologies are assessed by an

independent committee of experts, the Domestic Offsets Integrity Committee (DOIC). The DOIC brings a range of experience to these assessments, including expertise in science, technology, law, methodology development and greenhouse gas measurement approaches.

To be approved for use under the CFI, an offset methodology must contain: *i)* a description of the abatement activities, GHGs, and sources and sinks affected by a project; *ii)* procedures for determining the baseline GHG emissions and storage for the project, against which project abatement will be estimated; *iii)* procedures for identifying any GHG effects of the project outside of its boundary; and *iv)* procedures for measuring and monitoring project emissions.

The CFI has provisions to exclude activities that have the potential to negatively impact the availability of water, biodiversity conservation, employment or local communities. This will help ensure that abatement is achieved in a way that protects Australia's natural environment and improves resilience of the agriculture sector to the impacts of climate change.

Announcement of the CFI in 2010 included the introduction of two programmes to support participation in the scheme:

- A CFI *Communications* programme is investing AUD 4 million from 2011-12 to 2013-14 to provide farmers and other land managers with credible, clear and consistent information on the CFI. The programme includes targeted grants to each of Australia's 56 Natural Resource Management regions to assist stakeholders in identifying how they can participate in and benefit from the opportunities created by the CFI.
- A *Biochar Capacity Building* programme is investing AUD 2 million between the periods 2011-12 to 2013-14 to investigate how biochar mitigates greenhouse gas emissions, demonstrate the use of integrated biochar systems on-farm and facilitate the development of biochar offset methodologies to enable land managers to participate in domestic and international carbon markets through the CFI.

Clean Energy Future Plan

The *Clean Energy Future Plan*, announced by the Australian Government in 2011, is a major economic reform which entails a range of measures aimed at reducing the nation's GHG emissions and supporting businesses transition to a low emissions path. In order to achieve the set target of reducing emissions by 5% by 2020 – compared with 2000 levels – the following four broad policy approaches were established: a carbon pricing mechanism; investment in renewable energy; support for energy efficiency improvements; and investment to drive abatement in the land sector.

The carbon pricing mechanism requires companies that emit over a threshold of 25 000 tonnes of carbon dioxide equivalent per year to pay for their emissions from 1 July 2012. This price is fixed at AUD 23 per tonne (rising at a rate of 2.5% per year) between 1 July 2012 and 30 June 2015. From 1 July 2015, this will transition to an emissions trading scheme with a fully flexible price. Kyoto-compliant offsets created under the CFI can be purchased by liable companies under the carbon pricing mechanism. In addition, the Australian government and the European Commission have announced the linking of the Australian and European carbon markets and, as from 1 July 2015, liable Australian companies will be obliged to meet half of their liabilities under the carbon price mechanism using European compliance units.

The AUD 1.7 billion *Land Sector Package* will support participation in the CFI while assisting the agricultural sector to increase production efficiency and protect food production

into the future. Land Sector Package measures are funded through revenue from the carbon price mechanism and include the following programmes:

- The *Carbon Farming Initiative non-Kyoto Carbon Fund* provides AUD 250 million, commencing in mid-2013, to support the uptake of abatement activities that are not counted towards Australia's emissions targets under current international carbon accounting rules − for example, feral animal management and cropland and grazing land management. The CFI non-Kyoto carbon fund will be administered by the Department of Climate Change and Energy Efficiency.
- The *Indigenous Carbon Farming Fund* provides AUD 22.3 million to encourage indigenous Australians to benefit from carbon farming. This fund includes two main streams:
  - A *Research and Development* stream, delivered by the Department of Climate Change and Energy Efficiency, which provides AUD 5.2 million over five years for research and reporting tools for CFI methodologies. This funding is directed towards low-cost methodologies likely to have a high participation of the indigenous population.
  - A *Capacity Building and Business Support* stream (AUD 17.1 million over five years) to assist indigenous organisations and individuals assess, establish or participate in CFI projects. This stream will be delivered by the Department of Sustainability, Environment, Water, Population and Communities. The fund will provide support for indigenous organisations and individuals to access carbon farming specialists, business development expertise and legal advice for developing governance and contractual arrangements for carbon farming projects.
- The *Carbon Farming Futures Program* will provide AUD 429 million to help farmers and other land holders to benefit from economic opportunities provided by the CFI, while assisting Australia in achieving its emissions reduction targets. This programme includes five elements: *i)* AUD 201 million to fund research into new technologies and practices to enable land managers to reduce emissions and store soil carbon; *ii)* AUD 99 million to assist industry and farming groups to trial and apply research outcomes in real farming situations; *iii)* AUD 20 million to convert research into estimation methodologies for use in the CFI; *iv)* AUD 64 million to provide information, support and an extension network to help farmers take action on the land; and *v)* AUD 45 in the form of a Refundable Tax Offset (RTO) to provide support to the uptake of conservation tillage practices.
- The *Carbon Farming Skills* programme will provide AUD 4 million in funding, over five years, to train and accredit key CFI-related service providers and ensure land holders have access to credible, high-quality advice and services.
- The *Regional Natural Resource Management Planning for Climate Change Fund* of AUD 44 million over five years to support regional natural resource management (NRM) organisations to incorporate climate change mitigation and adaptation components into existing regional NRM plans.
- The *Biodiversity Fund* will provide funding of AUD 946 million over six years to support projects that establish, restore, protect or manage biodiverse carbon stores.

The Rural Research and Development Corporation Model

Australia's R&D Corporation (RDC) model is unique to Australia and is a partnership between the Australian government and the agriculture, forestry and fishery industries. This rather complex model was created in 1989 and, since then, has remained largely unchanged. It commissions and manages targeted research, and fosters uptake and adoption of technology based on the identified needs and priorities of both industry and the Australian Government. Agricultural R&D is funded on a competitive basis amongst public and private stakeholders using funds from levies on production and matching Commonwealth grants. R&D funding can be targeted either to production (on-farm) or processing (off-farm) issues and is expected to fund portfolios of projects that have a mix of both public good and private industry good components.

Under this co-investment model, industry (particularly individual farm businesses) agrees to finance R&D. Once agreement is reached from the majority of farmers − who will have to pay a levy − the industry submits a proposal to the government to mandate, through legislation, that these levies should be paid by all relevant businesses in the sector. Such a mandate ensures that every producer makes a contribution to R&D consistent with their size and production levels, thereby avoiding some of the free-rider issues that a voluntary system may pose. Once private industry voluntarily agrees that the government should issue a mandate, it becomes a statutory responsibility for producers to pay their contribution.

Once the mandate is issued, government and industry collaboratively determine priorities for R&D, based on the industry's strategic plans. When the government collects levy funds from producers, it provides these funds to the relevant RDCs along with matching funds up to a limit of 0.5% of each industry's gross value of production.

There are 15 RDCs under this system, representing all of the major sectors of commodity production in Australia. One of the largest is the Grain Research and Development Corporation, which is the recipient of levy funding from 25 different sources.

Overall, the RDC model allows for a targeted approach to R&D fund allocation by industry, where those funds are a mixture of government and industry contributions. A major challenge is to get the balance just right – to ensure the correct incentives are in place to encourage the private sector to continue to invest in R&D, while ensuring that key public good concerns are also addressed by relevant R&D.

National Enabling Technologies Strategy

The Strategy, which was established in the 2009-10 federal budget, provides a framework to support the development of enabling technologies, such as nanotechnology, biotechnology and other emerging technologies. The Strategy is a partnership between the Federal, State and Territory governments, agencies and a wide range of stakeholders.

With funding of AUD 38.2 million over four years, its aim is to improve the management and regulation of biotechnology and nanotechnology in order to help Australian industries capitalise on growth opportunities and ensure that the country can benefit from enabling technologies, while making sure that processes are in place to identify, monitor and mitigate any associated risks.

More specifically, the expected outcomes of the Strategy entail: timely and accurate information that informs policy makers' decisions on the impacts, opportunities and challenges of enabling technologies, with a particular focus on policy co-ordination and coherence of government responses; increased competitiveness through uptake of nanotechnology-based products, processes and services; effective regulatory frameworks that manage the impacts of enabling technologies on public health, safety and the environment but do not unreasonably inhibit or prohibit uptake of technologies; effective regulation and

improved industry use of enabling technologies, through world-class bio-metrology and nano-metrology capability; and public confidence in enabling technology products and services through better understanding of their risks and benefits, and how these are managed; and an understanding amongst government, researchers and industry of public concerns with regard to enabling technologies.

The Strategy also aims to assist government, researchers, industry and other stakeholders to prepare for the advent of new technologies by undertaking foresighting activities and supporting the development of policy and regulatory frameworks. Towards this end, an Expert Forum has been established to assess future challenges and opportunities arising from enabling technologies.

Landcare

Landcare is a community-based approach that has played an important role in raising awareness, influencing farming and land management practices and delivering environmental outcomes across Australian landscapes for many years. Landcare has over 20 years of experience in bringing communities and governments together to promote the Landcare ethic and support the sustainable management of natural resources. There are approximately 6 000 Landcare, Coastcare and other community-based groups working on environmental projects in their local communities.

The Australian Government supports the Landcare ethic and the Landcare movement through its *Caring for our Country* programme (see above). The Government has invested more than AUD 2 billion over five years (2008-13) in order to achieve measurable improvements to the nation's environment. Grants have been made available to Landcare and other community groups, regional natural resource management bodies, indigenous organisations and various other organisations to identify and promote best-practice sustainable agriculture and to undertake works on-ground designed to protect and enhance the natural environment. Support, through the *Caring for our Country-Landcare stream,* of over AUD 180 million also provides support to Landcare through initiatives such as Regional Landcare Facilitators, a National Landcare Facilitator, Landcare Australia Limited (the corporate arm of Landcare), the Australian Landcare Council (the ministerial advisory body), and national and state Landcare conferences and awards for promoting the adoption of best practices.

Australians have pioneered, developed and refined the Landcare model over the past two decades. Initiatives such as tax deductions for farmers undertaking Landcare further encourage the uptake of the Landcare ethic and practices. Landcare has developed both nationally and internationally and has now been adopted in over 21 countries, overseas.

Austria

The Resource Efficiency Action Plan

The *Resource Efficiency Action Plan* (REAP) was published in early 2012 by the Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management.[1] It is an ongoing process and entails a multi-stakeholder partnership approach to achieving increased resource efficiency in Austria. Its overall objectives are to reduce the environmental impacts of resource consumption, to create new markets, export opportunities and green jobs and to support the economy and industry in designing innovative and sustainable technologies, products and services.

The REAP provides an analysis of recent resource efficiency trends and sets medium- and long-term national targets for increased resource efficiency. By 2020, resource consumption should be fully decoupled from economy growth, and resource efficiency should be increased

by at least 50%, compared with 2008 levels. As a long-term goal (2050) has been set to accomplish a 4/10 gain in resource efficiency. In order to achieve these medium-and long-term goals, REAP includes a short-term implementation programme (2012-13) which focuses on four main "action fields": *i)* resource-efficient production; *ii)* public procurement; *iii)* a closed loop economy; and *iv)* raising awareness, in particular, identifying specific measures of sustainable consumption and production, and identifying measures of the cascading use of natural resources.

Belgium

Federal Authorities

As reflected in the 2011 Federal Government Agreement, the federal authorities fully support the greening of the economy and of the agro-food industry, although there is no specific green growth strategy in place for the agro-food sector. The Federal Authorities also strongly encourage the industry to integrate sustainable development into their activities, on a voluntary basis. In this context, the Belgian Food Industry Federation published in 2011 its first "sustainability report" for the agro-food industry in Belgium.[2] The future *Federal Plan for Sustainable Development* will be elaborated on the basis of the objectives of the future "long-term vision" (under negotiation at the Federal Parliament).[3]

Flemish Region

There is no specific "green growth" policy for the agro-food sector, although, under the current coalition agreement (2009-14), such policy forms part of sustainable development, which is the principal guiding policy of the Flemish Government. More specifically, the Government is pursuing policies aimed at achieving sustainability in various socio-economic areas, including the following: sustainable business processes; sustainable materials within the Flemish administration; establishment of a science policy aimed at sustainable employment creation and the greening of the economy; infrastructure durability and the promotion of public transport; the creation of sustainable spatial development; establishing a sustainable consumption pattern for agricultural and fisheries production and the development of the sustainable re-development of the fishing fleet; the use of sustainably produced timber.

In addition to the policy measures undertaken in the context of the EU CAP, the following initiatives will be undertaken:

- The *Flemish Sustainable Development* Strategy (2010-14), which provides a reference framework and ensures a long-term vision (2050) of the Flemish economy.[4] The *New Food Frontier* is a Flemish network established in 2011, involved in a search for a more sustainable agriculture and food system (thenewfoodfrontier.be).
- A *New Industrial Policy* White Paper was approved in May 2011 with 50 actions under four policy pillars, to foster system innovations:[5] within this framework a *Round Table on Agro-food and Innovation Platform in the Agro-food* will be established. In 2011, an agreement between the Flemish Government and the food sector was signed with specific objectives and appointments to further green the sector, including a joint feasibility study of a CO_2- water- and waste-neutral food-processing industry by 2030.[6]
- An *Action Plan-Flemish Materials* programme was set up in 2011, which also entails a shift towards a bio-based economy, with the agro-food sector being one of its levers (vlaamsmaterialenprogramma.be). An interdepartmental working group has also been established to prepare this strategy.

- The agro-food sector is eligible for financial support in almost all economic programmes, including the "ecology premium", the "investment support for the agro-food sector", and support for research and innovation in the agricultural sector.[7]

Within the sustainable production and consumption theme of the Flemish Government's environmental policy plan for 2011-15, different actions to foster the greening of agriculture and food industry are envisaged, including the issue of food waste.[8] Moreover, in the context of the Flemish climate change mitigation policy, the 2006-12 Flemish Climate Policy Plan includes several measures relating to agriculture: promoting a fuel switch to natural gas and other sustainable energy sources (biomass, heat, solar energy) in greenhouse horticulture; supporting the rational use of energy and energy-saving investments in agriculture; creating an energy knowledge centre for agriculture; and stimulating the production of energy crops for renewable energy.[9] A progress report that gives an account of the state of affairs of Flemish climate policy is produced annually.

Walloon Region

The green economy is part of Wallonia's Development Strategy. The *Priority Action Plan for* the *Future of Wallonia* – better known as the *Marshall Plan 2 Green* – will allocate, for the period 2010-14, over EUR 1.6 billion to six priority areas (i.e. human capital; competitiveness clusters and business networks; scientific research; creating businesses and quality jobs; employment-environment alliances; and combining employment and social well-being). For each priority area, quantified objectives have been defined.

Second priority area of the *Marshall Plan 2 Green* ("competitiveness cluster and business networks") aims at implementing an industrial policy based on networking for five economic areas: life sciences; agri-business; mechanical engineering; transport logistics; aeronautics-space. Each cluster brings together companies (of all sizes), training centres and research units. These different bodies sign partnership agreements and establish innovative projects, creating businesses and jobs.

The goals of the "Agro-Industry Competitiveness Cluster" involve improving competition between companies in the food industry, and boosting business and employment in the sector by: bringing manufacturers together; developing the spirit of innovation with products and technology whose qualities meet the needs of the customer and the market; improving the profitability of networks by encouraging people to work together and nurture sustainability; and increasing production capacity and the size of businesses by enhancing their place in growing markets and extending their sales skills and capacities (clusters.wallonie.be/wagralim/en/index.html). To achieve these goals, manufacturers in the sector have defined four priority development areas which are: health foods; innovative production and conservation technology; bio-packaging; and the development of durable food industry networks.

The *Regional Policy Declaration* for 2009-14, entitled "A shared energy for a sustainable, human and more solid society", expresses the intention of promoting sustainable development for all policies. One of its chapters explicitly refers to agriculture.[10]

The 2007 *Air-Climate Plan* of the Walloon region gathers 100 concrete measures to tackle the climatic challenges and to improve air quality. One chapter is dedicated to agriculture and forestry.[11] It enumerates practical actions that Wallonia plans to implement to favour the development of agriculture while combating climate change and air pollution.

Wallonia supports the development of the organic sector (namely by providing financial support to the BioForum, which represents/supports companies working in the organic agricultural and food sector and which informs consumers on the surplus value of organic agriculture and food). A new strategy plan for the development of the organic sector for the

2020 horizon is currently being analysed by the Walloon Government. Wallonia also supports "Quality Product Differentiation" in agriculture. This system defines new sets of criteria (positive energetic balance of farms, for instance) to differentiate some products from their "standard" counterparts. The Walloon Rural Development Programme 2007-13 includes measures ("modernisation of agricultural holdings", "increase in added value of agricultural products", "creation and development of micro-enterprises") that will promote green growth by granting subsidies to farmers and companies that invest in renewable energy (pwdr.be).

Brussels Capital Region

According to the Government Agreement 2009-14, promoting and developing a sustainable agro-food sector in Brussels is one of the key concerns of the Region. An overall policy to create green jobs and to boost the green economy in the region is the so-called *Green Jobs Pact* (*Alliance Emploi-Environnement*), which was launched in 2011 and will run until 2014. Concerning the agro-food sector, the objectives are to create new green jobs in the sustainable food sector and to stimulate the demand for sustainable food. The strategy is focused primarily on the demand side (mostly on "collective" consumption such as in school canteens and restaurants), as there is almost no production in the Brussels region.

