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Agricultural Policy and Support in Light of Climate Change Mitigation Ambitions

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Note by the Secretariat

As agreed by the Working Party on Agricultural policies and Markets (APM) at its meeting in November 2021, the 2022 edition of the *Agricultural Policy Monitoring and Evaluation* will be published online (via iLibrary in web (HTML), PDF and ePUB formats). The online publication contains the Executive Summary, Part I ("Agricultural Policy and Support in Light of Climate Change Mitigation Ambitions") and Part II ("Developments in Agricultural Policy and Support by Country").

This document contains Part I – Agricultural Policy and Support in Light of Climate Change Mitigation Ambitions – of the report entitled *Agricultural Policy Monitoring and Evaluation 2022*.

It is part of the following set of documents forming the 2022 report:

Executive Summary

[TAD/CA/APM/WP(2022)8/FINAL]

Part I – Agricultural Policy and Support in Light of Climate Change Mitigation Ambitions

[TAD/CA/APM/WP(2022)9/FINAL]

Part II – Developments in Agricultural Policy and Support by Country

[TAD/CA/APM/WP(2022)10/FINAL]

Statistical Annex – Summary Tables of Estimation of Support

[TAD/CA/APM/WP(2022)11/FINAL]

Document [TAD/CA/APM/WP(2022)8/FINAL] contains the Executive Summary which appears at the beginning of the report.

Document [TAD/CA/APM/WP(2022)10/FINAL] contains Part II - Developments in Agricultural Policy and Support by Country.

Document [TAD/CA/APM/WP(2022)11/FINAL] contains the Statistical Annex – Summary Tables of Estimation of Support – of the report.

The Executive Summary and Part I of the report were declassified by the Working Party on Agricultural Policies and Markets (APM) during its 86th session on 17-19 May 2022. Part II and the Statistical Annex were declassified under the responsibility of the Secretary-General of the OECD.

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1 Reforming agricultural policies for climate change mitigation

1. Agriculture faces a complex and unique challenge in the context of climate change. First, agriculture is particularly vulnerable to climate change, due to its dependency on weather and climatic conditions. It is already experiencing negative impacts from climate change from higher temperatures, increased variability of rainfall, invasive pests, and the greater frequency of extreme weather events. Around the world, building the resilience of the sector and ensuring adaptation to climate change is a significant challenge, particularly in the poorest countries in which agriculture both plays an important role for the economy and basic subsistence needs, but where climate change impacts are expected to hit the hardest.

2. Second, agriculture is itself a major source of global greenhouse gas (GHG) emissions, both directly, through on-farm emissions linked to production, and indirectly, through land use change due to agricultural expansion. In the absence of action, emissions from agriculture are projected to continue to rise and the sector's share of total emissions to increase as efforts to decarbonise other sectors accelerate. That said, there are ample opportunities for agriculture to contribute to global efforts to mitigate climate change, by reducing both direct and indirect emissions.

3. Third, unlike many other emissions-intensive sectors, agriculture also has the potential to contribute positively to reducing emissions by removing carbon from the atmosphere, through efforts to sequester carbon in biomass and soils. This can be achieved through practices that also raise productivity, such as conservation agriculture and the restoration of degraded agricultural lands, both to mitigate direct emissions and prevent further indirect emissions from land use change.

4. There are also particular challenges to tackling GHG emissions in agriculture. The sector is subject to a wide range of government policies, including significant support policies in OECD countries. A key question is thus the extent to which existing policies help or hinder efforts to adapt to, or mitigate climate change in agriculture. Equally as important is examining the types of mitigation policies that governments have adopted, or are considering, to combat agricultural emissions. With the strategic importance of food security set to increase, as population growth and rising incomes continue to boost extra demand for food, agriculture lies at the heart of the triple challenge facing food systems: providing adequate, affordable, safe and nutritious food for a growing global population; providing livelihoods all along the food value chain; and doing so while increasing the sustainability of the sector and its contribution to combatting climate change.

5. Against this background, this chapter discusses the contribution of agriculture and current agricultural policies to climate change and how policy changes can help the sector to become a greater part of the solution to reducing global GHG emissions. While resilience and adaptation are key issues, they have already been the subject of extensive work (see Box 1.1) and are not covered further here. Furthermore, while GHG emissions from other pre- and post-production segments of food systems have witnessed substantial increases in recent decades, this chapter focuses on the contribution of agriculture and closely related issues where agricultural policymakers may be more directly involved (such as food loss and waste and consumer demand). The chapter begins with an overview of agriculture's contribution to climate change; it then discusses the opportunities for the sector to contribute to emission reductions.

The chapter then looks ahead to country targets under the Paris Agreement and policy actions taken by countries to mitigate agricultural emissions. It concludes by discussing the extent to which current agricultural support policies may help or hinder global efforts to mitigate GHG emissions, and offers a way forward with recommendations for countries to reform their agricultural policies to address climate change mitigation objectives.

Box 1.1. Adaptation to climate change and resilience of the agricultural sector

According to the Intergovernmental Panel on Climate Change (IPCC), global temperatures have already increased by 1.1°C on average over the past decade, compared to preindustrial levels (IPCC, 2022[1]). As a consequence, human activities are already exposed to changing climatic patterns, highlighting the urgent need for effective mitigation action. While agriculture has strong potential to contribute to GHG emissions reduction and carbon sequestration efforts, it is also among the most exposed sectors to changing weather patterns and natural disasters. Low income countries are particularly vulnerable, as a large part of their population still depends on agricultural activities for their livelihoods and rural poverty is at the core of many development challenges.

For these reasons, climate change mitigation needs to be complemented by adaptation efforts, and agriculture needs to find new and innovative pathways combining these two transformation agendas. Adaptation strategies can rely on both the adoption of new management practices (e.g. crop diversification, improved water management) that are better suited to the changed environmental conditions, and new technologies (e.g. flood or heat-resistant crop varieties) supported by R&D investments (Ignaciuk and Mason-D'Croz, 2014[2]).

In the face of increasingly unpredictable climatic events, agriculture also needs to strengthen its resilience – defined as its ability to prepare and plan for, absorb, recover from, and more successfully adapt and transform in the face of shocks – by revising its approach to risk (OECD, 2020[3]). In particular, risk management should move from focusing on individual agents to a more systemic perspective, and involve different decision levels. Policies should be put in place to not only help farmers to recover from various shocks, but also to build capacities to adapt in response to new risks, and to transform in order to eliminate these risks to the best possible extent.

OECD work has emphasised five dimensions that should be considered by public and private actors when designing their risk management strategies in agriculture (OECD, 2020[3]). These should pay attention to: 1) the time-frame, taking early ex-ante actions and targeting for the long-term; 2) possible trade-offs between policy objectives and actor interests, comparing outcomes of alternative options; 3) participatory collaborative processes involving multiple stakeholders; 4) investments in on-farm resilience capacity, based on strengthening human capital and supporting the uptake of adapted technologies and practices; 5) no regret policies, taking into account of possible future scenarios on climate change and other economic and environmental conditions.

Country case studies underscore how this framework for agricultural resilience can help address natural disasters faced by the agricultural sector (OECD/FAO, 2021[4]). Key elements include setting the right incentives at policy level to trigger action at the farm level; providing the data to help farmers choose the right strategic investments on the farm; and engaging with trusted stakeholders to help ensure the effective implementation of policy actions by farmers.

Measuring agriculture's contribution to climate change

Direct and indirect emissions

6. Agriculture is a major driver of climate change via two main channels:

- Emissions from the sector itself, linked to production. In particular, the agricultural sector is a major source of non-CO_2 emissions, notably methane (CH_4) and nitrous oxide (N_2O) directly emitted from crop and livestock production.[1]
- Emissions related to land use, land use change and forestry (LULUCF).[2] The main sources of LULUCF emissions related to agriculture include net forest conversion to cropland and pasture, conversion of native grasslands to cropland, tropical forest fires, peat fires, soil organic carbon changes and drained organic soils (Figure 1.1).

7. Together, both these elements – agriculture and LULUCF – are referred to as agriculture, forestry, and other land use (AFOLU). Over the period from 2010 to 2019, average annual net GHG emissions from AFOLU represented around 21% of total global anthropogenic GHG emissions, and that share increased to 22% by 2019.[3] Of this, emissions from LULUCF accounted for around 11% of global GHG emissions,[4] while on-farm emissions linked to agricultural production accounted for a further 11%.[5] In other words, AFOLU represents roughly one-fifth of anthropogenic GHG emissions, half of which comes from CO_2 LULUCF emissions and the other half from CH_4 and N_2O direct emissions from agricultural production.

[1] The agriculture category from UNFCCC inventories covers only the non-CO_2 emissions associated with agricultural production and some small CO_2 sources related to soil improvements. Fossil-fuel emissions generated on the farm are accounted as part of the "Energy" sector. Changes in carbon stocks in agricultural soils are accounted as part of the LULUCF category.

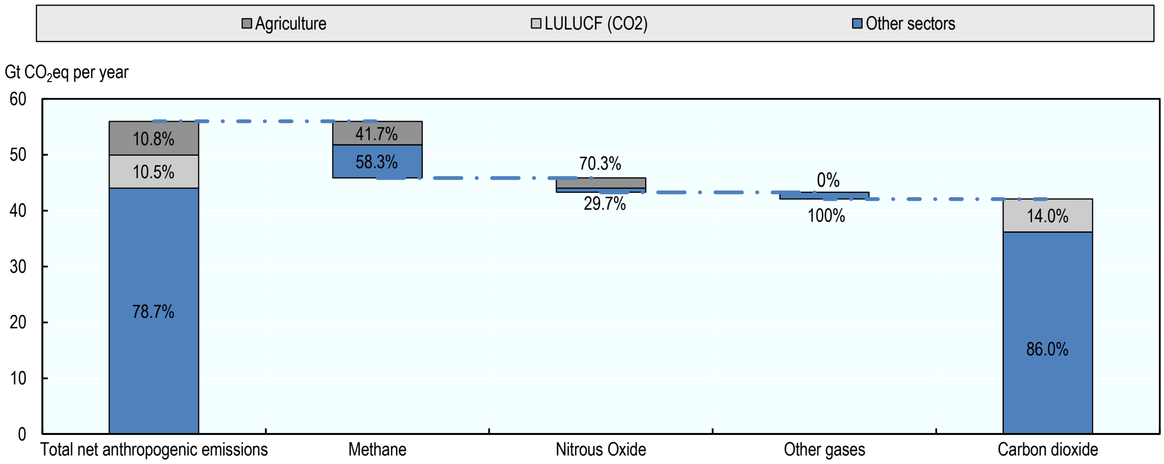
[2] LULUCF corresponds to the land use and land use change part of AFOLU, therefore AFOLU = agriculture + LULUCF.

[3] Emissions from AFOLU in 2010-19 averaged 11.9 ± 4.4 billion tonnes carbon dioxide equivalent ($GtCO_2eq$), out of a total of 56.3 ± 6.1 $GtCO_2eq$, per year. In 2019, AFOLU emissions amounted to 12.8 ± 5.0 $GtCO_2eq$ out of a total of 58.6 $GtCO_2eq$ with IPCC AR6 GWP100 for CH_4 and N_2O (IPCC, 2022[5]; Minx et al., 2021[6]).

[4] 5.9 ± 4.1 $GtCO_2eq$ per year.

[5] 6.0 ± 1.7 $GtCO_2eq$ per year for the IPCC agriculture category (which excludes on-farm energy consumption).

Figure 1.1. Global net anthropogenic emissions from agriculture, forestry and other land use (AFOLU) and other sectors, total and decomposition by gas, annual average for 2010-19



Note: LULUCF: Land use, land use change and forestry. Data labels indicate the percentage share of Agriculture, LULUCF (CO_2) and Other sectors in the total emissions from each individual GHG, as well as total global net anthropogenic GHG emissions. Other sectors correspond to buildings, transport, industry, other energy, and also include fossil fuel emissions at farm level, consistent with IPCC nomenclature. Other gases include fluorinated gases such as chlorofluorocarbons (CFCs), hydrofluorocarbons (HFCs), hydrochlorofluorocarbons (HCFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6). All values expressed in units of CO_2eq are based on IPCC AR6 100-year Global Warming Potential (GWP_{100}) values with climate-carbon feedbacks (CH_4 = 27.0; N_2O = 273). LULUCF only shows CO_2 emissions, as reported in IPCC (2022[5]). Non-CO_2 LULUCF emissions (not shown) represent an additional 0.6 GtCO_2eq, due to emissions from vegetation and peatland burnings.
Source: Compiled from IPCC (2022[5]) and EDGAR (Minx et al., 2021[6]).

8. Direct on-farm emissions from agriculture contribute much more to non-CO_2 gases than other sectors: they generate 42% of global anthropogenic methane emissions and 70% of global nitrous oxide emissions.[6] These gases have a much higher impact on global warming than CO_2, and the 100-year global warming potential (GWP_{100})[7] of methane has been regularly revised upward over the past two decades by the IPCC (from 21 in 1995 to 27 currently for agriculture). Furthermore, methane is a short-lived gas, which means its climate impact is much stronger over a shorter time-frame, whereas its effect becomes negligible faster when compared with carbon dioxide. That is, the GWP for non-fossil methane increases from 27 over a 100-year period to close to 80 over a time horizon of 20 years. This means that methane emissions are set to have an effect on global temperatures by mid-century about three times larger than indicated by the usual calculations which take a 100-year perspective.

9. Indirect emissions from agriculture are mainly CO_2 emissions, particularly from the clearing of forests and other natural vegetation and the drainage of wetlands and peatlands for agricultural purposes. Land clearing removes carbon stored in above-ground biomass, while organic soil drainage leads to the oxidation of soil carbon, and this important below-ground carbon sink continues to emit for many years

[6] On average, agriculture generates 4.2 ± 1.3 GtCO_2eq per year in methane emissions and 1.8 ± 1.1 GtCO_2eq per year in nitrous oxide emissions.

[7] Global Warming Potentials (GWPs) are used to convert GHGs to carbon dioxide equivalent (CO_2eq), providing a common scale to measure the climate impacts of individual GHGs. Carbon dioxide is the reference and has a GWP of 1 for all time periods. Methane from non-fossil sources such as agriculture is estimated to have a global warming potential (GWP_{100}) of 27.0 ± 11, meaning that one tonne of methane emissions will absorb 27 times more energy over a 100-year period than one tonne of carbon dioxide. Nitrous oxide has a GWP_{100} of 273 ± 130 times that of carbon dioxide for a 100-year timescale.

following the land conversion. The burning of biomass on agricultural and forest land and the combustion of organic soils (peatland fires) also contribute to GHG emissions from forestry and other land use.

10. On the other hand, agriculture can also contribute to GHG removals, through carbon sequestration in agricultural plantations, and in cropland and grassland soils, as well as partially rewetted peatlands (Henderson et al., 2022[7]). Overall, the capacity of land to act as a natural sink of CO_2 will be affected by both climate change and by future agricultural activities (IPCC, 2022[5]).

11. Global emissions of carbon dioxide from AFOLU have remained relatively constant over the past few decades. In contrast, non-CO_2 emissions from AFOLU increased by 15% between 1990 and 2019. This was primarily driven by direct agricultural emissions, which represented 91% of AFOLU's non-CO_2 emissions on average over the period.[8]

12. **Direct GHG emissions from agriculture vary across countries** due to differences in factors such as agricultural land area, size of the agricultural sector, mix of commodities produced, and the structure of agricultural production. Total agricultural GHG emissions across all 54 countries covered in this report contribute about two-thirds of total global agricultural GHG emissions.[9] The five largest emitters are India, the People's Republic of China (hereafter "China"), the United States, Brazil and the EU-27, collectively accounting for 72% of the total across all 54 countries. Conversely, the five smallest emitters (Iceland, Israel, Costa Rica, Norway and Switzerland) represent just 0.4% of total agricultural GHG emissions (see Figure 1.2 for direct agricultural GHG emissions in 2019 from these 54 countries). To allow the relevant compositional breakdown to be legible, this chart is presented in total, and then as three separate charts covering groups of countries according to the size of their agricultural emissions: low, medium and high.

13. **Enteric fermentation** and **manure management** from livestock account for more than 50% of direct emissions from agriculture across all 54 countries. Enteric fermentation, a digestive process of cattle, sheep, goats and other ruminant livestock which generates methane, accounts for the vast majority of these emissions (42% of direct agricultural emissions). Manure management contributes 8%, both from methane and nitrous oxide emissions. The share of these livestock emissions in total agricultural emissions varies across the 54 countries covered in this report, ranging from 19% in the Philippines to 78% in Australia and New Zealand. Livestock is also responsible for additional emissions due to manure deposition on grassland and manure applications to croplands (see further below on agricultural soils). When manure left on pasture is added to the sources above, livestock accounts in total for two-thirds of agricultural emissions over the 54 countries covered.[10]

14. **Rice cultivation** is also a significant source of methane emissions, and is responsible for 11% of direct agricultural emissions across the 54 countries. These emissions are concentrated in Asia, with five countries (China, India, Indonesia, the Philippines and Viet Nam) collectively accounting for 67% of global rice production and 91% of total emissions from rice cultivation across the 54 countries (OECD/FAO,

[8] Average annual non-CO_2 emissions from agriculture have risen from 5.2 ± 1.4 $GtCO_2eq$ during 1990-99, to 6.0 ± 1.7 $GtCO_2eq$ for the period 2010-19 (using IPCC AR6 GWP_{100} values to aggregate CH_4 and N_2O emissions to CO_2eq) (IPCC, 2022[5]). Non-CO_2 LULUCF emissions are estimated to account 0.6 $GtCO_2eq$ and are accounted separately in IPCC (2022[5]).

[9] Or 4.1 $GtCO_2eq$.

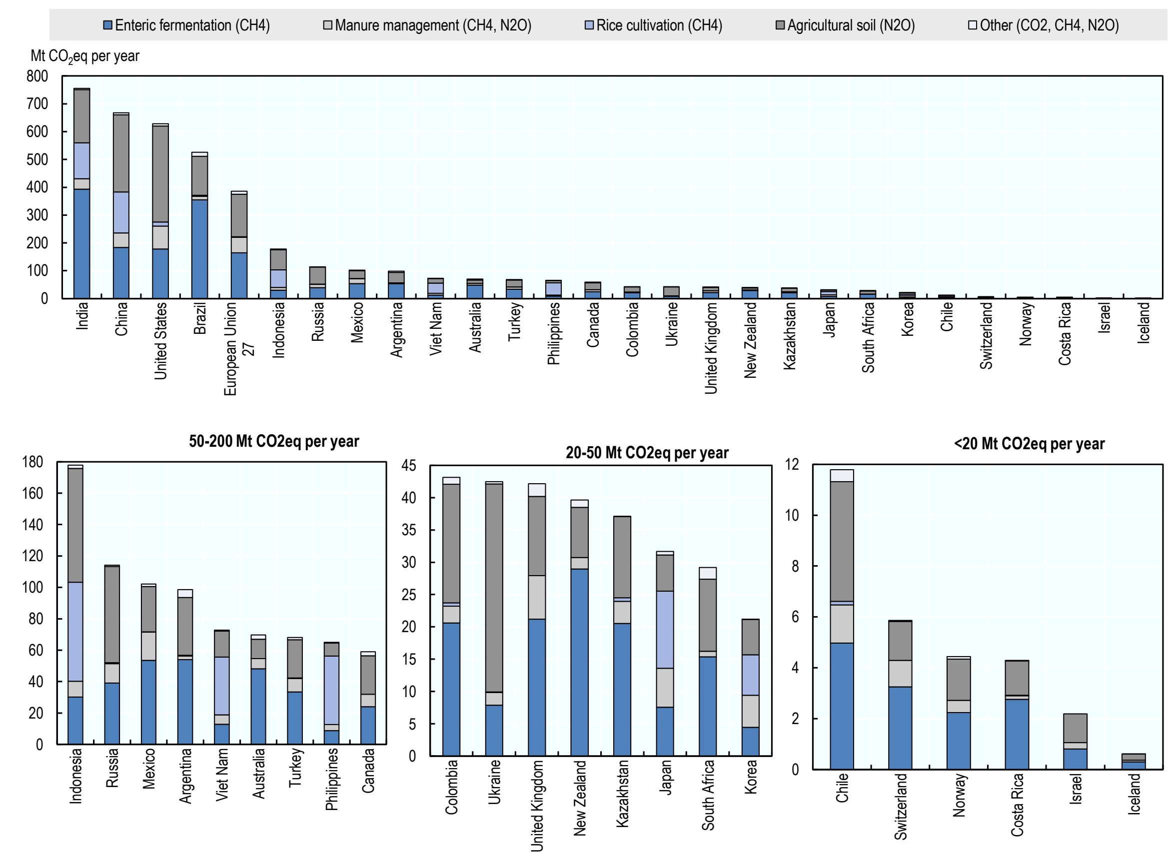
[10] The share of livestock emissions associated with enteric fermentation, manure management and manure deposited on grassland accounts for 67% of direct agricultural emissions over the 54 countries covered in this report, based on IPCC AR6 GWP_{100} for methane and nitrous oxide. When adding manure applied to cropland as organic fertiliser, this emissions share rises to 70% (FAO, 2022[36]).

2021[8]). On average across the OECD, rice cultivation only represents 2% of direct emissions from agriculture.

15. **Agricultural soils** are the principal driver of nitrous oxide emissions, due to the application of synthetic nitrogen or organic fertiliser, crop residues, as well as manure and urine deposited on grassland by ruminant livestock. These emissions account for 37% of direct agricultural emissions across all 54 countries, but with high variation across countries: agricultural soils account for 76% of direct agricultural emissions in Ukraine, and more than half of total agricultural emissions in Israel and the United States.

16. Other sources of direct agricultural emissions come from more marginal sources across all 54 countries, and represent only 2% of total agricultural emissions. These include carbon dioxide from liming, urea application and other carbon-containing fertilisers as well as methane and nitrous oxide from prescribed burning of savannahs and field burning of agricultural residues. In addition, some on-farm emission sources are not accounted for as direct agricultural emissions under the UNFCCC inventory typology, but can be non-marginal: they cover in particular energy consumption on the farm, such as fuel for agricultural machinery, other energy sources used for barns and glasshouses, as well as irrigation. Box 1.2 provides more detail on these sources, including accounting of GHG emissions through a food systems lens.

Figure 1.2. Direct GHG emissions from agriculture, by country and source, 2019

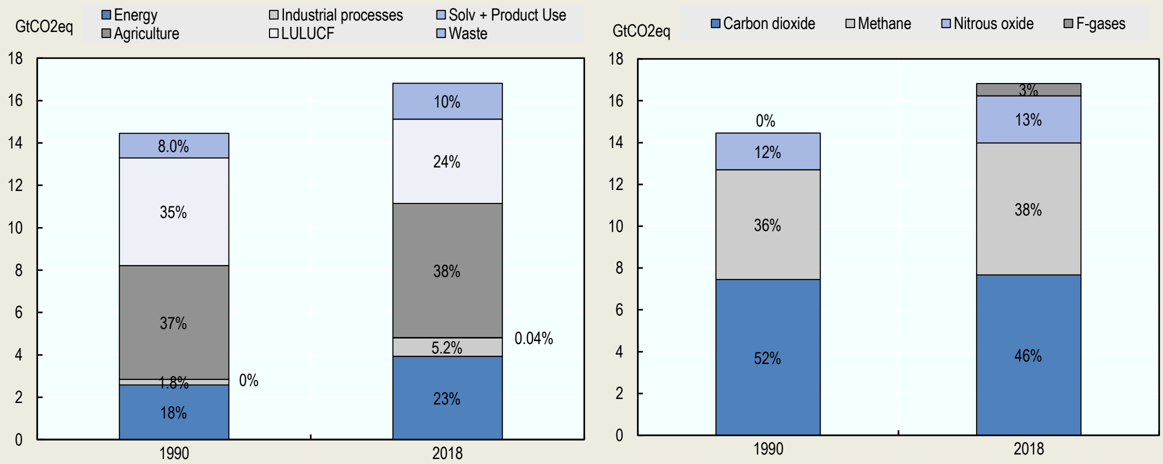


Note: Data from 2019, except for Chile, Israel, Korea (2018); Mexico (2015); Colombia and Argentina (2014). CO_2: Carbon Dioxide, CH_4: Methane, N_2O: Nitrous oxide.
The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data 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.Stat, 2021[9]).

