Agriculture and Climate Change

1. Climate change is exacerbating the challenges faced by the agriculture sector, negatively affecting both crop and livestock systems in most regions.
2. Agriculture is also contributing a significant share of the greenhouse gas (GHG) emissions that are causing climate change – 17% directly through agricultural activities and an additional 7% to 14% through land use changes.
3. Technical solutions exist and underscore the potential of the agriculture sector to be part of climate change mitigation and adaptation solutions.
4. Without consistent policy signals, autonomous efforts by farmers are unlikely to be sufficient to create a sustainable, productive and resilient agriculture sector.
5. This note highlights three pillars of reform that can help governments to achieve sustainable productivity growth without sacrificing climate change mitigation and adaptation objectives:

    » At the national level, the signals sent by the wider social, economic and environmental policy settings should support the objectives of a sustainable, climate friendly, resilient and productive agriculture sector.

    » At the sector level, governments should strengthen consistency and get the incentives right within the overall agriculture policy set by removing policies which generate unsustainable production systems and exacerbate climate change.

    » At the farmer level: emphasis should be on incentives to enhance farmer capacity to adopt practices that contribute to sustainable productivity growth while also responding to climate change.

This note was prepared ahead of UNFCCC COP21 to provide decision makers with key highlights from OECD analyses on challenges and policy recommendations related to agriculture and climate change in the wider context of sustainable productivity growth.

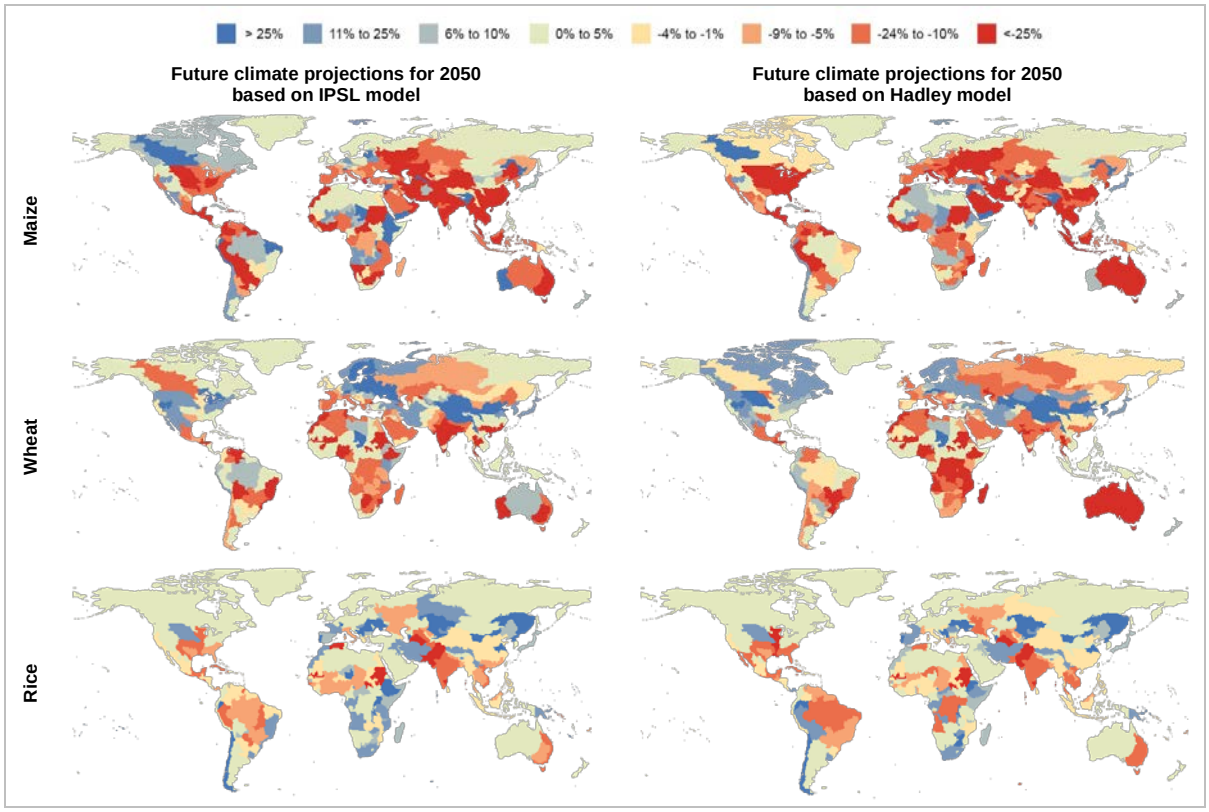
What's the issue?