An *Action Programme for the Stimulation of Sustainable Food* was launched in April 2011. This action programme describes the objectives and actions that the authorities will undertake − or are currently undertaking − in order to stimulate the demand for sustainable food consumption in the Brussels Capital Region. The actions and policies as described in the action programme are:

- Promotion of the use of sustainable food in canteens ("sustainable Canteens Project"), which has been in existence since 2008. Its objective is to provide sustainably-produced food in canteens in the private and public sectors and also in school canteens.
- Stimulation of the consumption of sustainable food in HoReCa (hotels, restaurants and cafés) businesses.
- Encouragement of the provision of sustainably-produced food during organised events.
- Promotion of green public procurement criteria for public purchasers of food items (since 2009).
- Education and training of the public: distribution of free publications on sustainable food to the general public, training for the creation of kitchen gardens.
- Support for the development of kitchen gardens, fruit orchards and apiaries.
- Subsidies for associations that work on the promotion and education of sustainable food.
- Publication of a study entitled *Système d'alimentation durable – Potentiel d'emplois en Région de Bruxelles-Capitale.*

Canada

Agriculture is a shared jurisdiction under Canada's constitution. As such, interprovincial agri-environmental initiatives require significant collaboration between federal and provincial/territorial (FPT) governments. Provincial governments are responsible for their own environmental targeting and many have instituted climate change action plans for their jurisdictions.

In consultation with the sector, FPT governments jointly develop policy objectives and strategic outcomes, and develop programmes and initiatives to include in collective multilateral agricultural policy frameworks. FPT governments implemented their first

collaborative framework, the Agricultural Policy Framework (APF), in 2003. The goal of the APF was to secure the long-term prosperity, profitability and success of the sector, and to position Canada as the world leader for food safety, innovation and environmentally responsible production. The APF was succeeded in 2008 by Growing Forward (GF), which built on the APF with a vision for a profitable, innovative, competitive, market-oriented agriculture, agri-food and agri-based products industry. GF was replaced on 1 April 2013 with Growing Forward II (GFII), with an emphasis on innovation, competitiveness, market access, sustainability and adaptability.

Agricultural policy frameworks have proven to be an effective way of co-ordinating government action in support of the sector. GF and GF II, similar to APF, contribute to sustainability objectives for the sector by helping the farm sector to remain economically viable and environmentally responsible. The vision of GF II focuses on ensuring the sector is competitive and profitable in markets over the long term and capable of adapting to changing circumstances and maintaining sustainable productive capacity.

Through focusing on GF II strategic outcomes, Agriculture and Agri-Food Canada (AAFC) strives to help the sector maximise its long-term profitability and competitiveness, while respecting the environment and the safety and security of Canada's food supply. The activities of the Department extend from the farmer to the consumer, from the farm to global markets, through all phases of producing, processing and marketing of agriculture and agri-food products.

Canada has had a Federal Sustainable Development Strategy (FSDS) in place since October 2010. The FSDS is focused on the Government of Canada's environmental sustainability priorities and links to the broader context of social and economic priorities. The strategy reflects the Government's commitment to improve transparency and accountability of environmental decision-making Progress Report on the 2010-13 FSDS cycle was released in February 2013 and present the progress of 27 federal departments and agencies towards achieving the goals and targets set out in the first cycle of the FSDS (2010-13), supported by 34 Canadian Environmental Sustainability Indicators, and highlights of key actions from selected implementation strategies of the FSDS departments and agencies. As the first progress report of its kind under the Federal Sustainable Development Act, this report shows, at a broad level, that the Government of Canada is making progress both towards greater transparency of environmental decision-making as well as towards the FSDS goals and targets. The report points to challenges and underscores the opportunities to further improve environmental sustainability. This is an important step as the Government of Canada develops the next cycle of the 2013-16 FSDS and future progress reports. In addition, Canada also has a Federal Policy on Green Procurement. As part of its ongoing commitment to improve the environment and the quality of life of Canadians, this policy seeks to reduce the environmental impacts of government operations and promote environmental stewardship by integrating environmental performance considerations in the procurement process.

AAFC also has a Departmental Sustainable Development Strategy (DSDS) that supports the FSDS. This approach was tabled through the Department's 2012-13 Report on Plans and Priorities (RPP). The DSDS strategy commits AAFC to supporting an economically, socially and environmentally sustainable agriculture, agri-food and agri-based products sector that ensures proper management of available natural resources and adaptability to changing environmental conditions. Through this strategy, the department has a full range of programmes and services dedicated to helping the sector to augment its environmental leadership capacity and environmental stewardship and reduce the sector's overall impact on the environment. AAFC conducts integrated economic and environmental policy research and analysis to support departmental decision-making related to the environment. Its investments in data and analytical model capacity support the department's work to ensure environmental priorities are met.

AAFC has also developed the Departmental Environmental Strategic Plan, a strategy that describes how the department will support the agricultural sector's efforts to ensure sound management of available natural resources and adaptation to changing environmental conditions, will be an important consideration when negotiating the next policy framework.

While AAFC has no explicit department-wide "green growth" policies, it is committed to an over-arching goal to promote programming that supports environmental sustainability actions in a manner that increases economic returns and shares knowledge among sector participants.

AAFC encourages innovation and productivity growth, areas that contribute directly to overall growth in the sector and the ability of the sector to meet global demand for agricultural products within the existing resource base. Emphasis is placed on improving input use efficiency and increasing outputs with genetic improvements. Improved efficiency means that lands being brought into agricultural production, and water use, can be kept to a minimum. Continued investment in research and development and technology transfer are key policy supports.

A number of programming initiatives that complement green growth with the objective of reducing existing negative environmental impacts include:

- *Agri-Environmental Programming/Environmental Farm Planning (EFP):* Sustainable agricultural systems can only result from sound management of natural, economic and human resources. Implementation of beneficial management practices (BMPs) for the preservation of soil, land and water resources and development of effective policy for promoting these practices contribute to the goal of an environmentally responsible and competitive agricultural sector in Canada. With an approved EFP, FPT governments cost share incentives for the adoption of BMPs.
- *Canadian Agriculture Adaptation Program:* The objective of the programme is to facilitate the agriculture, agri-food, and agri-based products sector's ability to seize opportunities, respond to new and emerging issues and pilot solutions to new and ongoing issues in order to adapt and remain competitive.
- *Agri-Flexibility Program:* The objective of the programme is to help reduce the cost of production or improve environmental sustainability for the sector, support value-chain innovation or sectoral adaptation, and address emerging market opportunities and challenges for the sector.
- *Agriculture Greenhouse Gases Program (AGGP):* Under the programme, Canadian farmers will benefit from a partnership between the Government of Canada, industry and universities across Canada to boost producer profitability through green agriculture technologies. The AGGP represents Canada's initial contribution to the Global Research Alliance. The programme represents a partnership between the Government of Canada, industry and universities across Canada to boost producer profitability through green agriculture technologies. The AGGP will provide funding of CAD 27 million over five years to various partners across Canada to investigate innovative mechanisms, tools and approaches to benefit farmers.

AAFC is active in contributing to the monitoring of environmental outcomes and meeting the environmental targets established by the Government of Canada. For example, Canada has agreed to international commitments to reduce use of ozone-depleting substances and the agriculture sector will be responsible for meeting established commitments. AAFC also sets time-bound, quantitative targets for adoption of environmental practices and reductions in risks to soil, water and biodiversity. These targets are reported in annual federal government "Reports on Plans and Priorities", such as "Fresh Water Quality: Achieve a value between

81-100 on each of the Water Quality and Soil Quality Agri-Environmental Performance Indices by 31 March 2030.

AAFC's National Agri-Environmental Health Analysis and Reporting Program (NAHARP) provides science-based agri-environmental information that plays a critical role in guiding policy and program design, and can help determine which policy options could be most effective in addressing environmental issues, such as water quality, biodiversity or air quality.

As policies and programs are implemented, information from NAHARP will help monitor and understand progress towards reducing environmental impacts. The information generated will also provide a report card that can help track the environmental performance of Canadian agriculture over time and assess the degree to which the sector is managing its resource use.

The Sustainable Agriculture Environmental Systems (SAGES) initiative aims to provide science based responses to two high level priorities: water and climate change. SAGES supports 25 peer-reviewed research and development projects and provides benefit to producers through knowledge and development. SAGES is designed to accelerate the creation of BMPs, offer policy options and provide a better understanding of impacts and adaptation opportunities.

Lastly, AAFC completes Departmental Performance Reports (DPRs) that provide information on results achieved against planned performance expectations as set out in respective RPPs. These Reports are tabled annually in Parliament in the fall by the President of the Treasury Board on behalf of Ministers. AAFC's DPRs include information on the department's success at supporting an "environmentally sustainable agriculture, agri-food and agri-based products sector", a departmental strategic outcome. In the most recent DPR, AAFC identified the percentage of farms in Canada which have a formal EFPs and the percentage of farms taking action on their EFPs as performance indicators. Results are made available to the public through the Treasury Board of Canada Secretariat.

Renewable energy

The Government of Canada's renewable fuels strategy was announced in 2006. The strategy has four key objectives and corresponding sets of policy instruments aimed at supporting the development of a domestic biofuels industry in Canada:

- *Reducing GHG emissions resulting from fuel use by increasing the retail availability of renewable fuels through regulation:* Canada's federal Renewable *Fuels Regulations* require an annual average renewable content of 5% based on the volume of the national gasoline pool and 2% renewable content in diesel fuel.
- *Supporting the expansion of Canadian production of renewable fuels:* The CAD 1.5 billion ecoENERGY for Biofuels Program provides production incentives to Canadian biofuel producers. The programme aims to support 2 billion litres of ethanol production and 500 million litres of biodiesel production. The programme expires in 2017.
- *Helping farmers capture new opportunities in this sector:* The CAD 200 million ecoAgriculture Biofuels Capital Initiative (ecoABC) provides capital incentives for the construction or expansion of biofuels facilities that include new equity investment from farmers of at least 5% of eligible project costs. ecoABC expires in 2013. The CAD 20 million Biofuels Opportunities for Producers Initiative, which ran from 2006 to 2008, helped farmers and rural communities hire experts to assist in developing business proposals, feasibility studies and other work necessary to create and expand agricultural producers' biofuels production capacity.

- *Accelerating the commercialisation of new technologies:* The CAN 500 million NextGen Biofuels Fund was designed to support the construction of large-scale demonstration facilities for the production of next-generation renewable fuels, such as cellulosic ethanol made from agricultural residues and waste products. The NexGen Biofuels Fund will disburse funds up to 31 March 2017.

Czech Republic

Up to date there is no any conceptual document dealing with the policy of Green Growth in the Czech Republic. A *Strategy for Agriculture* and the Rural Development Plan for period 2014-20 are being prepared by the Ministry of Agriculture. A particular focus is accorded to: production of renewable energy (i.e. solar, biogas, etc.); farming under organic and integrated regime; special targeted farming on HNV biotopes; and land consolidation.

Denmark

Green Growth Strategy

Launched in 2009, Denmark's Green Growth Strategy was designed to establish a green growth economy in which the agro-food sector can improve its innovative and competitive potential. The stated purpose of the Strategy is to bring about a modern and competitive agro-food sector that is compatible with a high level of environmental, nature and climate protection. Its central aspect is that it promotes coherence between the environment and production methods through technological innovation and revision of agricultural legislation.

The Strategy, prepared with the collaboration of sectoral ministries and public agencies, and with expert inputs from working groups, is an ambitious and long-term plan defining environment and nature policies and the conditions of growth for the agriculture sector until 2020. A total of DKK 13.5 billion (EUR 1.8 billion), to be financed in part by the EU Rural Development Programme 2007-14, is to be invested in green growth activities until 2015, which is an increase of around 50% compared to previous initiatives.

Renewable energy

A central element in the Strategy is the emphasis placed on the development of renewable energy in the agricultural sector. In particular, the role of the agricultural sector as a supplier of green energy is to be strengthened, with up to 15% of arable land to be used for energy crops − which represents a 16-fold increase in production of energy coming from agriculture − and the share of farm animal manure to be used for green energy is to be increased from 5% to 50% by 2020.[12]

Policy initiatives to reach targets include annual financial support of DKK 100 million for starting investments in biogas and a biogas team to co-ordinate biogas activities around the country. The treatment of slurry for biogas is voluntary and farmers receive a premium of DKK75 per m^3. Up to 100 farmers can use one biogas installation. Under this scheme, a grant covering up to 20% of the investment in the plant can be provided. The remaining funds will be provided by a 60% loan, guaranteed by the local municipality and 20% of own financing. Municipalities are obliged to include the construction of biogas plants in their municipal planning, as well as the allocation of grants for selling biogas to co-generation plants and the natural gas net.

The status of the development of the biogas plants will be assessed in 2012, including an evaluation of the need for any further initiatives to achieve greater energy exploitation of livestock manure. As the general public has proved rather reluctant to accept the construction

of biogas plants, the location of these installations will pose a challenge to meeting the target levels of production (SEI, 2011).

Other initiatives to promote the role of the agricultural sector as a supplier of green energy include a grant scheme for planting perennial crops totalling DKK 32 million annually from 2010 to 2012. The scheme became effective as from the 2010 planting season. The grant can be given to areas in normal operation, in which planting results in a large reduction of nitrogen, and at locations where a reduction in the nitrogen burden can contribute towards meeting the requirement of the Water Framework Directive. The grant scheme for perennial crops will be assessed in 2012.

Less nitrogen and phosphorus loss

Less nitrogen loss to the aquatic environment can be achieved through higher storage/usability of slurry and the reduced use of synthetic fertiliser: concrete initiatives to reduce the discharge of nitrogen and phosphorus into aquatic environments include targeted measures, such as permanent buffer zones and wetlands that are spraying-free, fertiliser-free and cultivation-free, as well as general regulation, including the neutralisation of the negative effects of nitrogen, when agricultural land is taken out of production.

Unlike previous action plans, where targets for nitrogen reductions were based on leaching from the root zone, the targets in the Green Growth Strategy are based on the discharge of nitrogen into the aquatic environment. The goal is an annual reduction of 19 000 tonnes of nitrogen and 210 tonnes of phosphorus discharge into the aquatic environment.

Organic farming

The Green Growth Strategy considers organic farming to be an important driver of green growth as it is a combination of green production with a sound economy. It is planned to increase the area used for organic production from 6% in 2007 to 15% in 2020 through a massive effort amounting to almost DKK 350 million a year.

Agricultural R&D

In its Green Growth Strategy, the Government aims at an efficient organisation of agricultural research and development. Among other things, this will brought about through a green development and demonstration programme, aimed at increasing the co-ordination between research, innovation and demonstration in agro- and aquaculture and food sectors. At the same time, DKK 145 million per year has been earmarked for green investments, while the Action Plan for the Promotion of Environmental Technology 2010-11 includes DKK 225 million dedicated to the development of green agricultural technologies.

Modernising legislation and harnessing the structural development

The Green Growth Strategy also introduced legislative changes to improve the policy environment for an improved structural development in order to provide farmers with better opportunities for growth, improve their the financial viability and increase the competitiveness of the agricultural sector. The limit on the number of animals on a farm and the requirement that a farmer must have a certain amount of land in relation to the number of animals on his/her farm has been removed.

The legislative changes introduced permit farmers, for the first time, to form shareholding corporations for the ownership of land for farming purposes. The previous legislation required individual ownership and management, and a maximum of four farms owned per farmer, or a

maximum of 400 ha. The motivation for these changes was to avoid the closure of one-quarter of Denmark's 13 000 farms that had been forecast to take place within five years.

New pesticide tax

The law on the restructured pesticide tax, which was due to be submitted in the autumn of 2009, came into force in January 2012. This new level of tax, which is designed to place the highest tax on the potentially most harmful products, will consist of four components: a basic tax based on the content of the active ingredients in the product; a component for health, based on the classification of the formulated product; a component for the effect on non-target organisms, based on the properties of the active ingredients in the product; and a key component for the environmental fate of the products, also based on the properties of the active ingredients contained in them.

A key element of the tax is that smaller or specialised crops, such as potatoes and lettuce, should not be so heavily taxed that their production will be outsourced. The new taxes are expected to generate extra revenue of DKK 150 million (around EUR 20 million) compared to the previous taxes. The revenue will be returned to the agricultural sector via reduced taxes on land to compensate for the cost incurred.[13]

In addition to the new tax, a new national target for the use of pesticides based on environmental impact and several measures to support the greater use of Integrated Pest Management (IPM), according to the EU Directive 2009/128/EC. One of the objectives is to provide subsidised advice in the implementation of IPM.

Estonia

The country's interest in green growth is mainly reflected through various government programmes concerning either renewable energies or bio-economy:

- National Renewable Energy Action Plan (until 2020)
- Estonian Rural Development Plan 2007-13:
  - Investments into the production of bio-energy
  - Improving the economic value of forests and forestry products
- Estonian Development *Strategy* of Energy Related Technologies
- National Energy *Efficiency* Programme 2007-13
- Estonian *Biotechnology* Programme 2010-13
- R&D support for *energy*-related technologies
- Procurement of *electric* cars for public institutions, support measures for purchasers of electric cars and the establishment of a network charging stations.

There are also several other government strategies which include "Green Growth" components of the agricultural sector, such as waste management, materials design/production, but these are not carried out by the Ministry of Agriculture.

European Commission

While the key EU strategy of "Europe 2020" does not formally include the term "green growth strategy" (GGS), it has many of the features a GGS and seeks "green" outcomes, citing "green growth" as an object of attention. The "CAP towards 2020 Communication" COM(2010)672 of 18 November 2010 deals with the application of the "smart, sustainable

and inclusive growth" of the Europe 2020 strategy to agriculture states that: "this means *green growth* in the agricultural sector and the rural economy as a way to enhance well-being by pursuing economic growth while preventing environmental degradation".

The linkages between the CAP and the "Resource Efficiency" flagship of the Europe 2020 strategy indicate that a "green growth" type approach to the challenges of the future has been internalised in the EU policy process.