Box 1.2. How do food systems contribute to global GHG emissions?

In addition to the emissions generated by agricultural production, land use and land use change, food systems contribute to GHG emissions through various pre- and post-production processes such as fertiliser manufacturing, food processing, packaging, transport, retail, household consumption and food waste disposal. However, there are major knowledge gaps and large uncertainties regarding the quantification of food systems emissions. Estimates from (IPCC, 2022[10]) based on (Crippa et al., 2021[11]) and (FAO, 2021[12]) indicate that food systems emitted 16.8 $GtCO_2eq$ per year in 2018 (95% confidence range: 13-23 $GtCO_2eq$ per year), equivalent to 31% (range 23-42%) of total anthropogenic GHG emissions.[11] This represents an increase of 16% over 1990 levels, primarily driven by non-AFOLU emissions which have grown to represent 39% of food systems emissions in 2018 (compared with 28% in 1990) (Figure 1.3).

Figure 1.3. GHG emissions from global food systems by sector and gas, 1990 and 2018



Note: Solv+Product Use: Solvent and Other Product Use. LULUCF: Land Use, Land-Use Change and Forestry. Data labels indicate the percentage share of each individual sector/gas in total global net anthropogenic GHG emissions.
Source: (IPCC, 2022[10]).

Emissions from energy use occur throughout the food supply chain and consist almost entirely of CO_2 emissions. In 2018, two-thirds of energy emissions came from energy industries supplying electricity and heat, manufacturing and construction, and transport. Refrigeration is an important source of energy use in the retail sector, and leads to substantial increases in fuel consumption during distribution. Refrigeration in supermarkets is energy intensive and also contributes to leakages of fluorinated gases (F-gases). Transport represents just 5-6% of food systems emissions and is dominated by road transport (92% of food systems transport emissions), followed by marine shipping (4%), rail (3%) and aviation (1%).

Emissions from industrial processes in food systems consist of emissions from refrigerants (F-gases) and the fertiliser industry (CO_2 from ammonia production and N_2O from nitric acid). Emissions from F-gases

[11] Earlier estimates from (IPCC, 2019[86]) put global food systems emissions at between 10.8 and 19.1 $GtCO_2eq$ per year, or 21-37% of total anthropogenic emissions. According to (Poore and Nemecek, 2018[13]), food systems generate 26% of anthropogenic GHG emissions; this rises to 31% if non-food agriculture and other drivers of deforestation are included. (Crippa et al., 2021[11]) found that food systems contributed 34% to total anthropogenic GHG emissions in 2015, while (FAO, 2021[12]) estimated total emissions from food systems at 16.5 $GtCO_2eq$, or 31% of global emissions in 2019.

can have disproportionately large effects on global temperatures even at small atmospheric concentrations. Although F-gases contributed only 3% of global food systems emissions in 2018, this share is projected to increase rapidly due to growth in cold chains and refrigerated storage capacity in developing countries.

Waste accounts for 10% of food systems emissions, and includes domestic and commercial wastewater (55% of food systems waste emissions), solid waste management (36%), industrial wastewater (8%) and waste incineration and other waste management systems (1%). Food waste decay also generates significant quantities of methane, through the decomposition of organic materials in landfills.

Source: (IPCC, 2022[10]).

Emissions intensity of the agricultural sector

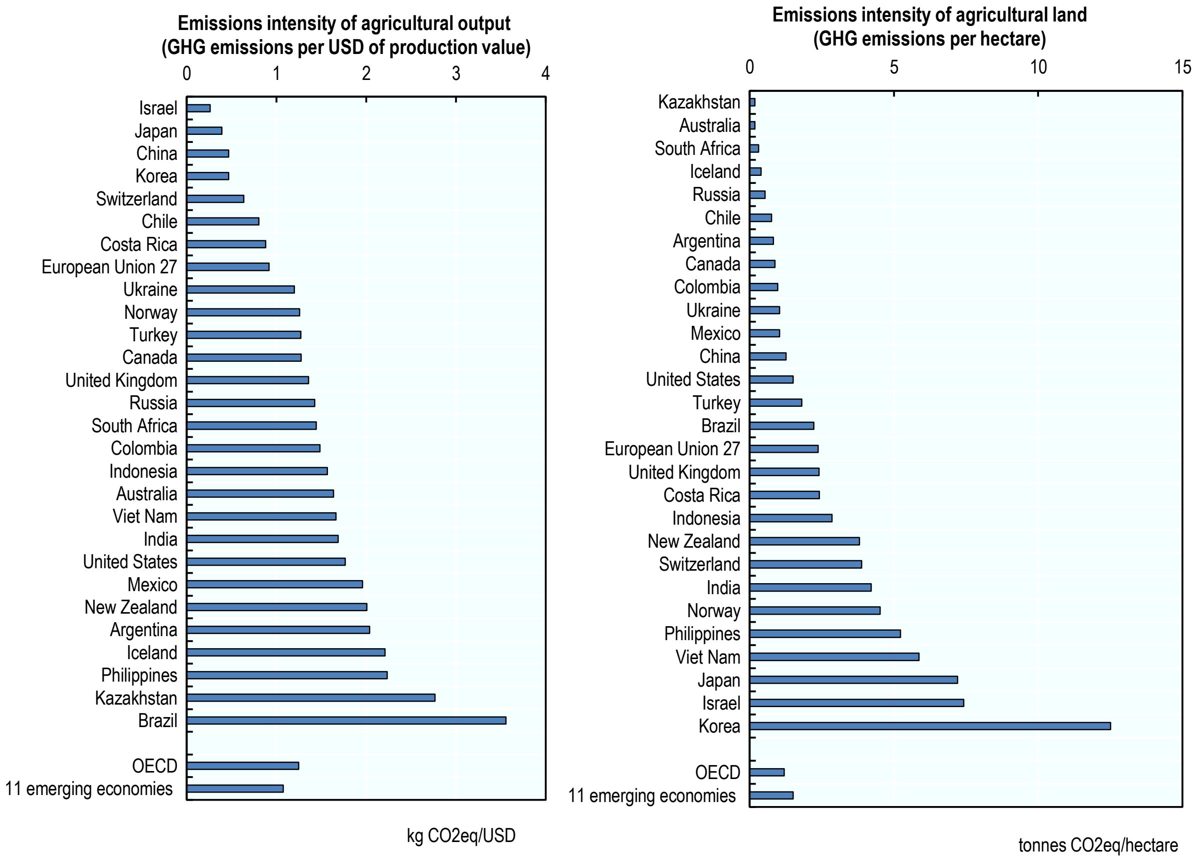
17. To account for the vast differences in the size of countries' agricultural sectors, emissions can also be expressed relative to agricultural output, or relative to a factor of production, such as agricultural land. Measuring agricultural emissions per USD of production value reveals the ***emissions intensity of agricultural output*** (Figure 1.4). Countries with a strong share of ruminant products in agricultural production (e.g. Brazil, Argentina, New Zealand, Mexico) or low domestic market prices (e.g. Kazakhstan, Philippines) rank the highest. On the other hand, countries with high value of production (e.g. Japan, Korea, Switzerland) and/or low share of ruminant products (e.g. China) tend to show a low emission intensity of agriculture. Overall, the emissions intensity of agricultural output in the OECD is slightly higher than in the 11 emerging economies covered in this report.[12]

18. When looking at the ***emissions intensity of agricultural land**,* measured as agricultural emissions relative to total agricultural land area, countries with large territories such as Australia, Kazakhstan and South Africa tend to have the lowest agricultural emissions per hectare. Agricultural emissions per hectare tend to be higher in countries with a relatively small agricultural area, and where emissions-intensive commodities (e.g. rice cultivation in Korea, Japan, Viet Nam and the Philippines; or livestock production in Norway, Switzerland and New Zealand) represent an important share of agricultural production. In addition to geographical characteristics, differences across countries can also be explained by variations in production systems and the extent to which land contributes to output relative to other factors of production. By this metric, agricultural emissions per hectare in the OECD are lower than the average for the 11 emerging economies.[13] However, it is important to note that this indicator does not capture indirect agricultural emissions (i.e. those relating to changes in land use), which are substantial in a number of countries. High land emissions intensity, when driven by production intensification, may also result in GHG emissions offsets associated with reduced land use expansion.

[12] At 1.2 kg CO_2eq/USD and 1.1 kg CO_2eq/USD respectively.

[13] At 1.2 t CO_2eq/ha and 1.5 t CO_2eq/ha respectively.

Figure 1.4. Emissions intensity of agricultural output and land across countries



Notes: Data is from 2019, except for Canada, Chile, Israel, Korea (2018); Mexico (2015); Argentina and Colombia (2014). The emissions intensity of agricultural output is calculated as the ratio of direct GHG emissions from agriculture to the value of agricultural production. Agricultural GHG emissions per hectare is calculated as the ratio of direct GHG emissions from agriculture to total agricultural land area.
The OECD total does not include the non-OECD EU Member States.
The 11 emerging economies include Argentina, Brazil, China, India, Indonesia, Kazakhstan, the Philippines, Russian Federation, South Africa, Ukraine and Viet Nam.
Source: OECD.Stat (2021), Agri-environmental indicators, https://stats.oecd.org/# ; OECD (2022), "Producer and Consumer Support Estimates", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-pcse-data-en.

19. GHG emissions intensities also vary significantly when comparing across food commodities. Poore and Nemecek (2018[13]) provide estimates of GHG emissions intensities, expressed in kg CO_2eq per kg of product and per nutritional functional unit (e.g. 100g of protein) for more than 40 commodities (Figure 1.5).[14] Emissions intensities are measured using attributional Life Cycle Assessment considering the full supply chain.

20. On average, emissions intensities are highest for ruminant meat, notably beef from beef herds, and lamb.[15] Emissions from dairy systems are shared between milk and meat production, resulting in a

[14] Estimates are based on a comprehensive meta-analysis of 1 530 studies covering more than 38 000 commercial farms in 119 countries.

[15] Beef originating from beef herds generates 90 kg CO_2eq per kg of product and 45 kg CO_2eq per 100g of protein. Lamb and mutton generates 34 kg CO_2eq per kg of product and 17 kg CO_2eq per 100g of protein.

lower carbon footprint for beef from dairy cattle.[16] Emissions intensities are significantly lower for plant-based food products. While rice is more emissions intensive, most other grains generate relatively low emissions per unit of product, and most fruits, vegetables, roots and tubers have even lower average emissions.[17]

21. GHG emission intensities for individual products also vary considerably when considering the full heterogeneity of farms, depending on where and how the relevant product is produced (Figure 1.5). For example, the highest emissions from **beef** producers are more than five times greater than those from the lowest emitters in the case of beef herds, and nearly twelve times those from the least emitting dairy herd producers.[18] This wide variation reflects differences in production systems, which vary in terms of productivity, diet composition, diet quality, and feed use efficiency. Livestock in grazing systems mostly consume grass and tend to have higher emission intensities than mixed crop-livestock systems, where animal feed rations can be more easily optimised. Average emissions intensities are particularly high in grazing systems that lead to the expansion of pasture and hence to additional emissions from land-use change, as well as systems characterised by low feed digestibility, poor animal husbandry and lower slaughter weights (Herrero et al., 2013[14]; Gerber et al., 2013[15]).

22. Within **major staple crops** such as wheat and maize, the highest emissions per kg are three times greater than those from the lowest emitters. Rice is the most emissions-intensive staple crop, as the production of rice in flooded paddies blocks oxygen from penetrating the soil, facilitating the growth of methane-producing bacteria (Adhya et al., 2014[16]). However, the range of emissions among rice farms can vary considerably, with the highest emissions from rice farms reaching levels six times greater than those of the lowest emitters.

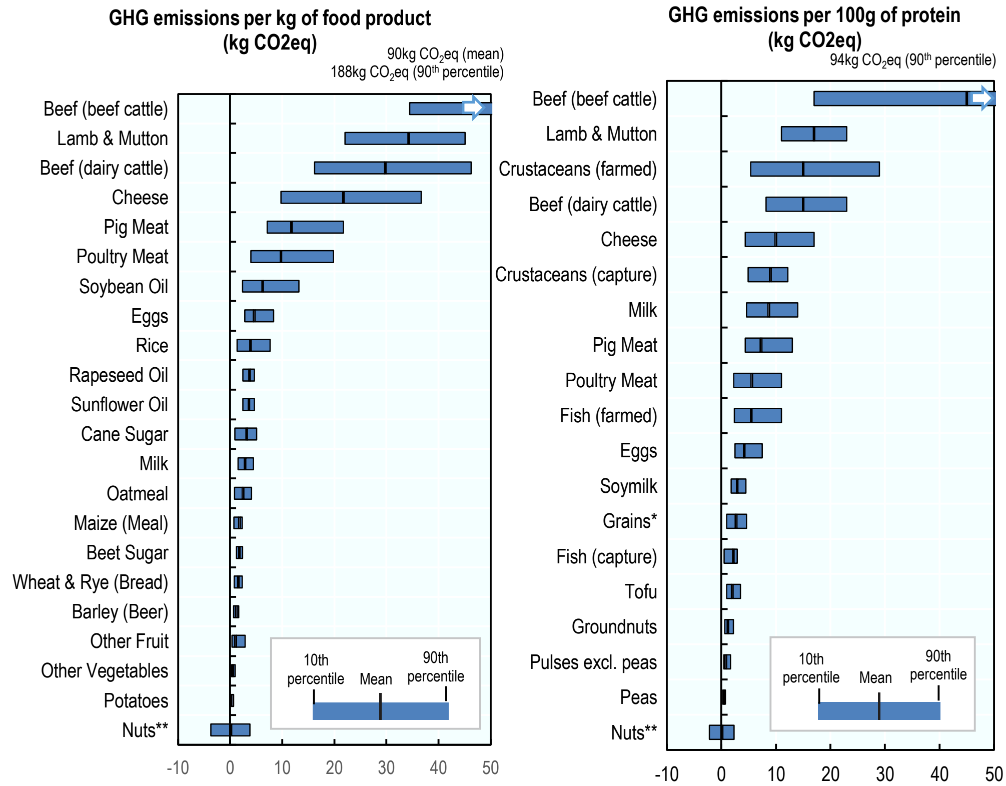
[16] 30 kg CO_2eq per kg of product and 15 kg CO_2eq per 100g of protein.

[17] Rice generates emissions of 3.9 kg CO_2eq per kg of product. Most grains generate less than 3 kg CO_2eq per kg of product and per 100g of protein, while most fruits, vegetables, roots and tubers have average emissions of less than 1 kg CO_2eq per kg of product.

[18] In these examples, highest emissions refers to the 90th percentile, while lowest refers to the 10th percentile. The highest emissions from beef reach 188 kg CO_2eq per kg, compared to 34 kg CO_2eq per kg for the lowest within beef herds and 16 kg CO_2eq per kg for the lowest within dairy herds.

Figure 1.5. GHG emissions intensity of food commodities

Mean, 10th and 90th percentile emissions intensities (per kg of food product and per 100g of protein)



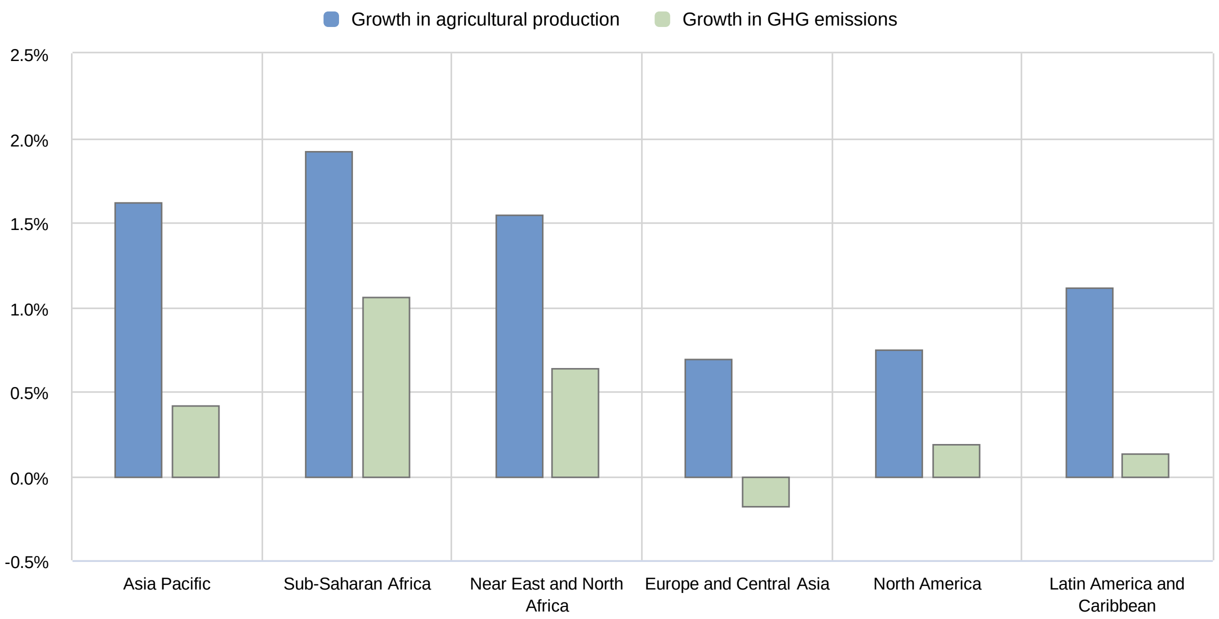
Note: Aggregation of CO_2, CH_4, and N_2O emissions in (Poore and Nemecek, 2018[13]) updated to use IPCC-AR6 100-year GWP. Data for capture fish, crustaceans, and cephalopods from (Parker et al., 2018[17]), with post-farm data from (Poore and Nemecek, 2018[13]), where the ranges represent differences across species groups. CH_4 emissions include emissions from manure management, enteric fermentation, and flooded rice only.
*Grains are not generally classed as protein-rich, but they provide ~41% of global protein intake. Here grains are a weighted average of wheat, maize, oats, and rice by global protein intake (FAO Food Balance Sheets).
**Conversion of annual to perennial crops can lead to carbon sequestration in woody biomass and soil, shown as negative emissions intensity.
Source: (IPCC, 2022[10]); (Poore and Nemecek, 2018[13]).

Looking ahead

23. With the global population projected to reach 9.7 billion in 2050, agricultural emissions are expected to continue to rise in the coming years. Projections from the *OECD/FAO Agricultural Outlook 2022-2031* forecast that direct emissions from agriculture should grow by 6% between 2019-21 and 2031 (assuming no changes in current policies and on-trend technological progress). Livestock would account for more than 85% of the global increase, and agricultural emissions are expected to rise in nearly all regions over the next decade (except for Europe and Central Asia) (Figure 1.6). Emissions growth should be highest in middle and low-income regions, which are characterised by faster output growth and more emissions-intensive production systems. Most of the increase is to occur in Sub-Saharan Africa, where direct GHG emissions from agriculture are projected to grow by 17% over that period.

24. That said, in all regions, agricultural production growth is expected to exceed the growth in direct GHG emissions from agriculture, resulting in a partial decoupling of emissions from production and a decline in the carbon intensity of agricultural production over the next decade. The decoupling of emissions from production represents the continuation of a longstanding trend over the past few decades, and will primarily be driven by yield improvements and a decline in the share of ruminant livestock in total agricultural production (OECD/FAO, 2022[18]).

Figure 1.6. Projected annual growth in production and direct GHG emissions from agriculture, 2022-2031



Note: This figure shows projected annual growth in direct GHG emissions from agriculture together with annual growth in the estimated net value of production of crop and livestock commodities covered in the Outlook (measured in constant USD 2014-16 prices). Estimates are based on historical time series from the FAOSTAT Emissions Agriculture databases which are extended with the Outlook database.
Source: (OECD/FAO, 2022[19]).

25. While longer-term projections vary considerably, most studies predict a continuation of the increase in agricultural GHG emissions by mid-century in the absence of sustained efforts to mitigate these emissions. Under a business-as-usual scenario, FAO (2018[20]) forecasts a 50% expansion in global agricultural output between 2012 and 2050, as well as an 18% increase in harvested areas, a 46% increase in total animal herd size, a 50% growth in nitrogen fertiliser consumption, and a 20% increase in global agricultural GHG emissions. Increases in agricultural emissions could easily exceed 50% over the same time period if less favourable conditions are considered (OECD, 2016[21]; Popp et al., 2017[22]; Springmann et al., 2018[23]).

Opportunities for agriculture to contribute to climate change mitigation

26. As a major source of global GHG emissions, agriculture has an important role to play in helping to meet the world's climate change mitigation objectives. Indeed, the Paris Agreement targets will remain out of reach if mitigation efforts do not include the agriculture and food sectors (Clark et al., 2020[24]). The latest assessment report from the IPCC finds that rapid deployment of mitigation measures in AFOLU will make an essential contribution to all potential pathways to limit the increase in global temperatures to 1.5°C above pre-industrial levels (IPCC, 2022[5]). Based on integrated assessment modelling and technical bottom-up studies, it is estimated that AFOLU as a whole could contribute 20-30% of global mitigation efforts for a 1.5°C or 2°C pathway by 2050, at a relatively modest cost (IPCC, 2022[5]). The largest share of this reduction would come from the protection and restoration of forests and other natural ecosystems, with a smaller but still important contribution coming from agriculture alone (OECD, 2019[25]).

27. There are two major areas of opportunity for the agricultural sector to mitigate GHG emissions:

- *Supply side options.* These involve different areas of intervention aimed at various stages of the production process:
  - *Reducing direct on-farm emissions from agricultural production:* increasing productivity and efficiency in input use through better technology and management, as well as specific technical options reducing agricultural emissions.
  - *Reducing indirect emissions from land use change and increasing carbon stocks in agricultural soils:* reducing the expansion of agricultural land, including through advances in land productivity, restoring degraded lands and rewetting drained peatland, increasing soil carbon sequestration on cropland and grassland, and afforestation.
  - *Reducing emissions from food losses:* limiting losses in the field, and post-harvest losses on the farm.
- *Demand side options.* These options correspond to changes in the demand for agricultural products, at the consumer level, due to changes in dietary preferences, purchase of food with lower embedded emission and reductions of food waste, all leading to lower emission footprint at consumer level.

28. In addition, agriculture can contribute to some extent to global mitigation through bioenergy production. These options do not primarily aim at reducing agricultural emissions, but rather to use agricultural production to reduce emissions from fossil fuels in other sectors (see Box 1.4).

29. This section provides more details on these technical options, both on the supply and the demand side, followed by an overview of their mitigation potentials.

Reducing direct on-farm emissions from agricultural production

30. On-farm emissions mostly relate to non-CO_2 emissions associated with fertiliser use, rice cultivation and, in the case of the livestock sector, enteric fermentation, manure management and manure deposition on soil. Some fossil fuels are also consumed on the farm, for the use of machinery, irrigation, heating of barns, etc., and can form part of mitigation efforts, even if they are not directly accounted as part of the AFOLU sector.

Crop cultivation emissions reduction

31. For many crops, the largest source of emissions is nitrous oxide related to the use of synthetic or organic fertilisers. Improved cultivation practices and more efficient usage of synthetic fertilisers and organic manure have allowed many countries to reduce their nitrous oxide emissions, while steadily expanding agricultural production. However, considerable scope remains to reduce emissions without compromising productivity and food security, as 45% of nitrogen added to fields globally is not absorbed by crops (Blandford and Hassapoyannes, 2018[26]). Advances in precision agriculture and the use of nitrification and urease inhibitors can further enhance the management of crop nutrient cycling, but should be complemented by more holistic approaches, relying on integrated crop management and improved crop rotations (e.g. with legumes and cover crops), as well as crop-livestock systems integration.

32. Irrigated rice is a significant source of methane emissions, generated by the area flooded for its cultivation. Bacterial methane production in rice paddies can be strongly influenced by changes in water management regimes, such as the duration of flooding intervals and frequency of flooding. Midseason drainage, a common irrigation practice in China and Japan, along with intermittent irrigation in northwest India, can result in significantly lower methane emissions (Wassmann, Hosen and Sumfleth, 2009[27]). Improvements in rice yields can also help to reduce emissions from rice cultivation, although there can be

trade-offs between improved water management to reduce methane emissions, and offsetting increased emissions from fertiliser use, and yield size.

