Environmental Performance of Agriculture in OECD Countries

Key Trends and Insights

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Key findings

Over the period 1990 – 2021 covered in this report, agricultural production in OECD countries has significantly increased, while environmental performance showed mixed results.

On the positive side, while agricultural output grew by 40% over this period, agricultural area decreased by 10% and agricultural greenhouse gas (GHG) emissions increased by 4% only, reflecting significant productivity gains in the sector and the positive environmental impact resulting from the adoption of more climate-efficient farming practices.

Progress in terms of environmental performance, however, has slowed over the past 10-15 years.

- Agricultural GHG emissions in OECD countries that were previously stable started to increase at an average rate of 0.4% per year in the 2010s. Meanwhile, the decline in the median emission intensity has slowed down, dropping from -0.6% per year in the 1990s and 2000s to -0.2% per year in the 2010s.
- From 1990 to 2009, nutrient surpluses also showed a marked decline across OECD countries, reflecting the observed improvements in nutrient management or reduced fertiliser use in many countries. However, this progress appears to have stalled since 2010, and OECD maximum nitrogen balance has even increased.
- The trend of ammonia emissions at the OECD level has also changed in the last decade. Data show a downward trend up to 2015, followed afterwards by a reversal, with an average increase in emissions of 2.8% per year between 2015 and 2021. This could be the source of potential environmental threats in the most affected regions.

Between 2011 and 2021, total agricultural land area in OECD countries remained relatively stable, although cropland area declined at an average annual rate of 0.7% and pasture area expanded by 0.4% per year. Combined with the observed increase in use of agricultural inputs, this trend suggests a slight intensification overall of cropland production in OECD countries.

Farmland bird population continued to decline in 22 of the 27 OECD countries that monitored this indicator over 2009-21, revealing the importance to better mitigate the pressures exerted by human activities and other disturbances on biodiversity.

1 The OECD Agri-Environmental Indicators

Against the background of increased attention to the sustainability of the agriculture sector, the OECD has developed indicators of the environmental performance of agriculture. The OECD Agri-Environmental Indicators (AEI) provide internationally comparable data that offer a comprehensive, long-term perspective of the changes in resource use and environmental outcomes related to agriculture. The database covers key dimensions of agri-environmental sustainability, including land, water and other input uses, greenhouse gas (GHG) and ammonia emissions, nutrient balances, farmland bird biodiversity in OECD and additional countries.

The OECD agri-environmental indicators provide a reliable and robust source of data to assess environmental performance and inform policy action. They can help review trends, highlight areas of progress, and identify persistent challenges, thereby signalling policymakers where efforts may be needed to improve the environmental performance of their agriculture. By providing comprehensive and comparable data, the AEIs can also help benchmark agriculture's environmental performance across countries.

Covering the OECD as a whole over the period 1990-2021, the data analysed in this report show that, while most OECD countries increased their agricultural production, the environmental performance of the agriculture sector registered mixed results. Agricultural land shift coupled with increased water and other input uses suggest an overall slight intensification of agricultural production in cropland. While many countries have made progress in improving nutrient management and reducing GHG emission intensities, the overall level of GHG emissions from agriculture in OECD countries continue to remain high and significant challenges persist. Biodiversity loss, as observed in selected countries through the Farmland Bird Index is also a continuing concern, particularly in areas with high-intensity farming. By providing a data-driven overview of these trends, this report contributes to discussions on how to align agricultural policies with environmental sustainability objectives.

2 Key trends in the environmental performance of agriculture in OECD countries

This section examines key trends in the environmental performance of agriculture across OECD countries, based on data from the 2025 version of the OECD dashboard Measuring the Environmental Performance of Agriculture. The dashboard presents the evolution of key indicators in the Agri-Environmental Indicators (AEI) database for the OECD as a whole and in each country it covers.

Increased total agricultural production in OECD countries (+40% overall between 1990 and 2021[1]) has been accompanied by progress in the sector's environmental performance over the observation period, for example improvements in both emissions intensity and nutrient use efficiency, signalling a relative decoupling of environmental effects of production. However, the data presented in this report suggest that such gains were generally concentrated in the first two decades of the observation period, and improvements in environmental performance since 2010 were more difficult to achieve.