Titles of the policies and the date when they were (or planned to be) introduced:

- Europe 2020 Strategy COM(2010)2020 of 3 March 2010
- Innovation Union Flagship COM(2010)546 of 6 October 2010
- CAP towards 2020 Communication COM(2010)672 of 18 November 2010
- A Resource-efficient Europe Flagship COM(2011)21 of 26 January 2011
- Resource-efficient Europe Initiatives *February* – December 2011
- Tackling the *Challenges* in Commodity Markets and on Raw Materials COM(2011)25 of 2 February 2011
- Roadmap for moving to a competitive low carbon economy in 2050 COM(2011)112 of 8 March 2011
- Roadmap to a *Single* European Transport Area – Towards a competitive and resource efficient transport system COM(2011)144 of 28 March 2011
- Energy Roadmap *2050* COM(2011)885 of 15 December 2011
- Roadmap to a *Resource*-efficient Europe[14] COM(2011)571 of 20 September 2011
- CAP after 2013 *Legal* proposals COM(2011) 625 of 19 October 2011
- Establishing Horizon 2020 – The Framework Programme for Research and Innovation[15] of 30 November 2011
- A Bioeconomy for Europe COM(2012)60, 13 February 2012
- Agricultural *Productivity* and Sustainability European Innovation Partnership (EIP) COM(2012)79 of 29 February 2012
- Commission position at the "Rio+20: United Nations Conference on Sustainable Development" on 19 June 2012[16]
- Future steps in bio-waste management in the EU COM(2010)235 of 18 May 2010.

Mainstreaming resource efficiency into EU legislation

Launched in September 2011, the initiative for a resource-efficient Europe is one of seven flagship initiatives designed to deliver smart, sustainable and inclusive growth for Europe, as part of the Europe 2020 strategy (ec.europa.eu/resource-efficient-europe). The initiative for a resource-efficient Europe addresses all natural resources, from raw materials to food, water, air and ecosystems and establishes guiding principles for EU policies on energy, transport, climate change, industry, commodities, agriculture, fisheries, biodiversity and regional development.

The resource efficiency flagship initiative aims to create a framework of policies designed to support the shift towards a resource-efficient and low-carbon economy capable of achieving sustainable growth by: boosting economic performance, while reducing resource

use; identifying and creating new opportunities for economic growth and greater innovation, thus boosting the EU's competitiveness; ensuring security of supply of essential resources; and combating climate change and limiting the negative environmental impacts of resource use.

The resource efficiency flagship initiative is now Europe's engine for generating growth and employment. The strategy will also be instrumental in reaching a variety of EU objectives, including reducing emissions of GHG in Europe by 80 to 95% by 2050, and reforming the agricultural and fisheries sectors to make the EU more resilient to future rises in global energy and commodity prices.

The resource efficiency flagship initiative also sets an integrated framework and long-term agendas for these policies, and lists over 20 initiatives, that include proposals designed to deliver concrete results for the resource-efficient Europe flagship. It recommends an integrated approach across many policy areas, ranging from a roadmap for a low-carbon economy by 2050, to reform of the Common Agricultural Policy (CAP); a new EU 2020 biodiversity strategy; a review of reform of cohesion policy; and measures concerning commodity markets and raw materials. The instruments employed will include legislation, market-based instruments, refocusing of funding instruments and promotion of sustainable production and consumption. Clear targets and indicators will be developed by 2013, through a participative process involving policy makers, experts, NGOs, business and consumers.

The concrete proposals to be tabled will seek to exploit synergies to secure win-win eco-innovations that are good for business and the environment – for example, rewarding consumers for recycling. But they will also address trade-offs between policy options, in order to avoid undesirable consequences – such as in the glass sector, where the production of super-insulating glass requires large amount of energy, but, once in use, the amount of energy required to heat a building decreases. Another example of trade-offs is the use of land for food and energy production, which may compete with land allocated for biodiversity and ecosystem services, such as carbon capture.

The European Innovation Partnerships (EIP) on Agricultural Productivity and Sustainability

European Innovation Partnerships (EIP) are a new approach to innovation which were first proposed in the Europe 2020 strategy and further elaborated in the European Commission's 2010 Communication on Innovation Union. The Partnerships come as a response of the need to help accelerate the adoption of research findings and to overcome the fragmentation of research activity in Europe. Their aim is to accelerate the process of research, development and deployment of innovations in order to address major societal challenges, and pool expertise and resources to boost Europe's competitiveness and aid job creation and economic growth. The Partnerships encompass the whole research and innovation cycle by bringing together all relevant actors at EU, national and regional level.

In February 2011, the EC adopted a Communication on an EIP Agricultural Productivity and Sustainability, with the motto of "achieving more from less", in order to address, through innovation, both the lagging productivity growth and the need for greater sustainability in agriculture (ec.europa.eu/agriculture/eip/pdf/com2012-79_en.pdf). The aim of this new tool is to promote resource efficiency, and to fill gaps, by improving the links between research, advisory services and practical farming. Particular emphasis is placed on overcoming perceived bottlenecks to getting research results adopted on the ground and to ensuring feedback on research needs from practice to science, such as insufficient information flow and missing links between different actors (farmers, advisers, enterprises and researchers). Its main role is to bring together the whole research spectrum, from fundamental science through to actual applications, involving a range of funding instruments and policy initiatives.

The EIP on Agricultural Productivity and Sustainability seeks to improve co-ordination between actors and to facilitate the taking up of opportunities provided by the different policy fields, such as the Common Agricultural Policy (CAP) and the EU Research Policy. It will rely mainly on the existing instruments of the Rural Development policy and the Research Framework, currently being reformed.

The EIP will draw on Rural Development programmes to provide support for co-operation and the establishment of "operational groups" composed of farmers, advisers, enterprises, researchers and administrations. These groups will carry out projects, and test and apply innovative processes, products and technologies. A specific innovation network will be established, under the umbrella of the European Network for Rural Development, aimed at fostering the sharing of experience of innovative approaches and improving communication between agricultural practice and science.

The EIP will also draw on the Research Policy to finance innovative actions. In this respect, the EC's Communication on the Multi-annual Financial Framework for 2014-20, shows the high importance being placed on research and innovation in agriculture by proposing to earmark EUR 4.5 billion for this purpose, which is more than double current resources devoted to agricultural research at EU level.

Finland

Renewable energy – Biogas

According to the Finnish Long Term Climate and Energy Strategy launched in 2008, the use of biogas should be increased by 2020 (ec.europa.eu/energy/renewables/transparency_platform/action_plan_en.htm). In order to promote combined head and power production using biogas, a market-based feed-in tariff scheme has been introduced, which is financed from the state budget. The feed-in tariff is: equivalent to the difference between the target price and the market price of electricity; excludes the possibility to obtain a simultaneous investment subsidy; supports only the generation of electricity, while other forms of energy (i.e. alternative fuels for traffic, etc.) are excluded; facilities under 100kWA are excluded (a significant proportion of facilities are below this threshold); and the tariff is fairly low. Within the scope of the country's energy-related targets, agricultural investment support is granted to on-farm boiler houses that use renewable energy sources. The purpose of the investment support is to promote the increased use of renewable energy sources, the more efficient use of energy and energy saving, the adoption of new energy technologies and the reduction of environmental damage from energy production and use.

Over the 2008-11 period, EUR 5 million per year for relevant research, investigation, training and communications projects to promote the establishment of bio-energy production plants, as well as for pilot projects applying new research data and technologies. A particular objective of the support is to promote the construction of biogas plants in areas with large farm animal populations and consequent environmental impacts. It is estimated that as a result of these projects, 6-10 fairly large biogas plants will be constructed in the next few years, particularly in areas with large farm animal populations. Biogas plants can produce electricity, heat or transport fuels, but, in addition to producing renewable energy, they also have positive environmental impacts brought about by the improved use of manure and reduction of GHG emissions. The support is primarily targeted at biogas plants that are not accepted under the terms of the electricity feed-in tariff scheme.

As regards the boiler houses on farms, the requirement for granting the support for the construction, expansion or renovation of a boiler house is that the boiler house must utilise waste, water, air, earth or solar heat or any other source of renewable energy, biomass

included. If peat is used as an energy source, the boiler house must also be able to produce heat from wood or another renewable energy source. The support is not granted for costs resulting from the utilisation of oil, hard coal or other similar fossils. The amount of support depends on the nature of the target receiving the funding. Of the primary material used in the eligible biogas plants, 50% must originate from the farm, and over 50% of the energy produced must be used on the farm.

In addition to the support for the production and use of biogas, bio-energy investments in rural micro-enterprises and small- and medium-sized enterprises can receive financing under the Finnish 2007-13 Rural Development Programme. For example, support can be granted to bio-energy product refinement, energy production from biomass or other construction investments related to bio-energy business activities.

France

The programme "Produisons autrement" (Let's Produce Differently) and the "Agro-ecological project for France"

The programme *Produisons Autrement* and the "agro-ecological project for France" were launched in a national conference held on December 2012. They aim to *initiate a new transfer of agricultural production models* and farming systems by reconciling economic and environmental performance.

The agro-ecological project is based on three complementary components:

- Assessing current knowledge and experience in agro-ecology. As part of the campaign *Produisons autrement*, a participatory forum has been created to organise and exchange information on existing practical *experiences* and agricultural knowledge. In addition, the orientation documents of the research and technical Institutes in agronomy and agriculture fields are being in-depth revised to promote agro-ecology.
- Strengthening agro-ecological training, continuing education and farming advice.
- Encouraging farmers to convert to and maintain agro-ecological practices at the farming level, through public support. The Common Agricultural Policy is being strongly and crosswise oriented *to encourage changes in practices and investments*. The bill for the future of French agriculture ***(****Loi pour l'Avenir de l'Agriculture****)*** which is expected for the end of 2013 will also strongly support agro ecological practices.

Beyond these three components, six action plans have been launched. They aim to: *i)* support the reduction of pesticides; *ii)* support the reduction of antibiotics; *iii)* seek methane energy production and nitrogen autonomy; *iv)* support the bee-keeping sector; *v)* enhance vegetal protein autonomy; and *vi)* support organic agriculture.

Energy Performance Plan (PPE) for Farms

The Energy Performance Plan (PPE) for Farms, 2009-13 programme was launched in February 2009 and is part of the French environmental plan "Grenelle". This five-year programme aims to reduce the energy dependency of 30% of French farms, through various kinds of actions and investments, based on the production of an "energy and GHG emissions audit". Its specific objectives are to: increase awareness of energy consumption on farms through: reducing energy consumption; enhancing energy efficiency in agriculture; producing renewable energies; and improving farmers' competitiveness. Its total budget was EUR 160 million for 2009-11. It includes a number of actions to be conducted at the farm level, with particular emphasis on the "energy and GHG emissions audit".

The Energy performance audit reviews farms direct and indirect energy consumption, identifies room for improvement, and formulates recommendations. These may cover practices to reduce energy consumption (e.g. through reducing nitrogen input, or changing crop management), to promote the use of different equipment (e.g. isolation materials, heat economisers), and to develop renewable energy production (mainly through methanisation and the use of biomass. Depending on the recommendations of the audit, aid for investments may be granted, and, in particular, aid for investments aimed at producing renewable energies and/or saving energy.

The programme comprises eight pillars:

- Improved knowledge of energy consumption and production on French farms to be obtained through national energy surveys, designed to improve the statistical basis
- Increased implementation of farm energy and GHG emissions audits (e.g. through the provision of grants)
- Improved tractor-energy efficiency
- Increased energy efficiency on farms (e.g. through grants offered to farmers who install energy-efficient equipment; encouraging field operations that take into account the reduction of input consumption (such as nitrogen fertilisers), and promoting the use of Energy Performance Certificates)
- Development of renewable energy production (e.g. providing grants to farmers who install renewable energy equipment such as biomass heating systems and solar heating, thermal exchangers and heat pumps, and for methanisation units and equipment linked to the production of electricity on an isolated site not connected to the network, such as small wind farms and photovoltaic panels)
- The taking into account of the characteristics of France's overseas territories
- Promotion of research and innovation, and
- The monitoring and assessment of the PPE.

After three years of implementation, 10 000 energy and GHG emission audits have been carried out on farms, and 6 400 projects to promote renewable energy production or energy saving are now being implemented on farms. In addition, 127 methanisation units have been developed and more than ten tests benches for tractor engines have been granted. The Plan has also contributed to the national policy of "energy savings certificates". In addition, Research and Development projects, which are an important part of the Plan, have received financing of EUR 10 million.

Grenelle de l'Environnement and Écophyto plan on pesticides

The *"Grenelle de l'environnement"*, launched in 2007, is a comprehensive multi-stakeholder consultation on environmental protection, including agriculture. Following the consultation the government brought the *Loi Grenelle* legislation into force in 2009, which concerning policies relevant to green growth in agriculture include:

- Total area certified as organic *agriculture* to increase from a 2% share of agricultural land in 2004 to 6% by 2012, and eventually to 20% by 2020[17]
- Number of farms under high *nature* value certification to reach 50% of all farms by 2012
- 50% reduction in the use of plant production by 2018 if feasible
- Withdrawal from commercial use of 40 of the most harmful pesticides

- Support for research aiming to reduce pesticide use.

The Écophyto plan on pesticides, which is part of the *Loi Grenelle,* aims to reduce pesticides by 50% by the year 2018 if possible, while keeping a high level of production, as well as quality of agricultural products (agriculture.gouv.fr/ecophyto). It is led by the Ministry of Agriculture, Agro-food and Forestry, together with the implication of the major actors concerned – farmers, technical institutes and researchers.

The Écophyto plan on pesticides encompasses the following eight sets of actions to manage risks and monitor impacts, and to reduce cropping system dependence on pesticides:

- Evaluate progress towards a reduction of pesticide use
- Identifying and mainstream practices and existing agricultural systems to enable pesticide use reduction by mobilising research, development and knowledge transfer partners
- Encourage innovation in the design and development of low pesticide input practices and cropping systems
- Training on the reduction of secure use of pesticides
- Reinforce pest surveillance networks and monitor un-intentional effects of pesticides
- Take into account the specificities of the *départements d'Outre-Mer*
- Reduce the use and improve the safety of pesticides used for non-agricultural purposes
- Monitor the plan at both national and local scales, including improving communication of then plan to stakeholders.

Interestingly, a specific indicator of pesticide pressure is used to monitor the plan, to take into account the fact that pesticides are more or less biologically active. The plan also mentions the development of a set of socio-economic indicators consistent with the pressure-impact framework.

The research and development effort within the *Ecophyto* plan is seeking to develop new Integrated Pest Management solutions that can contribute to sustainable agriculture while preserving the competitiveness of French agriculture (OECD, 2012). To that end, the Ministries of Agriculture and Environment have requested that the *Institut National de la Recherche Agronomique (INRA)* launch research which is mobilising a hundred experts from over 30 organisations and is focusing on four main sub-sectors: arable crops, fruit arboriculture; viticulture; and vegetables. For each of these sub-sectors different strategies for limiting the use of pesticides are being analysed, with research efforts focussing on the following.

Environmental certification for farms

The "*Grenelle 2*" environmental law of 12 July 2010 enshrined environmental certification in the French code of rural law. It also created a new value statement for products, both processed and unprocessed, from farms certified as having "High Environmental Value".

The environmental certification for farms is a scheme designed by the partners in the *Grenelle* consultation process: the farming industry, environmental organisations, consumer bodies, representatives from downstream industries and relevant official bodies. It is voluntary and open to all sectors of the industry. It is built around four themes: biodiversity, plant protection strategy, management of fertiliser use and management of water.

It has been constructed on the basis of progressive certification of the whole of a farm as verified by independent third-party bodies approved by the Agriculture Ministry. Three levels of environmental progress are recognised:

- Level 1 indicates fulfilment of the environmental requirements in cross-compliance and assessment of the holding by the farmer based on the level 2 criteria or the indicators of level 3.
- Level 2 reflects compliance with a set of criteria laying down 16 requirements with an effective impact on the environment and designed for relevant integration into the farm's daily management. The criteria for environmental progress focus on the farm, providing in particular for the rational use of inputs and the limitation of accidental leakage into habitats. At this level, certification can be managed within a collective framework. Existing programmes can receive recognition on the basis of dual equivalence: equivalence of requirements and equivalence of control measures.
- Level 3, defined as "High Environmental Value", involves meeting a formal obligation to achieve defined outcomes. The farmer can choose to be assessed according to a battery of four composite indicators that include the four themes already described (option A) or two synthetic indicators (option B). These two options allow the diversity of the systems of production encountered in practice to be taken into account while maintaining the same level of environmental excellence.

Oversight of the scheme is exercised by the *Commission Nationale de la Certification Environnementale* (CNCE), a body set up on 25 October 2011. Its membership includes all the Grenelle partners and it examines: Applications for official approval of certifying bodies to audit environmental certification levels 2 and 3; and Applications for official recognition relating to existing environmental schemes. The CNCE may also suggest necessary changes to the scheme in light of experience acquired during practical implementation. For more detailed information in the scheme's structure, see: http://agriculture.gouv.fr/exploitations-agricoles. As of mid-2013, nineteen initiatives, such as production charters, have been certified as "level 2", representing thousands of farms. Regarding the "level 3" certification, thirty farms have already been certified, some of which have certified organic status.

Greece

Promotion of green growth in the agro-food sector is mainly effected through the implementation of measures under the Rural Development Programme (RDP) of Greece 2007-13. More specifically, investments in renewable energy sources are promoted via the modernisation of agricultural holdings and measures to increase the value of agricultural products (processing and marketing).

Furthermore, investment aiming at environmentally friendly actions is also promoted via agri-environmental support, such as: promotion of environmentally-friendly production practices (organic agriculture; organic stock-farming; stock-farming extensification; and rotation with non-irrigated crops on fields formerly cultivated with tobacco); agri-environmental actions for protection of water resources (protection of areas vulnerable to nitrates; protection of wetland areas; integrated management system); special actions for the preservation of biodiversity (e.g. preservation of endangered indigenous livestock races; preservation of extensive crops threatened by genetic erosion); and the protection of the rural landscape formed by agricultural activity (e.g. protection of traditional olive groves in Amfissa and preservation of the practice of viniculture on the island of Thira).