Livestock emissions reduction

33. As noted above, the most prominent source of GHG emissions in agriculture is from enteric fermentation of ruminant livestock, with beef having the largest emissions footprint globally by a wide margin per unit of protein produced (Blandford and Hassapoyannes, 2018[26]). On the supply side, the emissions intensity of ruminant products can be reduced through improved productivity at the animal or herd level, or via more direct interventions aimed at limiting enteric fermentation.

34. Increasing feed conversion efficiency in livestock production can be achieved through advances in herd genetics, improving feed and pasture quality, and strengthening farm and animal management, including through disease prevention (MacLeod et al., 2015[28]). All these options also allow for higher production and larger incomes for a given number of animal heads. Due to the large heterogeneity in livestock productivity and emission intensities around the world (Herrero et al., 2013[14]), they could be particularly useful in low and middle income countries to deliver jointly climate mitigation and improvements in food security and nutrition. For advanced economies, the use of methane inhibitors appears more promising, with new technologies being developed, such as chemically synthesised inhibitors, specific species of seaweed that could be used as feed supplements, and anti-methanogen vaccine solutions (Reisinger et al., 2021[29]). Many of these options have been intensively studied over the past decade and could soon become available commercially. That said, questions remain as to their long term efficacy and effects on animal health and productivity, their social acceptability and the required regulatory framework. Feed supplement options may also not be well placed to address emissions from extensive agricultural systems where ruminants are largely grass-fed.

35. Manure management also contributes significantly to livestock GHG emissions. Options to limit associated CH_4 and N_2O emissions include improved application methods, storage and composting, the use of nitrification inhibitors for stored manure and urine patches, alteration of animal diets and grazing practices, manure acidification and solid liquid separation, and the use of anaerobic biodigesters. Such options have already been widely deployed in some regions, with small and large-scale biodigesters producing biogas. While emissions abatement estimates for such mitigation technologies are more limited than for enteric fermentation, reduction potentials exist, in particular in developed regions and for intensive management systems (IPCC, 2022[5]).

Other on-farm emissions

36. On-farm energy consumption from electricity, heat and fuels is an important source of emissions. Various technologies exist to reduce these emissions, including switching to renewable sources of energy such as solar and wind power, and adopting greener and more efficient fuels to power agricultural machinery. The deployment of renewable energies on agricultural land can also provide farmers with an opportunity to earn additional income, for example with special fees for locating wind turbines on their land (the electricity production from which then contributes to the decarbonisation of other sectors). The share of emissions associated with on-farm energy consumption remains small compared to other AFOLU sources, but studies suggest these categories could be relatively cheap to abate and more easily adopted by the farming community (MacLeod et al., 2015[28]).

Reducing land use change emissions and increasing carbon stocks in agricultural soils

37. While productivity improvements in agriculture have reduced the need for agricultural land expansion (see Box 1.3), land use change emissions from agriculture have nonetheless been considerable, due to conversion of forests, grasslands and other carbon stocks into cropland or pastures.

Agriculture currently uses approximately half of the world's habitable land (IPCC, 2019[30]). Livestock occupies about 78% (40 million km^2) of all agricultural land; this includes 35% of global crop production which is devoted to the production of animal feed (Dasgupta, 2021[31]). Empirical studies have shown that agricultural expansion is among the largest drivers of deforestation and degradation worldwide (Busch and Ferretti-Gallon, 2017[32]; Curtis et al., 2018[33]). Recent estimates suggest that large-scale commercial agriculture (i.e. cattle ranching, soy production and palm oil plantations) accounts for about 40% of tropical and sub-tropical deforestation, while local subsistence agriculture is responsible for a further 33% (Hosonuma et al., 2012[34]; FAO and UNEP, 2020[35]). Land use change is also a major cause of declining biodiversity and the depletion of soil carbon, in particular in carbon-rich peat organic soils (IPCC, 2019[30]).

38. Reducing deforestation induced by agricultural expansion is critical to mitigate LULUCF emissions, particularly in tropical regions where agricultural production has expanded significantly into new areas. On the production side, increasing agricultural productivity and yields is key to reducing the need for additional land to meet food demand, as well as reducing (but not eliminating) trade-offs between increased food production and negative impacts on natural ecosystems (see Box 1.3). Productivity gains can also help offset emissions through carbon sequestration, by providing the opportunity to restore and reforest marginal lands. These measures can also be accompanied by demand side options to further reduce the demand for land, as highlighted further below.

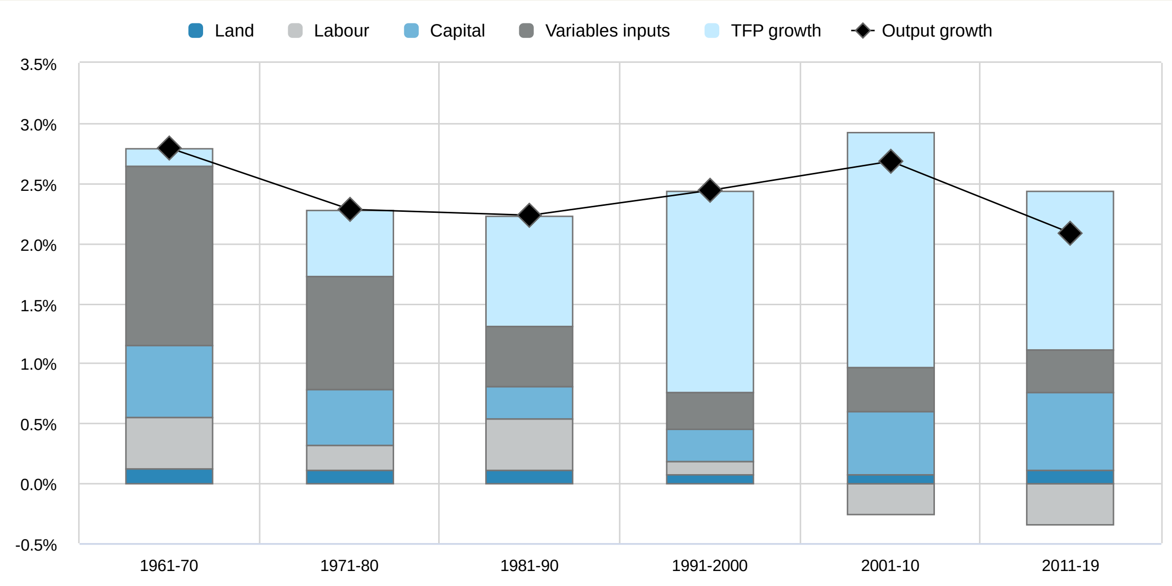
39. However, achieving forest protection requires additional policy interventions, such as the establishment of protected areas, effective law enforcement and forest governance, improvements in land tenure and sustainable management certification. Better forest protection is seen as a major source of emissions abatement, with the largest mitigation potential mostly located in deforestation hotspot regions, in Latin America, Africa and Southeast Asia. Agricultural activities can also lead to the conversion and degradation of other lands, such as grasslands and savannahs; however, the mitigation potential associated with protecting these lands is lower.

40. Among sensitive ecosystems, peatlands deserve particular attention due to the significant carbon stocks that they contain. Peatland drainage leads to large GHG emission releases through soil mineral carbon oxidation, which persist over time, and through peat fires. Globally, around 25 million hectares of drained peatlands (about 0.6% of agricultural land) are estimated to generate around 2% of total anthropogenic emissions (FAO, 2022[36]), and will continue to do so unless these are rewetted. This phenomenon is particularly acute in Southeast Asia, due to the expansion of palm and rubber plantations, which account for 80% of global peat emissions (Leifeld and Menichetti, 2018[37]; IPCC, 2022[5]). Halting and reversing peatland conversion is seen as an important emissions abatement action, at a relatively low cost (Henderson et al., 2022[7]).

Box 1.3. Total factor productivity growth contribution to climate change mitigation

Since the 1960s, the relationship between agricultural production growth and input use has evolved. Notwithstanding continued deforestation associated with expansion of agriculture in the tropics, the growing demand for food has progressively moved production away from increasing use of factors (land, labour, capital) and emission-intensive variable inputs (synthetic fertilisers, animal feed) thanks to total factor productivity (TFP) gains (Figure 1.7). TFP improvements have been the most important source of additional production since the 1990s, based on improved farm management practices, new crop varieties and breeds, and innovations related to digitisation.

Figure 1.7. Sources of growth in global agricultural output, 1961-2019



Note: Each bar represents the annual average growth rate over that period. Agricultural TFP growth is estimated as the residual between output growth and input growth. The aggregate input index is calculated according to the "cost decomposition" methodology, which multiplies the growth rate of each input by their respective factor shares, revealing the extent to which each input contributes to changes in unit costs of production (Fuglie, 2015[38]). Capital includes farm machinery and livestock inventories. Variable inputs include fertilisers and animal feed (all types, except forages and silage).
Source: (USDA, 2021[39]).

Improvements in TFP have greatly mitigated the upward trend in agricultural emissions by decreasing the emissions intensity of agricultural production (i.e. emissions per unit of output) through the more efficient use of agricultural inputs (higher output per hectare of cropland or pasture, per kg of fertiliser, per animal, per kg of animal feed, and per litre of fuel or kW of electricity). Direct emissions from agriculture grew by approximately 0.5% per year between 1990 and 2016, while crop production grew by an estimated 2.5% per year and livestock production grew by about 1.9% per year over the same period (OECD, 2021[40]). This has primarily been achieved through new production techniques implying substitution of labour by capital and more efficient use of inputs, such as fertilisers, animal feed and land.

TFP growth has also enabled a partial "decoupling" of food production growth and land use change, leading to a more than three-fold increase in agricultural production since 1960, while agricultural land use for crops and pasture grew by only 10-15% over the same period (OECD, 2021[40]). Although land use changes from agriculture are still a major concern, productivity growth has been indispensable in enabling agriculture to feed the world. For instance, in spite of increased fertiliser emissions, past land use intensification is estimated to have led to an overall saving of 590 $GtCO_2e$ between 1961 and 2005 through avoided conversion of natural land (Burney, Davis and Lobell, 2010[41]).

Continued improvements in agricultural TFP should therefore contribute to reductions in emissions intensity, both through decreases in the use of emission-intensive inputs and mitigation of land use change. However, it is critical that productivity improvements do not come at the expense of other sustainability dimensions. Productivity improvements do not necessarily lead to a reduction in all input use (substitution may occur) and land use intensification can impact biodiversity and water pollution. This underscores the importance of improving the measurement of TFP to take account of environmental externalities.

Additionally, while TFP growth reduces emissions intensity, this does not necessarily result in lower overall emissions. By lowering agricultural production costs and improving output (and food security), improvements in TFP can also trigger increased production and consumption, thereby offsetting part of the reduction in GHG emissions (Blandford and Hassapoyannes, 2018[26]). This phenomenon is known as the Jevons paradox, which describes the tendency of a resource exploitation to rebound, when its use benefits from an efficiency improvement. This paradox is particularly relevant in the case of large impacts at the margin of agricultural production, such as land use change emissions (Villoria, 2019[42]; Hertel, Ramankutty and Baldos, 2014[43]) or water resource impacts (Grafton et al., 2018[44]).

Notwithstanding these caveats, improving productivity remains fundamental to the mitigation intervention portfolio, in particular for crop and livestock emissions. That said, productivity improvements alone are insufficient and accompanying measures need to be in place to protect natural resources. A better understanding of the trade-offs and synergies in productivity and sustainability efforts is also needed, including through the development of indicators to take account of sustainability impacts in conjunction with TFP increases.

41. Agricultural soils are also an important reservoir of carbon, and the evolution of these stocks depends importantly on crop and livestock management practices. Crop rotations, residue management, tillage intensity, water management and irrigation practices, and biochar application all affect cropland carbon stocks. On grasslands, management of vegetation, cattle stocking density and grazing pressure, as well as fire management also determine the evolution of soil organic carbon. Although conservation practices involving reduced tillage have shown great efficacy in very dry environments, large uncertainty remains in wetter conditions, and soil carbon sequestration measurement and monitoring is key to ensure the potential from this sink is realised. Overall, the economic mitigation potential from soil carbon sequestration remains considerable, as it could offset 4% of total anthropogenic emissions (Henderson et al., 2022[7]).

42. Planting trees on agricultural land also appears to be a promising avenue for carbon sequestration. This can take the form of agricultural plantations (e.g. palm oil on existing agricultural land, orchards, dedicated bioenergy crops), agroforestry (combining trees and shrubs with annual crops or livestock), or simply afforestation of agricultural land. The most suitable options will depend on local and market conditions and policy incentives, but could deliver significant temporary or permanent carbon sequestration. However, an important caveat of afforestation on agricultural land is the indirect land use change effect, as agricultural production could be displaced to other areas, driving additional deforestation.

Reducing food losses

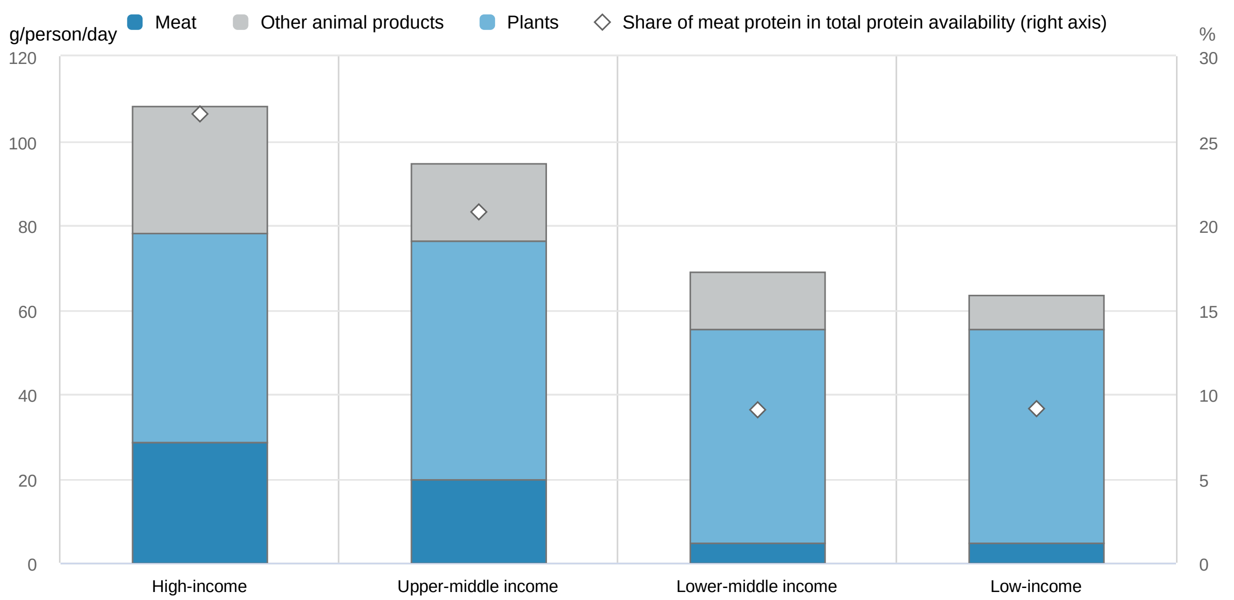
43. Reducing food losses should also provide a significant opportunity to limit emissions related to food production. Food losses occur at all stages of the supply chain, including production, harvesting, transport, storage and distribution. Losses that take place at retail and public or household consumption stage are rather classified as waste (see further below). According to FAO (2019[45]), 14% of food production is estimated to be lost along the supply chain, from post-harvest phase to distribution (but excluding retail). This generates substantial GHG emissions through the need for food production that is not consumed. At the harvest stage, losses can be reduced through better crop quality using agronomic techniques, better timing of harvests and improvements to harvesting equipment. Food losses can be further reduced at the post-harvest stage through better storage infrastructure, and optimisation of food processing facilities, in particular by more efficient transformation processes, improvements in the logistical chain and reduction of contamination. Packaging improvements should also help reducing losses from damages in the logistical chain, while reducing material consumption.

Demand side options: dietary changes and consumer waste reduction

44. Demand side options have gained increased attention, as the general public becomes more aware of the impact of consumption choices and behaviours on climate change. Two main mitigation opportunities can be identified on the demand side: changes in dietary patterns, and reduction of consumer waste.

45. The emissions abatement potential of shifting consumption away from food products with high emissions intensities (e.g. ruminant meat and dairy) and replacing them with less emissions-intensive sources of nutrition (such as plant-based or more efficient animal-based protein, see Figure 1.5) has been well-documented (Stehfest et al., 2009[46]; Popp, Lotze-Campen and Bodirsky, 2010[47]; Tilman and Clark, 2014[48]). Estimates of protein consumption levels in different parts of the world (Figure 1.8) reveal significant potential for reductions in animal-based protein in developed economies, while still remaining within the recommended dietary intakes for proteins. According to a broad literature review by the IPCC (2022[5]), changing diets globally has a feasible potential of 1-2.7 $GtCO_2eq$ for direct agricultural emissions, and up to 4 $GtCO_2eq$ when indirect emissions are also accounted for. For instance, when compared to a conventional (omnivorous) diet, a Mediterranean (less meat and more fruits and vegetables), pescatarian (no meat, more seafood proteins) or vegetarian (only plant based proteins) diet has been shown to deliver important GHG emissions savings globally, as well as substantial health co-benefits (Tilman and Clark, 2014[48]). Food consumption changes towards low emission diets need however to remain nutritionally adequate to be an acceptable option, which requires considering all macro- and micro-nutrients to ensure healthy nutrition (Willett et al., 2019[49]). The feasibility of such large dietary changes at global scale, satisfying both climate and health requirement, is debated. The IPCC indicates that shifting away from high emission intensity products should be feasible in many regions, but economic studies also highlighted the potentially higher cost for the consumer associated with a fully sustainable and healthy diet, in particular in low income regions (Hirvonen et al., 2020[50]).

Figure 1.8. Per capita protein availability, by country income group, 2018-20



Note: Meat includes beef and veal, pork, poultry and sheep meat; Other animal products include dairy products, fish and eggs; Plants include vegetable oil, pulses, roots and tubers and cereals (maize, wheat and rice). The recommended WHO dietary intake for protein is 0.83g/kg body weight per day i.e. 58 g/day for a 70 kg adult.
Source: (OECD/FAO, 2021[8]).

46. Beside climate change and nutritional benefits, dietary changes are also expected to deliver other sustainability benefits. For instance, pasture represents two-thirds of agricultural land globally, rising to 78% of farming land when feed crop requirements are included. The expansion of cattle systems is strongly tied to deforestation patterns and the loss of biodiverse ecosystems in Latin America. Overgrazing is also responsible for large carbon and biodiversity losses for grass-fed systems, while for more intensive ones, high stocking densities lead to nutrient surpluses that are important sources of water pollution. That said, reducing animal products in diets poses immense challenges for livelihoods and for rural development. Livestock represents an important part of agricultural value added in many developed economies, while in poorer regions, rural populations are often dependent on cattle rearing for their basic income and food security. Pasture land cannot always be converted to other agricultural use due to topographical and climate constraints, and animals can also be a source of organic fertilisers that would require substitutes. Transformations would therefore need to be context-specific, progressive and accompanied with appropriate reconversion programmes and social safety nets, as well as local development and landscape adaptation plans.

47. Besides dietary changes, reducing food waste represents an important potential mitigation option, with possible decreases in the amount of production needed without impacting food consumption (Table 1.1). Beyond behavioural changes driven by increased consumer awareness, possible interventions include regulation and taxation targeting retailers and large businesses; reporting and reduction targets; longer-lasting products; and incentives for consumers to purchase cosmetically imperfect products. Food waste reduction would also bring a number of environmental co-benefits related to lower production; but, again, would also have revenue implications for farmers.

Table 1.1. Waste in food consumption

	Average food waste (kg/capita/year)		Global food waste in 2019 (Mt)
	High income countries	World*	
Household	79	74	569
Food service	26	32	244
Retail	13	15	118
Total	118	121	931

Note: *World estimates are based on a sample covering 75% of the world population for “Household”, 32% for “Food services” and 14% for “Retail”.
Source: UNEP (2021[51]).

Box 1.4. Bioenergy from agricultural sources

Conventional bioenergy is not a supply-side option for mitigating agricultural emissions in a strict sense, as its main mitigation effect comes from the replacement of fossil fuels consumed in the rest of the economy. Because the absorption of CO_2 during plant growth offsets emissions subsequently generated through the combustion of the biomass, the convention is to not account for emissions resulting from their combustion. This assumption, called carbon neutrality, does not mean that biofuels completely offset fossil fuel emissions, because the cultivation, collection and transformation of feedstocks to produce these fuels is also a source of GHG emissions. The final levels of GHG savings associated with biofuels is determined by a life cycle assessment (LCA), comparing emissions from the biofuels supply chain with the emissions from fossil fuel alternatives along their production and combustion cycle (OECD, 2008[52]).

The largest source of bioenergy at present is solid biomass from forests used in energy power plants (modern biomass) and traditional use at home for cooking and heating through wood collection, common in developing countries (traditional biomass, considered unsustainable). In contrast, agricultural feedstocks are used mainly for the production of liquid biofuels and biogas, and their use has recently become more mainstream. The most common feedstocks for biofuels are sugar cane in Brazil and maize in the United States, both of which are converted into ethanol, as well as vegetable oils from palm and rapeseed that are used for biodiesel, for instance in Europe and Southeast Asia.

Feedstocks derived from crops that are used for biofuels, also called first-generation feedstocks, show relatively mixed performance in terms of GHG savings, and have made a limited contribution to overall mitigation to date (OECD, 2019[25]). More advanced feedstocks based on agricultural residues (sugar cane bagasse, cereal straw, corn stover, rice husk) are often considered more promising, but their availability remains limited, and, similar to first-generation feedstocks, may compete with alternative uses. These feedstocks can be used as solid biomass or transformed through more advanced processes to be used as liquid biofuels with much higher environmental benefits. Similarly, dedicated lignocellulosic crops can be grown to produce such fuels with higher efficiency, and with the possibility of growing on marginal land. Yet these so-called second-generation energy crops remain expensive to convert into fuels and their deployment currently remains limited in scale.

Biofuels may also be a direct mitigation option for the AFOLU sector. Biodigesters reduce non-CO_2 emissions from manure management and produce biogas that substitutes for fossil fuel energy sources. Dedicated energy crops can also sequester carbon in the soil through reduced tillage management, whereas palm tree and wood plantations increase carbon storage time in landscape vegetation. Bioenergy with carbon capture and sequestration (BECCS) involves reinjecting emissions from the biofuel production process into geological reservoirs. Although considered as the most efficient route, this latter technology is not mature at the present time.

The overall environmental benefits of land-based biofuels depend not only on their local management, but also on their indirect effects on land use. The displacement of crops and animals to convert land to biofuels has been heavily debated as a possible source of additional GHG emissions that may occur in different regions of the world and the associated potential emissions are generally not considered in LCA. For this reason, some countries have considered additional safeguards or restrictions on their use (minimum emission saving thresholds, incorporation rate caps, or specific certification criteria). Due to the significant need for decarbonisation across the rest of the economy to achieve carbon neutrality, bioenergy will likely remain part of the mitigation options to which agriculture will need to contribute, in particular for sectors that currently have limited alternatives to reduce their emissions (e.g. international aviation), and where land use impacts can be contained.

Mitigation measure potentials

48. The potential contribution of the different measures above to climate change mitigation varies depending on their nature, the sources they are targeting and the regions where they are applied. The IPCC estimates that AFOLU as a whole has a technical potential of 28 $GtCO_2eq$ per year, bioenergy excluded, which is about half of annual anthropogenic emissions over 2010-2019. The economic potential would, however, be lower, with 8-14 $GtCO_2eq$ of reduction per year achievable at a cost less than USD 100 per tCO_2eq, 30-50% of which would be actionable for less than USD 20 per tCO_2eq. The detailed mitigation potentials per AFOLU action area are presented in Table 1.2 below, as identified by the IPCC, based on bottom-up sectoral assessments, and corresponding to the upper bound of the 8-14 $GtCO_2eq$

total feasible economic potential.[19] Supply side measures represent an economic mitigation potential of about 10 $GtCO_2$ per year, but only 0.6 $GtCO_2eq$ are estimated as being achievable through reductions of on-farm non-CO_2 emissions, representing only 10% of these agricultural sources, underscoring the importance of action in the LULUCF domain. Agricultural soils can in particular contribute 1.6 $GtCO_2eq$ per year according to IPCC, which is also consistent with the estimate from Henderson et al. (2022[7]).