Climate change is intensifying challenges for the agriculture sector

Climate change is exacerbating the challenges faced by the agriculture sector. Climate change-induced increases in temperatures, rainfall variation and the frequency and intensity of extreme weather events are adding to pressure on the global agriculture system – which is already struggling to respond to rising demands for food and renewable energy. The changing climate is also contributing to resource problems beyond food security, such as water scarcity, pollution and soil degradation. As resource scarcity and environmental quality problems emerge, so does the urgency of addressing these challenges.

Climate change is expected to negatively affect both crop and livestock production systems in most regions, although some countries may actually benefit from the changing conditions. Overall, productivity levels are expected to be lower than without climate change – due to changes in temperatures, crop water requirements and water availability and quality. Figure 1 presents projected changes in yields for maize, wheat, and rice in 2050 under a climate change scenario (calculated by two different models) as compared to potential 2050 yields under a scenario without climate change after 2005. Impacts on agricultural production will vary among regions and will depend not only on the intensity of the changes in temperatures and water but also on how these factors interact.

Figure 1. Effects of climate change on yields are negative in most producing regions (red shades), but some regions may actually benefit (blue shades)

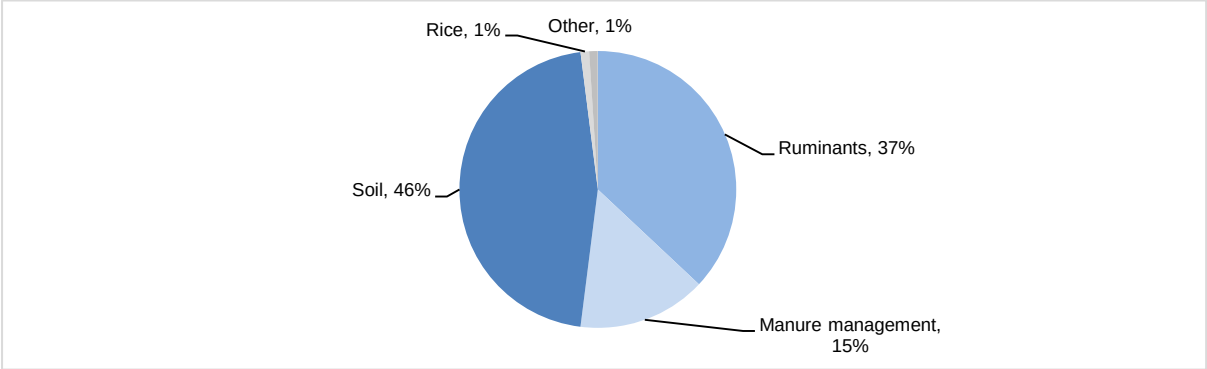


Note: Projected changes in yields for maize, wheat, and rice in 2050 under climate change as compared with potential 2050 yields if there had been no change in climate after 2005

Source: Based on Ignaciuk and Mason-D'Croz (2014)

Agriculture is also contributing a significant share of the greenhouse gas (GHG) emissions that are causing climate change – 17% directly through agricultural activities and an additional 7% to 14% through changes in land use. The main direct agricultural GHGs emissions are nitrous oxide emissions from soils, applications of fertilisers, dejections from grazing animals, and methane production by ruminant animals (enteric fermentation) and paddy rice cultivation (Figure 2). Currently accounting for 58% of total anthropogenic nitrous oxide emissions and 47% of total anthropogenic methane emissions, agriculture is expected to remain the main source of these non-CO_2 gases in the coming decades. This trend is particularly concerning given the significantly higher global warming potential of nitrous oxide and methane relative to CO_2. In addition, the sector generates emissions indirectly due to changes in land use, including land clearing and deforestation.

Figure 2. Agriculture sector is a key source of methane and nitrous oxide emissions, in OECD countries