The Integrated Management System in agricultural production

According to AGROCERT, the Hellenic Agricultural Products Certification and Supervision Organization, the introduction of the Integrated Management System (IMS) in agricultural production helps farmers to drastically reduce the use of pesticides as well as to avoid unbalanced implementation of cultivation techniques. The farmer is obliged to follow certain cultivation management rules and techniques, under the surveillance of a supervising agronomist, and to keep track of the implemented practices. Greek national protocols have been issued by AGROCERT describing the obligations of the participating farmers.

The Integrated Management System in the production of tobacco

IMS has been implemented in the tobacco-production areas of Greece. The objective is to reinforce the transition from conventional methods to IMS farming in the tobacco sector. It is financed by the Greek RDP 2007-13 and the aim is to cover 12 800 ha over five years.

Beneficiaries of the programme receive financial aid of EUR 936 per ha per year, to cover: *i)* extra costs arising from the implementation of the IMS (e.g. agronomic advisory services, such as planning and monitoring of the five-year Environmental Action Plan of the farm, IMS certification costs, the cost of buying specialised apparatus, cost involved in soil analysis, etc.); *ii)* income forgone by the implementation of the extra obligations (i.e. no tobacco cultivation on the 5% buffer strip around the parcel, and 20% crop rotation with legumes); and *iii)* the extra cost produced by the additional work needed for non-chemical weed control.

The rationalised management practices followed under IMS are expected to produce positive environmental impacts, such as: a 30% reduction of inorganic fertiliser and pesticide use; improvement of the soil's organic content and texture; reduction of fertilisers and pesticides causing pollution of soil, surface water and the groundwater table; improved water efficiency; and reduction of GHG emissions, mainly nitrous oxide (N_xO). Apart from the obligations deriving from the IMS, beneficiaries are expected to implement supplementary eco-friendly farming management techniques, such as: *i)* crop rotation with legumes on at least 20% of the utilised land, which are not to be harvested but incorporated in the soil for amelioration of its texture, organic and nitrogen content; *ii)* the creation of buffer strips of at least one metre in width (at least 5% of the utilised land) around each parcel for the creation of passages and feeding/resting areas for animals, insects and birds; and *iii)* adoption of non-chemical weed control in 75% of the utilised area for the protection and enhancement of wild flora and fauna.

Integrated Management System in sugar beet production

IMS in sugar beet production, which is also financed by Greek RDP 2007-13, aims at covering 12 500 ha of the sugar beet cultivation area over 5 years. Sugar beet was selected for support as the Hellenic Sugar Industry S.A. (the sole sugar producer in Greece) is finding it difficult to increase the national sugar beet production to fill the national production quota of 158 702 tonnes. Moreover, the increase in sugar beet production has to be achieved in an environmentally responsible way and IMS in sugar beet production was considered a good way to achieve the goal.

As with the case of tobacco, the agri-environmental Action has the aim of improving the environmental performance of the farming system through IMS management. In addition, beneficiaries are obliged to reduce the use of nitrogen fertilisers by 30% and the use of irrigation water by 20%, compared to the baselines. Implementation of the integrated crop management (decrease of inputs, such as fertilisers, pesticides and irrigation water), in combination with the extra reductions in nitrogen fertilisers (-30%) and/or irrigation water

(-20%), is expected to have a negative impact on the yields for sugar beet, and consequently, on the income of the beneficiaries.

The financial aid provided to the beneficiaries of the programme compensates farmers for income forgone due to implementation of the IMS in sugar beet production and the extra limitations on the use of fertilisers and irrigation water. Beneficiaries of the programme receive financial aid of: a) EUR 299 per ha per year on condition that they undertake to decrease their use of nitrogen fertilisers (by 30%); b) EUR 318 per ha per year if, in addition to the decrease in the use of fertilisers, they decrease the use of water for irrigation purposes (by 20%). The latter case is applicable mainly in rural areas equipped with collective irrigation systems using electronic abstraction apparatus with rechargeable memory cards, as only with such systems can the reduction of water use be accurately quantified.

Green infrastructure and efficient resource use (smart irrigation system)

The smart electronic irrigation system, which is based on a rechargeable memory card, is an example of good practice to improve efficiency in the use of water for irrigation. The system was established by the Local Land Improvement Organisation in the Region of West Macedonia-Velvento, Kozani, and financed by the RDP 2007-13. The microclimate of that area is ideal for the production of such products as peaches, apples, plums, cherries and wine, which all benefit from the smart irrigation system.

Renewable energy

At present Greece is preparing the legal framework for the implementation of the EU Renewable Energy Directive (Directive 2009/28/EK). In May 2010, the Ministry of Environment, Energy and Climate Change implemented a law which permits farmers to construct solar photovoltaic installations on their land, in order to produce electricity, either for personal use or for sale to the Public Enterprise of Electricity, thus offering farmers a potential source of additional income. According to the legislation, the area of farmland used for such photovoltaic installations cannot exceed 1% of the total farmland of each prefecture. This measure has as a goal the promotion of renewable energy systems and in the long-term the mitigation of climate change. Some of the above measures serve not only as a tool for "greening" agricultural growth by implementing environmental friendly policies, but also add to the economy through creating "green" jobs.

Water use efficiency in agriculture

According to the requirements of Directive 91/676/EEC (introduced into the national legislation with Joint Ministerial Decision 161890/1335/1997), eight vulnerable zones, with respect to nitrogen pollution from agricultural run-off, have been identified and suitable action programmes have been put in place. The adoption of sound agricultural practices, obligatory for all farmers operating in vulnerable zones, is a key element of these programmes. In addition, a National Plan of Action has been developed in the context of implementing the 2009/128/EC Directive aiming to protect the human health and the environment (based on a joint ministerial decision).

The newly developed legislative framework aims to protect the aquatic environment and freshwater from the impacts of pesticide use. For this purpose, a number of special areas have been set up, where the use of pesticides is restricted or forbidden.

Moreover, a Joint Ministerial Decision was signed in March 2011 regulating wastewater management: it includes, among other things, the re-use of treated wastewater for irrigation purposes. This measure has been designed to save water resources and to promote the use of treated wastewater (i.e. minimising the use of freshwater in irrigation, industry, etc.). A Joint Ministerial Decision was passed in June 2011, requiring farmers and cattle breeders to declare

their irrigation bores by the end of the year. This measure is aimed at monitoring the abstraction of groundwater used for irrigation reasons, to control the unreasonable use of water resources and to define the water rights of farming areas.

Ireland

Food Harvest 2020

Food Harvest 2020 is a strategic vision for the development of the agri-food, fisheries and forestry sector in Ireland for the period to 2020. It envisages a sector that can reap considerable rewards if it works and acts "smartly", so as to make the most productive use of Ireland's rich natural "green" resources in a way that is both economically viable and sustainable in the future.

Examples of elements of the strategy include:

- *Agricultural Catchments Programme*: The Agricultural Catchments Programme (ACP) is a key component in the provision of environmental quality verification which will be at the heart of the smart, green growth set out in Food Harvest 2020. The ACP is monitoring six intensively farmed wholly agricultural catchments and is contributing to the delivery of smart, green, growth by providing comprehensive hydrological, ecological, economic and attitudinal knowledge for agriculture under current regulatory standards. This detailed scientific knowledge is critical to the sustainable holistic expansion of Irish milk and meat production from grass.
- *Dairy Efficiency Programme & Beef Technology Adoption Programme*: These programmes are discussion group schemes which focus on improving grass utilisation which is Ireland's primary resource for agriculture. Participants attend a minimum number of discussion groups throughout the year where emphasis is placed on the transfer of knowledge, technology and best practice in relation to grassland management, animal breeding and financial management.

Origin Green

In 2011, Bord Bia (Irish Food Board) introduced carbon footprint monitoring for all Bord Bia Quality Assured Beef farms, which is the world's first nation-wide sustainability standard. The *Beef and Lamb Quality Assurance Scheme*, developed by Bord Bia in conjunction with Teagasc (the Irish Food Development Authority) incorporates a carbon model which calculates the carbon footprint of Irish beef and lamb production, thus providing an objective assessment of sustainability on Irish farms. The model was accredited by the Carbon Trust and this accreditation ensures consistent measurement to a fully recognised specification and helps deliver solid feedback to producers on how they can further improve their environmental performance.

Building on these initiatives, Bord Bia launched the *Origin Green* voluntary sustainability development programme in 2012. The programme involves manufacturers setting targets in areas such as emissions, energy, waste, water, biodiversity, and corporate and social responsibility activities. The programme has set a target of 75% of Irish food and drink exports to be sourced from its participants before the end of 2014, and 100% by the end of 2016 (bordbia.ie/origingreen/sustainabilitycharter/pages/default.aspx).

Participants in the programme are required to submit a sustainability charter, outlining their annual sustainability targets over a five-year period in key areas such as emissions, energy, waste, water, biodiversity and corporate social responsibility. The overall purpose of the Charter is to promote best practice in the design, implementation and reporting of environmental and other sustainability practices operating in the Irish food and drink industry.

It is also designed to promote shared learning within the industry as to what constitutes good performance.

Companies are required to sign up to developing and implementing an action plan covering up to five years, which can be renewed/updated as appropriate at the end of the period. This action plan will need to clearly set out targets in the key action areas (i.e. sourcing of raw materials, manufacturing process and social sustainability) identified by the company. It will also require a commitment to deliver a progress report on an annual basis. For each target area, each company will need to set out a baseline, decide on short, medium and long term targets and commit to reporting progress on an annual basis.

Rainwater Harvesting Scheme

The objective of the Rainwater Harvesting Scheme is to conserve water by maximising the use of rainfall run-off and reducing water costs on farms. Grant-aid support is provided for rainwater harvesting facilities and equipment. The scheme has been targeted initially at young trained dairy farmers.

Japan

Although Japan does not have any policy package which is sorted under the name of "Green Growth" focusing solely on agro-food sector, ensuring the sustainability of the environment and economy are reflected in a number of government initiatives: *i) The New Growth Strategy* of 2010 which aims to ensure the sustainability of the environment and the economy; *ii) The Strategy for the Rebirth of Japan* of 2011, to aid the recovery from the Great East Japan Earthquake, utilising rural area resources for producing energy;[18] and *iii)* "the promotion of the greening economy and society, and green innovation" has also been addressed recently in the 4th Basic Environment Plan (Cabinet decision, 27 April 2012),[19] which is the principal Japanese environmental policy. Based on the result of the discussion on energy and environmental policy, led by the National Policy Unit, *Broad Outline of the Green Growth* will be launched by the end of 2012.

Policy measures which could contribute to enhancing sustainability in the field of agriculture are widely implemented, although it is difficult to define a principal green growth policy:

Renewable energy: Utilising rural areas' resources for energy production

- Legislative measures are discussed at the Diet.
- Pilot projects are introduced in order to utilise the resources in rural areas and to promote supply of renewable energy that is locally-led in a balanced manner with the food supply and with the conservation of national land.
- Promote maximum utilisation of biomass resources under integrated framework of agriculture and forestry industry, producer of biomass products, local public organisations and related governmental bodies.

GHG mitigation

- Advanced heating systems in greenhouses are introduced.
- GHG mitigation in the food industries are encouraged through government assistance such as education or workshop.
- Industry's Voluntary Action Plan for GHG mitigation is determined, implemented and verified by MAFF.

- Direct payments to farmers to adopt management practices which contribute to GHG mitigation (e.g. cover cropping, living mulching/grass cultivation, winter season flooded paddy fields) subject to reduction of chemical fertiliser and pesticide more than 50% are introduced.
- Introduction of "The visualisation of carbon dioxide" (carbon footprint) Plan.
- Japan's Offset Credit (so-called J-VER)[20] Scheme and the Domestic Emissions Trading System are implemented.

Adaptation to climate change

- Research on the impact assessment of global warming is promoted.
- High temperature-resistant varieties are developed.

Biodiversity conservation

- Direct payments to farmers to adopt management practices which contribute to biodiversity conservation subject to reduction more than 50% of chemical fertiliser and pesticide are introduced.
- Labelling for biodiversity-friendly rice (Living Creature Label) is introduced in the local market.

Concerning monitoring, in the 4th Basic Environment Plan appropriate monitoring measures are to be developed in order to analyse and evaluate the environmental effectiveness of policy measures. Regarding energy use, government's "Energy Basic Plan", which includes renewable energy supply targets, has been drafted in August 2012, following national debate. This plan for future energy supply balance is closely related to the GHG mitigation target.

The Strategy for the Rebirth of Japan

As noted earlier, green growth in agriculture in Japan is primarily reflected by government initiatives to utilise sources of renewable energy (such as wood waste-crushing operations and conversion into biomass energy, in east Japan) to aid the recovery and reconstruction measures following the earthquake and tsunami.

In particular, the Government's programme, "The Strategy for the Rebirth of Japan", identifies as immediate and priority policy: the utilisation of rural resources for producing energy, the introduction of legislative measures and the implementation of pilot projects.

In terms of legislative measures, a bill has been passed, aimed at revitalizing rural areas by introducing the production of renewable energy, as well as promoting agriculture, forestry and fisheries. Moreover, the discussion and the necessary work introduced in revising the Government's "Basic Energy Plan", in which renewable energy supply targets are included, is currently under process. It is envisaged to be completed by mid-2012, following a national debate.

In terms of budgetary support, the following areas have been identified of major importance:

- Facilitating heat and electric supply by utilising rubble created by the earthquake (FY2011, supplementary budget). This support for the development of electric and heat-generating facilities is aimed at utilising wood-waste and wood produced through the thinning of unused forest. This will facilitate the reconstruction of communities through the stable and sustainable supply of energy produced from woody biomass in rural areas.

- Setting-up a pilot project for the supply of renewable energy, with farmer participation. This budgetary support is also intended to cover investigation of the possibility of introducing renewable energy (i.e. wind, geothermal heat, solar, biomass and small hydroelectric generation) in distressed areas. In addition, budgetary support is envisaged for the trial project in which farmers (forestry and fisheries) can participate in the energy business by utilising rural resources.

Basic Promotion Plan for Biomass Utilisation

The Plan, endorsed by the Cabinet in 2010, is based on the *Fundamental Law for the Promotion of Biomass Utilisation* that aims to support the creation of an autonomous, distributed system of energy supply in local regions through the use of local biomass, and is of crucial importance in the aftermath Great East Japan Earthquake of March 2011 and the ensuing nuclear power plant accident. Its basic principles are to develop R&D into the technological aspects of providing efficient and effective biomass applications, and to promote the dissemination of practical installations.

The Basic Plan set targets in three broad areas to be achieved by 2020: to combat global warming by utilising about 26 million tonnes (CO_2 equivalent) of biomass; to create new biomass industries worth up to JPY 500 billion; and to vitalise rural communities through the formulation of plans to promote the utilisation of biomass in 600 municipalities.

Guidelines for achieving these targets are set out, along with a technical "road map" to identify key technologies and biomass resources, and a list of priorities ranging from raw material procurement to the securing of markets. Also included is an estimate of annual energy potential from biomass by 2020: approximately 13 billion kilowatt-hours in available power (enough to power 2.8 million households), about 11.8 million kilolitres in available crude oil (enough gasoline for 13.2 million vehicles), and about 40.7 million tonnes (CO_2 equivalent) in reduced GHGs (equal to about 3.2% of Japan's GHG emissions).

In September 2012, Japan's Ministry of Agriculture, Forestry and Fisheries (MAFF) announced that, along with six other ministries, it had finalised the "Biomass Industrialisation Strategy". Its main objectives include: *i)* the creation of biomass-based industrial practices focusing on conversion technologies (e.g. methane fermentation and combustion); *ii)* the establishment of an integrated and co-ordinated biomass-system; *iii)* the creation of green industries and the enhancement of renewable energy supply in the regions and *iv)* the establishment of a stable policy environment to attract investors. Main policies to achieve these objectives include: *i)* technological development; *ii)* incentives to stimulate market demand (e.g. feed-in tariff scheme, carbon credit system, tax reduction, etc.); *iii)* procurement of raw materials (the establishment of agricultural and forest management systems to supply biomass resources to manufacturers in a stable manner; development of a highly-productive energy crops and plants; full utilisation of waste-related biomass, such as food, animal and human waste, etc.); *iv)* specific measures concerning the targeted biomass (biofuel, woody biomass, food waste, sewage sludge and animal waste); *v)* establishment of "biomass industrial communities" and the development of high technologies and business models related to biomass overseas, particularly in Asia.

Korea

Low-Carbon Green Growth Strategy

Korea has been at the forefront of green growth initiatives. In Korea, green growth policies are part of the government's "Low Carbon, Green Growth Strategy" (LCGG) launched in 2008, as a part of a new national development paradigm adopted in order to respond to the challenges posed by excessive energy-dependency on imported fossil fuel and

doubling of its GHG emissions in the past 15 years.[21] The strategy, based on the concept of environmentally sound and sustainable socio-economic development, emphasises the role of technological progress and innovations as a source of new growth momentum. It is composed of three pillars: *i)* to reduce GHG emissions through introduction of market-based instruments (e.g. an emissions trading system by 2015) and through regulatory reforms; *ii)* to develop green technologies and products through provision of business incentives; and *iii)* to enhance consumer awareness and demand for green products.

The institutional base of Korean green growth began with the establishment of the Presidential Committee on Green Growth as headquarters for policy promotion. The government also introduced the "Five-Year Green Growth Plan for 2009-13" and the "Framework Act on Low Carbon Green Growth" during 2009.

The Five-Year Plan outlines government actions for implementation of the Strategy, and detailed tasks for ministries and local governing entities, as well as specific budgets. Under the plan, the government will spend approximately 2% of annual GDP on green growth programmes and projects. Investments will initially be geared towards infrastructure systems in order to boost the economy. In line with this plan, Korea has passed a USD 30.7 billion stimulus package aimed at supporting its green objectives. This includes renewable energy resources, energy-efficient buildings, expansion of railway systems and improvement to waste management systems. Over time, the government aims to become a leading exporter in green research and technology.