49. Demand side measures are shown to have relatively high potential, at 4.2 $GtCO_2eq$ per year, and could reach much higher levels if land expansion emission savings, as well as other supply chain emissions, are also accounted for (up to 8 $GtCO_2eq$ per year).[20] The comparative cost-efficiencies of demand-side versus supply-side measures are subject to debate. The IPCC estimates an economically feasible potential of 2.2 Gt CO_2eq per year for demand side measures, but many of these options depend on consumer behavioural changes, which, while potentially requiring lower upfront investment, may be hard to introduce due to normative, cultural and institutional resistance. In terms of efficacy, both channels of action are seen as having significant mitigation potential for the same sources (OECD, 2019[25]), and there is a growing consensus on the need to use both in combination.

50. The current composition of food production, relying on a large share of land and crop production dedicated to animal products, is at the core of the climate mitigation challenge for agriculture. However, it is also important to recognise the heterogeneity of emission intensities on the supply side. Targeting emissions hotspots and addressing the most inefficient and emissions-intensive producers could drastically reduce GHG emissions without necessarily impacting consumption.[21]

Table 1.2. Global AFOLU abatement potentials relevant for agriculture, 2020-2050 time horizon

Average IPCC estimates (with reviewed range in parenthesis) – $GtCO_2eq$

	Abatement technical potentials	Abatement economic potentials (cost < USD 100 per tCO_2eq)
Supply side measures	21.3 (5.4 – 49.6)	10.0 (4.9 – 17.4)
Direct on farm emissions	1.7 (0.5 – 3.2)	0.6 (0.3 – 1.3)
Crops cultivation	0.3 (0.06 – 0.7)	0.2 (0.05 – 0.6)
Rice cultivation	0.3 (0.1 – 0.8)	0.2 (0.05 – 0.3)
Enteric fermentation	0.8 (0.2 – 1.2)	0.2 (0.1 – 0.3)
Manure management	0.3 (0.1 – 0.5)	0.1 (0.09 – 0.1)
Land use and agricultural soils*	19.6 (4.9 – 46.4)	9.4 (4.6 – 16.1)
Deforestation	4.5 (2.3 – 7.0)	3.4 (2.3 – 6.4)
Afforestation and reforestation	3.9 (0.5 – 10.1)	1.6 (0.5 – 3.0)
Other LUC conversion	0.2 (0.1 – 0.4)	0.04 (0.0 – 0.1)
Peatlands protection and restoration	1.6 (0.9 – 3.3)	0.9 (0.4 – 1.3)
Soil organic carbon		
Cropland	1.9 (0.4 – 6.8)	0.6 (0.4 – 0.9)
Grassland	1.0 (0.2 – 2.6)	0.9 (0.3 – 1.6)
Biochar	2.6 (0.2 – 6.6)	1.1 (0.3 – 1.8)

[19] The lower bound corresponds to the average results based on Integrated Assessment Models (IAMs). These models have the advantage of capturing the possible combinations between options in a structurally consistent framework, but they do not capture all the range of mitigation options analysed by sectoral models.

[20] Technical potentials can be as high as 8 $GtCO_2eq$ for dietary changes and 5.8 $GtCO_2eq$ per year for food loss and waste reduction, according to IPCC (2022[5]). Considering there are strong overlaps between these two mitigation options, acting on the same sources, we do not sum up here the two estimates but only present the highest.

[21] For instance, in the case of beef originated from beef herds, 25% of production with the largest emissions intensities represent 56% of the sector's emissions and 61% of land use (Poore and Nemecek, 2018[13]).

	Abatement technical potentials	Abatement economic potentials (cost < USD 100 per tCO_2eq)
Agroforestry	4.1 (0.3 – 9.4)	0.8 (0.4 – 1.1)
Other AFOLU non relevant for agriculture	*2.9 (1.2 – 8.4)*	*1.4 (0.7 – 2.4)*
Demand side measures**	4.2 (2.2 - 7.1)	2.2 (1.1– 3.6)
Diet change***	N/A	1.7 (1.0 – 2.7)
Food waste and losses***	N/A	0.5 (0.0 – 0.9)
TOTAL AFOLU (agriculture related)*	25.5 (7.6 – 56.7)	12.2 (6.0 – 21.0)

Note: Land use categories relevant for agriculture indicate the full mitigation potential of the category, even if only a part of it can be achievable through the agricultural sector (e.g. afforestation). All estimates are based on sectoral assessment data and reflect averages. Uncertainty ranges are documented in IPCC (2022[5]).
* Total excluding "Other AFOLU non relevant for agriculture", featured for completeness. The following categories are not accounted: forest management, fire management, coastal wetlands protection and restoration. ** IPCC only provides a total estimate for technical potential of demand side measures. The split between dietary change and food waste is however available for economically feasible potentials. *** Estimates corresponding to avoided agricultural production emissions (land use change excluded to limit double-counting).
Source: (IPCC, 2022[5])

What are countries doing to mitigate agricultural emissions?

51. Considering the role that AFOLU has to play to meet the 2015 Paris Agreement's objectives, ambitious policy action on agriculture is needed to ensure that countries take advantage of the opportunities available for mitigation. This section provides an overview of the targets set by countries and the policies introduced to mitigate agricultural emissions. While the coverage is not exhaustive, it aims to shed light on the main policies and instruments relating to mitigation in agriculture.

Setting mitigation targets for agriculture

52. All of the 54 countries covered in this report have submitted Nationally Determined Contributions (NDCs) under the Paris Agreement of the United Nations Framework Convention on Climate Change (UNFCCC). However, national ambitions and commitments to mitigate emissions vary considerably across countries (Table 1.3). While most of the countries covered in this report have set intermediate targets for 2030 and net zero targets for 2050 (or in some cases, 2060 or 2070), not all countries have established these as binding targets within their legislation. Out of the 54 countries covered in this report, 36 countries (plus the European Union as a whole) have communicated their long-term strategies to the UNFCCC.

53. Although agricultural emissions are included in most countries' NDCs, only 16 out of the 54 countries have set specific emissions reduction targets for their agricultural sectors. Where agricultural targets have been defined by countries, they are typically lower than the reductions needed to stabilise global temperatures at 2°C (Henderson, Frezal and Flynn, 2020[53]).

Table 1.3. Economy-wide and agriculture-specific GHG mitigation targets

	Economy-wide emissions reduction targets		Long-term strategy submitted to UNFCCC	Agriculture-specific target (base year/level)	Global methane pledge (reduce global CH_4 -30% from 2020 levels by 2030)
	2030 target (base year/level)	2050 target			
Argentina	Max 359 $MtCO_2eq$	None	No	None	Yes
Australia	-26-28% (2005)	Net zero	Yes	None	No
Brazil	-50% (2005)	Net zero	No	None	Yes
Canada	-40-45% (2005)	Net zero	Yes	-30% fertiliser emissions by 2030 (2020)	Yes
Chile	Max 95 $MtCO_2eq$	Net zero	Yes	None	Yes
China	Peak CO_2 ; -65% GDP emission intensity (2005)	Net zero by 2060	Yes	None	No
Colombia	-51% (BAU)	Net zero	Yes	None	Yes
Costa Rica	Max 9.11 $MtCO_2eq$	Net zero	Yes	None	Yes
European Union	-55% (1990)	Net zero	Yes	None at EU level	Yes
EU Member States			18 out of 27 countries (except BGR, CYP, EST, GRC, HRV, IRL, ITA, POL, ROU)	2030 targets: BEL -25% (2005); DNK -55% (1990); DEU -31-34% (1990); FRA -18% (2015); IRL -22-30% (2018) PRT -11% (2005)	19 out of 27 countries (except AUT, CZE, HUN, LVA, LTU, POL, ROU, SVK)
Iceland	-55% (1990)	"Largely neutral" by 2040	Yes	None	Yes
India	-45% GDP emission intensity (2005)	Net zero by 2070	No	None	No
Indonesia	-29% from BAU; up to -41% conditional on int. support	Net zero by 2060	Yes	None	Yes
Israel	-27% (2015)	-85% from 2015 levels	No	None	Yes
Japan	-46% (2013)	Net zero	Yes	49.5 $MtCO_2eq$ by 2030	Yes
Kazakhstan	-15% (1990)	None	No	None	No
Korea	-40% (2018)	Net zero	Yes	-27.1% by 2030; -37.7% by 2050 (2018)	Yes
Mexico	-22% (BAU); up to -36% conditional on int. support	None	Yes	-8% by 2030 (BAU)	Yes
New Zealand	-50% (2005)	Net zero except methane	Yes	-24-47% reduction in biogenic methane by 2050	Yes
Norway	-50-55% (1990)	-90-95% (1990)	Yes	Voluntary agreement with agriculture sector: -5 $MtCO_2eq$ by 2030	Yes
Philippines	-2.7% (2020); up to -75% conditional on int. support	None	No	-29.4% by 2030 (BAU) conditional on int. support	Yes
Russia	-30% (1990)	Net zero by 2060	No	None	No
South Africa	350-420 $MtCO_2eq$ (BAU 398-614 $MtCO_2eq$)	None	Yes	None	No
Switzerland	-50% (1990)	Net zero	Yes	-40% by 2050 (1990)	Yes
Turkey	-21% (BAU)	Net zero by 2053	No	None	No
Ukraine	-65% (1990)	Net zero by 2060	Yes	None	Yes
United Kingdom	-68% (1990)	Net zero	Yes	-17-30% by 2030 ;	Yes

	Economy-wide emissions reduction targets		Long-term strategy submitted to UNFCCC	Agriculture-specific target (base year/level)	Global methane pledge (reduce global CH_4 -30% from 2020 levels by 2030)
	2030 target (base year/level)	2050 target			
				-24-40% by 2035 (2019)	
United States	-50-52% (2005)	Net zero	Yes	None	Yes
Viet Nam	-9% (BAU); up to -27% conditional on int. support	Net zero	No	-20% every 10 years	Yes

54. Some countries have set targets to reduce specific GHGs, such as methane or nitrous oxide emissions. Under the Zero Carbon Amendment Act 2019, **New Zealand** has set separate long-term emission reductions targets for long-lived and short-lived GHG emissions. This includes a specific objective for methane, targeting a reduction in biogenic methane emissions of 10% by 2030 and 24-47% by 2050 (relative to 2017 levels). **Canada** set a national target to reduce emissions from fertilisers by 30% from 2020 levels by 2030, and will work with fertiliser manufacturers, farmers, provinces and territories to develop an approach to meet the target. **China's** first NDC submitted in 2016 included a target for achieving zero growth in fertiliser and pesticide utilisation by 2020, which the government reported as achieved in 2018, as well as broad objectives to control methane emissions from rice fields and nitrous oxide emissions from farmland. **Korea** set a target of reducing methane emissions by 30% by 2030 (relative to 2018 levels), and 20.6% in the agricultural sector.

Policy levers to mitigate agricultural emissions

55. Governments have a range of policy instruments at their disposal to mitigate agricultural emissions. These can be divided into four broad categories: emissions pricing instruments; agricultural support, grants and preferential credits; environmental regulations; and R&D and knowledge transfer.

56. Research shows that these policy approaches perform quite differently with respect to their effectiveness in reducing emissions, cost effectiveness, and impacts on producers, consumers and government budgets (OECD, 2019[25]). Emissions pricing instruments based on the "polluter pays principle", by either taxing emissions or establishing tradeable permits, are the most effective at reducing emissions for a given carbon price because they provide incentives to adopt low emission measures, switch from higher to lower-emission commodities, and scale back overall production and emissions. These policies also raise revenue for governments. On the other hand, they also impose costs on producers, particularly farmers producing emission-intensive commodities, and consumers, and these welfare impacts need to be managed. Regulations restricting specific high emission practices can also impose costs on producers and consumers, but they lack the efficiency and cost effectiveness of policies based on the "polluter pays principle" (Baumol and Oates, 1988[54]).

57. Policies based on the "beneficiary pays principle" that subsidise emission reductions can provide an alternative market-based approach, and one which does not impose costs on producers or raise food prices. However, these policies require careful design to ensure that producers are not over-compensated, they tend to be less effective, and they can impose large costs on governments and other sectors purchasing emission reductions (if implemented on a large scale). The use of grants to support the adoption of low emission practices, either directly or via cross-compliance requirements, shares some similarities with abatement subsidies. However, since grants do not use competitive market-based approaches to disburse funds and typically do not have stringent emission measurement requirements, they do not set an explicit carbon price and are less efficient than abatement subsidies (OECD, 2019[25]).

58. Other supply-side mitigation policy approaches such as R&D and knowledge transfer, and preferential credit schemes are particularly relevant for stimulating the adoption of profitable mitigation measures that are un- or under-utilised due to knowledge and financing barriers. They can also provide an enhanced enabling environment to improve the performance of other mitigation policies and, in the case

of R&D and knowledge transfer, they can stimulate innovation and competitiveness over the longer term and help drive down emissions without imposing costs on producers and consumers (OECD, 2019[25]). Investment in accurate and affordable measurement, reporting and verification (MRV) procedures and technologies is also critical, particularly for enabling the efficient functioning of emission pricing policies.

59. Table 1.4 presents specific policy instruments corresponding to these categories and some selected examples of countries that have applied these instruments.

Table 1.4. Policy levers to mitigate agricultural emissions

Policy category	Specific instrument	Examples
Emissions pricing instruments	Emissions taxes	
	Emissions trading schemes / carbon offsets	New Zealand (NZ ETS)
	Abatement subsidies / auctions	Australia (Emissions Reduction Fund)
Agricultural support, grants and preferential credits	Agricultural support	EU (CAP); Canada; other countries
	Grants	United States (biogas); China; Australia
	Dedicated credit line	Brazil (ABC programme)
Environmental regulations	Pollution regulations	EU (Nitrates directive and pollution control)
R&D and knowledge transfer	R&D	Global Research Alliance
	Knowledge transfer	Multiple countries

Source: (Henderson, Frezal and Flynn, 2020[53]).

Emissions pricing instruments

60. Emissions pricing instruments aim to influence incentives for production and consumption. Mechanisms that put a price on emissions include carbon pricing through emissions taxes and emissions trading schemes, carbon offsets, and some abatement subsidies (e.g. those that are delivered via auctions). There are relatively few examples of countries that have introduced emissions pricing to mitigate agricultural emissions.

61. **Australia's** Emissions Reduction Fund (ERF) was established in 2015 and is a voluntary scheme providing incentives for businesses to undertake emissions reductions and carbon sequestration projects that meet strict integrity requirements, including in relation to additionality. For agriculture, landowners and farmers can earn income by generating Australian Carbon Credit Units (ACCUs) for every tonne of emissions reduced or carbon stored through a project, and selling these to the government or to third parties. As of April 2022, the ERF had committed AUD 2.7 billion (USD 2 billion) through 14 auctions for a total of 217 $MtCO_2eq$ of abatement, including 15.2 $MtCO_2eq$ of agricultural emissions (of which just 1.1 $MtCO_2eq$ of abatement has been delivered so far). **Japan** introduced the J-Credit scheme in 2013, providing certified carbon credits for emissions reductions and carbon sequestration activities such as introduction of energy-saving technologies and forest management. As of January 2022, 107 projects were registered in the agriculture, forestry and fisheries sectors, with expected emission reductions or avoidance totalling 1.5 $MtCO_2eq$.

62. Ultimately, the scale of such voluntary market-based approaches is limited by the availability of funding from the government and private sector to pay producers for emissions reductions (Henderson, Frezal and Flynn, 2020[53]). Combining emissions abatement with other environmental services offers one possibility for farmers to increase and diversify their sources of funding. **Australia** recently launched the Carbon + Biodiversity Pilot, trialling a market-based approach to pay farmers for long-term biodiversity improvements, on top of income they can earn from the ERF for carbon sequestration projects. Landholders are required to plant, manage and maintain their carbon plantings in line with biodiversity protocols developed by the Australian National University.

63. Emissions pricing instruments that apply the “polluter pays” principle are not subject to these constraints. **New Zealand** has developed an Emissions Trading Scheme, which covers all sectors of the economy, although it does not currently cover methane and nitrous oxide emissions from agricultural production. Forestry emissions are included in the scheme, increasing the incentives for farmers and landowners to reduce deforestation and store carbon by converting pastureland to forests. Companies in the agricultural supply chain (e.g. meat processors, dairy processors, nitrogen fertiliser manufacturers and importers) are required to report on their agricultural emissions, but are not required to pay for their emissions. The New Zealand ETS also imposes a cost on emissions from transport fuels, electricity production, synthetic GHGs, waste and industrial processes, including in the primary sectors. Options for pricing agricultural emissions are currently under discussion.

64. Agricultural emissions tend to be excluded from most other economy-wide carbon pricing schemes, and are often dealt with through other mechanisms. The **EU** emissions trading scheme (EU-ETS) provides a framework for emissions reductions in the power, manufacturing and aviation industries, but does not include agricultural emissions, which are subject to annual mitigation targets under the EU’s Effort Sharing Decision (for non-CO_2 emissions from agriculture) and the LULUCF Decision (for CO_2 emissions from land use change). The **Korean** Emissions Trading Scheme (KETS) was introduced in 2015, and imposes emission reduction obligations on companies that exceed a defined GHG emissions threshold. While agriculture is not currently included in the KETS, the Korean Ministry of Agriculture, Food and Rural Affairs operates voluntary emission reduction and offset projects to reduce emissions in the agricultural sector, and subsidises the cost of verification. Farmers can obtain certified offset credits for emission reduction projects and sell these in the emissions trading market. Several regional and state-level emissions trading schemes are in place or in the process of being set up in the **United States,** including in California, Washington, Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, Vermont and Virginia. While agriculture is not required to reduce GHG emissions under these programmes, it is a permitted source of offsets in all of them.

65. Several countries have introduced taxes on emissions, but these also exclude the agricultural sector. **Canada’s** carbon pollution pricing system, in place in every jurisdiction since 2019, largely excludes the agricultural sector. **Indonesia** has established legislation to introduce a carbon tax, due to be implemented in July 2022. The carbon tax is initially limited to coal fired power plants, and will provide the basis for the development of a broader carbon tax mechanism and a carbon exchange where companies can trade their emissions permits by 2025. **Norway’s** agricultural sector is largely exempt from the country’s carbon tax, with the exception of emissions from fossil fuel use in agriculture. **South Africa** introduced a national carbon tax under the 2017 Carbon Tax Act, however primary agriculture is exempted from the current Phase 1.

Grants, income support and credit programmes

66. Subsidised loans are sometimes used as a tool to encourage emissions reductions in agriculture. **Brazil’s** Low Carbon Agricultural Programme or GHG Emission Reduction Program (ABC programme) was launched in 2010, and provides resources and incentives to farmers for adopting sustainable agricultural practices and technologies. The ABC programme provides low-interest loans to farmers for activities that reduce emissions, such as recovering fragile areas and pastureland, expanding integrated crop-livestock-forestry systems and no-till farming, adopting forest conservation practices, improving unproductive and degraded soils, forest planting, organic agriculture, bio-inputs and bio-fertilisers and renewable energy generation for agriculture. The programme reduced an estimated 166 $MtCO_2eq$ of emissions over the period from 2010 to 2019. The **United States** has introduced initiatives providing preferential credit and grants to promote the adoption of GHG mitigation practices. For example, the Rural Energy for America Program (REAP) provides guaranteed loan financing and grant funding to agricultural producers for the adoption of renewable energy systems and energy efficiency improvements. The

AgSTAR: Biogas Recovery in the Agriculture Sector programme helps producers to find information and financing for biogas recovery systems to reduce methane emissions from livestock waste.

67. Several countries have provided funding for initiatives that promote afforestation and soil carbon sequestration. **Canada's** Natural Climate Solutions Fund has made more than USD 2 billion available over ten years to plant two billion trees, USD 48 million over two years to protect existing wetlands and trees on farms, and USD 470 million for projects that conserve, restore and enhance wetlands, peatlands and grasslands. **China's** Grain for Green programme was introduced in 2000 and provides direct payments to farmers to re-establish forest and shrub vegetation on sloped cultivated land at risk of erosion, and to afforest large tracts of barren land. The programme is estimated to have achieved 29 million hectares of afforestation, including converting 9 million hectares of cropland to forestland. **India's** Ministry of Environment, Forest and Climate Change has been conducting the National Afforestation Programme since 2000, targeting community-based activities such as agro-forestry, improved soil conservation and restoration of degraded forests. **Ireland's** Afforestation Scheme was established in 2014 and provides grants and financial support to encourage the establishment and maintenance of new forests and woodlands.

68. **Ukraine** introduced the Green Country large-scale afforestation of Ukraine initiative, which aims to plant one billion trees over the next three years, and increase forested areas by one million hectares over the next ten years. The **United Kingdom** has introduced several new environmental land management schemes that contribute to the mitigation of emissions through tree planting and peatland management and restoration. These include **England's** Farming in Protected Landscapes Scheme, **Scotland's** Forestry Grant Scheme, and **Wales'** Forests for Our Future Programme. The **United States** set up the temporary Pandemic Cover Crop Program (PCCP), which encourages the adoption of cover crops by providing reduced crop insurance premiums for producers who plant a qualifying cover crop during the 2021 or 2022 crop years.

69. **India** has several programmes in place to reduce emissions from rice production, including systems of rice intensification under the National Food Security Mission (currently being implemented in 24 states), providing farm equipment to enable timely sowing in standing paddy residues, and Custom Hiring Centres and Farm Machinery Banks to enable sowing of wheat crops without the burning of paddy residues. **Japan** provides farmers with direct payments for mitigation activities, such as applying compost, extending the period of mid-season drainage in paddy rice fields, and reducing the use of synthetic fertilisers. Area-based payments are provided to dairy farmers for implementing environmentally friendly practices such as no-till farming in conjunction with reducing the use of synthetic fertilisers and pesticides. Investment support is provided to farmers for introducing renewable energy, biogas plants and composting facilities for better manure management and clean energy production, and biomass-based greenhouse heating systems in horticulture. Since 2014, **Switzerland** has provided resource efficiency contributions to farmers to support the use of environmentally friendly techniques such as conservation tillage systems (no-till, strip-till and mulch tillage), emission-reducing application methods for farmyard manure, and nitrogen-reduced phase feeding of pigs.

Environmental regulations

70. Regulatory policy instruments to reduce diffuse pollution from agricultural inputs such as fertilisers and manure can also have a strong influence on agricultural GHG emissions. The **EU** Nitrates Directive was established in 1991 and aims to prevent nitrate pollution of surface water and groundwater resources by promoting the use of good farming practices. While nitrate is not a GHG, by restricting nitrogen inputs into the agricultural system the directive also helps to mitigate important sources of nitrous oxide emissions. This includes establishing limitations on the application of nitrogen fertilisers and livestock manure on land, restricting livestock stocking rates, setting minimum storage requirements for livestock manure, and establishing crop rotations, soil winter cover and catch crops to prevent nitrate leaching and runoff. **Norway**

has established regulations for manure and fertiliser management to control emissions from these sources, and restricted the cultivation of peat bogs to prevent additional emissions from organic soils. As of 2025, agricultural buildings will be prohibited from using fossil fuels for heating (this ban is in effect for other building types as of 2020). **Switzerland's** water quality plan adopted in 2022 introduces a minimum reduction target of 20% for nitrogen and phosphorus fertiliser losses by 2030. More stringent environmental cross-compliance requirements relating to manure application will further increase farmers' incentives to reduce their use of fertilisers.

71. **EU** cross-compliance rules can also support efforts to mitigate agricultural emissions by requiring farmers to respect EU rules on public, animal and plant health, animal welfare and the environment. In addition, farmers receiving CAP support are required to respect EU standards on good agricultural and environmental condition of land, including standards to prevent soil erosion, maintain soil organic matter and soil structure, maintain permanent grassland, protect biodiversity and protect and manage water. In **Kazakhstan**, some interest rate subsidies provided to livestock producers come with an obligation to rehabilitate their pasture lands, which could potentially help to lower agricultural emissions. **Korea** introduced a direct payment system with enhanced environmental cross-compliance requirements and increased green coverage through expanded urban farming. The **United States** also ties eligibility for federal farm programmes and subsidies to conservation practices.