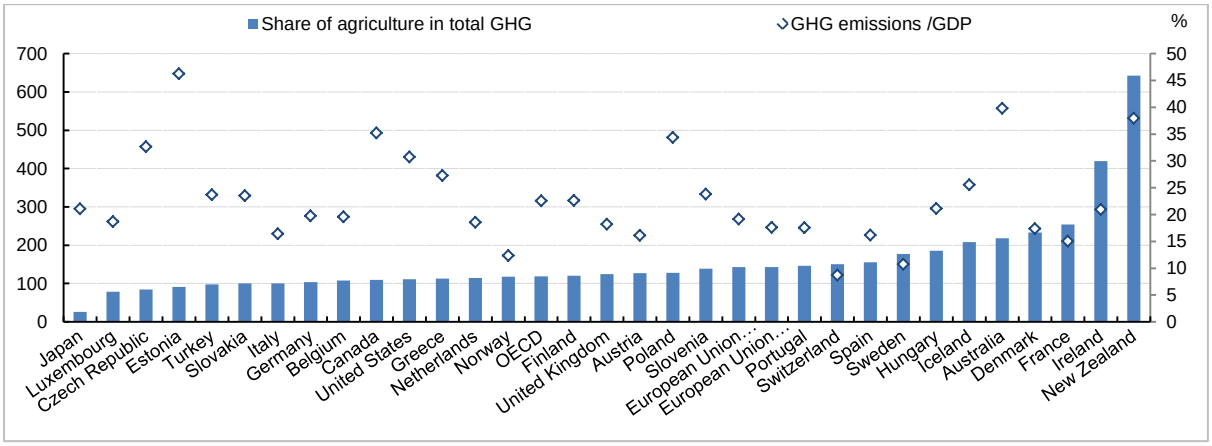


Note: Excluding LULUCF (land use, land use-change and forestry).

Source: OECD (2014), *Green Growth Indicators for Agriculture: A Preliminary Assessment*, OECD Green Growth Studies, DOI: http://dx.doi.org/10.1787/9789264223202-en

In OECD countries, the agriculture sector accounts for 8% of total average GHG emissions, but the sector's contribution varies significantly across countries.[1] As illustrated in Figure 3, the share of agriculture in GHG emissions ranges from 2% in Japan to 46% in New Zealand.

Figure 3. Share of agriculture in national total GHG emissions differs among OECD countries (2010-12)



Note: Excluding LULUCF (land use, land use-change and forestry).

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.

Source: OECD (2014), *Green Growth Indicators for Agriculture: A Preliminary Assessment*, DOI: http://dx.doi.org/10.1787/9789264223202-en

Do technical solutions exist for mitigation and adaptation?

Existing technical practices that mitigate GHG emissions underscore the potential of the agriculture sector to be part of the fight against climate change. The overall GHG emission intensity (emissions per unit of production or area) of OECD agricultural producers has declined over the last 20 years. From 1990 to 2010, total gross agricultural GHG emissions in the OECD area decreased, leading to an overall reduction of nearly 44 million tonnes of CO_2 equivalent. During the same period, agricultural production volume increased by 1.6% per annum, resulting in annual reductions of 2.0% in the emissions intensity of agricultural output. This was achieved by switching to cost-effective practices such as more efficient fertilisation and input uses that reduced nitrous oxide emissions.

Productivity growth has also been maintained in the agriculture sector because farmers have been independently taking measures to adapt to climate change. They have begun to adapt farming practices based on their own private cost-benefit calculations, taking into account the additional production risks created by climate variability as well as the need to achieve higher productivity to improve resource-use efficiency. Many climate adaptation options that have been adopted to date reflect current "best practices" and "sustainable resource management". Practices such as adopting climate-smart inputs and shifting to more efficient irrigation methods have helped many farmers to maintain productivity levels and concurrently reduce GHG emission intensity. However, there is still room for further adoption of climate-friendly and climate-proof practices.

[1] These totals do not include CO_2 emissions arising from fuel combustion on-farm, land use changes on-farm, or any emissions that occur off-farm, such as those that arise from the production of inputs, such as feed, energy or fertiliser.

What should policymakers do?

Efforts at the national, sector and farm level are needed

Without consistent policy signals, farmers may not be able to do enough to create a sustainable, productive and resilient agriculture sector. Where there are market failures, where private costs are lower than social benefits, farmers will not invest enough in adaptation and mitigation. Moreover, farmers are often faced with conflicting policy signals. Some policies encourage production at the expense of climate change objectives, while other measures try to offset these negative effects. Governments need to identify such inconsistencies and develop a coherent set of incentives for achieving sustainable productivity growth with mitigation and adaptation as part of this effort. Achieving this will require involvement of the private sector, communities and governments, with policy solutions tailored to reflect private and social costs and benefits. Some situations will call for national and international cooperation, others for local or regional initiatives.

Key policy reforms across three pillars are needed to strengthen farmer incentives to achieve productivity growth sustainably, and without sacrificing climate change mitigation and adaptation objectives:

1. At the national level: The signals sent by the wider social, economic and environmental policy settings should consistently support sustainable productivity growth in combination with adaptation and mitigation efforts. The agriculture sector is subject to a wide range of influences, including innovation, macroeconomic, trade, investment, infrastructure, and education and training policies. For example, import restrictions protecting water-intensive crops can exacerbate maladaptive choices by farmers. Moreover, the general education level of farmers has a significant effect on how farmers are able to absorb innovative and resource efficient practices. The Agricultural Policy Monitoring and Evaluation report (2015) expressed the need for broader reforms in such areas to achieve sustainable productivity in agriculture. A comprehensive approach to assess gaps and improve coherence with other policies (social, economic and environmental) will in most countries be more effective than marginal fine tuning of existing agricultural policies.