In the agricultural sector "low carbon, green growth" policies have been adopted in order to cope with the environmental challenges faced in agriculture, such as the negative impacts of climate change, an increase in agricultural management costs due to the rising price of oil, and the degradation of the agricultural environment due to the excessive use of agricultural chemicals and the inappropriate treatment of livestock manure. Examples of green growth policies in the agricultural sector include, but are not limited to, the development of biomass energy, the supply and national diffusion of green technology/equipment, and the strengthening of the sector's capacity to cope with climate change.

Concerning agriculture's contribution to the implementation of the green growth strategy, the Ministry for Food, Agriculture, Forestry and Fisheries (MIFAFF) has adopted three areas: *i)* climate change, energy saving and renewable energy, to reduce greenhouse gas emissions beyond business-as-usual projections, adopt carbon-footprint in paddy rice and promote the use of technologies to reduce fossil fuel (e.g. through biogas systems); *ii)* fostering green industry, promoting new technologies and new functional crops; and *iii)* promoting a green diet and enhancing the quality of life, starting a green dietary campaign in elementary schools, local food campaigns and promoting low-carbon food.

Since "low carbon, green growth" was announced as the future national growth paradigm, the MIFAFF has been working to prepare green growth measures based on the low carbon, green growth policies proposed by each bureau and department within the ministry. In December 2008, the MIFAFF created "The Council for Green Growth in Food, Agriculture, Forestry and Fisheries" (chaired by the Minister of MIFAFF) and the "Green Future Strategy Department" was created in 2009 to supervise green growth affairs. The Department administrates the tasks related to the agro-food sector from among the 50 major implementation tasks listed in the "Five-year Plan for Green Growth (2009-13)" issued by the Presidential Committee on Green Growth.

The plan established "agriculture, forestry and fisheries and rural, forest and fishing districts that will lead to national happiness and prosperity" as its vision to promote green growth in the agro-food sector. The Committee has formulated and implemented three strategies (low-input, high-efficiency green industry; sustainable utilisation and management of natural resources; and improvement of public health and enhancement of national quality);

six initiatives and 50 practical tasks. Concerning policy targets for green growth, the following were presented: reduction of GHGs emissions from its 2007 level (18.39 million tonnes); bioenergy supply: an increase from 66% in 2007 to 88% in 2013; environmentally friendly agricultural production: a rise from 3% in 2007 to 10% in 2013 and to 15% in 2020.

The six initiatives are: *i)* to put green growth in practice in people's everyday lives; *ii)* to promote the utilisation of biomass energy and enhance energy efficiency in the green energy field; *iii)* to firmly establish low-carbon food, agricultural, forestry and fishery policies in the low carbon policy field; *iv)* to expand investment in green R&D and foster a foundation for an environment-friendly agricultural industry in the green industry field; *v)* to protect the ocean and forest ecosystems in the sustainable resource management field; and *vi)* to strengthen the green global partnership in the field international co-operation. Of the 50 practical tasks set forth for green growth, a total of 34 policy programmes are aimed at the agro-food sector, which appears to have green growth measures properly combined.

As stipulated by the Framework Act on Low Carbon, Green Growth, the Korean Government revised the Restriction of Special Taxation Act to provide tax breaks for green finance as of January 2010. In 2010, the Government, in a joint effort with the relevant ministries, announced measures for promoting green certificates. Green-certified firms will be given prioritised access to public funding, including R&D programmes. These categories are: renewable energy, carbon reduction, alternative water resources, green IT, green cars, high-tech, green residential cities, new materials, clean production methods, eco-friendly agriculture and food, and environmental protection and preservation. The criteria for the award of certificates are the ability to demonstrate that the technology has reached 70% of the most advanced level in the same line of technologies. The list of candidates will be renewed every year to reflect related technological advancement and social change.

Mexico

The Sustainability of Natural Resources Programme

This programme, which will be implemented by the Mexican Ministry of Agriculture (SAGARPA) during the 2012 fiscal year, is the main policy instrument to promote green growth in the agri-food sector. The programme is comprised of seven specific components:

- *Bioenergy and alternative sources:* Subsidies to promote production of inputs used in the production of biofuels, bio-fertilisers, organic fertilisers, and other products of the bio-economy.
- *Conservation and sustainable use of soil and water:* Subsidies to build, repair and maintain small infrastructure for the storage of water, soil preservation actions, and crop reconversion towards products that demand less water and tillage.
- *Reduction of fisheries' rate of extraction:* Direct payments to promote withdrawal of large fishing boats.
- *Fisheries inspection:* Subsidies to finance inspection and surveillance campaigns focused on preventing illegal fishing.
- *Fisheries and aquaculture management:* Subsidies for the elaboration of public policy instruments and plans to improve national fisheries and aquaculture management.
- *Livestock management:* Direct payments to ranchers and animal growers on a per-head basis, to promote sustainable livestock production.

- *Reconversion:* Subsidies to promote the adoption of new "technological packages" in the production of crops that are better suited to specific regional conditions.

National Strategy for Climate Change

Launched in 2007, the *Strategy* is a first attempt to translate policy intentions into concrete actions to address climate change issues. A Ministerial Commission on Climate Change (MCCC)[22] was created under the Strategy to work on the design and integration of the 2008 Special Programme for Climate Change (SPCC). The SPCC is the main legal instrument outlining the Mexican strategy, actions, and goals to meet the challenges of climate change. It describes the main actions to be adopted for mitigation and adaptation.

Regarding the Ministry of Agriculture, the SPCC establishes the following objectives and goals:

Agricultural Production

- Objective: To reduce agricultural vulnerability to climate change and ensure agro-biodiversity.
  - 2008-12 Goals:
    - Insure 9 million ha of crops against extreme meteorological events.
    - Save 3 000 million cubic metres of water in agricultural uses.
    - Increase water storage capacity by 116.2 million cubic metres.
    - Create a National Center of Genetic Resources.
- Objective: To upgrade existing irrigation infrastructure.
  - 2008-12 Goals:
    - Upgrade 1 772 000 ha under irrigation using existing technical improvements (in conjunction with the National Water Commission).
    - Increase water productivity in agricultural uses at an annual rate of 2.8%.
    - Consolidate the organisation of 2 000 irrigation units.
    - Elaborate 21 Master Plans in the Irrigation Districts.
    - Issue 85 "Exclusive Planting Licenses" in the Irrigations Districts.
    - Establish Agricultural Plans in 58 Irrigation Districts, with emphasis on the use of "Exclusive Planting Licenses" as the main determinants of planting decisions.
- Objective: Deepen the knowledge about the vulnerability of agriculture to climate change.
  - 2008-12 Goals:
    - Elaborate 3 maps of productive potential for maize, barley and beans in selected Mexican regions, under different climate change scenarios.
    - Elaborate 1 study on the negative effects of flooding and sea water penetration on agricultural activities in coastal areas, under different climate change scenarios.

Livestock Production

- Objective: Reduce livestock production vulnerability to climate change and strengthen adjustment capabilities in the sector.
  - 2008-12 Goals:
    - Restructure the National Commission of Animal Genetic Resources.
    - Insure 5 million animal units against extreme meteorological events.
    - Declare 91% of total area used for livestock production as animal disease free or with low disease prevalence.
- Objective: Deepen the knowledge about the vulnerability of livestock production to climate change.
  - 2008-12 Goals:
    - Creation of the guiding framework for research on the vulnerability of livestock production to climate change.
    - Elaboration of 500 studies on the so-called *Coeficientes de Agostadero* (the optimal number of animal units grazing on a given area), and on the optimal use of existing grazing areas.
    - Development of Geographic Information Systems to be used by livestock producers.
    - Promotion of scientific research, through the Mexican Carbon Programme.

Regarding mitigation, full implementation of the SPCC is estimated to achieve a reduction in total annual emissions of 51 million tonnes of carbon dioxide equivalent in 2012, with respect to the business as usual scenario (in which emissions would rise to 786 million tonnes of carbon dioxide equivalent by 2012), resulting from actions carried out in the energy use and production (59%); agriculture (1.9%); livestock (1.8%); forestry (19.6%), land use (6.9%) and the waste (10.8%) sectors.

New Zealand

Primary Growth Partnership (PGP)

The PGP scheme, launched in 2009, is a programme of investment by the Crown and industry in research and innovation which provides investment in research and innovation to boost productivity, economic growth and sustainability across New Zealand's primary, forestry and food sectors.

The PGP will provide funding of no less than NZD 5 million over the lifetime of the programme, which must be matched by co-investors from industry. In 2009, the Government increased the funding for the PGP from NZD 30 million for 2009/10 to NZD 70 million per annum from 2012/13. As of September 2011, PGP has funded seven programmes with almost NZD 493 million, with almost NZD 400 million committed to these programmes from PGP and industry.

Industries eligible to participate in the PGP are pastoral (including wool) and arable production; horticulture; seafood (including aquaculture); forestry and wood products; and food processing. Investments can cover the whole of the value chain, including education and skills development, R&D, product development, commercialisation and technology transfer.

A key programme under the PGP is the establishment of the Centre for Agricultural Greenhouse Gas Research, which has been allocated NZD 5 million per year. The Centre, which is fully government-funded, with a commitment to 10 years' core funding was created with the aim of developing technologies to reduce emissions and improve on-farm efficiency and productivity. Its research focus includes methane emissions from farm animals and waste systems; nitrous oxide from farm animals and nitrogen fertiliser; and soil carbon from agriculture, arable and horticultural land.

Sustainable Farming Fund (SFF)

MAF's SFF invests up to NZD 9 million a year to support rural community-driven projects aimed at improving the productive and environmental performance of the primary sectors. The SFF includes funding specifically for projects that focus on climate change. Its purpose is to support rural communities to undertake applied research and extension projects to tackle a shared problem or to develop a new opportunity. SFF projects are led by rural landowners and managers, often with the support of industry organisations, agri-business, researchers or consultants. Most successful projects are able to secure leverage of a high proportion of other funding or in-kind support to complement the SFF grant. The maximum investment SFF can provide to any one project is NZD 200 000 annually for three years. The SFF requires a minimum of 20% non-governmental contribution (either cash or in-kind) towards the total project costs − however, the most successful projects have significantly more co-funding.

SFF projects include (but are not restricted to): sustainable land management; novel production systems; human capability development; dairy, sheep and beef production; horticulture; deer, goats and pigs; sustainable arable systems; indigenous and exotic forestry; alternative land-use options; bee-keeping; marine and land-based aquaculture; niche crops; cross-sectoral catchment issues; irrigation efficiency; soil management; floriculture; organic systems; Māori land-use options; viticulture; climate change adaptation, mitigation and business opportunities.

Projects that are not eligible for SFF funding include: fundamental or long-term research; projects not directly related to New Zealand's primary industries; projects that benefit an individual or a single business (including funding for farm plans); large capital expenditure; work already underway; projects primarily benefiting participants outside New Zealand.

The following criteria are used to assess applications:

- Contribution to sustainability or climate change objectives: how will the project contribute to economic, social and/or environmental sustainability, or advance the climate change objectives of mitigation, adaptation and/or business opportunities?
- Significance of the problem or opportunity: what is the significance of the problem or opportunity for the community of interest submitting the application?
- Community of interest commitment: is the project led by the community of interest and supported by appropriate levels of cash and in-kind contributions?
- Ability to deliver: does the team have the appropriate technical skills, project management, financial management and methodology to deliver on the project?
- Adoption and extension: how will the proposed project make a difference, and to whom?
- Innovation: does the proposal display innovation?
- Risk: is the level of risk involved in the project acceptable?
- Value for money: is this project likely to provide a good return on investment?

Final investment recommendations also take into account consideration of the overall portfolio balance (the balance of projects across sectors, regions and outcomes) and other factors, such as issues of timeliness and relationship to other project applications.

Emissions Trading Scheme (ETS)

The ETS is a price-based mechanism for greenhouse gases and is a key policy instrument of the Government's efforts to meet its international commitments on climate change and move towards a low carbon economy. Its aim is to strike the right balance between introducing incentives to reduce emissions, while maintaining the economic viability of the agricultural sector. The Ministry for the Environment is the lead agency for the ETS, while the Ministry of Agriculture and Forestry is responsible for development of the regulations for agriculture and forestry sectors; the Environmental Protection Authority is responsible for the emissions unit register.

The principle behind the ETS is that emitters of GHGs must either reduce their emissions (e.g. methane and nitrous oxide) or purchase New Zealand Units (NZUs) to pay for those emissions. NZUs can be purchased through an online exchange, a broker, or direct from the holder of the emission units.

The rationale behind an ETS is that it allows for the abatement of emissions at least cost. No other financial incentives are provided. However, complementary measures in the areas of R&D and technology transfer seek to facilitate reduced emissions and lessen the impact of the ETS on the agricultural sector. These initiatives will encourage innovation and provide the information farmers need to respond to the market signal.

The scheme covers all major sectors of the economy. Forestry was the first sector to enter the ETS, on 1 January 2008, while stationary energy, transport and the industrial sector entered in 2010. Agriculture is set to fully enter the ETS in 2015, with voluntary reporting starting in 2011 and mandatory reporting in 2012 through, to 2014, but participants are not required to pay for emissions in these years.

From 1 January 2015, participants in the ETS for agriculture will have to report GHG emission activities and surrender NZUs to account for agricultural emissions at the end of each calendar year. Although participants will report and surrender NZUs, in order to reduce the cost of participation in the ETS they will be eligible to receive a free allocation of NZUs from the Government. The framework for distributing NZUs under the ETS for removal activities is independent of the framework for calculating and assigning emissions liabilities.

The allocation will be provided on an output intensity basis. This means that a participant's allocation will vary with output. The assistance level will be 90% of an emissions baseline and will phase out at -1.3% per annum from 2016. The baseline will be the industry average emissions per unit of output for a given year or years. The baseline will be established by regulation and subject to a consultation process. The allocation will be uncapped − there is no set limit on the number of NZUs that may be allocated. The ETS is set to be reviewed every five years by an independent panel. The first review was undertaken in 2011.

The ETS for agriculture will cover all the major agricultural sources of methane and nitrous oxide, such as methane from ruminant animals and nitrous oxide from urine, manure and nitrogen fertiliser applied to pasture. With some exemptions, participants for agricultural emissions liabilities are currently set at the processor level, which includes fertiliser manufacturers and importers, dairy processors, meat processors, live animal exporters and egg producers. Farmers and growers are not required to register and participate directly in the ETS.

By placing a price on carbon, the ETS provides an incentive to landowners to reduce the level of emissions for every unit of agricultural output. Reductions can be made by:

improvements to farming efficiency; increased forest/tree planting on farmland (creating carbon sinks); efficient use of nitrogen fertiliser; increased use of nitrification inhibitors; more effective management of animal waste and the use of other mitigation technologies as they are developed; and the reduction of the carbon intensity of outputs through improved productivity.

The ETS encourages action by large industry participants (e.g. large processors) to promote behaviour that will result in lower emission factors for the sector. Incentives are also likely to develop over time with refinement of the ETS and with changes in farming practices. The legislation also allows the government to change the point of obligation to the farmer in the future, having regard to issues of verifiability, effectiveness and cost. However, the successful implementation of the programme will depend, *inter alia*, on the emission trading context in the international market.

The broad settings of the ETS − including how New Zealand's trade competitors are addressing their emissions, what mitigation technologies are available, and whether the allocation path or other settings might need to be adjusted − are currently being reviewed by an independent panel. Among the recommendations it makes is the exclusion of laying hens from the ETS on the grounds that: this sector accounts for an insignificant proportion of agricultural emissions annually; inclusion in the ETS (with 100 participants) would place a relatively large and costly administrative burden on a sector with a tiny level of emissions; there are no greenhouse gas mitigation options currently available to this industry; exclusion from the ETS provides the greatest benefit to New Zealand over the next ten years, given the lack of mitigation options at the current time; exclusion from the ETS does not provide a competitive advantage to the laying hen industry over other sectors that are included in the ETS; exclusion will not undermine the primary purpose of the ETS, which is to support global efforts to reduce greenhouse gas emissions by assisting New Zealand to meet its international obligations (maf.govt.nz/agriculture/agriculture-ets).

The government held a review of the ETS scheme in 2011. It is currently consulting on a number of changes – including a power to defer agriculture obligations from 2015 for up to three years – based on the findings of a review in 2014 which will assess the following: the availability of practical technologies to reduce emissions; and/or progress by trading partners on policies to reduce emissions.

Sustainable Land Management and Climate Change Plan of Action (SLMACC)

Launched in 2007 and administered by the Ministry of Agriculture and Forestry (MAF), this is a five-year programme for the land-based sectors, running in partnership with the land management sectors, local government and Maori. Key work streams include: the impacts of climate change and adapting to climate change; reducing New Zealand's GHG emissions and enhancing carbon sinks; research; and a technology transfer programme. Priority research topic areas and funding are identified through consultation with stakeholders.

Research programmes have been carried out in the following areas: farm-level GHG reporting using the Overseer nutrient budget model; bioenergy and biochar R&D; national nitrification inhibitor research; national agriculture and forestry inventory development; life-cycle analysis for a number of industry sectors and products.

Pastoral Greenhouse Gas Research Consortium (PGGRC)

The PGGRC is a partnership, formed in 2002, between the Government and the dairy and fertiliser industries, to provide livestock farmers with the information and means to mitigate their greenhouse gas emissions. The scope of the programme is broad, and includes research into improvement to the production efficiency of ruminant animals. The PGGRC target is to decrease emissions by 10% per unit of output by 2013 over business as usual relative to 2005

(estimated to be 4 million tonnes). The PGGRC will receive funding until 2012. The 2011 level of annual direct funding for the PGGRC was just over NZD 7.0 million, of which approximately 50% is from industry.