72. Deforestation is an important driver of agricultural emissions in many countries. In **Argentina**, the 2007 National Law of Native Forests, the 2015 National Forest Management Plan with Integrated Livestock (MBGI) and the Law for the Promotion of Forests are efforts to ensure good practices and curb deforestation. **Brazil's** Forestry Code contains regulations to constrain land use change, and makes access to subsidised credit conditional on compliance with environmental regulations.

73. Regulations to promote biofuels can to some extent contribute to reductions in emissions from fossil fuels. For example, **Canada's** Clean Fuel Standard (CFS) will support the domestic production of biofuels by requiring liquid fuel suppliers to gradually reduce the carbon intensity of their fuels over time. The CFS will establish a regulated market for carbon credits, allowing ethanol and bio-diesel producers to earn credits for supplying low carbon intensity biofuels. It is complemented by the government's recent USD 1.1 billion investment in the Low-carbon and Zero-emissions Fuels Fund, which will support the domestic production of feedstocks for biofuels.

R&D and knowledge transfer programmes

74. Many of the countries covered in this report provide funding for R&D and knowledge transfer programmes to support the mitigation of agricultural GHG emissions. **Australia's** Long-Term Emissions Reduction Plan sets out the government's plan to achieve net zero emissions by 2050. It includes the Technology Investment Roadmap, which aims to accelerate the development and commercialisation of new and emerging low emissions technologies, including in the agricultural sector. **Canada's** 2030 Emissions Reduction Plan provides USD 366 million for the On-Farm Climate Action Fund to help farmers adopt climate friendly practices such as nitrogen management, cover cropping and rotational grazing, and USD 234 million for the Agricultural Clean Technology Programme to support R&D, commercialisation and the adoption of new clean technologies for the agricultural sector. In addition, USD 78 million is provided for Transformative Science and USD 117 million is allocated for a resilient Agricultural Landscape Programme. **Chile's** Long-Term Climate Strategy was launched at COP26 in November 2021, and contains several objectives relating to the promotion of R&D and extension services to reduce agricultural emissions. Under the Agricultural Technology Development and Application Plan to Achieve Carbon Neutrality by 2050, **Korea's** Rural Development Administration is working to expand the development of low-carbon technologies for agriculture such as alternate wetting and drying for rice cultivation and recycling of livestock manure, increase the use of renewable energy and energy-efficient technologies, and enhance the carbon sequestration capacity of soils. The **United States** Department of Agriculture's

Climate Hubs develop science-based information and technologies, and deliver them in co-operation with USDA agencies and partners to support the implementation of climate-smart practices. State-level extension services also provide outreach, training, technical assistance and on-farm testing of climate mitigation practices.

75. A number of countries have established research initiatives to tackle livestock emissions. **Australia** is providing USD 23.1 million in funding over six years for the Methane Emissions Reduction in Livestock (MERiL) grants programme. MERiL supports trials, development and commercialisation of new livestock feed technologies and low-emission feed supplement delivery technologies to reduce enteric methane emissions from cattle and sheep. **China** launched several collaborative research projects with academia and the private sector in 2018, to identify novel feed solutions and estimate emission reductions from more sustainable dairy farming practices. **Colombia** is currently implementing several projects on sustainable livestock production and has established the Roundtable on Sustainable Livestock, an inter-agency public-private body for technical consultations. **Costa Rica** trained 200 extension service providers to formulate diets for animal feed, monitor livestock farms, and implement mitigation actions such as rotational grazing and silvopasture systems. **New Zealand's** He Waka Eke Noa – Primary Sector Climate Action Partnership provides extension and advisory services for farmers to measure and manage their emissions, and R&D investments in mitigation technologies such as methane inhibitors and a methane vaccine. The New Zealand Government also researches mitigation technologies for ruminant livestock through the New Zealand Agricultural Greenhouse Gas Research Centre, the Pastoral Greenhouse Gas Research Consortium, and in co-ordination with the member countries of the Global Research Alliance on Agricultural Greenhouse Gases.

76. Several countries are supporting the development of climate-smart agriculture. **Iceland** is implementing the Climate-Friendly Agriculture project, which provides comprehensive advice and education to farmers with the aim of reducing GHG emissions from agriculture and land use. The project is a part of the 2020 Climate Action Plan, which also includes actions to reduce the use of mineral fertilisers, improve livestock feeding to reduce enteric fermentation, increase domestic vegetable production, and achieve carbon neutrality in cattle breeding. **India** has increased funding for R&D in technologies to convert agricultural stubble into biogas or other energy products. The **Indonesian** Agency of Agriculture Research and Development has established a number of R&D and extension programmes focusing on climate-smart practices and technologies, including the development of plant varieties resistant to climate stress, a planting calendar adjustment system, and efficient agricultural equipment and machinery.

77. **Israel** has introduced several programmes to strengthen conservation and regenerative agricultural practices (e.g. minimum tillage, cover crops, applying organic matter to soils), reduce the use of natural and synthetic fertilisers, improve the treatment of organic agricultural waste, develop know-how for climate-smart agriculture, protect trees and forests to sequester carbon, and facilitate the role of farming in renewable energy production. **Mexico's** agricultural sector strategy promotes agricultural practices adapted to climatic and environmental conditions, such as soil conservation and reduced burning of residues, considering community and scientific knowledge; and adopting agroforestry, agroecology and biodigesters on livestock farms. **The Philippines** is promoting new technologies and practices to reduce emissions, such as Alternate Wetting and Drying for irrigated rice cultivation, microbial inoculants, biochar, livestock feed supplements and nature-based solutions. **Ukraine** has introduced minimum-tillage techniques and a ban on stubble burning in fields, improved agricultural practices in zones vulnerable to nitrate pollution, increased support for restoring degraded land, and is supporting the use of manure in biogas production.

78. Building the capacity for measurement, reporting and verification (MRV) of farm-level emissions can help to pave the way for the introduction of carbon pricing policies. **Australia** launched the three-year USD 38.1 million National Soil Carbon Innovation Challenge to identify and fast-track low-cost, accurate technological solutions for measuring soil carbon at below USD 2.25 per hectare per year on average. The five-year USD 5.9 million Soil Carbon Data Programme is working to improve soil carbon data, build

confidence in low-cost alternatives for measuring and estimating soil carbon, and contribute to a national soil data repository. **Viet Nam's** Ministry of Agriculture and Rural Development is also establishing MRV systems for agriculture and LULUCF under its Plan to Implement the Paris Agreement on Climate Change for 2021-30.

International policy initiatives

79. The *Global Research Alliance on Agricultural Greenhouse Gases* was launched in 2009, and includes 65 member countries that work together to increase co-operation and investment in R&D to reduce the emissions intensity of agricultural production and increase the potential for soil carbon sequestration. The *Coalition on Sustainable Productivity Growth for Food Security and Resource Conservation* aims to accelerate the transition to more sustainable food systems through sustainable agricultural productivity growth. It was launched at the 2021 UN Food Systems Summit and is supported by 46 countries (including the European Union), as well as a broad range of academic and research organisations, private sector associations, and industry bodies.

80. Several international initiatives were launched at COP26 in Glasgow in November 2021, including:

- The *Global Methane Pledge*, signed by over 100 countries including 29 OECD members and the European Union as a whole. Countries joining the Pledge agreed to take voluntary actions to reduce global methane emissions by at least 30% from 2020 levels by 2030, potentially eliminating over 0.2°C of warming by 2050. While the target is global and any reductions in national methane emissions are made on a voluntary basis, participation sends a strong signal of a country's willingness to substantially reduce its methane emissions by 2030.
- The *Glasgow Leaders' Declaration on Forests and Land Use* was signed by 141 countries, and calls for efforts to halt and reverse forest loss and land degradation by 2030 through efforts to conserve and restore forests and other terrestrial ecosystems and accelerate their restoration.
- The *Agriculture Innovation Mission for Climate (AIM for Climate)* was launched at COP26 with 31 countries and over 48 non-government partners, and aims to significantly increase investment in agricultural innovation for climate-smart agriculture and food systems over the next five years. The initiative will also support technical discussions and promote expertise across international and national levels of innovation, and will facilitate co-operation on climate-related agricultural innovation on shared research priorities.
- The *Policy Action Agenda for Transition to Sustainable Food and Agriculture* sets out pathways and actions that countries can take to repurpose public policies and support to food and agriculture, to deliver these outcomes and enable a just rural transition.

Impacts of current agricultural support on climate change

81. Agricultural support policies have significant consequences for climate change and environmental sustainability. Governments across the 54 countries covered in this report provided USD 817 billion per year in transfers to agriculture in 2019-21, of which USD 611 billion per year was provided as positive support to individual producers. The remainder was almost equally split between support for general services (USD 106 billion) and budgetary transfers to consumers (USD 100 billion). Some emerging economies also implicitly taxed their producers by an average of USD 117 billion per year.

82. Support policies can influence GHG emissions and environmental outcomes in different directions depending on their design. By changing agricultural market prices, they can influence farmers' decisions to produce and the emissions generated through changes in production volume. If they target input or factor prices, they can also affect the way in which farmers produce, by encouraging substitution between intermediate inputs and primary production factors (e.g. land, capital and labour), affecting the emissions

intensity of production, either on the farm or through changes in land use (Henderson and Lankoski, 2019[55]). Due to these effects, support policies, whether provided in the form of market transfers or budgetary payments, can work against other policy interventions for climate change mitigation.[22] Support policies can also be targeted to incentivise environmentally beneficial practices, or can provide for broader general services with potential to support emissions reductions, such as support for R&D and innovation.

83. Against this background, this section discusses the impacts of current support policies on GHG emissions reduction incentives and efforts.

Emissions impacts of production support policies

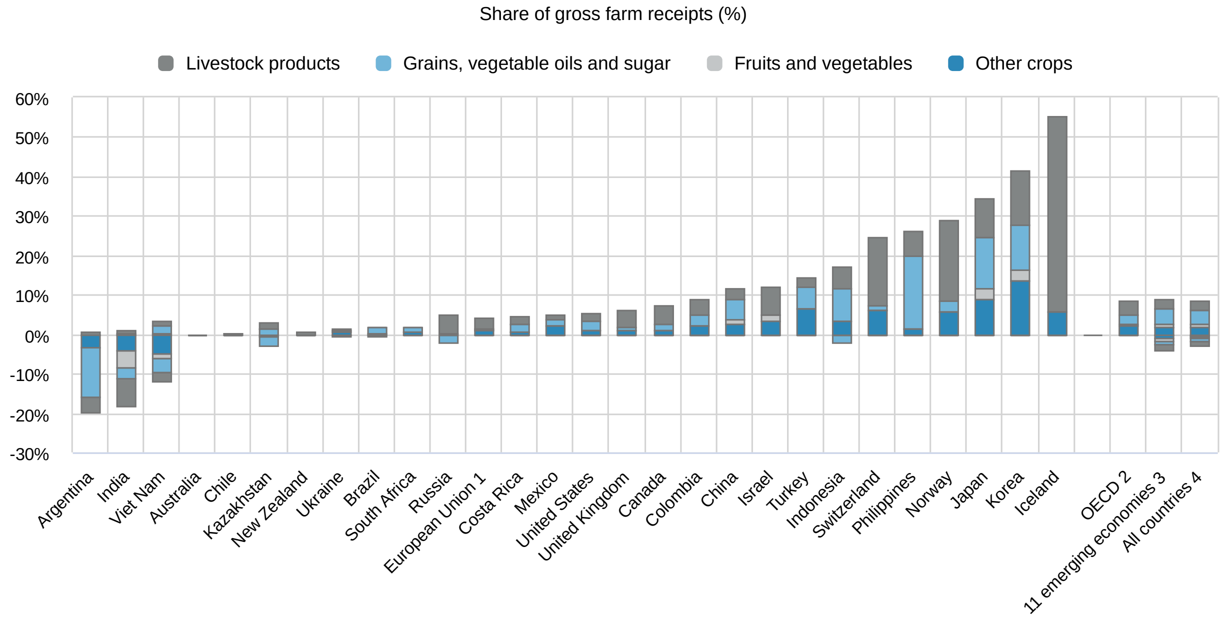
Direct agricultural support for the production of specific commodities

84. Agricultural support policies are often aimed at facilitating the production of specific commodities. For example, market price support (MPS) corresponds to policies that create a price gap between domestic market prices and border prices for specific agricultural commodities. Import licences, tariffs, tariff rate quotas and minimum prices are examples of measures that result in higher prices paid by consumers. MPS increases the price received by the producer, thus providing incentives for additional production, the intensification of input use, the allocation of land to supported crops, and the entry of land to the agricultural sector. Other types of direct production support include coupled payments, whether they are based on output, current cultivation area, or number of animals. These also typically encourage farmers to increase their production, either through intensification, expansion of land, or the retention of farms that would be financially unviable without support. On the consumer side, however, the impacts of these interventions differ: MPS increases market prices, which (all else equal) will result in reduced domestic consumption. On the other hand, coupled payments decrease market prices, which ultimately supports and stimulates domestic consumption.

85. Direct support to the production of specific agricultural products is monitored in the context of this report by the single commodity transfer (SCT) indicator, which takes into account both MPS and coupled payments to single products. On average across all 54 countries covered in this report, SCTs accounted for half of the support provided directly to producers, or USD 247 billion in 2019-21 (USD 362 billion in positive transfers and USD 115 billion in implicit taxation). Support for livestock products, which tend to have high GHG emissions intensities, amounted to USD 111 billion, or 31% of total positive SCTs (Figure 1.9). Transfers to livestock products represent more than 60% of positive SCTs in Iceland, the United Kingdom, Norway, Switzerland, Canada, and the European Union.

[22] This is also true for other forms of environmental policies. Studies have shown that most distortive agricultural support is also the most environmentally harmful from a nitrogen pollution perspective (Henderson and Lankoski, 2019[88]; Henderson and Lankoski, 2020[87]; OECD, 2020[66]; DeBoe, 2020[89]), or for biodiversity (DeBoe, 2020[89]; Lankoski and Thiem, 2020[63]).

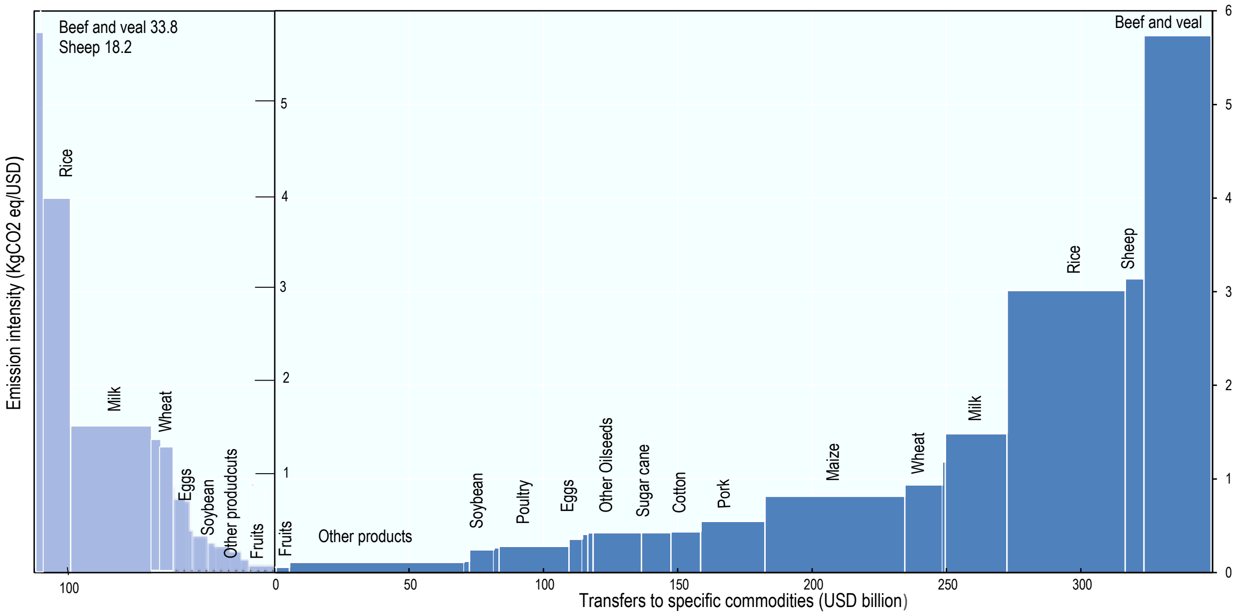
Figure 1.9. Breakdown of transfers to specific commodities (SCT), 2019-21



Notes: Countries are ranked according to the % SCT levels.
1. EU28 for 2019, EU27 and the United Kingdom for 2020 and EU27 for 2021.
2. The OECD total does not include the non-OECD EU Member States.
3. The 11 emerging economies include Argentina, Brazil, China, India, Indonesia, Kazakhstan, the Philippines, Russian Federation, South Africa, Ukraine and Viet Nam.
4. The All countries total includes all OECD countries, non-OECD EU Member States, and the emerging economies.
Source: OECD (2022), "Producer and Consumer Support Estimates", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-pcse-data-en.

86. Among the commodities receiving the highest SCTs, several show particularly high emissions intensities as measured in kgCO_2eq per USD of gross farm receipts (Figure 1.10). In particular, three high emission intensity products (in terms of emissions per USD of production value – including receipts), representing 47% of the direct agricultural emissions covered in this report, receive a large volume of positive support: USD 25 billion for beef, USD 7 billion for sheep and goat meat, and USD 44 billion for rice. From a climate perspective, this corresponds to an equivalent transfer of USD 22, USD 31 and USD 115 per tCO_2eq, for these three products respectively. This support mostly comes in the form of market price support, however, rather than direct payments to farmers.

Figure 1.10. Emission intensity mapped to single commodity transfers (SCTs)



Note: Data show single commodity transfers from all 54 countries covered by this report. The dark blue bars correspond to positive SCTs, whereas the light blue bars show negative SCTs.
Source: OECD (2022), "Producer and Consumer Support Estimates", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-pcse-data-en.

87. The overall climate impact of SCTs ultimately depends on the specific instruments used. The potentially most environmentally harmful measures are output-based support, including both MPS and output payments, as they increase directly domestic production, as well as input-based payments, except if they improve the competitiveness of low-emission commodities relative to high emission ones or lessen the use of emission-intensive inputs relative to other inputs. At a global level, the widespread use of market price support has more uncertain impacts on overall production and may even lower global emissions, if raising the competitiveness of low emission production systems (Laborde et al., 2021[56]; Guerrero et al., 2022[57]).[23] The overall climate impact of reforming MPS will therefore depend on relative differences in emissions intensities in the regions where production is relocated, and the potential productivity gains associated with the reform. Local contexts and accompanying conditions for specific forms of support should also be considered. Nonetheless, SCTs generally provide relatively untargeted transfers to producers, and therefore are not as effective as targeted investments in emission-saving technologies and management practices, or other incentives to accelerate mitigation options (Gautam et al., 2022[58]). Lastly, less distortive forms of SCTs, such as payments based on area or animal numbers, can increase emissions if they favour production of more GHG intensive products, which is often the case with livestock payments. However, when associated with cross-compliance requirements on farm management practices these forms of support may also provide incentives for the adoption of mitigation measures.

Payments based on variable input use

88. Payments based on variable inputs deserve specific attention, as this category represented USD 60 billion of support in 2019-2021, and a large part is not covered by the SCT category. Variable

[23] Laborde et al. (2021[56]) estimate that removing domestic support and border measures would increase direct agricultural emissions by 1.7%. Guerrero et al. (2022[57]) finds in a similar assessment accounting for the full AFOLU that such policy change would generate an emission increase of 0.5%.

inputs targeted by this category typically include the use of fertilisers, fossil fuels or irrigation, which are direct GHG emissions sources or a source of extra energy demand, and which can also cause other environmental impacts. Over application of fertilisers and animal manure leads to substantial nitrogen surpluses, which, in addition to nitrous oxide emissions, generates local pollution, damaging freshwater ecosystems, harming invertebrates and fish, and causing acidification and eutrophication, which stimulate the growth of toxic algae and lower oxygen levels in water (hypoxia) (Guerrero, 2018[59]; Sud, 2020[60]). Similarly, irrigation subsidies can generate significant resource overexploitation issues and exacerbate water scarcity in already vulnerable regions (OECD, 2017[61]).

89. In most countries, there are few restrictions to protect against the over-utilisation of supported inputs, which leaves their GHG emissions impacts unabated. The optimal policy mix for support related to the use of environmentally harmful inputs would be to impose a tax rather than a subsidy to account for the damage they cause to climate, waterways and natural ecosystems (Anderson and Valenzuela, 2021[62]).

Other forms of payments

90. Other forms of support to producers – non-coupled area payments and other non-commodity specific payments – have a less direct impact on emissions from production and can sometimes provide other forms of environmental and social benefits. Nevertheless, payments based on current land area, even if not directed to specific crops, still create incentives to expand cultivated areas and maintain marginal lands in production. If crop area payments favour arable farming over livestock production, they may induce a shift away from livestock and a reduction in agricultural GHG emissions and nutrient surpluses. Conversely, area payments may increase GHG emissions in countries where crops account for the dominant share of agricultural GHG emissions (Henderson and Lankoski, 2019[55]).

91. Fully decoupled payments based on non-current crop area (e.g. payments based on historical entitlements or overall farming income) are among the least environmentally harmful support policies (Henderson and Lankoski, 2019[55]). These measures allow farmers to follow market signals in their production decisions, and in some cases, production is not required for farmers to receive support payments. If historical acreage is fixed for payments, then there is no incentive to bring additional land into the sector (Lankoski and Thiem, 2020[63]). However, payments based on historical entitlements could still affect incentives, if farmers expect their current decisions to influence future payments (DeBoe et al., 2020[64]). Moreover, by supplementing farmer incomes and making agriculture more profitable relative to other land uses, decoupled payments could still stifle structural change and hinder the conversion of agricultural land to more sustainable land uses. Ultimately, the climate impact of decoupled payments depends on the type and effectiveness of mandatory management practices and environmental requirements (cross compliance) that accompany payments (DeBoe, 2020[65]).

92. Reorienting agricultural support towards more decoupled payments and away from the most production distorting forms of support should support reduction of climate impacts and strengthen further the sustainability of production. At the same time, it is important to recognise that agricultural policies can shape the structure and intensity of production over the long term. Decoupling is therefore unlikely to be sufficient on its own, particularly in countries with a high livestock density and intensive production systems (OECD, 2020[66]; Lankoski and Thiem, 2020[63]). In such cases, more targeted measures may be needed to ensure that policies and market prices reflect the negative environmental externalities associated with agricultural production.

Policies that encourage emissions reductions

Payments for environmental and climate services

93. Agricultural policies can also be designed to generate positive environmental outcomes, by encouraging farmers to provide environmental goods and services such as carbon sequestration, preservation of rural landscapes, resilience to natural disasters, pollination, habitat provision, and control of invasive species. Agri-environmental payments that encourage the use of environmentally friendly inputs or practices (e.g. compliance with fertiliser use restrictions) are potentially among the most environmentally beneficial types of support measures (DeBoe, 2020[65]). This applies in particular to climate change mitigation, which requires very specific management changes and technologies. That said, only USD 1.7 billion of the USD 293 billion per year of budgetary payments to producers in 2019-21 was purely dedicated to the provision of environmental public goods (i.e. payments based on specific non-commodity outputs). Larger support could however have strong direct or indirect impacts on environmental goods, through decoupled payments (see above), for instance in the case of support to organic farming. Cross-compliance associated to direct payments to producers can also bring environmental benefits compensating for the potentially environmentally harmful impacts from subsidies.

94. Other policies can have positive climate effects. For example, land retirement policies can create incentives for farmers to switch from crop production to permanent pasture or forests, encouraging a contraction of agricultural land and reducing environmental pressures. However, if not well-managed, a contraction of agricultural land resulting from land abandonment can in some instances lead to negative environmental outcomes such as biodiversity loss, increases in invasive species, or a greater risk of wildfire (DeBoe et al., 2020[64]). While reductions in agricultural land use often have beneficial climate effects by enhancing carbon stocks, they can also be accompanied by the intensification of production on remaining land areas, potentially resulting in unintended negative environmental impacts, including extra fertiliser emissions.