Natural resource and other input uses

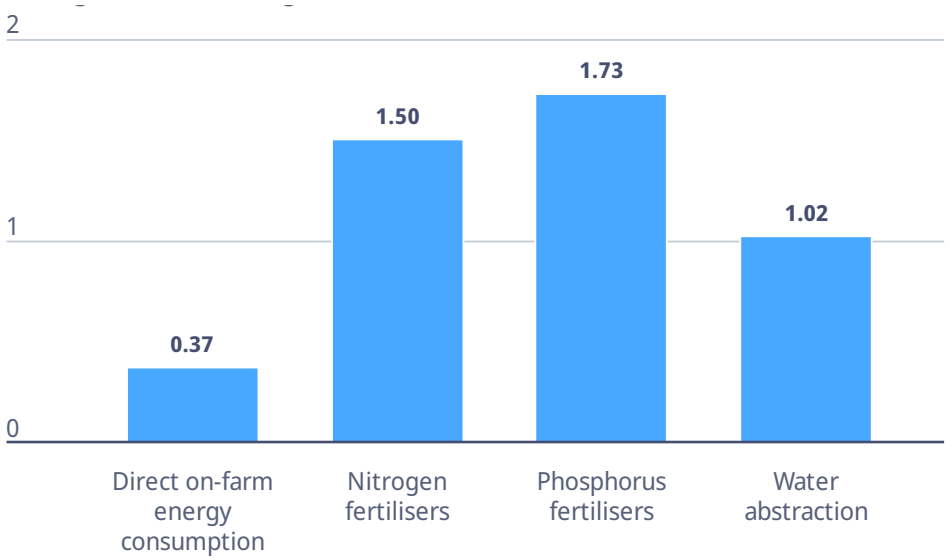
Between 2009-11 and 2019-21, there were mixed trends in the use of key agricultural inputs in OECD countries. While direct on-farm energy consumption remained relatively stable, with a low annual increase (0.4% for the OECD), the use of nitrogen and phosphorus fertilisers grew at higher rates, with phosphorus use increasing the most (1.7% per year). Water abstraction also increased (1.0% per year), indicating rising pressures on water resources across OECD countries (Figure 2.1).

While trends in agricultural input use reflect shifts in production practices across OECD countries, changes in land use patterns provide further insight into how agricultural landscapes are evolving over time. Total agricultural land area in OECD countries, which decreased by 10% since the 1990s, remained relatively stable between 2011 and 2021, with a negligible annual increase of 0.02% (Figure 2.2). However, land use patterns within the sector shifted significantly. Cropland area declined at an average annual rate of 0.7%, while pasture area expanded by 0.4% per year. These changes suggest a shift in land use dynamics, potentially reflecting factors such as land conversion, changes in agricultural production systems, and policies aimed at preserving or restoring natural ecosystems. Combined with the observed increased use of agricultural inputs, this suggests an overall slight intensification of cropland production in OECD countries.

[1] See OECD/FAO (2024), *OECD-FAO Agricultural Outlook 2024-2033*, OECD Publishing, Paris/FAO, Rome, https://doi.org/10.1787/4c5d2cfb-en.

Figure 2.1. Trends in agricultural input use in OECD countries

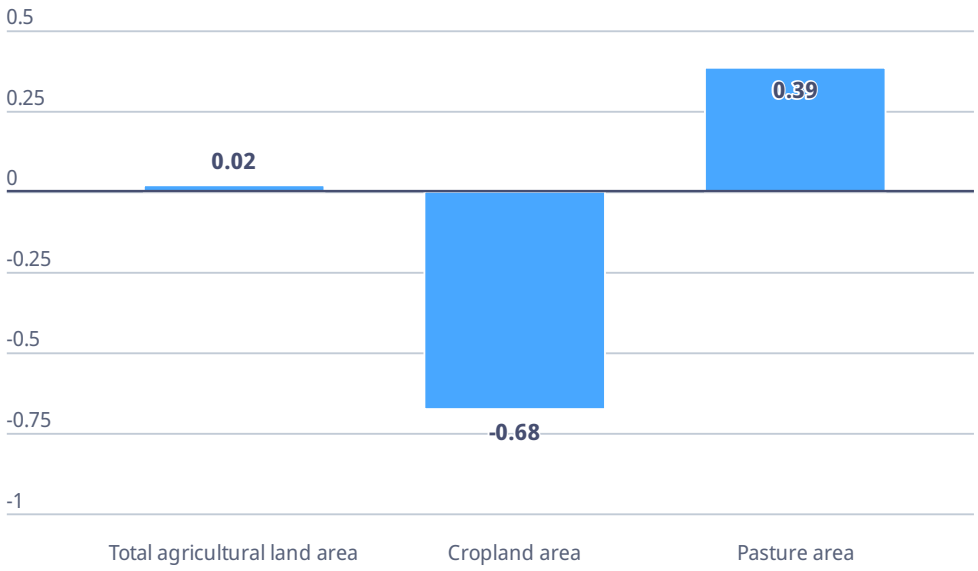
Average annual % change, 2009-11 to 2019-21*