The membership of the consortium includes major companies, industry bodies and research organisations and currently includes: Fonterra Ltd, Beef and Lamb NZ, DairyNZ, AgResearch Ltd, Fert Research (NZFMRA) PGG Wrightson Ltd - Observers: DEEResearch Ltd, Landcorp Farming Ltd, MAF, NIWA, NZAGRC.

A significant area of investment for the PGGRC has been a three-year trial of nitrification inhibitors aimed at providing independent verification of the role these inhibitors play in reducing the environmental impacts of farming practices. In particular, the research aims to: *i)* determine the best management practice for the use of nitrification inhibitors in New Zealand's grazing systems; *ii)* improve understanding of the potential for nitrification inhibitors to improve a broad range of environmental outcomes, including those related to water quality and GHG emissions; *iii)* assess the ability of nitrification inhibitors to reduce nitrous oxide emissions; and *iv)* promote uptake by farmers by providing scientifically sound information on the productivity advantages, potential cost reductions and environmental benefits of using nitrification inhibitors.

Irrigation Acceleration Fund (IAF)

The primary purpose of the fund is to support regional scale rural water infrastructure proposals. Funding of NZD 35 million has been allocated over five years (FY2011/12 to FY2015/16) to support the development of irrigation infrastructure proposals. Qualifying applicant's contributions must be equal to or greater than 50% of the programme cost. There is no minimum size for IAF grants.

IAF funding is available for three distinct components to target the delivery of investment rural water infrastructure proposals: regional rural water infrastructure; strategic water management studies; and community irrigation schemes. Funding for the regional rural water infrastructure component aims to assist the development of proposals for large-scale, regionally significant water harvesting, storage and distribution, which must be consistent with agreed regional approaches to the sustainable use and management of water. Funding for strategic water management studies focuses on the development of regional approaches to integrated water management, particularly the potential of rural irrigation-related infrastructure to contribute to the sustainable use and management of water for future generations. Funding for community irrigation schemes is aimed at improving the development of both new, smaller-scale community schemes and providing capital upgrades of existing community scheme infrastructure. The proposals must be consistent with agreed regional strategies.

Proposals are assessed against the following criteria: *i)* use of collaborative processes early in the planning phase; *ii)* demonstrated commitment to good industry practice and management; *iii)* fit with regionally agreed approaches to the sustainable use and management of water; *iv)* expected direct and indirect net economic benefits to New Zealand; *v)* expected co-benefits; *vi)* ability to deliver the programme; *vii)* having a work programme that fits with good industry management practice; and *viii)* programme costs and contributions.

The Netherlands

Sustainability Agenda

Launched in October 2011 by the Government, the Sustainability Agenda presents the Netherlands' green growth strategy for. It sets out the country's commitment to achieving more sustainable society and identifies the priorities and key actions of the government in

creating a green economy (e.g. the goals of having close to 85% of waste recycled and 15 000 to 20 000 electric cars on the roads by 2015).

There is a focus on number of priority areas: natural resources, use of water and land, food, mobility, climate, energy and a number of remaining issues. The agricultural sector is mentioned in the Strategy, and plays an important role in a number of these priority areas, such as getting the agricultural sector on to a more sustainable path.

Green Deals

To promote and speed up the transition to a green economy, in 2011 the Dutch Government launched the *Green Deals* programme, as part of the Sustainability Agenda. *Green Deals* encourages the private sector, NGO and citizens to develop and implement plans for a more sustainable economy. They give much attention to the legislative framework. The role of central government is to remove administrative obstacles for the exploitation of the project, such as confusion about licences, lack of collaborative partners, or ambiguous regulations.

The government has set agreements with the Dutch Dairy Organisation and the Dutch Agricultural and Horticultural organisation to have zero-carbon emissions in dairy chains by 2020. By removing harmful regulations, *Green Deals* aims to strengthen private initiatives.

The Government evaluates proposals on the basis of the following criteria:

- They must concern specific sustainable initiatives in the field of energy, raw materials, mobility and water.
- The project must (potentially) be profitable.
- The project must produce rapid results.
- The project must lead to new economic activity or energy saving for companies.

One of the projects where the agricultural sector is involved is the green deal "Biogas XL". The Dutch central government, Essent, Friesland Campina and Dutch Green Gas Company will work over the next two years on two "Biogas XL"-scale projects. Two small-scale farmers will experiment with two (mono-) manure fermentation biogas produced and liquid biogas, which will be then used as fuel for transport. Working together with the government, ways to shorten the licensing procedure and simplify. The process will be explored. Ultimately, the goal is to have 125 of these projects nationwide.

Incentive renewable energy

In 2006, the Dutch Government decided on a target for the production of renewable energy and for the reduction of CO_2 emissions by 2020. To meet these targets the Government developed a new scheme *Incentive for Renewable Energy*. The scope of the scheme is to promote the production of renewable energy (wind, sun and biomass). The production of biogas on farms is also supported, including conversion of biogas into electricity. The scheme can be called a feed-in subsidy. In fact, electricity producers are guaranteed a fixed tariff that would adjust in proportion to fossil fuel energy prices. In cases when the feed-in tariff is higher than the electricity price, the mechanism acts like a premium. On the contrary, should the electricity price/kWh be higher than the estimated generation cost for a determined technology, no subsidy will be received from the government. The subsidy is for twelve years.

The Dutch Enterprise Policy: Top-sector approach

This is a government initiative to boost growth and innovation in nine sectors, in which the Netherlands excels globally and they are a priority for the Dutch government: agro-food; horticulture and propagating stock; high-tech; energy; logistics; creative industries; life sciences; chemicals; and water. Core to the top-sector approach is collaboration among researchers, entrepreneurs and government (the "golden triangle"). The government does not make proposals, but asks companies and scientists to join an action agenda.

Two of those top-sectors refer to agriculture: propagating stock and agro-food; and horticulture. In the *Top-sector approach* proposals concerning energy, the agricultural sector is also involved. Most of the green growth themes are described as an element of the innovation contracts.

In relation to agro-food, the *Top-sector approach* focuses on further promoting sustainable food supply chains where there is a continuous challenge of dealing with an increasing resource efficiency. Furthermore, there is an increasing ambition to reach a level of:

- Sustainable land management.
- Emission-neutral production (by 2030) in terms of minerals (losses to be no greater than in un-fertilised systems. Greatly reduced emissions and residues of pesticides.
- Reduction of energy use and GHG emissions and increased use of renewable energy, following the ambitious commitments made in 2008 to be clean and efficient by 2020 in terms of CO_2 emissions (i.e. 30%), renewable energy production and energy efficiency towards a future climate neutral management and chain.
- Have energy neutral stables. Greatly reduce products CO_2 footprint.
- Reduction in the use of fertilisers, in conformity with the objectives of the Nitrates Directive, the Water Framework and Marine Framework.
- Efficient use of water in agriculture.

The *Top-sector* approach to horticulture and propagating stock contains a proposal for four innovation themes. One of the green growth themes is the production of food utilising less space, water, energy and minerals to feed the future 7.7 billion people in the world.

Long-Term Agreements (LTAs) on energy efficiency in the Netherlands

Since the early 1990s, the Ministry of Economic Affairs, Agriculture and Innovation has been making voluntary long-term agreements (or covenants) (LTAS) with various industrial and non-industrial sectors as part of Dutch energy policy. The aim is to promote energy savings in the Netherlands by improving energy efficiency. The current LTAs span the period 2005 to 2020.

Medium-sized – and sometimes smaller – enterprises take part in LTAs. Larger energy-intensive companies participate in the LEE Covenant (LTA on Energy Efficiency for ETS enterprises). LTAs are signed by two government ministers (for Economic Affairs, Agriculture and Innovation; and of Infrastructure and the Environment), the provincial authorities, the Association of Dutch Local Authorities, the participating companies and relevant trade organisations. Over 1 000 companies and over 40 sectors have signed the LTAs. Concerning agriculture, LTAs are in place to improve energy efficiency for the horticulture sector with heated greenhouses.

Every four years, LTA companies must draft an *Energy Efficiency Plan* (EEP) mapping out the company's energy efficiency goals, the measures they intend to employ, and a schedule for reaching the goals. An EEP describes measures for improving energy efficiency not only *within* the company's production process, but it also covers *energy management* and product and supply chain efficiency.

The total use of energy within the total life cycle of a product, from raw materials up to disposal, is taken into account. Improvement of energy efficiency per sector can result from energy efficiency measures taken by companies to improve the performance of products (process efficiency); and measures taken by companies regarding product and supply chain efficiency, such as more efficient transportation, or savings in the use phase (e.g. lower energy consumption, lifetime extension), or savings resulting from efficient and effective disposal of products (e.g. re-use, recycling/up-cycling). Companies also report the use of renewable energy.

In terms of monitoring, the LTA programme is implemented by the NL Agency, which is part of the Ministry of Economic Affairs, Agriculture and Innovation and implements government policy for sustainability, innovation, and international business and co-operation. Companies must provide the NL Agency with monitoring data, on an annual basis, before 1 April. This information – on the progress they have made with implementing their EEP and the practice of systematic energy management – provides the basis for the sector reports that are discussed each year with the members of the Dutch energy-saving consultative body of the sector.

Clean and Efficient Programme

The *Clean and Efficient Programme* (CEP) is a package of measures aimed at achieving the following targets: *i)* reduction of GHGs (mainly CO_2) by 20% by 2020 compared with 1990; *ii)* an increase of the proportion of renewable energy to 20% by 2020; and *iii)* the achievement of an energy efficiency level of 2% per year by 2020. The programme came into force in June 2008 and will run until December 2020. Considerable attention is given to the efficient use of heat, as well to the production of extra wind power, both on land and at sea. A mix of policy instruments to achieve these objectives is used:

- Financial instruments (the European Emission Trading Scheme (ETS) to reduce CO_2 emissions)
- Normative measures for energy efficiency, CO_2 emissions and sustainability
- Instruments to stimulate innovation
- Temporary stimuli (e.g. subsidies for renewable energy or fiscal stimuli)
- International climate and energy diplomacy.

The programme includes measures for all sectors. Under the CEP, multi-year agreements are also being made with other agricultural sectors, such as livestock farming, open cultivation, bulb cultivation and the forestry and timber sector, with a view to achieving energy efficiency improvements averaging 2% per year in the period up to 2020, and introducing the production of renewable energy in 2020. Progress will be monitored through annual work programmes, and adjustments will be made where necessary.

Food industry

In the food and drink industry, around 200 (small) and medium-sized businesses in the dairy, meat processing, margarine, oils and fats, coffee-roasting, fruit and vegetable processing, cocoa, potato processing and flour milling sectors participate in a separate

covenant, "LTAs energy efficiency". Under this agreement, participants endeavour to achieve (on average) for the combined businesses a 30% energy efficiency improvement in the period 2005-20.

Greenhouse horticulture

Greenhouse horticulture is the biggest energy consumer in the primary agricultural sector, mainly using natural gas for heating greenhouses and generating electricity. The electricity produced by the greenhouse horticulture industry accounts for 10% of national consumption.

The 2020 goals for this sector include: the introduction of climate neutral (new) greenhouses; the achievement of 48% less CO_2 emissions (compared with 1990); establishment of a supply of renewable heat and power; significant reduction use of fossil-fuel energy. Many different measures are used, including research, demonstration, communication, teaching, subsidies, settlement system and insurances. The national government and the greenhouse horticulture sector have also agreed to set up a system of CO_2 emissions trading for greenhouse horticulture businesses not participating in the EU's Emissions Trading Scheme (ETS).

Through the *Glasshouses as Energy Providers* innovation programme, the government, in Public-Private Partnership with the industry and knowledge institutes, attempts to ensure that new greenhouses become virtually independent of fossil energy by 2020. Improvement in energy efficiency is to be sought partly through more efficient cultivation methods (e.g. replacing the primary fuel – usually natural gas – with sustainable energy, such as solar energy, geothermal heat and bio-fuels).

In order to achieve the targets, the total level of funds estimated for the period 2007-12 is around EUR 1 363 million (total investments from businesses and national government). Of this amount, it has been estimated that EUR 258 million would have to come from national government. In addition, a sum of EUR 50 million has been assumed for innovation, of which around 43% will come from greenhouse horticulture.

Arable farming, outdoor horticulture and livestock farming (ATV)

The CEP envisages that the emissions caused by direct energy use (gas, oil and electricity) in this sector should be reduced by approximately 60% by 2020 compared with 1990, by applying energy-efficiency measures, such as more efficient equipment and machinery, insulation and efficiency enhancement. The sector should also produce 63 PJ of sustainable energy by 2020 (equivalent to reducing CO_2 emissions by 3 Mtonnes/year).

The ATV sector should also make a contribution towards increasing the proportion of land-based wind energy: the number of wind turbines on land within the sector is to be doubled by 2020; and half of the existing wind turbines are to be replaced by turbines with a higher output. The sector (where it uses land) shall develop projects in the context of precision agriculture in order to reduce emissions from manure, artificial fertiliser and crop protection agents. The objective is to replace by 2020 50% of the artificial fertilisers being used with fertilisers that cause 50% less emissions during their production and application. The Innovation programme for precision agriculture and trials of climate-friendly fertilisers may be co-financed by the government.

With respect to livestock, the development of manure policy is recognised to be closely linked to the achievement of the targets in the field of sustainable energy, particularly in respect to reducing GHGs. Co-fermentation of manure is an important development with a view to achieving the stated targets. It can be used to produce sustainable energy in the form of heat, electricity or green gas, and it also leads to methane reduction and offers potential for

reducing artificial fertiliser use, resulting to less energy-intensive artificial fertiliser production.

The livestock sector should aim to produce 1 500 million m^3 (natural gas equivalent) of biogas (from around 400 installations) via co-fermentation of manure with fermentable biomass. Energy-intensive livestock farming (poultry, pigs and calves) should fully switch by 2020, on 20% of its holdings, to the use of sustainable electricity such as biomass, solar water heaters for heat and/or small windmills and solar panels for their own electricity consumption.

Examples of policy interventions to achieve these targets include: innovation programmes for the reduction of GHG emissions, such as animal nutrition; fundamental research to reduce emissions of methane from enteric fermentation; research into additives used in concentrate feed; precision agriculture; and the reduction of fertiliser use.

The dairy and pig sectors should separate 25% of their manure by 2020, thus reducing the need for artificial fertiliser and achieving a reduction (of 15%) in methane emissions from manure storage. The poultry sector should aim to incinerate 2/3 of its manure, to achieve a reduction in methane emissions from storage.

The dairy sector should aim to achieve the lowest emissions of other GHGs per litre of milk in the EU. Methane emissions per dairy cow should be reduced by at least 5% by 2020 compared with 2007, by focusing on optimising dairy cow rations in a way that takes account of methane emissions and by the use of specific feed additives.

Norway

The term "green growth" is not used in Norway, although the need to increase agricultural production in an environmentally sustainable manner is acknowledged in the 2012 White Paper. Current agricultural policy encompasses border control measures, agricultural support and targeted environmental measures – all of which are considered essential for achieving the country's sustainability goals. The importance of the role of research in improving agricultural productivity is also emphasised, and the Agricultural Knowledge Systems play a critical role in bringing forward new knowledge gained through research by using teaching and disseminating information to farmers. There are four research institutes under the Ministry of Food and Agriculture. Funding of research is provided by the Norwegian Research Council.

More specifically, the main policy instruments used are:

- The Annual Agreement on Agriculture between the government and the two farmer unions.
- Grants for research through the Research Council of Norway (for basic funding of research institutes and assets subject to competition).
- Grants for knowledge development, made directly to research institutes.
- Definition of statures for research institutes under the Ministry of Food and Agriculture.
- Regulation of the research levy on agricultural products.
- The Research Council participates in international forums where international research policy is formulated, with emphasis on the European Commission.

Slovak Republic

The Slovak Republic does not currently have a dedicated strategy or action plan on Green Growth or for improving resource efficiency for the agro-food sector, but these are addressed

primarily through: the national targets for the *Strategy Europe 2020*; the *Action Plan for Green Public Procurement 2011-15*; *Renewable Energy Action Plan*; *Rural Development Programme 2007-13*; *National Forestry Programme*; *Energy Efficiency Action Plan 2011-13*; and the *Biomass Action Plan* 2008-13.

The goals of the *Biomass Action Plan* clearly highlight the importance of biomass availability and the potential for exploitation in Slovakia, the problems related to the practical use of biomass and the implementation of the commitments of Slovakia in the field of renewable energy supply. The Plan also includes support systems that are currently used by different sectors in increasing the share of renewables in the market. It also includes targets for biomass energy utilisation in Slovakia reviewing biomass availability (agricultural biomass, animal manure, forest biomass, biomass resources generated by the wood-processing industry) and determining priorities for biomass utilisation.

The main priorities concerning resource efficiency are as follows: high quality of the environment; protection and sustainable use of natural resources, reduction of waste generation; decreasing energy demanded and pressures on natural resources, increasing the efficiency of the Slovak economy; and replacing a share of non-renewable resources utilisation with sustainable renewables.

Concerning monitoring progress, the following green growth indicators in the agro-sector for Slovakia are proposed: nutrient balances in agriculture; land use; agricultural land area affected by water and wind erosion by class of erosion.

Sweden

Vision for the Green Sector 2008-12 – "Using resources without using them up"

The Vision encompasses four strategic objectives: a dynamic and competitive business sector throughout the country, characterised by openness and diversity; a green sector distinguished by concern, responsibility and high ethical standards; an eco-efficient and resource-efficient green sector that plays a key role in Sweden's energy production; and a green sector that contributes to sustainable development on a global scale.