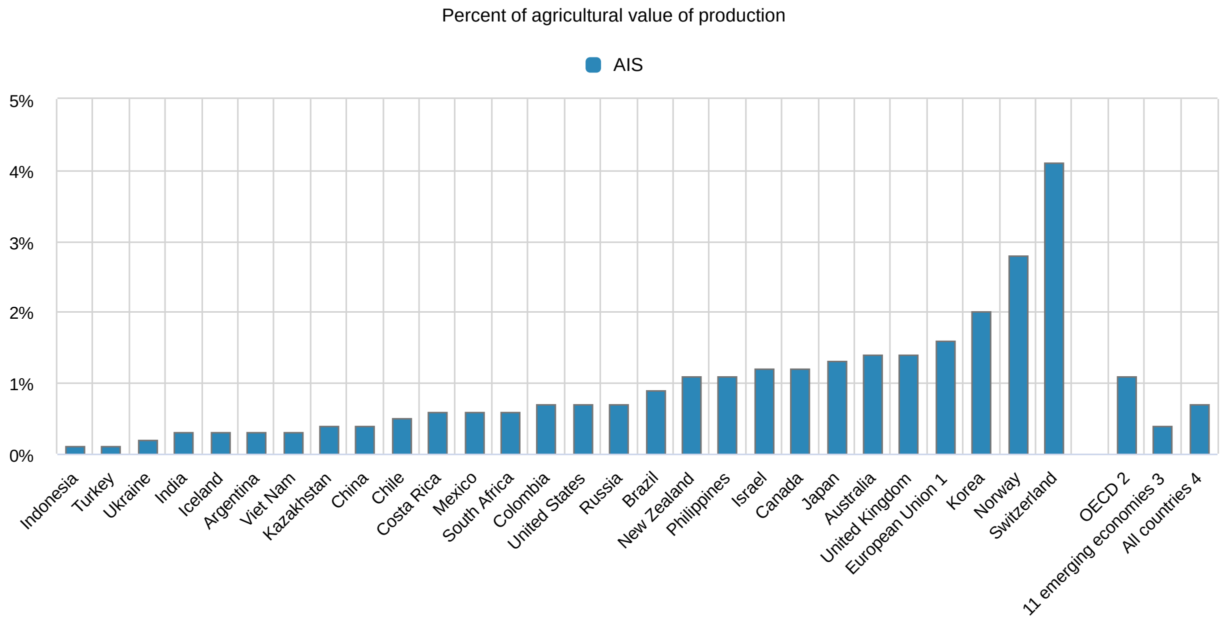
95. This underscores the importance of carefully managing the reform process to account for potential unintended environmental consequences. For example, reductions in market price support can also result in land abandonment and further intensification of production, with potential negative consequences for biodiversity and landscape ecology. Furthermore, agri-environmental schemes could benefit from improvements in their design to better integrate climate mitigation objectives and in the design of mandatory constraints to better deliver environmental improvements (DeBoe, 2020[65]).

Support for agricultural R&D and innovation

96. Support for agricultural R&D and innovation plays a vital role in helping to mitigate agricultural emissions. There is ample evidence that public investments in agricultural R&D also generate large rates of return (Alston, Pardey and Rao, 2021[67]; Alston et al., 2010[68]; Piesse and Thirtle, 2010[69]). Agricultural R&D is a key driver of productivity growth, which can help to reduce emissions by allowing more food to be produced with the same amount or fewer emissions-intensive inputs (e.g. land, fertilisers, feed). Innovations such as improvements in farm management practices, new crop varieties and livestock breeds, and new digital technologies (e.g. precision agriculture) can reduce the emissions intensity of production (i.e. emissions per unit of output) while mitigating emissions from land use change.

97. Support for agricultural innovation remains low at just 0.7% of the value of agricultural production for the 54 countries covered in this report (Figure 1.11). In OECD countries as a whole, public spending on agricultural innovation systems is 1.1% of the value of agricultural production, significantly higher than the average for the 11 emerging economies (0.4%). Support for agricultural innovation is highest in Switzerland, Norway and Korea, where it amounts to more than 2% of the value of agricultural production.

Figure 1.11. Support for agricultural R&D and innovation, 2019-21



Notes: Countries are ranked according to the share of government expenditure on agricultural innovation in the value of agricultural production. "AIS" refers to the Agricultural knowledge and innovation system.
1. EU28 for 2019, EU27 and the United Kingdom for 2020 and EU27 for 2021.
2. The OECD total does not include the non-OECD EU Member States.
3. The 11 emerging economies include Argentina, Brazil, China, India, Indonesia, Kazakhstan, the Philippines, Russian Federation, South Africa, Ukraine and Viet Nam.
4. The All countries total includes all OECD countries, non-OECD EU Member States, and the emerging economies.
Source: OECD (2022), "Producer and Consumer Support Estimates", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-pcse-data-en.

98. In some situations at the local level, productivity improvements may trigger increased production and will not necessarily result in lower emissions (see Box 1.3). However, channelling a greater share of R&D spending towards mitigation measures can help to foster sustainable intensification and is more likely to be successful in reducing agricultural emissions. While support for mitigation measures is increasing, there is limited evidence to suggest that it represents an important share of total funding for agricultural R&D and innovation. For example, Australia's support for the development of innovative livestock feed technologies amounts to USD 23 million over six years, which on an annual basis represents less than 0.4% of total annual spending on agricultural innovation (USD 994 million in 2019-21). Until recently, Canada's On-Farm Climate Action Fund (USD 160 million for 2021-24) represented just 6% of the agricultural innovation budget (USD 842 million in 2019-21), although new investments have just been proposed. These two examples relate to countries that have relatively high rates of support for agricultural R&D and innovation, suggesting that there is ample scope to further increase funding for R&D focused on the mitigation of agricultural emissions.

99. Recent studies have shown that using public expenditures on agricultural support to invest in the development and adoption of green innovations (i.e. new technologies that reduce emissions and increase productivity, such as climate smart agriculture) can reduce emissions from agriculture and land use by more than 40%, returning 105 million hectares of agricultural land to habitats (Gautam et al., 2022[58]). Unfortunately, growth in public agricultural R&D investment has been slowing over the past decade in high-income countries (Heisey and Fuglie, 2018[70]). Reversing this trend and increasing support for the development of new technologies and innovations to mitigate agricultural emissions is therefore of critical

importance to mitigate agricultural emissions. Agricultural R&D will however require time to deliver its impacts, therefore this policy measure should be used in complement to some other more immediate channels of action.

Conclusion and summary of recommendations: Reforming agricultural policies to address climate change mitigation objectives

100. Agriculture is a major driver of climate change, both through direct on-farm emissions and indirect emissions from land use change. AFOLU currently accounts for 22% of global anthropogenic GHG emissions; this share is projected to rise as global population growth and rising incomes continue to drive increases in food demand, and as other sectors decarbonise. Respecting the Paris Agreement's commitment of keeping global temperatures within 1.5°C above pre-industrial levels will not be possible without agriculture contributing to global mitigation efforts. The sector has significant potential to reduce its GHG emissions, and is also uniquely positioned to contribute to carbon dioxide removals through carbon sequestration. At the same time, agriculture faces unique challenges as it needs to adapt to a changing climate while providing safe and nutritious food for all and supporting rural incomes and livelihoods.

Greater policy ambition is needed for the mitigation of agricultural GHG emissions

101. Although agricultural emissions are included in most countries' NDCs, only 16 out of the 54 countries covered in this report have set some form of mitigation target for their agricultural sector. Some of these countries have included these targets in their NDCs or in national strategic plans, but these are not, in most cases, legally binding. Only a few countries have included agriculture in carbon pricing schemes and environmental regulations are often lagging behind when it comes to the climate dimension. There is therefore considerable scope for policy reforms to intensify and accelerate emission reductions in the sector in support of climate stabilisation.

Existing agricultural support policies contribute to higher emissions

102. The structure of support to agricultural production has changed little over the past decade and continues to contribute to increasing GHG emissions. Of the USD 611 billion in annual support to individual producers in 2019-21, more than half (USD 361 billion) was provided as positive transfers to specific commodities. This includes market price support (MPS) resulting from policies raising domestic market prices of agricultural products above international market levels, and payments targeted to specific commodities. These support measures provide incentives for additional domestic production, the intensification of input use, and the expansion of agricultural land, which all result in increased domestic GHG emissions (although the effect of market price support on global emissions is likely to be small and potentially negative due to differences in emissions intensities across countries). MPS could therefore be perceived as a way to reduce import-embedded emissions for low-emission intensity countries. However, such an indirect approach has uncertain impacts and is unlikely to be as effective as direct emissions pricing or targeted mitigation investments.

Countries should reduce and reform support targeting emissions-intensive products

103. The role of support for livestock production is particularly sensitive in this regard. Livestock is responsible for the largest share of agricultural GHG emissions, and is a strong contributor to the methane footprint globally, in particular due to enteric fermentation from ruminants. Support for livestock products, which tend to have high GHG emissions intensities, amounted to USD 111 billion, or 31% of total positive transfers to specific commodities. From a climate perspective, product-specific support is for instance equivalent to a USD 22 per tCO_2eq subsidy for beef, and a USD 31 per tCO_2eq subsidy for sheep and goat

meat. Rice also contributes significantly to emissions compared to other crops, due to methane from flooded areas. Support linked to rice production amounted to USD 44 billion, i.e. USD 115 per tCO_2eq. Most of the support above is in the form of MPS which encourages local production and may reduce domestic consumption through higher prices, but does not incentivise investments to reduce emissions. Support to other crops contributes relatively less to climate change impact, but still contributes to higher GHG emissions through fertiliser use. These forms of support should be reduced and reformed, while taking national conditions into consideration, as well as the specifics of policy design.

Subsidies for environmentally harmful inputs should be phased-out

104. Current policies also directly subsidise the use of variable inputs such as fertilisers, feed and fuel, amounting to USD 60 billion per year in 2019-21. Subsidies for synthetic fertilisers provided without appropriate constraints leads to increased nitrous oxide emissions, and nutrient leaching and runoff causing severe damage to freshwater resources. Subsidies for feed directly incentivise increased livestock production and related GHG emissions, whereas fossil fuel subsidies encourage carbon dioxide emissions from increased on-farm energy use. These inputs should be taxed rather than subsidised when they prove to be environmentally harmful, to account for their negative environmental externalities.

Targeted interventions towards sustainable management and productivity growth are needed

105. Reducing support for emissions-intensive products and inputs will not be sufficient on its own, and more targeted interventions will be needed for strong emissions abatement. Reducing direct on-farm emissions from agricultural production will require improvements in productivity and the efficiency of input use, greater deployment of new technologies, and improvements in farm management. For many crop producers, this entails improving cultivation practices, increasing the efficiency of fertiliser use, and promoting the use of precision agriculture and integrated crop management. Livestock emissions can be addressed through a combination of improvements in feed conversion efficiencies, better feed and pasture quality, strengthening farm and animal management, as well as methane inhibitors such as feed supplements. Production needs can be decreased by limiting on-farm losses through more resistant crops, improved harvesting equipment and techniques, better storage infrastructure and logistics. On-farm energy consumption can also be reduced by promoting renewable energies and the adoption of greener and more efficient fuels to power agricultural machinery. Agriculture can also help reducing fossil fuels consumption via bioenergy sustainable production.

106. On the land use change side, there are also several avenues to significantly reduce emissions. Forest protection, coupled with improvements in agricultural productivity, can play an essential role in limiting the expansion of agricultural land and can also create opportunities to sequester carbon by restoring and reforesting marginal lands. Halting and reversing peatland conversion can also be achieved at relatively low cost. Soil carbon sequestration can be achieved through measures such as improved management of crop rotations, residues, vegetation, cattle stocking densities and cropland-pasture integration. Agricultural plantations, agroforestry and afforestation on agricultural land are also promising avenues for carbon sequestration.

Support should transition towards less coupled payments and payments for environmental public goods

107. Other forms of support to producers, including non-coupled area payments and other non-commodity specific payments, have less of a direct impact on emissions from production, and bring environmental co-benefits through cross-compliance. Nevertheless, payments based on current land area, even if not directed to specific crops, may still create incentives to expand cultivated areas and maintain

marginal lands in production. There is large room to make these payments more beneficial for climate action. Payments can be made conditional on the provision of environmental goods and services such as carbon sequestration, afforestation and the restoration and rehabilitation of marginal lands. In 2019-21, only USD 1.7 billion of the USD 293 billion per year of budgetary payments to producers was purely dedicated to the provision of environmental public goods (i.e. payments based on specific non-commodity outputs). Larger support could however have strong direct or indirect impacts on environmental goods, through decoupled payments (e.g. for organic farming). Funding to climate services in agriculture should be ramped up to accelerate the adjustments needed at farm level.

Including agriculture in carbon pricing schemes could incentivise the transition to low-emission agriculture

108. Mechanisms that put an explicit price on emissions are the most efficient way to minimise the abatement burden for the sector, by recognising the heterogeneity of abatement costs across producers. Carbon pricing options include emissions taxes and emissions trading schemes, carbon offsets, and some abatement subsidies (e.g. delivered via auctions). Participation in voluntary schemes such as carbon offsetting and abatement subsidy programmes are limited by the availability of public and private sector funding to pay producers for emissions reductions. They also require strong transparency and integrity standards to ensure additionality, potentially limiting their scope and effectiveness. Conversely, instruments that apply the "polluter pays" principle such as emissions taxes are among the most effective and efficient policies to mitigate agricultural emissions, but they shift a part of the burden on consumers, which may require accompanying measures.

109. In spite of their efficiency and use in other sectors, there are currently relatively few examples of countries that have introduced emissions pricing to mitigate agricultural emissions. Agricultural emissions tend to be excluded from most economy-wide carbon taxes and emissions trading schemes, and are often dealt with through other complementary mechanisms. Applying pricing schemes to the agricultural sector could support more ambitious mitigation plans, even if such schemes will need to be adapted to the specific context and constraints related to the sector.

In addition to emissions pricing instruments, stronger environmental regulations and cross compliance can also help to reduce emissions

110. Strengthening environmental regulations can also accelerate progress on the mitigation of agricultural emissions. For example, governments can link support with measures to prevent additional clearing of forests and expansion of agricultural land. As a good practice, support should not be provided to farmers participating in illegal deforestation or conversion and drainage of peatland. Cross-compliance attached to farm payments could also be used to broaden the adoption of climate-friendly practices in agriculture. Tighter environmental regulations and standards may also be needed in other related policy domains such as water and air quality to foster climate action in agriculture.

Demand-side measures may also be needed, including efforts to reduce the emissions intensity of consumer diets

111. More sustainable production will help to limit the climate impacts of agriculture but may not be sufficient for the level of transformation needed. Deeper structural change will also have to take place to reduce the carbon footprint of agricultural production, requiring a food systems perspective and adaptation along the supply chain and in demand patterns. This may require changes in consumer behaviour to reduce the consumption of emissions-intensive products, in particular products of animal origin, in countries where per capita protein consumption far exceeds dietary guidelines. Dietary changes could also bring potential co-benefits for consumers in terms of health and nutrition improvements. Lower

consumption of livestock products can also reduce deforestation and biodiversity losses due to the expansion of pasture and cropland for feed production. Actions encouraging consumers to limit food waste and overconsumption can also help to mitigate agricultural emissions by reducing the volume of production needed, even though abatement scope is more limited for that route.

Greater support should be provided for R&D and innovation to mitigate climate change

112. Last, support for agricultural R&D and innovation has a vital role to play in agricultural emissions mitigation. Support for agricultural innovation amounted to only USD 26 billion in 2019-21 and remains low at just 0.7% of the value of agricultural production. While support for mitigation measures has been increasing, its share of total funding for agricultural R&D and innovation remains small. Channelling a greater share of R&D spending towards mitigation measures can help to foster sustainable productivity growth and develop the new technologies needed for low-emissions agriculture. Governments should improve public agricultural R&D funding, create the conditions to attract private investment and facilitate public-private partnerships and international R&D co-operation, with the involvement of farmers and other stakeholders.

Climate action for agriculture should build on synergies and manage potential trade-offs

113. Considering the urgency of the climate change challenge, agriculture should embrace climate action rapidly. However, optimal policies should take account of wider implications for food systems, exploit synergies with other social and environmental objectives and be balanced in each context with potential adverse impacts. For example, measures aiming to reduce deforestation or limit the use of synthetic fertilisers also result in improvements in biodiversity, soil health and water quality, but may come in conflict with agriculture production needs. Demand-side policies that encourage shifts towards lower emission intensity diets can have potential co-benefits for public health but may also pose a threat to farmers living from livestock production.

114. The introduction of emissions taxes may imply higher costs for some producers and consumers, and should be accompanied by transitional assistance and targeted transfers to the most vulnerable populations that may be affected by higher food prices. On the other hand, paying farmers to reduce their emissions can ease the impact on producers and consumers, but may also put pressure on public finances unless balanced by a reduction in existing agricultural support. A broader food systems approach is required to address these challenges and to take a holistic view on the performance of climate measures, in light of other multiple policy objectives and implications for the various stakeholders.

115. As with other food systems issues, effective climate action for agriculture will require collaboration between different policy communities (climate, agriculture, rural development, food security, public health), as well as overcoming barriers related to facts, interests, and values (OECD, 2021[40]). Robust, inclusive, and evidence-based processes are thus essential.

2 Developments in Agricultural Policy and Support

116. In 2021, agricultural policies and support to the sector continued to be affected by the ongoing pandemic caused by the coronavirus SARS-CoV-2. Most countries have undergone repeated waves of high infection rates and subsequent restrictions on populations and enterprises to contain the virus. That said, after the slowdown of the world economy in 2020, global GDP rebounded and unemployment receded in 2021, while the agricultural sector continued to demonstrate considerable resilience in the face of multiple stresses. At the same time, there are growing concerns that rising commodity prices may strain food security in some regions and stall economic recovery. In particular, flat or lower supplies, notably of natural gas, are tightening otherwise resurgent energy markets.

117. The growing tensions between the Russian Federation (hereafter “Russia”)[24] and Ukraine towards the end of 2021, and the large scale aggression by Russian forces against Ukraine in February 2022, risk additional and major implications for economies in general, and for global food markets in particular. This report describes the evolution of agricultural policies and quantifies the extent of support to the sector through to the end of 2021, i.e. preceding the war in Ukraine. That said, given their potential gravity, consequences of the war for agricultural markets and early policy responses are discussed further below.

118. This chapter first presents the general economic and market context in which agricultural policies evolved over 2021. The second section provides a brief discussion of the Russian large scale aggression against Ukraine by looking at both the implications for markets for major agricultural commodities and production inputs, and at responses by governments to mitigate the consequences for their agricultural producers and consumers. The third section then provides an overview of developments in agricultural policies in 2021 and early 2022. The fourth section provides different indicators of the support that is generated by agricultural policies for the sector. It also provides estimates of the changes in agricultural support induced by policy responses to the COVID-19 pandemic. The chapter concludes by briefly assessing this support against the broad set of policy objectives for the agricultural sector.

Key economic and market developments

119. Conditions in agricultural markets are strongly influenced by macro-economic factors, such as economic growth (measured by gross domestic product, GDP), which drives demand for agricultural and food products, as well as by prices for crude oil and other energy sources that underpin many production inputs in agriculture, such as fuel, chemicals and fertiliser. Energy prices also affect the demand for cereals, sugar crops and oilseeds through the market for biofuels produced from these feedstocks.

120. Global GDP, which shrank by more than 3% in 2020 due to the COVID-19 pandemic and related restrictions, rebounded in 2021 to grow by 5.6%. At the end of 2021, output in most OECD countries was

[24] This report does not contain a country chapter on the Russian Federation, nor any tables with support indicators in the Statistical Annex. However, aggregate data for the 11 emerging economies and for all 54 countries covered in this report continue to include those for Russia.

close to or above pre-pandemic levels (OECD, 2021[71]). Across OECD countries, growth was particularly strong, at rates between 9% and more than 15%, in Ireland, Colombia, Estonia, Costa Rica and Turkey, but remained below 2% in Japan. Across the Euro area, growth was close to the OECD average at 5.2%; however, this did not offset the economic contraction in 2020 (-6.5%).

121. The rebound in OECD economies in 2021 was associated with an increased demand for labour. Across the OECD area, unemployment, which in the context of the COVID-19 pandemic had increased to 7.1% in 2020, fell by almost one percentage point in 2021. At 6.2%, however, the level of unemployment continued to be higher than in 2019. In many countries, substantial public interventions put in place in 2020 to mitigate the negative impact of the pandemic on employment, continued in 2021, including notably publicly supported short-time work.[25] Average inflation, which had been falling for several years and had dropped to 1.5% in 2020, rose to 3.5% in 2021, driven, amongst other factors, by rising energy and food prices (see below).

122. Growth in emerging economies also rebounded in 2021, although the extent of the recovery varied. Amongst the countries covered in this report, India's rebounded most strongly, with 9.4% growth, following a 7.2% decline the previous year. The People's Republic of China (hereafter "China") and Argentina saw GDP growth of around 8%, moderately higher than Chinese pre-pandemic growth rates but the highest growth in Argentina in a decade. Recovery was more modest in South Africa, Brazil and notably Indonesia, where growth barely exceeded 3%, well below pre-pandemic growth rates.

123. Signs of global economic recovery were also seen in international trade. In real terms, global trade increased by more than 9% year-on-year, after an 8.4% contraction in 2020.

Table 2.1. Key economic indicators

	Average 2009-18	2019	2020	2021
Real GDP growth[1]				
World[2]	3.2	2.8	-3.4	5.6
OECD[2]	1.6	1.7	-4.7	5.3
United States	1.8	2.3	-3.4	5.6
Euro area	0.8	1.6	-6.5	5.2
Japan	0.7	0.0	-4.6	1.8
Non-OECD[2]	4.9	3.7	-2.2	5.8
Argentina	1.0	-2.0	-9.9	8.0
Brazil	1.3	1.4	-4.4	5.0
China	8.0	6.0	2.3	8.1
India	7.0	4.0	-7.3	9.4
Indonesia	5.4	5.0	-2.1	3.3
South Africa	1.6	0.1	-6.4	5.2
OECD area				
Unemployment rate[3]	7.3	5.4	7.1	6.2
Inflation[1,4]	1.6	1.9	1.5	3.5
World real trade growth[1]	3.6	1.4	-8.4	9.3

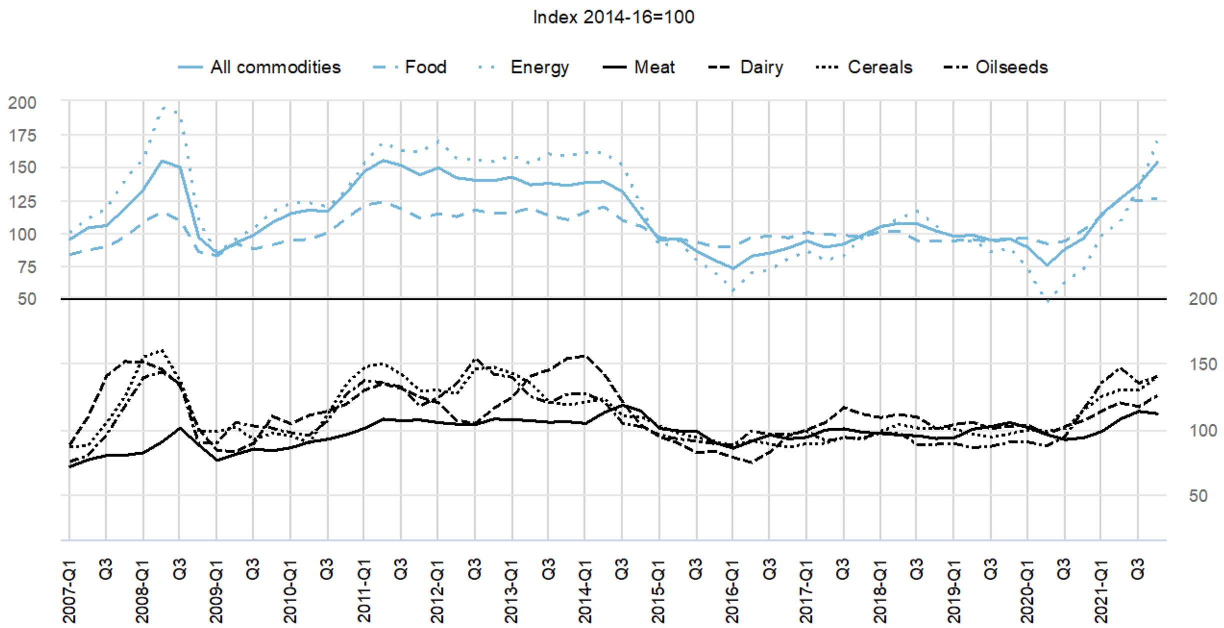
1. Percentage changes; last three columns show the increase over a year earlier. 2. Moving nominal GDP weights, using purchasing power parities. 3. Per cent of labour force. 4. Private consumption deflator.
Source: OECD (2021), OECD Economic Outlook N°110 - December 2021, https://stats.oecd.org/.