Note: Excludes Costa Rica. *Or closest available year.
Source: OECD Agri-environmental indicators: Energy use, Nutrients balances and Water use.

Figure 2.2. Trends in agricultural land use change in OECD countries

Average annual % change, 2011 to 2021*



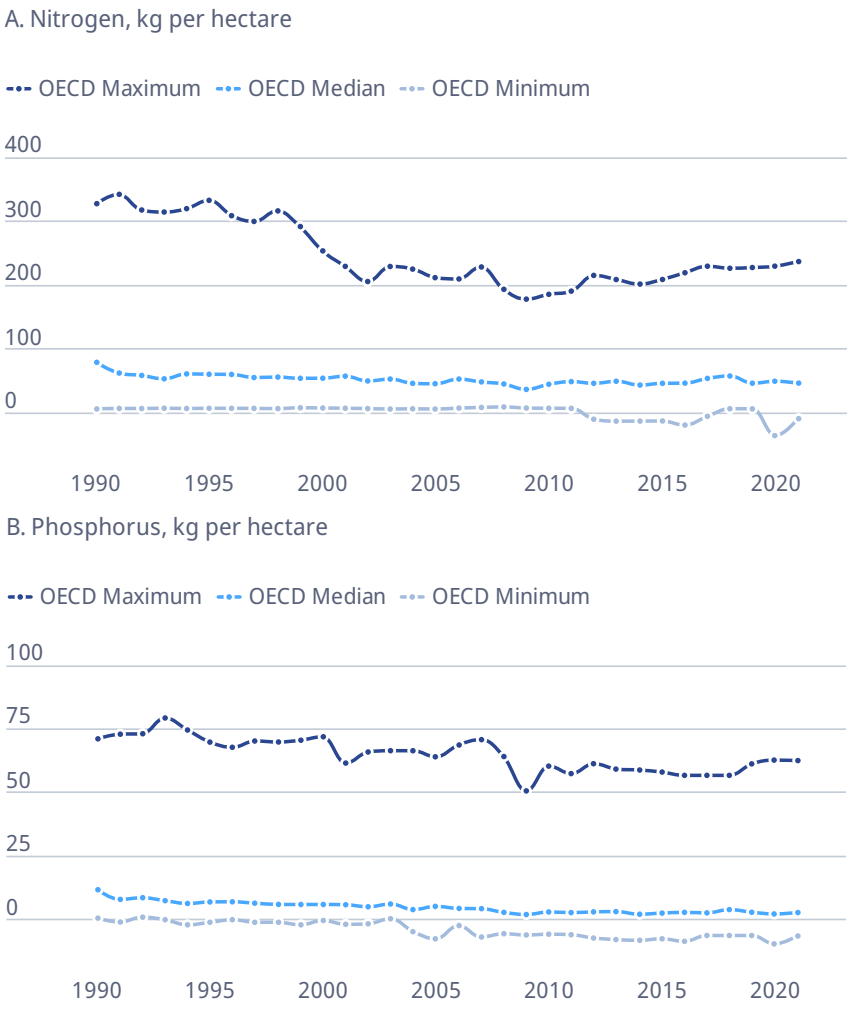
Note: Excludes Costa Rica. *Or closest available year.
Source: OECD Agri-environmental indicators: Agricultural land area.

Environmental impacts

Nutrient balances

Some environmental effects of agriculture stem from the status of input management and efficiency. While nutrients inputs can contribute to soil fertility when applied in the right quantities, persistent nutrient surpluses could indicate inefficiencies and environmental risks, e.g. acidification of soils and eutrophication in water bodies. Figure 2.3 illustrates the evolution of nitrogen and phosphorus balances (kg per hectare) in OECD countries since 1990.