Concerning the monitoring of progress towards achieving this Vision, the importance of choosing the following indicators was noted: In the green sector: agriculture, forestry, fishery, the food and beverage industry, and the wood and pulp industry; rural areas: population size, population density, commuting; official statistics published by agencies (Statistics Sweden); in addition, indicators should be quantitative, use available statistics and not be numerous. The establishment of a Parliamentary Committee for the Review of the Environmental Objectives System was noted.

Switzerland

Action Plan on the Green Economy

The Government's Action Plan on the Green Economy at national level, which was adopted by the Swiss Federal Council in March 2013, entails 27 measures (including food waste reduction). It mandated the Federal Department of the Environment, Transport, Energy and Communications (DETEC) to prepare a parliamentary dispatch to adapt the Environmental Protection Act (EPA). The salient points of the planned revision of the EPA are:

- Definition of targets for the efficient use of natural resources, the measurement of resource use, reporting, dialogue with economic actors, science and society, and the provision of information and raising of public awareness.

- Improvement of the resource efficiency of consumption and production; in particular improvements shall be made to the information provided about the ecological footprint of products; promotion of target agreements and dialogue with business.
- Closure of nutrient cycles that are not yet closed (recovery of phosphorus and copper).
- Strengthening of Switzerland's international commitment to the green economy and improvement of resource efficiency in the context of international environmental conventions and organisations; Swiss shall assume a more prominent presence in international networks.

In the area of sustainable agriculture and food security, the *objective* is to achieve a sustainable agro-food system with increased resilience that ensures: food security for all; maintains the availability of natural resources; and provides decent livelihoods and income for farmers and rural populations.

The *targets* for sustainable agriculture and food security are the following:

- Sustainable intensification of food and agriculture systems (increasing the efficiency of food and agriculture systems with a high ecological footprint; increasing the productivity of food and agriculture systems with a low ecological footprint; reducing post-harvest losses and food-waste);
- Increased environmental and economic resilience of agro-food systems and delivery of public goods (improved market and stocks information; reduction of trade-distorting measures and environmentally harmful subsidies; decrease of freshwater use for agriculture; increased soil fertility and agro-biodiversity);
- Maintenance of sufficient employment levels in agriculture and related sectors in rural and mountain areas and increased income; investments into smallholder production systems; investments in infrastructure to facilitate access to markets.

Concerning *instruments* a wide range is proposed, including the following: payment for ecosystem services and remuneration of good agricultural practices; information for sustainable products (labels) and promotion of sustainable consumption; harmonised methods for life-cycle analysis, water and energy use; full-cost pricing of food, energy and water; phasing-out the use and production of highly toxic pesticides; research and development in agro-ecology; provision of global public goods through investing in research into agriculture and technology; addressing post-harvest loss along the value chain; investment in infrastructure and public services in rural areas; establishment of principles for agricultural foreign direct investment; and appropriate and effective protection of intellectual property rights, including a legal framework enabling the protection of collective rights for geographical indications.

Since 1996, sustainable agriculture has been included in the Swiss constitution. Gradual policy reforms in Swiss agriculture since 1999, such as decoupling of support from commodity production, cross-compliance, abolition of export subsidies and reduction of environmentally harmful subsidies and increasing resource efficiency, are consistent with the principles of the OECD's Green Growth Strategy. Moreover, reforms of the system of direct payments envisaged under the Agricultural Policy Reform 2014-17 (AP 14-17), by focusing on targeting economic and ecological objectives, would further improve the efficiency of the agricultural programmes.

Sustainable use of agricultural resources

The *Sustainable use of agricultural resources* programme was launched in 2008 and is part of the Government's efforts to improve the efficient use of natural resources. This is a

six-year programme which co-finances (maximum 80% of costs) projects developed by local authorities ("cantons") in specific areas: nitrogen (e.g. direct injection of manure), phosphorus and energy, optimised pest control, protection and sustainable use of soils (e.g. direct injection of manure) and biodiversity. The cantons submit the projects to the federal government, which allocates the funding. The AP 14-17 proposes the allocation of funds to individual farmers instead of the cantons. Improving efficiency of the use of natural resources in agriculture and fostering sustainable consumption is also a key pillar of the government's 2025 strategy.

Turkey

National Climate Change Action Plan (NCCAP)

In order to ensure implementation of the *National Climate Change Strategy* (2010-20),[23] the National Climate Change Action Plan (NCCAP)[24] was published in July 2011. The NCCAP includes strategic objectives and goals for GHG emission control and adaptation to climate change over 2011-23. Its overall aim is to address climate change by identifying national actions to limit GHG emissions and build resilience through managing impacts, thereby encouraging mitigation and adaptation to climate change in Turkey.

The NCCAP addresses measures in priority sectors (energy, industry, waste, buildings, forestry, transportation and agriculture), specifically focusing on long term co-operation, technology development and transfer, and national and international financing mechanisms.

The NCCAP consists of two main parts which are: the Greenhouse Gas Emission Control Action Plan Energy (concerning buildings, transportation, industry, waste, agriculture, land use and forestry, cross-cutting issues) and Climate Change Adaptation Plan (water resource management, agriculture and food security, ecosystem services, biodiversity and forestry, natural disaster risk management, human health and cross-cutting issues). Under these headings, there are a total of 541 actions under NCCAP.

The established objectives and goals related to agriculture are the following:

Greenhouse Gas Emission Control Action Plan Energy

- Agriculture
  - Determining and increasing the quantity of carbon stock captured in the soil
  - Identifying the potential for GHG emissions limitation in agriculture sector
  - Decreasing the rate of GHG emissions originating from vegetable and animal production
  - Establishing the information infrastructure that will meet the needs of the agriculture sector in adapting to and combating climate change.
- Land use and forestry
  - Increasing the amount of carbon sequestered in forests by 15% of the 2007 level by 2020 (14 500 Gg in 2007; 16 700 Gg in 2020)
  - Reducing deforestation and forest damage by 20% of the 2007 level by 2020
  - Increasing the amount of sequestered carbon as a result of agricultural forestry activities by 10% of the 2007 level by 2020
  - Identifying the amount of sequestered carbon in pastures and meadows in 2012, and increasing the carbon stock by 3% of the 2007 level by 2020.

Adaptation

- Agriculture and food security
  - Integrating climate change adaptation into the agriculture and food security policies
  - Developing and expanding R&D and scientific studies to identify the impacts of climate change on agriculture and to ensure adaptation to climate change
  - Sustainable planning of water utilisation in agriculture
  - Protecting soil and agricultural biodiversity against the impacts of climate change
  - Developing institutional capacity and improving inter-agency co-operation in Turkey with regard to adaptation alternatives in agriculture.
- Management of water resources
  - Integrating adaptation to the impacts of climate change into water resource management policies
  - Strengthening the capacity of water resources management, inter-agency co-operation and co-ordination with regard to adaptation to climate change
  - Developing and expanding R&D and scientific studies to ensure adaptation to the impacts of climate change in water resources management
  - Integrated management of water resources and water basins for adaptation to climate change
  - Planning renewable energy resources taking into consideration the impacts of climate change and the sustainability of the ecosystem services oriented to increase resilience to climate change.

United Kingdom

The Department for Environment Food and Rural Affairs (DEFRA) has begun a number of different projects that are designed to improve the environmental performance of agriculture and also increase its ability to expand. Following the UK National Ecosystem Assessment published in June 2011, the Natural Environment White Paper (NEWP) (the first White Paper on the natural environment in 20 years), outlined the Government's vision for the natural environment over the next 50 years. Sustainability is a key objective for economic growth for the United Kingdom (e.g. greenhouse gas reduction targets; carbon budgets; and waste and recycling targets).

The NEWP covers the following areas: climate change, biodiversity, water, air quality and soils. Two specific projects of the NEWP relate to agriculture: *i)* Green Food Project; and *ii)* Advice and Incentives for Farmers.

The Green Food Project

This is the most significant agriculture-specific project. The objectives of the Green Food Project are to work with stakeholders on how to increase the production and productivity of the sector, while at the same time increasing the environmental performance of the whole supply chain (e.g. reduce GHGs, reduce waste and reduce water use, and improve biodiversity and soil quality).

Stemming from a commitment in the Natural Environment White Paper, published in June 2011, the project is driven forward in partnership bringing together government, the farming and food industries and environmental and consumer groups. The time period over which the project will consider is 2050. The project steering group has committed to publishing conclusions from this work by June 2012.

Among the questions addressed will be how competing pressures on land use and on natural resources can be managed, how new technology should be embraced and the implications of changing consumer behaviour and the potential to innovate.

The first steps have been the identification of a number of test cases to open the debate, focussing on the dairy industry, wheat and bread production, the production of "packaged" meals and issues affecting certain specific regions, including the Lake District, Norfolk and the South-West of England.

Advice and Incentives for Farmers Project

The focus of this project, which is still at the development stage, is on the provision of targeted advice to farmers. The aim of the project is to better integrate advice for better environmental outcomes and economic performance.

Reducing emissions and waste in food chains

Efforts to improve the environmental footprint of food systems can mobilise public-private partnerships. The Climate Change Act of 2008 commits the United Kingdom to an 80% economy-wide reduction in GHG emissions from 1990 levels by 2050. The agriculture industry's ambitious Greenhouse Gas Action Plan (GHGAP) aims to reduce annual emissions by 3 million tonnes of CO_2-equivalent by 2018-22 through strategic delivery of messages, technical advice and information to agricultural producers in all farming systems. GHGAP builds on existing initiatives (for example, the Dairy Roadmap) and brings together whole supply chains, to encourage adoption of farm practices that are more efficient and reduce greenhouse gas emissions while enabling cost savings per unit of production and enhancing landscapes and biodiversity.

Another UK initiative, the Waste Resources and Action Programme (WRAP) works with businesses, individuals and communities to reduce food waste. Household food and drink waste represents GBP 12 billion in lost value and 20 million tonnes of CO_2-equivalent in emissions each year. Research by WRAP focuses on ways to cut down the amount of food thrown away by consumers and covers consumer habits, attitudes and behaviours, appropriate ways of communicating to priority audiences and retail innovation. In partnership with WRAP, the grocery sector has made changes to make it easier for consumers to buy the right amount of food, and to optimise freshness and value, as well as to implement large-scale consumer-facing campaigns. As a result, 670 000 tonnes of food waste have been diverted from landfills, saving GBP 600 million a year.

United States

The United States employs a suite of programmes aimed at enhancing resource use efficiency and increasing productivity in a sustainable manner. For example, several programmes have been put in place to encourage the adoption and use of environmentally beneficial practices and the conservation of resources: these include agri-environmental payments (e.g. the Conservation Reserve Program, the Environmental Quality Incentive Program, etc.), compliance requirements and technical assistance (Conservation Technical Assistance). The United States also invests substantial resources in agricultural R&D to enhance productivity growth (OECD, 2011). These types of policies have been discussed in

various other studies undertaken by the Committee for Agriculture and will not be discussed here. Instead, the focus will be on renewable energy policies related to agriculture.

Renewable energy policies related to agriculture

Most of the federal programmes are administered by five separate agencies and departments (the Environmental Protection Agency, the US Department of Agriculture, the Department of Energy, the Internal Revenue Service and the Customs and Border Protection).[25] However, as renewable energy production has been considered primarily a concern of energy, tax and environmental policy (rather than agricultural policy) most of the federal programmes that support renewable energy production in general, and agriculture-based energy production in particular, are outside the domain of the Farm Acts.

Environmental Protection Agency (EPA) – Renewable Fuel Standard (RFS)

The RFS mandate, administered by the US Environmental Protection Agency, requires that the nation's fuel supply contain a specified amount of blended biofuel. The RFS, which has its origins in the 2005 Energy Policy Act and was expanded by the 2007 Energy Independence and Security Act of 2007 (EISA), sets a minimum on the quantity of biofuel to be used in the United States.

The EISA mandates the use of 36 billion gallons of renewable fuels by 2022 (an almost five-fold increase over pre-legislation levels).[26] Beginning in 2015, ethanol from maize will be capped at a maximum of 15 billion gallons. In 2015, 5.50 billion gallons of non-maize based biofuels are to be consumed; and by 2022 the mandate specifies 21 billion gallons of non-maize based biofuels.[27] The RFS also mandates maximum lifecycle GHG emissions from each type of biofuels contributing to the mandate. Lifecycle GHG emissions of qualifying renewable fuel must be less than the lifecycle GHG emissions of the 2005 baseline average of the gasoline or diesel fuel that it replaces.[28]

The mandate is enforced by a credit trading scheme tying together biofuel producers with refiners, importers and blenders of oil-based gasoline (EPA, 2010). Biofuel producers and importers generate Renewable Identification Numbers (RINs) with each gallon of biofuel they produce. Fuel refiners, importers or blenders can choose to use less biofuel than the stipulated amount, and buy credits from others who use in excess of the required amount. For example, if the blend exceeds the RFS, blenders can sell their excess RINs to other obligated parties who can then blend biofuels at a rate below the RFS.

With the termination of tax incentives and import duty on ethanol, and the more ambitious targets being mandated, the RFS mandate becomes the main policy instrument in promoting the use of biofuels. While this programme is not a direct subsidy for the construction of biofuels plants, the guaranteed market created by the renewable fuel standard is expected to stimulate growth of the biofuels industry and to result in higher world prices for biofuels (in particular ethanol) as well as for biofuel feedstocks (coarse grains, sugar cane) that would have been the case in the absence of the mandate (OECD/FAO, 2012).

U.S. Department of Agriculture[29]

The Department of Agriculture, particularly the Rural Business and Co-operative Programmes, comprise a wide array of programmes aimed at achieving the goal of 80% of America's electricity coming from clean sources by 2035 (including wind, solar, nuclear, clean coal and natural gas) and ensuring America's energy independence from imports.

These programmes provide grants, guaranteed loans and payments for a wide range of purposes, including: support for rural energy efficiency and self-sufficiency; research, development, deployment and production of advanced biofuels (especially cellulosic);

realisation of energy efficiency improvements (e.g. help convert older heating sources to cleaner technologies); installation of renewable energy systems (e.g. installation of flexible fuel pumps, solar panels and build biorefineries); completion of energy audits and feasibility studies; encourage federal procurement of bio-based products; and creation of educational programme to increase understanding of biodiesel and promote its use.

The 2002 Farm Act was the first omnibus Farm Act to explicitly include energy – as well as on the goals of EISA. Renewable energy policy under the 2008 Farm Act – The Food, Conservation, and Energy Act of 2008 – builds programmes put in place by the 2002 Farm Act: amended or established various biofuels incentives, including lowering the value of the ethanol excise tax credit, establishing a tax credit for cellulosic biofuel production, extending import duties on fuel ethanol, and establishing several new grant and loan programmes (OECD, 2011).

The 2008 Farm Act authorised USD 1.1 billion in mandatory funding for FY2008 through to FY2012, compared with USD 800 million under the 2002 Farm Act (FY2002-07), with most of the increase mandated for the Biorefinery Assistance Program, which aims at promoting the development of advanced biofuel refining capacity. More specifically, key biofuels-related provisions in the enacted 2008 Farm Act include:

The Biorefinery Assistance Program

This programme provides grants and loan guarantees to biorefineries that use renewable biomass to reduce or eliminate fossil fuel use. The programme was established to assist in the development of new and emerging technologies for the development of advanced biofuels, and aims to accomplish the following goals: to increase the energy independence of the United States; promote resource conservation, public health, and the environment; diversify markets for agricultural and forestry products and agricultural waste materials; and to create jobs and enhance economic development in rural America. Funding for FY2009 was USD 74 million and for FY2010 USD 245 million.

The Repowering Assistance Program

The programme provides grants to eligible biorefineries to help offset the costs associated with converting existing fossil fuel systems to renewable biomass fuel systems. The programme encourages the use of renewable biomass as a replacement fuel source for fossil fuels used to provide heat or power in the operation of eligible biorefineries.

The amount of assistance is determined by the availability of funds, the project scope, and the ability of the proposed project to meet all the scoring criteria – in particular, the percentage reduction in the amount of fossil fuels used by the biorefinery, the quantity of fossil fuels replaced by a renewable biomass system, and the cost effectiveness of the renewable biomass system.

Advanced Biofuel Payment Program

This programme provides payments to producers to support and expand production of advanced biofuels from sources other than maize kernel starch. Additional incentive payments may be made to producers who have increased their biofuel output over the previous year's production. To be eligible for the programme, an applicant must produce and sell an advanced biofuel. The programme provided USD 80 million in FY2010 and USD 85 million in FY2011.

Eligible advanced biofuel producer includes an individual, corporation, company, foundation, association, group of organisations, or non-profit entity that blends or otherwise combines advanced biofuels into a blended biofuel. The biofuel must meet the definition of

advanced biofuel, be a solid, liquid, or gaseous advanced biofuel, and be a final product; if the biofuel is used on-site, there must be an Agency-approved system to verify the quantity used. Fuel must be derived from renewable biomass other than maize kernel starch.

Payments are based on requests received and each producer's level of production. Examples of producers who are eligible are operations of biodiesel facilities producing advanced biofuel from canola oil, greases, and soybean oil. Ethanol facility that uses milo or sorghum, anaerobic digester on a farm that uses animal waste to produce electricity and wood pellets is not considered an advanced biofuel producer under the programme.

The Rural Energy for America Program (REAP)

The REAP provides assistance in the form of loan guarantees and grants to agricultural producers and rural small businesses to enable them to complete a variety of projects, including: the installation of renewable energy systems, such as solar panels or anaerobic digesters; the attainment of energy efficiency improvements, such as installing irrigation pumps or replacing ventilation systems; the development of renewable energy; and the carrying out of energy audits and feasibility studies. The REAP is comprised of the following components: The Renewable Energy System and Energy Efficiency Improvement Guaranteed Loan and Grant Program; The Energy Audit and Renewable Energy Development Assistance Grant Program; and the Feasibility Studies Grant Program. Funding for FY2009 was USD 90 million; for FY2010 USD 60 million; and USD 70 million for each FY2010 and FY2011.