[25] Publicly supported short-time work schemes allow companies to temporarily reduce the work time of employees by up to 100%, while wage differences are partly or fully subsidised by the government.

124. The acceleration of economic activity, combined with reduced restrictions on personal and business mobility, resulted in rising prices for non-food commodities in general, and for energy (and, consequently, fertilisers) in particular (IMF, 2022[72]). On average, energy prices in 2021 were twice as high as in 2020, after a 30% decline between 2019 and 2020. Prices for natural gas in particular rose by 263%, driven also by the cold European winter and tensions over the Nord Stream 2 pipeline connecting Russian supplies to the European market. Crude oil prices rose by 64% year-on-year in 2021, while coal prices also more than doubled on average. As a consequence of higher energy prices, fertiliser prices rose by almost 80%. The Russian large scale aggression against Ukraine and the subsequent tightening of sanctions against Russia will reduce Russian and Ukrainian exports of energy and fertiliser and looks set to drive prices higher in 2022 (see below and next section on this).

125. Food prices increased by less than energy prices in 2021, but still significantly. International food prices averaged some 28% higher in 2021 than in 2020, a higher year-on-year change than during the food price crisis of 2007-08. Price increases have differed across commodities, but generally have been more modest in livestock markets than for crops (FAO, 2021[73]).

Figure 2.1. Commodity world price indices, 2007 to 2021



Note: The top part of the graph relates to the left scale, while the bottom part of the graph to the right scale.
Source: IMF (2022), Commodity Market Review, for all commodities, food and energy indices (base year: 2016), www.imf.org/external/np/res/commod/index.aspx; FAO (2022), FAO Food Price Index dataset, for meat, dairy and cereal indices (base period: 2014-16), www.fao.org/worldfoodsituation/foodpricesindex/en.

126. World meat production declined in in 2019 and was flat in 2020, driven primarily by the impact of African Swine Fever (ASF) on China's pig meat sector. Global meat production increased by more than 4% in 2021, due mainly to rebounding output in Asian pig meat production, complemented by increased stock liquidation in China following the price declines. Meat production also increased in most other regions, with the exception of Oceanian beef, where restocking and lower cattle inventories resulted in lower output. Strong import demand lifted global meat prices by almost 13% year-on-year in 2021, although slowing imports by China led to some modest price declines since August 2021.

127. World dairy markets were impacted by strong import demand, especially from Asia, and often limited exportable supplies from major producing regions. Global milk production increased in most regions, led by Asia and North America, driven both by growing cattle numbers and increasing farm productivity and milk yields. However, lower rainfall and higher grain prices led to small production declines in South America. Overall, world dairy prices almost uninterruptedly continued the upward trend that began in mid-2020. On average, dairy prices in 2021 were 17% higher than those in 2020.

128. World prices for crop commodities saw even stronger growth in 2021. Oilseed markets, already buoyed by strong feed import demand from China in 2020, came under further pressure from rebounding demand for vegetable oils and continued growth in feed demand for oilseed cakes and meals. Despite strong growth in oilseed output, stocks in major exporting countries had declined during the 2020-21 marketing year.[26] As a consequence, average oilseed prices in 2021 were 44% higher than in 2020, led by prices for vegetable oils, which increased by almost two-thirds year-on-year.

129. Global cereal production increased slightly in 2021. Higher coarse grain output, particularly in China, Ukraine and the United States, more than offset lower production of wheat, notably in Canada and the United States. Lower incidences of droughts and floods in Asia helped to increase global rice production. While food cereal use largely grew in line with population growth, feed use, notably of wheat, rose more strongly due to higher livestock production and herd sizes and rising oil meal prices. Lower stock-to-use ratios and strong growth of Chinese maize imports underpinned rising cereal prices, which, on average in 2021, were 27% higher than in 2020.

130. Production recoveries notably in the European Union and Thailand in 2021 reversed three years of decline in global sugar production. Despite this increase, output fell short of demand, which was underpinned by the economic recovery and which experienced particularly strong growth in India and China. In view of the continued tight market, world sugar prices averaged 37% higher in 2021 than in 2020.

131. Overall, average farm receipts (including budgetary transfers from agricultural policies) across the 54 countries covered in this report continued their rising trend since 2016 and are estimated to be 19% higher in 2021 than in 2019 (OECD, 2022[74]). This suggests that, on average and partly due to rapid policy responses, the COVID-19 pandemic has not had major negative implications for farmer incomes in the countries covered by this report.

132. The Russian large scale aggression against Ukraine can be expected to continue affecting agricultural commodity supplies and prices. Significant international sanctions against Russia are in place and Ukrainian trade infrastructure and cereal and oilseed production are affected. Global shortages of major production inputs, such as energy and fertilisers, are also possible. While data on developments in agricultural commodity prices since the beginning of the aggression remain incomplete, world prices for crude oil jumped by more than 30% within ten days of the large scale aggression, before declining to more moderate levels.

The Russian large scale aggression against Ukraine: First implications for agricultural markets and policies

133. On 24 February 2022, Russian troops began a large-scale military aggression against Ukraine. Three days earlier, the Russian Government had officially recognised the independence and sovereignty of the so-called Luhansk People's Republic and Donetsk People's Republic regions of Ukraine. At the time of writing, the Russian large scale aggression against Ukraine continues.

[26] October-September Marketing Year.

134. As a consequence, and building on earlier measures in place since the Russian annexation of Crimea, a large number of countries, including the United States and the European Union, imposed sanctions related to trade (excluding food and fertilisers) and travel to or from the Russian Federation and Belarus, among others (PIIE, 2022[75]). In addition, as a direct consequence of the large scale aggression, trade infrastructure in Ukraine, including in particular its Black Sea ports, has been significantly impacted. Given the evolving conflict, the implications for agricultural production in Ukraine remain uncertain. Finally, Russia has announced a temporary export ban for key agricultural products, including notably cereals and sugar, and implemented export bans and licensing for certain nitrogen fertilisers.

135. This section provides a first assessment of the implications that reduced trade with Ukraine, Russia and Belarus may have for agricultural markets and policies globally.

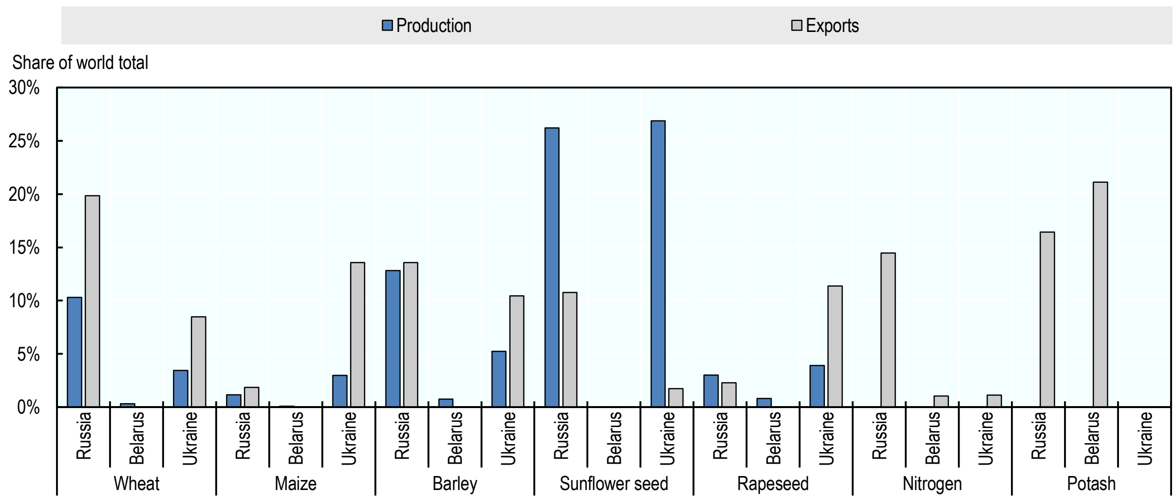
The importance of Russia, Belarus and Ukraine in world markets for relevant commodities

136. Russia and Ukraine are key producers and exporters of several agricultural commodities, including cereals and oilseeds. Combined, the two countries accounted for 28% of global wheat exports in 2018-20, while the corresponding shares are 15% for maize, 24% for barley, 12% for sunflower seed and 14% for rapeseed. The sunflower share is higher when derived products such as oil and meal are included: in 2018-20, Ukraine and Russia accounted for around 43% and 20% of global sunflower oil exports, respectively.

137. Together with Belarus, Russia is also amongst the main exporters of fertilisers. The two countries represented 16% of global nitrogen exports, and 38% of potash exports in 2018-20. Russia's role as the world's largest nitrogen exporter is related to its significant production of fossil fuels, of which it is also amongst the top exporters. Russia also exports significant amounts of mixed fertilisers containing phosphorous.

Figure 2.2. Shares of Russia, Belarus and Ukraine in global production and exports of selected agricultural commodities and fertilisers

Average 2018-20



Note: Agricultural commodities data in volumes, fertilisers data in values. No production data available for nitrogen and potash fertilisers.
Source: FAOSTAT (2022), https://www.fao.org/faostat/en/#data; UN Comtrade (2022), https://wits.worldbank.org/.

Implications for markets

138. Given the importance of these countries for global agricultural markets, the Russian large scale aggression against Ukraine and the political responses have significant and potentially longer-lasting implications for markets for both agricultural inputs and outputs, and hence also for farmers and consumers. Crude oil prices increased by more than 30% within ten days following the invasion, though they have subsequently fallen back to levels only moderately higher than just prior to the aggression.

139. Price volatility remains significantly above levels seen in late 2021. Export prices for major agricultural commodities, have climbed significantly (World Bank, 2022[76]). The IGC Grains and Oilseeds Index, which shows movements in export prices for grains and oilseeds, rose to its highest level on record in mid-March 2022.[27] Fertiliser prices, in particular for potash and nitrogen, have also seen significant increases.[28] Moreover, higher crude oil prices are adding to already high ocean transport costs. Overall, available information suggests that so far input prices may have increased more strongly than average crop prices, while livestock prices appear to be least affected. This would increase food costs, and likely affect margins for both crop and livestock producers.

Policy responses

140. In addition to humanitarian, economic and military responses aimed at Ukraine and Russia, countries have begun to implement measures to reduce the burden of the war for both agricultural producers and consumers.[29] Among these, changes in countries' trade policies are most prominent. Several countries have **announced, implemented or extended export bans, taxes or other export restrictions** including Egypt (key staples); Hungary, Moldova and Serbia (grains); and Argentina (soybeans and soybean products). China, which holds a large share of the world's grain stocks, has signalled that it may hold back on rice exports. Turkey has banned the export of grains and several other food commodities held in bonded warehouses at Turkish seaports. These measures come in addition to the export bans implemented by Russia.

141. That said, Argentina has also ceased registration of export sales of soybean oil and meal and reopened export sales for both products, which may offset some of the effect of the higher export tax. Argentina also increased its annual export quota for wheat.

142. Some countries have **reduced import barriers**. For instance, Switzerland decided to reduce import tariffs for feed grains from 15 March, while Turkey suspended documentation requirements for imports of agricultural products or transit trade loaded from Ukraine. Israel enlarged its import quota for table eggs, although this expansion may reflect increasing consumption during the Jewish Passover rather than a response to the war in Ukraine. Egypt facilitated imports by temporarily raising the moisture limit for imported wheat. Brazil temporarily eliminated import duties for several agricultural commodities, including ethanol and soybean oil.

143. More broadly, the European Union has also announced the use of "green lanes" over land to facilitate the importation of agricultural commodities from Ukraine. Several South-American countries have also submitted a proposal to the FAO calling for the exclusion of fertilisers from international sanctions on Russia.

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[27] AMIS Market Monitor, April 2022, http://www.amis-outlook.org/amis-monitoring/monthly-report/en/#.YlPZDMhBwuU.

[28] https://blogs.worldbank.org/opendata/fertilizer-prices-expected-remain-higher-longer.

[29] Examples of policy responses reported here are taken from the AMIS Market Monitor, April 2022, different media reports and government websites.

144. Domestic measures in response to the crisis have to date focused on **relaxed production constraints**, **direct support to farmers** and **labour markets**. The European Union has launched several policies, such as a derogation to grow food and feed crops on fallow land without loss of greening payments, and a support package allowing for additional support to farmers. Member States can opt for such policies. For example, Germany announced that, in 2022, it would exceptionally allow the use of crops as fodder on ecological priority areas in the categories “fallow land” and “catch crops”. Spain, Finland, France and China have all made additional funds available to help farmers cope with high input costs. Similarly, China has provided additional support to stabilise incomes and compensate grain producers for rising input costs, while the Czech Republic also abolished mandatory biofuel blending to increase grain availability on the market. The Czech Ministry of Agriculture also plans to launch a dedicated website to connect Ukrainian refugees with farms and other companies offering employment and accommodation.

145. Beyond those first-response measures, countries are also strengthening efforts to **reduce their vulnerability** to such shocks and to enhance their resilience more broadly. Several countries, such as Bulgaria and Egypt have increased efforts to build strategic reserves of food or feed commodities. Some have increased diplomatic efforts to open new markets for their produce previously exported to Russia (e.g. Colombia), or to find alternative sources, to supply their import needs, notably for fertilisers (e.g. Brazil, Costa Rica). Additional efforts are also being made to facilitate and promote the domestic supply of alternatives to imported fertilisers, e.g. through organic fertiliser sources or, in the longer run, domestic fertiliser production from fossil fuels.

146. For its part, **Ukraine** has imposed export license requirements for exports of wheat, poultry and eggs from 6 March 2022; maize and sunflower oil, originally included, have been removed from the list of products subject to export licensing. On 12 March 2022, Ukraine has also introduced a *de facto* export ban on a range of mineral fertilisers. On the import side, on 16 March 2022 Ukraine has eliminated excise duties on all imported goods. Domestically, Ukraine has introduced an additional farm loan programme and increased efforts to build strategic reserves of food and feed.

First assessment

147. Policies implemented in response to the market implications of the Russian large scale aggression against Ukraine focus on different areas, with trade policies dominating in the short term. Most of these aim to insulate domestic markets from the significant increases in international prices for agricultural commodities and inputs. That said, while export bans and other restrictions can temper domestic price increases for the covered commodities, they will further accelerate price spikes on international markets and undermine the trust that countries have in the reliability of the international trading system as a source of supply. For this reason, export restrictions should be avoided and, where already implemented, should be dismantled as soon as possible. In contrast, reductions of import barriers and simplification of trade procedures can facilitate trade and the functioning of international markets and should be made permanent to the extent possible.

148. There are new calls to relax environmental constraints, highlighting the trade-offs between environmental sustainability objectives and immediate concerns about the shortfall in global food supplies and potential consequences for food security. Countries considering such measures on an exceptional basis need to weigh the potential for other measures to address the consequences for food supplies, including the release of stocks, direct assistance to help consumers cope with higher food prices, and specific support for those countries facing burdensome food import bills. They also need to weigh the risk that measures is that they may be difficult to rescind, and may provide limited or marginal assistance with the current pressures, while carrying important longer term environmental costs, in particular for biodiversity. The balance may be particularly unfavourable if the agricultural land concerned has low productivity but high potential environmental value.

149. Compensating for labour shortages due to the reduced availability of migrant workers can be a particular challenge for countries neighbouring Ukraine. Ensuring that available workers among refugees are matched with labour needs on farms and in related companies in the short run will require simplified registration and employment procedures.

Recent developments in agricultural policies

Several countries revised their agricultural policy frameworks

150. **Australia** launched the *Delivering Ag2030* strategy, which aims to strengthen trade, biosecurity, natural resource management, supply chains and infrastructure. **Canada** issued the *Guelph Statement*, setting out the direction for the future of agricultural policy with priorities including tackling climate change, supporting research and innovation, and enhancing resilience. **China** launched a new *Five-Year Plan for Promoting Agricultural and Rural Modernisation 2021-25*, focusing on food security and improving living conditions in rural areas.

151. The **European Parliament and Council** reached political agreement on reforming the EU Common Agricultural Policy (CAP) for 2023-27. The new legislation seeks to ensure a sustainable future for European farmers, provide more targeted support to smaller farms, and allow greater flexibility for EU countries to adapt measures to local conditions. **Iceland's** new *Agricultural Framework Agreement* entered into force, covering the general operating environment for the agricultural sector. **Indonesia** established Badan Pangan Nasional (BAPANAS), a new national food agency under the authority of the President, with the objectives of stabilising prices of food staples, maintaining food availability, implementing food importation policies, achieving food and nutrition security, and ensuring food safety. **Kazakhstan** endorsed the *National Project*, which aims to improve productivity, exports, agro-food processing, and rural incomes over the next five years.

152. **Norway's** new government set out its policy priorities for agriculture in its *Hurdal Platform*. The platform identifies closing the income gap between agriculture and other groups in society as a key concern, and proposes reforms to the milk quota system, a cap on production subsidies, and new targets for food self-sufficiency. **Turkey** prepared its *National Food Systems Pathway*, including 10 main priority areas and 117 actions to transform food systems and achieve the Sustainable Development Goals by 2030. **Viet Nam** introduced several new strategic policy documents, including the *Resolution on National Food Security until 2030*; the *Agricultural Industry Structural Plan for 2021-2025*; and *the Scheme for Restructuring Viet Nam's Rice Sector by 2025 and 2030*.

Some countries introduced new measures (or extended existing measures) in response to the COVID-19 pandemic

153. The **Australian** Agriculture Visa was announced to help address workforce shortages in the agricultural sector. **Australia** also extended its *International Freight Assistance Mechanism*, providing additional support to keep international supply chains open in the context of COVID-19 related trade disruptions. The **European Union** prolonged its State Aid Temporary Framework to support the economy in the context of the COVID-19 pandemic, and the European Commission adopted exceptional measures to support the wine, fruit and vegetable sectors.

154. In response to the second wave of the COVID-19 pandemic, **India** extended the Pradhan Mantri *Garib Kalyan Anna Yojana* (PMGKAY) food distribution programme, adding nearly USD 10 billion to the cost of the programme. The government of the **Philippines** maintained measures to protect producers' livelihoods and food security, such as the Rice Resiliency Project which aims to increase the country's self-sufficiency in rice production. The government also expanded funding for additional loans and loan

guarantees to small farmers under the SURE COVID programme, and extended retail price controls on basic food items in 2021.

155. The **United States** established a number of ad hoc programmes to reduce the impact of market disruptions related to the pandemic. This includes compensation for reduced processing capacity for pork and poultry, and targeted voluntary programmes to encourage donations of surplus dairy products to feeding programmes. **Viet Nam** continued to provide support to offset the impacts of the COVID-19 pandemic on farmers, including deferred taxation, monetary payments and concessional credit. Over 250 000 tonnes of rice were distributed from reserve stocks, while tariffs on certain agricultural products were lowered to reduce cost pressures.

Additional support was provided to help farmers cope with rising input costs

156. **China** provided a one-time subsidy to grain farmers to offset increasing input costs. **Colombia** increased budgetary support to the agricultural sector substantially in 2021, and reduced tariffs on agricultural inputs to zero. **India** allocated additional funds for fertiliser subsidies to offset increases in international prices, and provided assistance under the *National Mission on Oilseeds and Oil Palm* to enhance self-sufficiency in oilseeds production. **Mexico** expanded the budget allocated to its fertiliser programme by 160% in 2022 relative to levels in 2021, adding new beneficiaries from some of the poorest states in the country.

Many countries strengthened policies to improve the sustainability performance of agriculture…

157. **Australia** provided increased funding for the *Agriculture Biodiversity Stewardship Package*, which includes payments to farmers to protect, manage and enhance remnant native vegetation, the implementation of a farm biodiversity certification scheme, and the establishment of a *National Stewardship Trading Platform* to connect farmers with buyers of biodiversity outcomes. A *National Soil Strategy* was also launched, setting out how Australia will value, manage and improve its soil resources over the next 20 years. The *Sustainability Strategy for the* ***Chilean*** *Agri-food Sector* was launched with the aim of identifying best practices for sustainable agricultural production. **Japan** developed a new Strategy for Sustainable Food Systems called MeaDRI (*Measures for Achievement of Decarbonisation and Resilience with Innovation*), which includes targets for the reduction of chemical fertiliser and pesticide applications as well as for increase of land under organic farming. **Korea** announced the *Fifth Five-Year Plan to Foster Environment-friendly Agriculture* for 2021-25.

158. **New Zealand's** *Productive and Sustainable Land Use* package financed a number of projects aiming at increased connection of farmers with other stakeholders such sector groups, regional councils and science providers. **New Zealand** also announced a ban on exports of livestock by sea to be phased in over two years, in response to animal welfare concerns about the suffering of livestock on ships. **Mexico** started phasing out the use of glyphosate and genetically-modified corn for human consumption, and announced a new strategy for reducing burning of agricultural land. The government is also developing maps of carbon sequestration potential in soils and the *Soils National Strategy for Sustainable Agriculture* for conserving, restoring and promoting sustainable soil management.

159. **Switzerland** adopted a *2030 Sustainable Development Strategy* and related action plan, with a set of objectives relating to reducing emissions from the food system, healthy and sustainable diets, reducing food loss and waste, and increasing ecosystem services. A package of measures on water quality was also adopted, including measures to reduce risks associated with pesticide use and reduce nitrogen and phosphorous losses. **Turkey** adopted its *Green Deal Action Plan*, which aims to increase the sustainability of agriculture through reductions in the use of pesticides, anti-microbials and chemical fertilisers, developing organic production, increasing renewable energy use in agriculture and improving

the management of waste and residues. **Ukraine**[30] adopted a *National Action Plan for Environmental Protection until 2025*, and laws to strengthen protection of forests and peatlands, encourage large-scale afforestation, and support the development of organic farming.

160. **The United Kingdom** is phasing in new domestic support schemes as it transitions from the EU CAP. In England, support to farmers will be aimed at improving the environment, improving animal health and welfare, reducing emissions, supporting resilience to climate risks, and improving the productivity and sustainability of farm businesses. The Scottish Government's *Vision for Scottish Agriculture* outlines plans to transform support to farming and food production in Scotland and to become a global leader in sustainable and regenerative agriculture. In Wales, the proposed *Sustainable Farming Scheme* will focus on sustainable land management and food production.

161. The **United States** updated a number of existing programmes to increase their climate benefits. For instance, a new pilot programme was introduced under the *Environmental Quality Incentives Program* to support climate-smart agriculture and forestry through the adoption of targeted conservation practices.

…Including bolstering support for small-scale producers and fostering more inclusive development in agriculture

162. **Costa Rica** implemented the *Puente Agro Initiative*, which aims to improve productivity of small-scale farmers through the provision of equipment, inputs, and technical assistance. **Korea** developed the *Fifth Basic Plan to Support Female Farmers for 2021-25*, which aims to increase the participation of women in farming, promote the rights of female farmers and improve their quality of life. **Korea** also passed the *Act on Fostering of and Support for Next Generation Farmers or Fishers and Young Farmers or Fishers*, which will help successors and young farmers settle in rural villages, and support sustainable rural development. **South Africa** launched the *Agri-Industrial Fund* to assist black producers and entrepreneurs in developing, expanding, acquiring and integrating operations in prioritised value chains. The Fund also aims to accelerate land redistribution and increase exports. **Ukraine** established a new *Fund for Partial Credit Guarantees in Agriculture*, providing credit guarantees to small and medium-sized farms and agricultural enterprises cultivating up to 500 hectares of land. The **United States** provided risk management education, outreach and targeted technical assistance to connect historically underserved producers with USDA programmes and services.