Figure 2.3. Trends in nitrogen and phosphorus balances across OECD countries



Note: For the following, the most recent value available (in parentheses) is used for all subsequent years: Austria, Poland and Sweden (2019); Belgium, Denmark, Greece and Luxembourg (2014); Estonia (2012), Ireland and United Kingdom (2017), Japan, and Norway (2016), Netherlands (2020). The OECD includes Australia from 2004 and Israel from 2005 and excludes Costa Rica.
Source: OECD Agri-environmental indicators: Nutrient balances.

From 1990 to 2009, the nitrogen balance (Panel A) shows a marked decline in the maximum value observed across OECD countries, which is representative of observed improvements in nutrient management or reduced fertiliser use across OECD countries with the highest nutrient balances. However, since 2010, the OECD maximum value for nitrogen balance has shown an increasing trend, reflecting an

observed resurgence of nutrient surpluses across highest-emitting OECD countries. Meanwhile, the median values remained relatively stable since 1991 and the minimum values hovered close to zero with a deficit observed in a country in 2020, perhaps associated with input constraints during the first year of the COVID-19 pandemic.

The phosphorus balance (Panel B) follows similar trends, with less pronounced changes. The maximum value follows a mostly downward trend until early 2010s, but progress has stalled over the past decade. The median values remained relatively stable, although on a relatively lowering trend close to zero. Meanwhile, the minimum values show that one or more countries have been facing deficit in phosphorus since 2004, with a small decrease again in 2020.

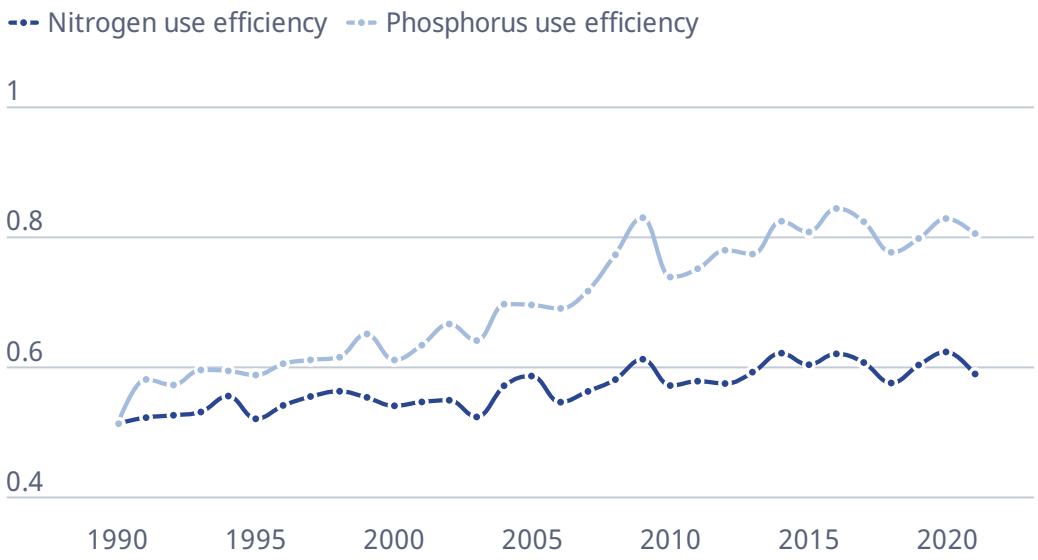
These observed trends in nitrogen and phosphorus surpluses across OECD countries reflect shifts in fertiliser use and environmental pressures, highlighting ongoing efforts to improve nutrient use efficiency in agriculture. Optimising nutrient use is an important lever to improving agricultural sustainability, yet there remains significant margin for improvement (Figure 2.4). Higher efficiency levels indicate better nutrient management which reduces environmental impacts, while lower values highlight persistent challenges to minimise nutrient losses.

Nitrogen use efficiency, measured as the ratio of outputs to inputs, has shown slight improvements over time, though fluctuations persist. The median efficiency has reached 0.6 in recent years, meaning however that only about 60% of applied nitrogen is effectively converted into outputs. This suggests ongoing challenges in reducing nutrient losses and optimising fertiliser use with 40% lost to the environment through soil, water or air. Phosphorus use efficiency has exhibited a clearer upward trend since the early 2000s, reflecting improved nutrient management overall.