Biomass Crop Assistance Program (BCAP)

This programme, established by the 2008 Farm Act, encourages biomass production or biomass conversion facility construction with contracts that will enable producers to receive financial assistance for crop establishment costs and annual payments for biomass production. Producers must be within economically practicable distance from a biomass facility. It also provides payments to eligible entities to assist with costs for collection, harvest, storage, and transportation to a biomass conversion facility.

The BCAP provides assistance to support the production of eligible biomass crops on land within approved BCAP project areas. In exchange for growing eligible crops, annual payments are provided under 10- to 15-year contracts. Up to 75% of establishment costs may also be provided under these contracts. The government also provides dollar-for-dollar matching payments for collection, harvesting, storage and transportation of biomass to qualified biofuel production facilities (as well as bioenergy or biobased products). Payments may not exceed USD 45 per tonne for a two-year period, and matching payments are available for no more than two years per participant.

Qualified applicants include: eligible biomass material owners and eligible biomass producers. Qualified technologies comprise: eligible material for a matching payment is renewable biomass, as defined by the 2008 Farm Act, with several important exclusions, including harvested grains, fibre or other commodities eligible to receive payments under the Commodity Title (Title I) of the 2008 Farm Act (the residues of these commodities, however, are eligible and may qualify for payment); animal waste and animal waste by-products, including fats, oils, greases and manure; food waste and yard waste; and algae. Eligible crops include renewable biomass, with the exception of crops eligible to receive a payment under Title I of the 2008 Farm Act and plants that are (or have the potential to become) invasive or noxious.

In response to concerns raised on the impact of increased ethanol production on agricultural and rural economies, the Biomass Crop Assistance Program requires an

assessment of the economic impacts of expanded cellulosic biomass production on local economies and infrastructures.

Biomass Research and Development

Established by the Biomass Research and Development Act of 2000 and significantly modified by the 2008 Farm Act, the programme provides grants for biomass research, development, and demonstration projects. Eligible projects include ethanol and biodiesel demonstration plants and a wide range of eligible applicants. The programme is administered by the National Institute of Food and Agriculture. Like the BCAP, this programme also requires an assessment of the economic impacts on rural economies of bio-refinery expansion and conversion by USDA. Annual funding: mandatory funding of USD 20 million for FY2009; USD 28 million for FY2010; USD 30 million for FY2011; and USD 40 million for FY2012.

New Era Rural Technology Competitive Grants Program

The programme, authorised by the 2008 Farm Act, is administered by the National Institute of Food and Agriculture and provides grants to community colleges or advanced technological centres located in rural areas, for technology development, applied research, and training necessary to produce graduates capable of strengthening the nation's technical, scientific and professional workforce in the fields of bioenergy, pulp and paper manufacturing, and agriculture-based renewable energy resources. In FY2010 funding was USD 875 000; in FY2011 it was USD 875 000; and is estimated at USD 875 000 for FY2012.

Feedstock Flexibility Program for Producers of Biofuels (Sugar)

The programme was established by the 2008 by the Food, Conservation, and Energy Act of 2008, and is administered by the USDA's Commodity Credit Corporation (CCC). It authorises the use of CCC funds to purchase surplus sugar, in order to ensure that the sugar programme operates at no-net-cost. Qualified applicants are producers of biofuels using eligible sugar as a feedstock.

Biomass and Biorefinery Systems R&D Program

The programme, administered by the Office of Energy Efficiency and Renewable Energy, provides financial assistance to industrial partners, national laboratories, universities and other stakeholders to develop the technologies and systems needed to cost-effectively transform domestic biomass resources into clean, affordable and sustainable biofuels, bio-products and bio-power. In recent years, the programme has been primarily geared towards the development and deployment of ethanol from non-food feed stocks, but its scope is now expanding to include additional alternative fuels, such as bio-butanol, green gasoline, jet fuel and diesel. Total annual funding increased from USD 89.8 million for FY2006 to USD 220 million for FY2011.

Business and Industry Guarantee Loan Program

The Business and Industry (B&I) Guarantee Loan Program, which provides guarantees of up to 90% to commercial lenders, could possibly be used to assist biofuels producers indirectly. The primary purpose of the B&I programme is to create and maintain employment and improve the economic climate in rural communities. It is targeted on the needs of rural residents and of communities suffering from out-migration, persistent poverty, long-term population decline and job deterioration, natural disasters, and fundamental structural changes in their economic base. Higher priority is accorded to loans and loan guarantees for locally or regionally produced agricultural food products (i.e. those products that are transported less

than 400 miles between their place of production and point of sale) – 5% of funding annually is reserved for this purpose. Priority is given to projects benefitting under-served communities.

Under this programme, during the FY2002-05 period, over 2 200 loans were guaranteed, and almost 23 000 jobs were created, and 68 000 jobs saved. Alternatively, the cost of each job created or saved amounted to USD 1 500 (USDA, 2006c). In FY2009, the B&I programme represented about 80% (USD 700 million) of the funds allocated to business programmes. This level of support is expected to save or create 25 836 jobs.

A study by Johnson (2009) provides an empirical evaluation of the effectiveness of the programme in increasing employment, using standard econometric techniques based on a sample of 1 369 loans. The study found a robust association between loan reception and increased employment growth: a county that receives a loan of USD 1 000 per capita experiences a 3-6% increase in employment-per-capita-growth over the two years following the granting of the loan, but also experiences a 3-5% decrease in earnings-per-worker growth, which leaves the effect on total county earnings unclear. The cost to the federal government per job created is estimated at USD 1 827. The study concludes that the B&I loan programme subsidises loans associated with increased employment growth, although the jobs created pay less than the average wage.

Value-added grants

The Value Added Producer Grant Program (VAPGP), which came into force under the 2002 Farm Act, provides grants for the marketing of value-added products and farm-based renewable energy. Like the B&I programme, it could possibly be used to assist biofuels producers indirectly. Its ultimate goal is to enhance the economic well-being of rural areas. The programme does not allow the grants to be used for on-farm or business purposes, such as acquiring or repairing equipment. Under the 2002 Farm Act, the programme was authorised for six years, with an annual allocation of USD 40 million. In FY2006, there were 185 beneficiaries, who received a total of USD 21.2 million.

The US Office of Management and Budget Program Assessment Rating Tool assessment undertaken in 2006 found the VAPGP to be both well-designed and managed (US Government, 2006). However, its overall assessment rating was only "adequate" and some performance indicators lacked data. In terms of improvement, the assessment suggested actions in various areas, including the continuous re-assessment of existing performance indicators, evaluation of potential new indicators and increased targeting towards emerging markets.

Sustainable Agriculture Research and Education Program (SARE)

Established by the 1990 Food Act, SARE is a decentralised, grass root programme run by four regions (North Central, Northeast, South and West. SARE's mission is to advance agricultural innovations that improve profitability, stewardship and quality of life by investing in ground breaking research and education. The purpose of the programme is to encourage research designed to increase our knowledge concerning agricultural production systems that: *i)* maintain and enhance the quality and productivity of the soil; *ii)* conserve soil, water, energy, natural resources, and fish and wildlife habitat; *iii)* maintain and enhance the quality of surface and groundwater; *iv)* protect the health and safety of persons involved in the food and farm system; *v)* promote the well-being of animals; and *vi)* increase employment opportunities in agriculture.

In particular, SARE grants fund research and education projects exploring: on-farm renewable energy; pest and weed management; pastured livestock and rotational grazing; no-till and conservation tillage; nutrient management; and agro-forestry. Since 1988, SARE has

funded more than 5 000 projects through its regions, including research and education grants, professional development grants and producer (farmers and ranchers) grants.[30]

Qualified applicants include the following: federal and state governments; colleges and universities; state agricultural experiment stations; state co-operative extension services; non-profit organisations; individuals with demonstrable expertise. Qualified technologies include biomass; biofuels. Annual funding amounted to: USD 12.5 million for FY2006; USD 12.4 million for FY2007; USD 9.1 million for FY2008; USD 14.5 million for FY2009; USD 14.5 million for FY2010 and USD 13.5 million for FY2011.

The American Taxpayer Relief Act of 2012

The American Taxpayer Relief Act of 2012 (so-called "fiscal cliff" bill), which came into force in January 2013, re-instated the biodiesel blenders credit and extended the cellulosic biofuels producer tax credit. More specifically, the Act: *i)* extends, retroactively to 1 January 2012 and through the end of 2013, the USD 1.00 per gallon tax credit for biodiesel (which had expired on 31 December 2011); *ii)* the small agri-biodiesel producer credit of 10 cents per gallon; and *iii)* extends through the end of 2013 the USD 1.00 per gallon tax credit for diesel fuel created from biomass.

Under the Act, the Biobased Markets Program, Biorefinery Assistance program, Repowering Assistance program, Bioenergy Program for Advanced Biofuels and Biodiesel Fuel Education Program are extended through 2013. The bill also extends the Rural Energy for America Program, the Biomass Research and Development program, the Rural Energy Self-Sufficiency Initiative, the Feedstock Flexibility Program for Bioenergy Producers, Biomass Crop Assistance Program, Forest Biomass for Energy and Community Wood Energy Program through the end of 2013.

Department of Energy

Loan Guarantees for Ethanol and Commercial By-products from Cellulose, Municipal Solid Waste and Sugar Cane

These programmes, administered by the Department of Energy (DOE) and authorised by the 2005 Energy Policy Act, provide loan guarantees for the construction of facilities that produce ethanol and other commercial products from cellulosic material, municipal solid waste, or sugar cane. Qualified applicants include private lending institutions to guarantee loans for the construction of biofuels plants.

Cellulosic Ethanol Reserve Auction

The programme, established by the 2005 Energy Policy Act and administered by DOE, provides per-gallon incentive payments for cellulosic biofuels until either annual domestic production reaches 1 billion gallons or until the year 2015 whichever is earlier. Qualified applicants include: any US cellulosic biofuel production facility that meets applicable requirements. Annual funding of USD 1 billion is authorised for all fiscal years, with a cap of USD 100 million per year.

Internal Revenue Service

Renewable Energy Grants (1603 Program)

This programme, which is part of the American Recovery and Reinvestment Act of 2009 and is administered by the US Department of the Treasury, expired at the end of 2011. It provided grants for investments in certain energy production property in lieu of tax credits. The programme provided payments equal to 10% or 30% of the eligible cost basis for

specified energy projects. The purpose of the payment was to reimburse eligible applicants for a portion of the cost of installing a specified energy property used in a trade, or business, or for the production of income. A payment was made after the energy property was placed in service; a payment was not made prior to, or during, construction of the energy property.

Special Depreciation Allowance for Cellulosic Biofuel Plant Property

Administered by the Internal Revenue Service, this programme was established in 2006 and was scheduled to run until the end of 2012. It provides to a taxpayer a depreciation deduction of 50% of a new cellulosic biofuel plant in the year it is put into service by the taxpayer. Any portion of the cost financed through tax-exempt bonds is exempted from the depreciation allowance.

Notes

1. lebensministerium.at/umwelt/nachhaltigkeit/ressourceneffizienz/aktionsplan_ressourceneffizienz/aktionsplan.html.
2. fevia.be/#ref=publication&val=44590 .
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12. According to the Danish Energy Agency, to meet this requirement, 130 biogas plants would have to be constructed by 2020.
13. The revenue from the reduction of taxes on land is estimated at DKK 500 million.
14. In particular section 5.1 "Addressing Food", in which there are initiatives on sustainable food, waste, sustainability criteria for key food commodities and phosphorus.
15. In particular under "Societal Challenges", 2, "Food security, sustainable agriculture, marine and maritime research and the bioeconomy" and 5, "Climate change, resource efficiency and Raw Materials".
16. EC press release supported moves "Towards a global green economy" and provided a factsheet on "Sustainable agriculture, Food Security and Nutrition".
17. Between 2008 and 2010, the number of farms engaged in organic agriculture rose by 55% and the AREA by 45%, but the target of 6% of the Utilized Agricultural Area in organic farming has not been reached (3.01% in 2010).
18. Strategy for the Rebirth of Japan (English) npu.go.jp/policy/pdf/20120127/20120127_en1.pdf
19. The Fourth Basic Environment Plan (English Summary): env.go.jp/policy/kihon_keikaku/plan/plan_4/attach/pamph_en-1.pdf; env.go.jp/policy/kihon_keikaku/plan/plan_4/attach/pamph_en-2.pdf
20. Offset Credit (J-Ver) Scheme: j-ver.go.jp/e/index.html

21. Korea is one of the top energy-consumer countries in the world, importing 97% of its gross energy consumption.

22. In Spanish: Comisión Intersecretarial de Cambio Climático. The MCCC was created in April 2005 by the then President, Vicente Fox. It consists of the Mexican Ministries of Agriculture, Foreign Affairs, Environment and Natural Resources, Energy, Commerce, Transportation, and Social Development.

23. Turkey's National Climate Change Strategy (English) iklim.cob.gov.tr/iklim/Files/Stratejiler/%C4%B0DES_eng.pdf

24. National Climate Change Action Plan(English) iklim.cob.gov.tr/iklim/Files/IDEP/%C4%B0DEP_eng.pdf

25. The Department of Energy operates the greatest number of efficiency and renewable energy incentive federal programmes; the Department of the Treasury and the Department of Agriculture operate several programmes; a few programmes are also conducted by the Departments of Transportation, Labor, and Housing and Urban Development. For more detailed discussion, see Yacobucci (2012) and OECD (2011).

26. The Energy Policy Act of 2005 required, starting in 2006, the use of 4 billion gallons of renewable fuels, increasing to 7.5 billion in 2012.

27. The EISA amendments to the RFS specifically mandate the use of cellulosic biofuel (16 billion by 2022) and biomass-based diesel fuel (1 billion gallons annually by 2012).

28. Cellulosic-based fuels must achieve at least a 60% lifecycle GHG reduction; maize starch-based fuel (produced by newer plants) a 20% GHG emissions reduction; and advanced-based biodiesel a 50% GHG emissions reduction.

29. In addition to these programmes, there are several conservation programmes which significantly reduce fuel and other energy-related costs, such as the Conservation Security Program, the Environmental Quality Incentive Program, Conservation Technical assistance, etc.

30. Generally, research and education grants range from USD 60 000 to USD 150 000; professional development range from USD 20 000 to USD 90 000; and producer grants range between USD 1 000 and USD 15 000.

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Chapter 6

Conclusions

A wide range of instruments and "policy mixes" are currently applied across OECD countries. Policy instruments relate not only to traditional regulatory approaches but to a much wider array of tools, including public-private partnerships and international co-operation in R&D to foster innovation for green growth in the sector.

An essential element of green growth is the adoption of policies that will foster economic development, while protecting environmental sustainability over time. Green growth implies policies that either incrementally reduce resource use per unit of value added (*relative decoupling*) or keep resource use and environmental impacts stable (or declining) while the economy is growing overall (*absolute decoupling*). A green growth strategy would yield a "double dividend" effect – higher growth with lower environmental impact – by improving the efficiency of resource use and increasing investments in natural capital to drive economic growth.

In several OECD countries, green growth has recently become an over-arching policy objective and all economic sectors are being scrutinised as to the extent to which they offer growth potential that is environmentally benign and socially beneficial.

The synthesis of the experience of OECD countries in developing and implementing policies to support green growth in the agricultural sector shows, that although most countries have some policies in place that relate to the concept of green growth, the degree of ambition shows considerable variation. A wide range of instruments and a variety of "policy mixes" are currently applied across OECD countries, with the majority of countries appearing to have strategic objectives covering a wide range of subjects related to green growth, particularly in the area of improving energy efficiency and reducing the carbon footprint of agriculture.

Policy instruments supporting green growth relate not only to traditional regulatory or "command and control" approaches, but to a much wider array of tools, including public-private partnerships and international co-operation in R&D to foster innovation for green growth in the sector. Caution is needed in making broad generalisations about the preferred approaches, as priorities and time paths vary across countries.

Innovation plays a key role in fostering green growth. Green growth can provide a new paradigm for agricultural research, placing the emphasis simultaneously on environmental and economic requirements, with the aim of enhancing productivity without compromising the natural resource capital. Improving the innovative capacity of the agricultural sector will involve identifying the obstacles to innovation; revisiting policies that hamper innovation, structural change and the functioning of output and input markets; and implementing measures to foster innovation and competitiveness. However, in practice it is a considerable challenge to achieve policy coherence across a range of government, ministries and other institutions.

One of the central issues in achieving green growth in agriculture is to ensure that all the costs associated with economic activity are reflected in production and consumption decisions. In contrast to other sectors, the use of market-based instruments in promoting green growth in agriculture is not significant, due to the nature of property rights systems and the fact that the agricultural sector is composed by a series of non-point sources of pollution.

Defining and enforcing property rights over scarce natural resources offers numerous potential advantages: incentives would be created to encourage efficient methods of exploitation and more responsible management practices; maintenance would be undertaken, and the future value of resources would be enhanced. The more complete the set of property rights, the more tightly meshed are the private and social net benefits resulting from the use of the resources − which eliminates externalities. The licensing of intellectual property benefits the competitive process by diffusing innovation and by helping innovators to capture their rewards. But licensing of intellectual property has become a challenging topic for policy makers as licensing agreements could increase the market power of a single licensor. The challenge for policy makers is to determine whether a particular agreement is likely to facilitate or hurt competition.

A coherent overall policy framework, which has clear objectives, sets R&D priorities, and policy measures that are targeted and implemented at the appropriate levels is essential for establishing a comprehensive strategy for green growth in agriculture. Appropriate policies for moving agriculture closer to meeting the conditions for green growth need careful design and continuous monitoring. Governments in several OECD countries are becoming increasingly aware of the importance of monitoring and evaluating their agricultural policies and are devoting considerable efforts to making progress in this area. The next phase of the work on green growth will develop and implement the OECD green growth measurement framework for the agricultural sector and to apply it to selected OECD countries.

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