2. At the sector level: Policies in the agriculture sector should be internally consistent. This requires reforming misaligned and distortive policies which encourage intensification and the overuse of natural resources and potentially damaging inputs. Further investment in research and development on sustainable productivity is also required.

   Policy reforms are needed to address a lingering reliance on distortive subsidies. While some OECD countries have reduced the most environmentally harmful subsidies, more than half of all the support provided is still potentially damaging. There has been insufficient progress in targeting sustainable productivity or climate change goals and such measures remain marginal in expenditure and coverage. In some countries recent policy developments have been going in the wrong direction. For instance, over-subsidised insurance can incentivise farmers to maintain practices or crops that are poorly adapted to a changing climate. Market price support which creates incentives for intensification is increasingly used to protect the agriculture sector. Subsidies for inputs such as fertiliser account for a large share of government spending on agriculture in some countries but such measures are likely to induce inefficient fertiliser use and thus lead to higher GHG emissions (N_2O in particular). To address such inefficiencies, market price support and input subsidies should be reduced with a view to eventual elimination.

   Further investment in research and development is needed to spur innovations in sustainable climate-friendly and climate-proof productivity, and the private sector can help. Public and semi-public research and development (R&D) programmes can play an essential role in this respect. Although most long-term R&D investment in OECD countries is public, the private sector is increasing its share in developing agricultural technologies that are specifically directed at increasing the resilience of this sector. Governments may further enable the development of private innovations by, for example, addressing investment barriers that impede R&D, ensuring that private knowledge is disseminated, and encouraging, where suitable, public-private partnerships (PPPs) for R&D with public goods outcomes.

3. At the farmer level: The emphasis should be on targeted initiatives – such as outcome-based farmer incentives and knowledge transfer systems – that enhance farmer capacity to achieve sustainable productivity growth through mitigating and adaptive practices.

   Strengthening access to knowledge and transfer mechanisms is key to increasing adoption of sustainable and productive practices. Relevant and up-to-date information on risk management and resource use efficiency can stimulate take-up of innovative technologies that support sustainable and climate-friendly goals. In terms of risk management, access to tools that assess future weather conditions (e.g. weather forecasting or early warning systems) enable farmers to take pre-emptive actions to minimise the negative effects of extreme events. Training and education about changing climate conditions and the long-term viability of different agricultural practices help farmers and other private agents to make educated investments in adaptation and mitigation. In view of the numerous existing advisory programmes, it is often advisable to streamline adaptation and mitigation actions into existing institutions and to co-ordinate such actions with the private sector. Agencies that deliver advice, training and extension services to support sustainable farm management will need to be well co-ordinated, effective in reaching different interest groups and types of farming, and capable of delivering a full range of services.

   Financial incentives can encourage farmers to adopt measures that have high upfront costs, or that are socially beneficial but costly at the private level. For adaptation, governments have an important role to play in supporting infrastructure projects – at the watershed level – that increase productivity and promote the efficient use of resources. For mitigation, governments have two main policy options: (i) sector-wide or broader economic instruments (such as taxes on emissions or cap and trade systems) and (ii) voluntary payment approaches promoting targeted measures (such as carbon offsets). The former can encourage the adoption of a wider range of measures based on the constraints of individual farmers, but the underlying instruments can be difficult to introduce and are not currently used in agriculture. The latter raises other challenges for policy design and implementation, including spatial heterogeneity of the costs and effectiveness of mitigation practices and how to adapt support to such heterogeneity.

   Importantly, incentives should focus on sustainability outcomes, as opposed to practices. When agricultural policies incorporate environmental objectives, they frequently do so by promoting or constraining a specific farming practice (such as imposing limits on the quantity of nitrogen farmers can use). Focusing on practices is often more costly, as it limits the flexibility of farmers. Redirecting policies to focus on climate change related outcomes – such as nitrogen balance and emission proxies – would enable farmers to weigh trade-offs and adopt more efficient and effective tools to achieve sustainable productivity growth (including adaptation and mitigation goals).

List of relevant OECD publications

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- OECD (2015 Forthcoming) Drying wells, rising stakes: towards sustainable agricultural groundwater use, OECD Studies on Water, OECD Publishing.
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