These trends underscore the progress achieved in nutrient use efficiency, while emphasising the need for further improvements to reduce nutrient losses and their environmental impact.

Figure 2.4. Trends in nutrient use efficiency in OECD agriculture

Ratio of nutrient outputs to nutrient inputs, OECD median



Note: For the following, the most recent value available (in parentheses) is used for all subsequent years: Austria, Poland and Sweden (2019); Belgium, Denmark, Greece and Luxembourg (2014); Estonia (2012), Ireland and United Kingdom (2017), Japan and Norway (2016), Netherlands (2020). The OECD includes Australia from 2004 and Israel from 2005 and excludes Costa Rica.
Source: OECD calculation based on OECD Agri-environmental indicators: Nutrients balances.

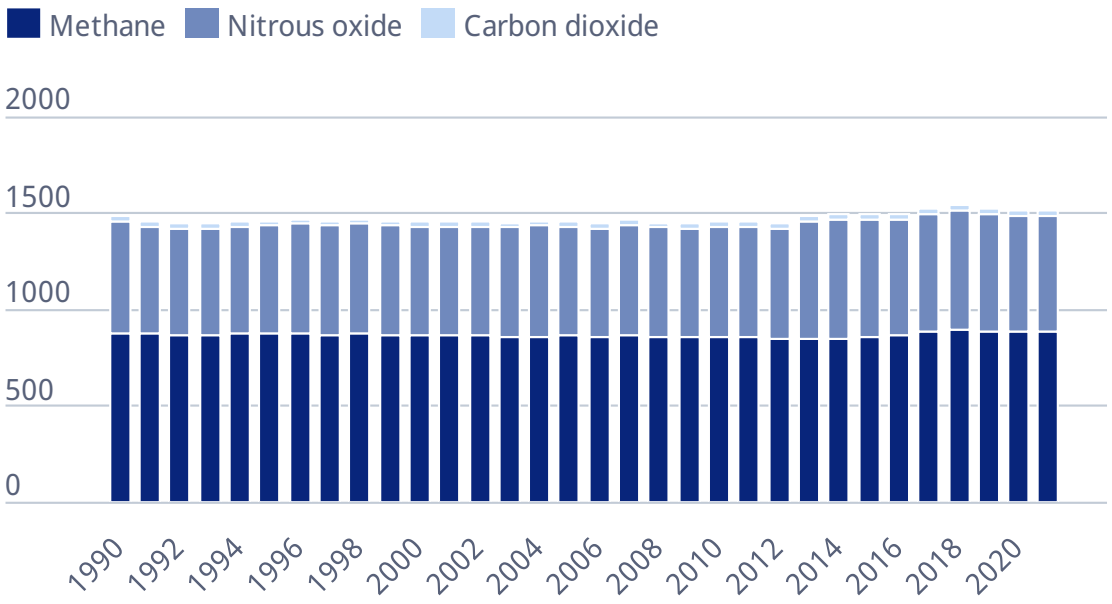
GHG and ammonia emissions

Agriculture remains a significant GHG-emitting sector through its methane and nitrous oxide emissions. Figure 2.5 illustrates the trends in GHG emissions from agriculture in OECD countries. Since 1990, methane emissions in OECD countries have fluctuated around 850–900 million tonnes CO_2-equivalent, with a slight decreasing trend until the mid-2010s, exhibiting however a rebound since then, to stabilise at a level slightly exceeding their historical values. In contrast, nitrous oxide emissions make up a relatively smaller proportion of total GHG emissions from agriculture but show greater variability, particularly with a noticeable rise between 2012 and 2018, followed by a decrease in the recent years.

These trends reflect the ongoing influence of livestock production and fertiliser use on agricultural GHG emissions, with methane primarily linked to enteric fermentation and manure management, while nitrous oxide emissions being largely driven by nitrogen-based fertilisers and associated soil processes. While agriculture also generates CO_2 emissions, these are comparatively much smaller and result mainly from soil processes. Overall, GHG emissions have increased from 1 453 million tonnes of CO_2 equivalent in 2009-11 to 1 515 million tonnes (+4.3%) in 2019-21, which corresponds to an average annual growth rate of 0.4% over the period.

Figure 2.5. Main agricultural GHG emissions in OECD countries

Million tonnes of CO_2 equivalent



Note: For the following, the most recent value available (in parentheses) is used for all subsequent years: Chile (2020), Colombia (2018); Costa Rica (2017), and Mexico (2019).
Source: OECD Agri-environmental indicators: Agricultural greenhouse gases emissions.

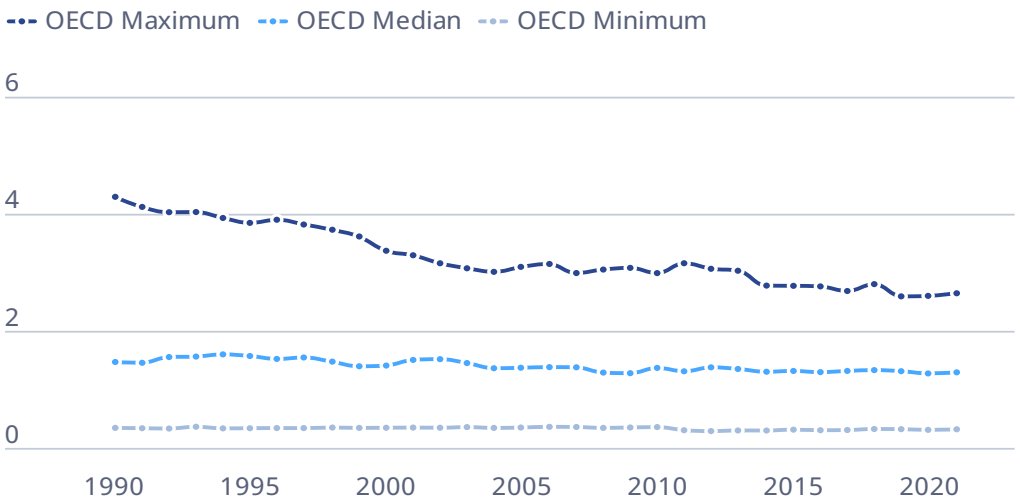
One way to reduce GHG emissions is to limit emission intensity of agricultural products. Figure 2.6 illustrates the evolution of GHG emissions intensity across OECD countries from 1990 to 2021, measured in kilograms of CO_2 equivalent per unit of agricultural output (USD). Over this period, the OECD maximum emissions intensity steadily declined, decreasing from above 4 kg CO_2e/USD in 1990 to less than 3 kg CO_2e/USD since 2014, reflecting improvements in productivity and adoption of less GHG-emission intensive practices. The OECD median has also declined by approximately 12%, from around 1.5 kg CO_2e/USD in the early 1990s to 1.3 kg CO_2e/USD in 2021. However, the rate of decline has slowed

down over the recent period, from -0.6% per year in the 1990s and 2000s to -0.2% per year since 2010. The OECD minimum, in comparison, has remained consistently low.

Despite these improvements in emissions intensity, total emissions from the sector have continued to rise. This suggests a situation of relative decoupling, where emissions grow at a slower rate than output. However, achieving absolute decoupling — a reduction in total emissions — would require more transformative changes, as efficiency gains alone have not been sufficient so far to compensate for the growth of agricultural production.

Figure 2.6. Agricultural GHG emissions intensity in OECD countries

Kg of CO_2 equivalent/USD

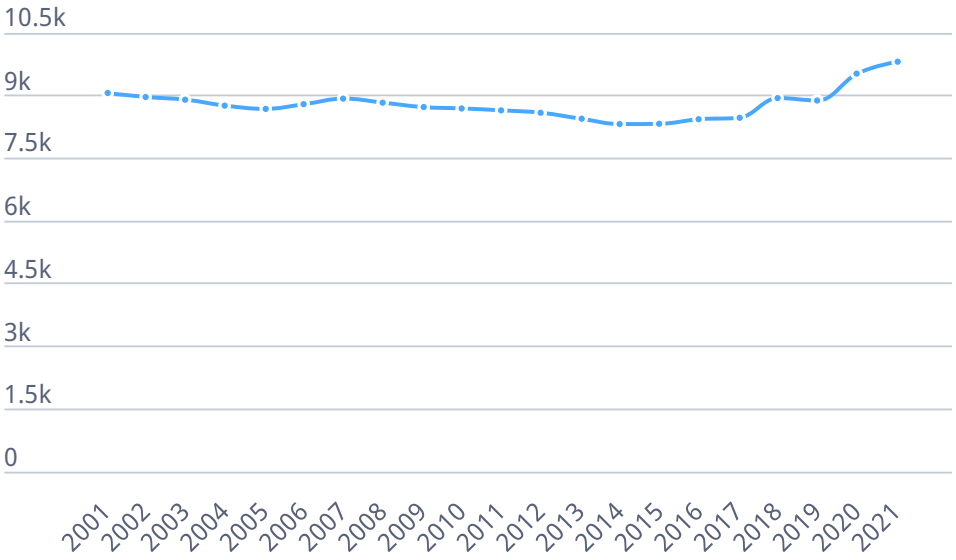


Note: For the following, the most recent value available (in parentheses) is used for all subsequent years: Chile (2020), Colombia (2018); Costa Rica (2017), and Mexico (2019).
Source: OECD calculation based on OECD Agri-environmental indicators: Agricultural greenhouse gases emissions and production value estimates from FAOSTAT.

Manure from livestock production and fertiliser use can also generate ammonia emissions contributing to air and water pollution. Agricultural ammonia emissions across OECD countries declined moderately from 2001 with slight fluctuations until the mid-2010s. As from 2015, the trend on emissions began to reverse with an average annual growth rate of 2.8%, leading to a record high level in 2021 over the last two decades (Figure 2.7). This could be the source of potential environmental threats in the most affected regions.

Figure 2.7. Agricultural ammonia emissions in OECD countries

Thousand tonnes



Note: The OECD total includes Australia from 2003; it excludes Chile, Colombia, Costa Rica, Japan, and New Zealand.
Source: OECD Agri-environmental indicators: Ammonia emissions.

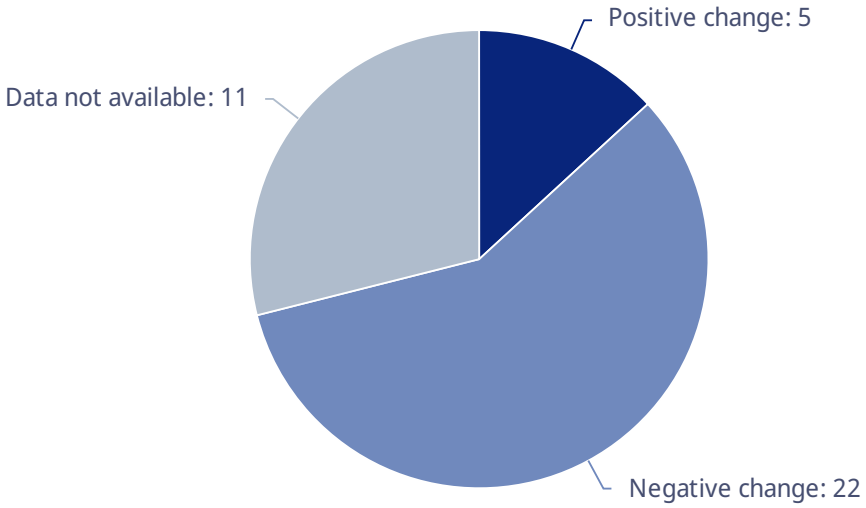
Farmland biodiversity

The impact of agriculture on biodiversity also remains an important challenge, as observed with farmland bird populations serving as an important indicator of ecosystem health in a subset of OECD countries.

Figure 2.8 illustrates the evolution of the farmland birds index across OECD countries. Of the 27 countries within OECD countries reporting that indicator, 22 experienced a decline in farmland bird populations between 2009-11 and 2019-21, signaling ongoing pressures from agricultural intensification, habitat loss, or land use changes. In contrast, only five countries reported a positive trend, suggesting localised improvements in conservation efforts or habitat management. The overall pattern underscores the continued challenges in maintaining farmland biodiversity and the need for targeted agri-environmental policies to support bird populations. More effort is ongoing to complement this indicator, including in non-covered countries, with the monitoring of farmland habitat biodiversity.

Figure 2.8. Trends in the Farmland Birds Index in OECD countries

Number of OECD countries by change in trend, 2009-11 to 2019-21



Note: Average annual % change, based on the period 2009-11 to 2019-21
Source: OECD Agri-environmental indicators: Biodiversity.

The overall environmental performance of agriculture in OECD countries is a mix of progress and persistent challenges. While improvements in nutrient use efficiency and emissions intensity indicate advances in sustainable practices, higher overall GHG emissions, nutrient surpluses, and worsening biodiversity indicators in some countries remain pressing concerns. Trends in land use, input consumption, and air emissions highlight the complex interplay between agricultural production and environmental sustainability. The continued decline of farmland bird populations further underscores the need for targeted policies to mitigate biodiversity loss. Strengthening data-driven policy approaches will be essential to improve sustainable productivity growth, ensuring that future food systems are both resilient and sustainable.

3 About the Agri-Environmental Indicators database

The OECD Agri-environmental Indicators (AEI) database provides comprehensive data on the environmental performance of agriculture across OECD countries and selected partner countries. The database serves as a critical tool for policymakers, researchers, and stakeholders in assessing trends, identifying policy impacts, and supporting evidence-based decision-making to enhance agricultural sustainability.

Scope and coverage

The AEI database covers a wide range of indicators that measure the environmental footprint of agricultural activities. These indicators are organised into thematic areas such as:

- Agricultural land area: Covers total agricultural land, cropland, pasture as well as organic farming and transgenic crop area.
- Nutrient balances: Tracks nitrogen and phosphorus balances, including detailed nutrient inputs such as fertilisers and manure as well as outputs such as crop harvest and forage.
- Water use and quality: Includes irrigation areas, agricultural water withdrawals, agricultural sources of nitrate and phosphate in surface water, and monitoring sites exceeding thresholds for nitrates and/or pesticides in surface and groundwater.
- Pesticide sales: Monitors sales of insecticides, herbicides, fungicides, and other pesticides.
- Biodiversity: Reports trends in farmland and forest bird populations.
- Air quality: Reports agricultural ammonia emissions and greenhouse gas emissions, by gas and by source, from agriculture and Land Use, Land Use Change and Forestry (LULUCF).
- Soil erosion: Evaluates land degradation due to water and wind erosion.
- Energy use: Assesses direct on-farm energy consumption.

The database includes historical data spanning from 1985 to the most recent updates, covering all 38 OECD countries, 5 non-OECD EU member states, and 11 emerging economies including Argentina, Brazil, People's Republic of China, India, Indonesia, Kazakhstan, the Philippines, the Russian Federation, South Africa, Ukraine and Viet Nam.

Data collection and methodology

Data for the AEI database is compiled through a combination of national statistical sources, international organisations, and OECD-specific surveys. The collection process is coordinated with Eurostat, FAOSTAT, the UNFCCC, and other relevant bodies to ensure consistency and comparability across countries.

- For EU countries, Norway, and Switzerland: Eurostat leads data collection efforts, with the OECD integrating the updates into the AEI database.
- For non-EU OECD countries: The OECD Secretariat distributes tailored questionnaires to collect missing or country-specific data.
- For non-OECD partner countries: Data is obtained from international databases, complemented by national reporting where available.

The methodologies used align with international standards, including the Eurostat/OECD Handbook on Nutrient Budgets and IPCC Guidelines for National Greenhouse Gas Inventories.

Data accessibility and visualisation

The AEI database is hosted on the OECD Data Explorer platform, providing users with interactive access to individual datasets by thematic area. The platform allows users to explore trends, compare countries, and generate customised visualisations for policy analysis.

The AEI database can be accessed here:

- Agri-environmental indicators: all data
- Agricultural land area
- Ammonia emissions
- Biodiversity
- Energy use
- Nutrients balances
- Pesticides use
- Soil erosion
- Water quality
- Water use

Additionally, the OECD AEI dashboard, published as a web-based tool, presents key agri-environmental indicators in an intuitive and accessible format. The dashboard is regularly updated, with the latest version including expanded country coverage and refined data integration.

The AEI dashboard can be accessed at https://www.oecd.org/en/data/dashboards/measuring-the-environmental-performance-of-agriculture.html.

Future developments

The AEI database will continue to evolve, with enhancements in data granularity, methodological improvements, and expanded geographic coverage. By continuously refining the AEI database, the OECD aims to support informed policymaking and promote sustainable agricultural practices worldwide.

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