Risk management and disaster assistance policies were strengthened

163. **Australia** provided additional funding to develop climate information services, drought indicators for a new early warning system, and infrastructure to improve drought preparedness. **Brazil's** Ministry of Agriculture launched a digital platform (AGROMET) that compiles meteorological information and facilitates online access to different climate services related to agriculture. **Canada** boosted support through its *AgriRecovery Framework* to alleviate financial pressure on livestock farmers who faced additional costs due to drought and wildfires. **New Zealand** provided additional funding for *Rural Support Trusts and Rural Assistance Payments* to help primary producers, their families and employees cope with the adverse effects of drought and floods. **Ukraine** introduced state support for agricultural insurance, reimbursing agricultural producers with up to 60% of the cost of insurance payments. The **United States** launched a new Quality Loss Adjustment programme under the *Wildfire and Hurricane Indemnity Program*

[30] The Russian large scale aggression against Ukraine, briefly discussed in the previous section, has created a significant change in the landscape of agricultural policies in Ukraine. The material on Ukraine in this section is based on information collected prior to the Russian aggression against Ukraine and has to a large extent been overtaken by recent events. The policy developments in Ukraine outlined in this section will therefore need to be understood against this background.

Plus (WHIP+) programme, and expanded the *Emergency Assistance for Livestock, Honey Bees and Farm-raised Fish Program* to cover feed transportation costs for drought-impacted ranches.

New laws and regulations on animal and plant health were introduced

164. In response to outbreaks of African Swine Fever (ASF) in the region, **Argentina's** plant and animal health and food safety body (SENASA) established the National Animal Health and Welfare Commissions for Swine and other animal species, and introduced a new regulation for swine production plants that follow standards of the World Organization for Animal Health (OIE) on compartmentalisation. **Australia** also introduced new investments in frontline biosecurity measures to manage the risk of pests and diseases entering Australia (including African Swine Fever), modernise IT systems and data analytics, and improve abilities to detect and manage threats offshore.

165. **Chile's** Agriculture and Livestock Service (SAG) updated its phytosanitary regulations, and upgraded systems for electronic certification. **Mexico** adopted new organic certification requirements for imports of organic products, including both raw and processed products. Reforms were also introduced under **Ukraine's** Association Agreement with the European Union to improve sanitary standards for the export of animal products.

Some countries provided new support to agricultural innovation and the development of human capital

166. **Australia** released the *National Agricultural Innovation Policy Statement*, establishing four new priorities for agricultural innovation that target exports, climate resilience, biosecurity and digital agriculture. The Australian Government *Roadmap to Attract, Retain, Upskill and Modernise the Agriculture Workforce* was also released, followed by several initiatives to improve employment opportunities in agriculture. **Indonesia** established *Badan Riset dan Inovasi Nasional*, a single national research and innovation agency to co-ordinate government R&D and innovation activities, including those relating to agriculture. **Korea's** Development of the Smart Agriculture Project continued in 2021 with the opening of two Smart Farm Innovation Valleys.

Many countries have concluded bilateral and regional trade agreements

167. The Regional Comprehensive Economic Partnership (RCEP) entered into force in January 2022, covering fifteen countries in the Asia-Pacific region including **Australia, China, Indonesia, Japan, New Zealand, the Philippines, Korea** and **Viet Nam.** The agreement will reduce tariffs on goods among the 15 participating economies by 90% over two decades from entry into force, and provides a framework for strengthening co-operation in the areas of standards, technical regulations, and conformity assessment procedures, as well as for streamlining rules of origin and border processes for perishable goods. The agreement includes significant tariff concessions for agriculture resulting in a tariff reduction of about 12.8 percentage points for about 8.4% of products, although agriculture will remain relatively more protected (17% of tariff lines remain uncommitted, versus about 5% for manufacturing) (UNCTAD, 2021[77]). The **EU-UK** Trade and Co-operation Agreement entered into force on 1 May 2021 after approval by the European Parliament and adoption by the European Council.

168. Several additional bilateral free trade agreements (FTAs) were negotiated or came into effect in 2021 and early 2022, helping to facilitate bilateral trade in agricultural products. These include: the **Australia-United Kingdom** FTA; EFTA-**Israel** FTA (updated with modernised and expanded bilateral agricultural agreements); **Turkey-United Kingdom** FTA; **Ukraine-Israel** FTA; **United Kingdom-Israel** FTA; **Ukraine-Turkey** FTA; EAEU-**Viet Nam**. Many other FTA negotiations are ongoing.

Trade promotion and market development policies were introduced by a number of countries

169. Additional funds were committed to revamp **Australia's** trade systems by simplifying regulations and establishing a one-stop shop for trade clearances. **Israel** introduced a government resolution aiming to reduce customs for agricultural fresh produce and to ease import procedures, as part of a broader set of measures.

Developments in support to agriculture

170. This section provides an overview on developments in policy support in agriculture, building on the OECD indicators of agricultural policy support that are comparable across countries and time. These indicators show the diversity of support measures implemented across different countries and focus on different dimensions of these policies. Definitions of the indicators used in this report are shown in Annex 2.A, while Figure 2.3 illustrates the links between, and components of, the different indicators.

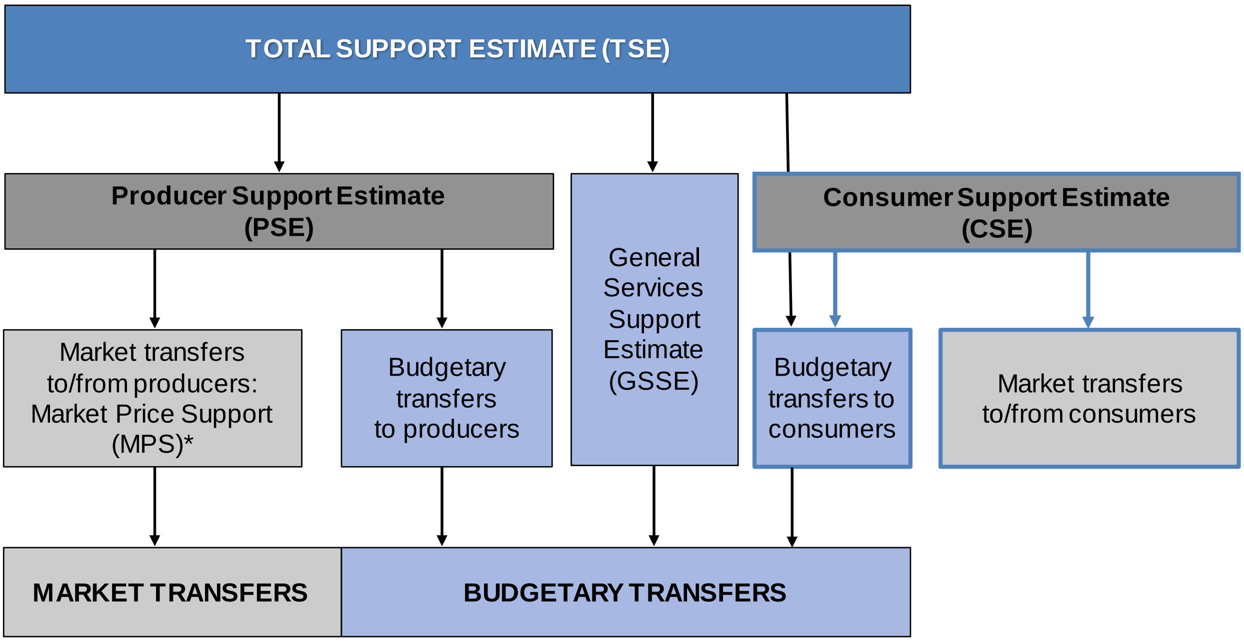
171. The **Total Support Estimate (TSE),** as the broadest of these indicators, combines three distinct elements: a) transfers to agricultural producers individually; b) policy expenditures for the primary agricultural sector collectively; and c) budgetary support to consumers of agricultural commodities. The TSE is expressed as a net transfer indicator, including both positive and negative elements.

172. The **Producer Support Estimate (PSE)** measures all transfers to agricultural producers individually. Two major types of transfers can be distinguished: ***Market Price Support (MPS)*** represents transfers from taxpayers and consumers to agricultural producers through domestic prices that are higher than their international reference prices due to domestic and trade policies (see Box 2.1). ***Budgetary support*** is financed by taxpayers only and is further broken down into various categories distinguished by the different implementation of the underlying policies. The PSE is expressed as a net transfer indicator, including both positive and negative elements.

173. The **General Services Support Estimate (GSSE)** measures policy expenditures that have the primary agricultural sector as the main beneficiary, but do not go to individual producers. Different types of expenditures are represented in specific categories of the GSSE.

174. Similar to the PSE, the **Consumer Support Estimate (CSE),** which reports support to consumers of agricultural commodities, distinguishes between market transfers that mirror the MPS, and budgetary support. To avoid double-counting, only the budgetary part of the CSE is included in the TSE.

Figure 2.3. Structure of agricultural support indicators



Note: *Market Price Support (MPS) is net of producer levies and excess feed cost.
Source: Annex 2.A.

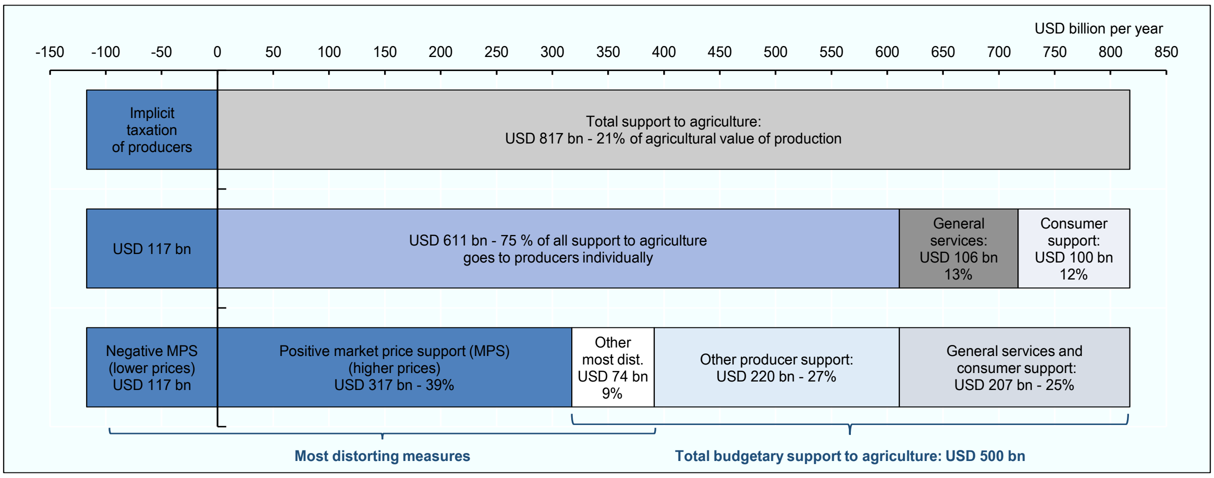
Total support to agriculture has risen to record highs

175. Across the 54 countries covered in this report, total support directed to the sector[31] has grown to more than **USD 817 billion per year on average in 2019-2021** (Figure 2.4). A combination of temporary factors, discussed further below, was mainly responsible for a marked increase of support in 2020 and 2021. Of the total, close to USD 611 billion per year or 75% was transferred to individual producers,[32] while the remainder was almost equally split between support for general services (USD 106 billion) and budgetary transfers to consumers of agricultural products (USD 100 billion). At the same time, some emerging economies implicitly taxed their producers to the tune of USD 117 billion per year on average. The negative Market Price Support in these countries is discussed in more detail further below.

[31] Corresponding to the positive part of the Total Support Estimate (TSE).

[32] Corresponding to the positive part of the Producer Support Estimate (PSE).

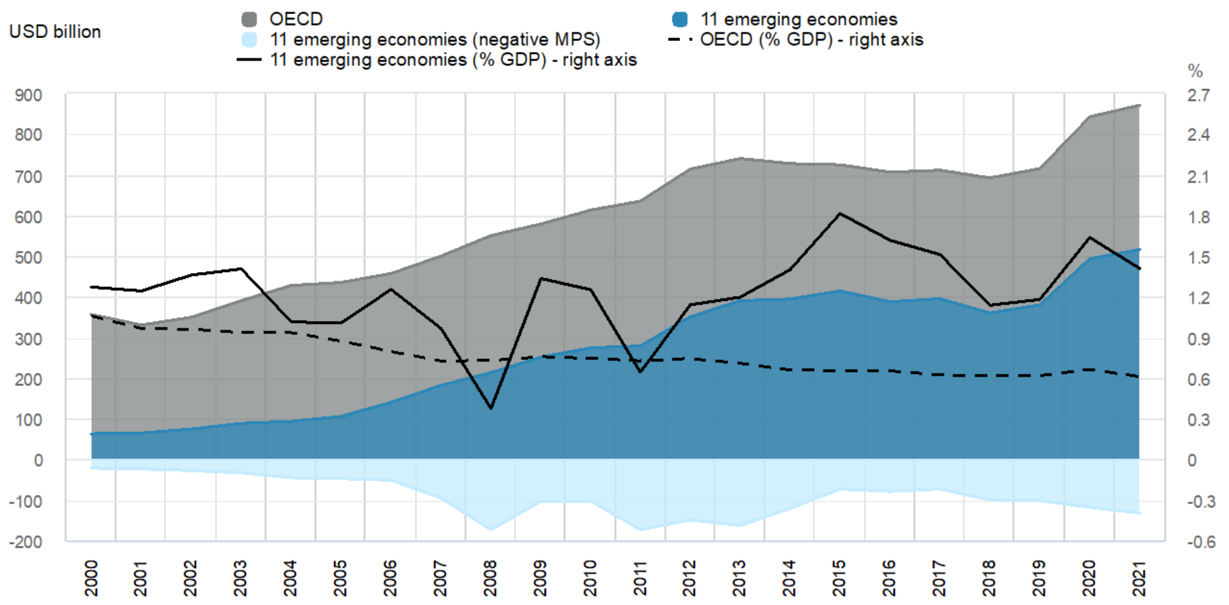
Figure 2.4. Breakdown of agricultural support, total of all countries, 2019-21



Notes: Data refer to the All countries total, including all OECD countries, non-OECD EU Member States, and the 11 emerging economies. “Implicit taxation” of producers refers to negative market price support, “General services” refers to the General services support estimate, “Consumer support” is transfers to consumers from taxpayers, “Other most dist.” refers to the most distorting producer support measures other than market price support (i.e. support based on output payments and on the unconstrained use of variable inputs).
Source: based on OECD (2022), “Producer and Consumer Support Estimates”, OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-pcse-data-en.

176. In nominal terms, over the past 20 years, support has increased markedly within the emerging economies (Figure 2.5). This group provided USD 464 billion per year to agriculture over 2019-21, up from USD 68 billion in 2000-02, with the overwhelming majority of this support accounted for by two countries: China (USD 285 billion) and India (USD 116 billion). Agricultural support in the OECD area remained consistently high, increasing more modestly in nominal terms over the same period, to reach USD 346 billion per year in 2019-21. At USD 117 billion and USD 114 billion, a significant portion of that was provided by the European Union and the United States, respectively. Given the lower GDP and higher shares of agriculture in the economies, total support for the 11 emerging economies covered on average represents a higher, albeit fluctuating, burden to the economy than across the OECD area.

Figure 2.5. Evolution of total support to agriculture in OECD and 11 emerging economies, 2000 to 2021



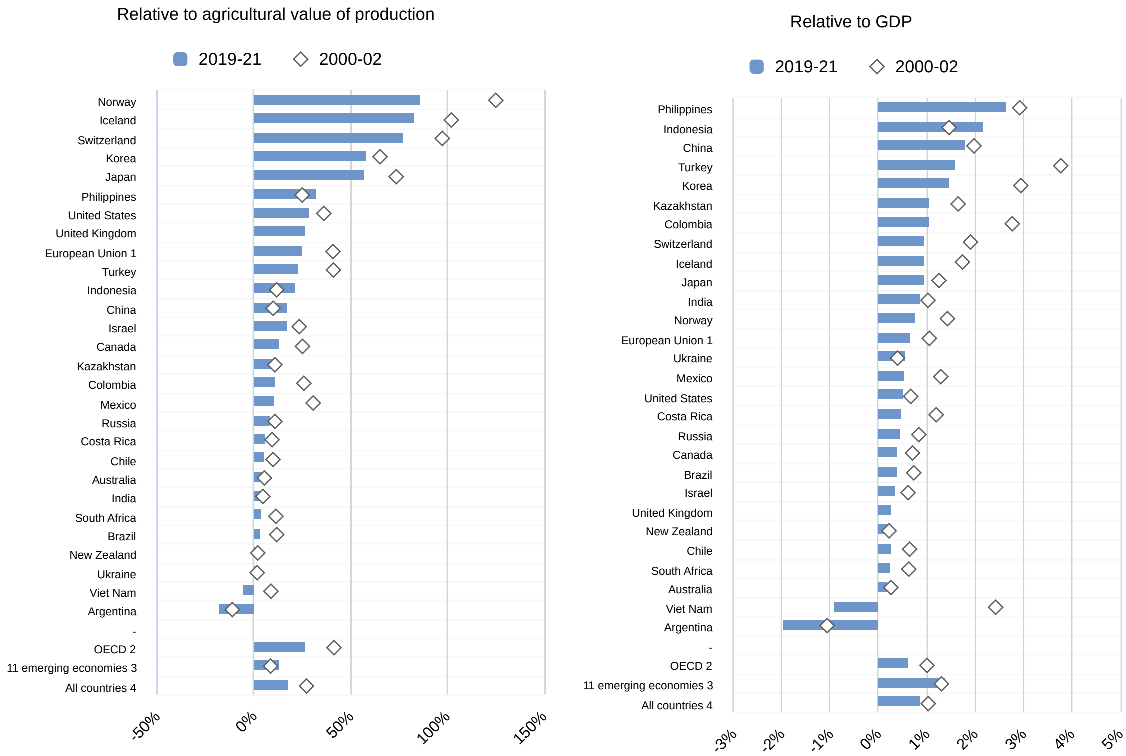
Notes: Negative MPS for OECD countries, mostly reflecting adjustments for higher feed costs due to positive MPS for feed commodities, averaged USD 461 million per year between 2000 and 2021, and is therefore too small to be visible on the graph.
The OECD total does not include the non-OECD EU Member States. Latvia and Lithuania are included only from 2004.
The 11 emerging economies include Argentina, Brazil, China, India, Indonesia, Kazakhstan, the Philippines, Russian Federation, South Africa, Ukraine and Viet Nam.
Source: OECD (2022), "Producer and Consumer Support Estimates", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-pcse-data-en.

177. To understand the relevance of this support for the agricultural sector, however, it is important to put these numbers into the context. For the 54 countries covered by this report, the total support provided in 2019-21 was equivalent to 18% of the production value generated by the sector. This compares to 27% of the production value of the sector in 2000-02. Across the OECD area, support as a percentage of the value of production fell from 41% to 27% over the last 20 years. Across the 11 emerging economies, it has increased in relative terms, from an equivalent of 13% in 2000-02 to 18% in the most recent years. That said, once the negative MPS in several of the emerging economies is factored in (that is, the extent to which these countries implicitly tax the sector), average net support to the sector corresponded in 2019-21 to 13.4% of its value of production (compared to 8.5% almost two decades ago).

178. These aggregate figures mask significant diversity across individual countries (Figure 2.6). While in Switzerland, Japan and Norway, total support added up to between 78% and 87% of national agricultural production value on average during 2019-21, net support corresponded to less than 5% of the production value in South Africa, Brazil, New Zealand and Ukraine, and was negative at -5% and -18% in Viet Nam and Argentina, respectively.

179. The economic burden to societies differs strongly as well. Higher support levels, lower levels of economic development and larger agricultural sectors in the economies all contribute to higher shares of agricultural support in countries' GDP (Figure 2.6, right panel), the countries with the highest economic burden of support are not always those that provide the highest level of support relative to the sector's size. Relative to GDP support is highest in the Philippines, Indonesia, China, Turkey and Korea, where support to agriculture accounts for 1.5% or more of the GDP. In Australia and South Africa, it accounts for 0.25% or less of GDP.

Figure 2.6. Total Support Estimate by country, 2000-02 and 2019-21



Notes: Countries are ranked according to TSE relative to the value of agricultural production (left panel) and relative to GDP (right panel) in 2019-21, respectively.
1. EU15 for 2000-02, EU28 for 2019, EU27 and the United Kingdom for 2020 and EU27 for 2021.
2. The OECD total does not include the non-OECD EU Member States. Latvia and Lithuania are included only for 2019-21.
3. The 11 emerging economies include Argentina, Brazil, China, India, Indonesia, Kazakhstan, the Philippines, Russian Federation, South Africa, Ukraine and Viet Nam.
4. The All countries total includes all OECD countries, non-OECD EU Member States, and the emerging economies.
Source: OECD (2022), "Producer and Consumer Support Estimates", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-pcse-data-en.

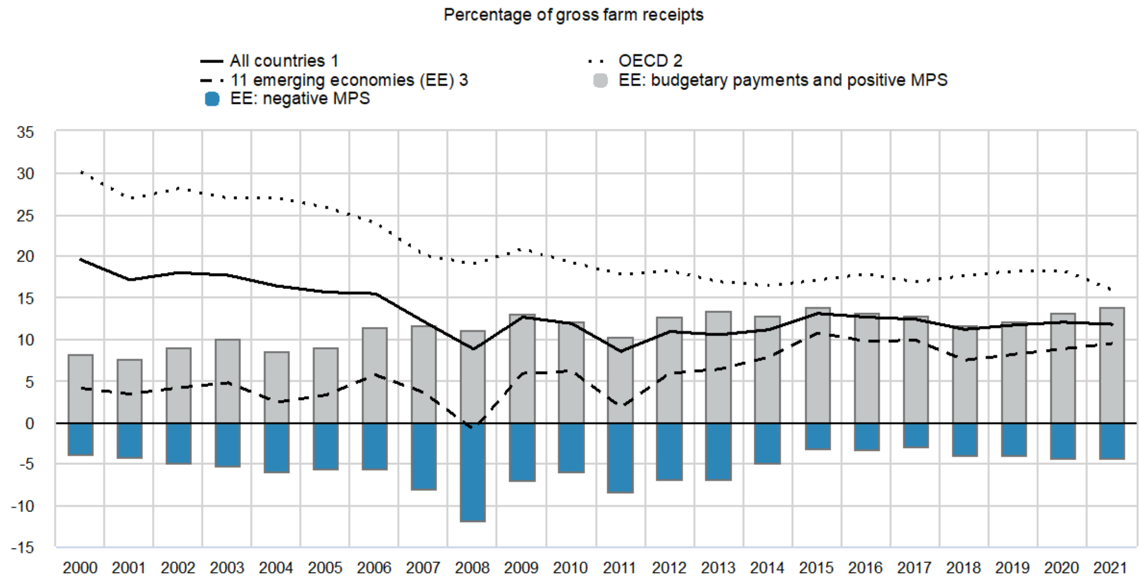
Reform to producer support has stalled in recent years

180. After a significant decline in support provided to individual producers within the OECD area until the early 2010s, levels of support relative to gross farm receipts (GFR) have subsequently remained largely unchanged (Figure 2.7). Overall, producer support across the 38 OECD countries stood at 17% of GFR in 2019-21 (%PSE). While preliminary data indicates that the level of market price support, and consequently of producer support overall, saw a marked decline in 2021, this is largely related to higher world market prices, not to policy reforms within the OECD.

181. Levels of average producer support across the emerging economies covered in this report peaked in 2015 and have changed relatively little since then. At 9% of GFR, average support is well below that of the OECD area, above the 4% reported for 2000-02 but slightly lower than the peak levels in 2015. This average figure comprises both positive and negative support to producers. In several countries, notably Argentina, India and Viet Nam, domestic and trade policies lower domestic prices of some or all commodities relative to their international reference levels. The resulting negative MPS corresponds to an implicit taxation of agricultural producers to the value of more than 4% of average GFR across all emerging economies. If the negative MPS is excluded, support to producers is represents more than 13% of GFR on average.

182. Across all 54 countries covered, 12% of gross farm receipts arose from some form of producer support during 2019-21, a level similar to that observed a decade earlier, and composed of almost 15% of positive support and close to 3% of implicit taxation of agricultural producers. In nominal terms, however, support to agricultural producers has reached record levels at more than USD 610 billion per year, while the implicit taxation has reached an average USD 117 billion per year, a level last seen almost a decade ago, and with an increase in the last two years.

Figure 2.7. Evolution of the % Producer Support Estimate, 2000 to 2021

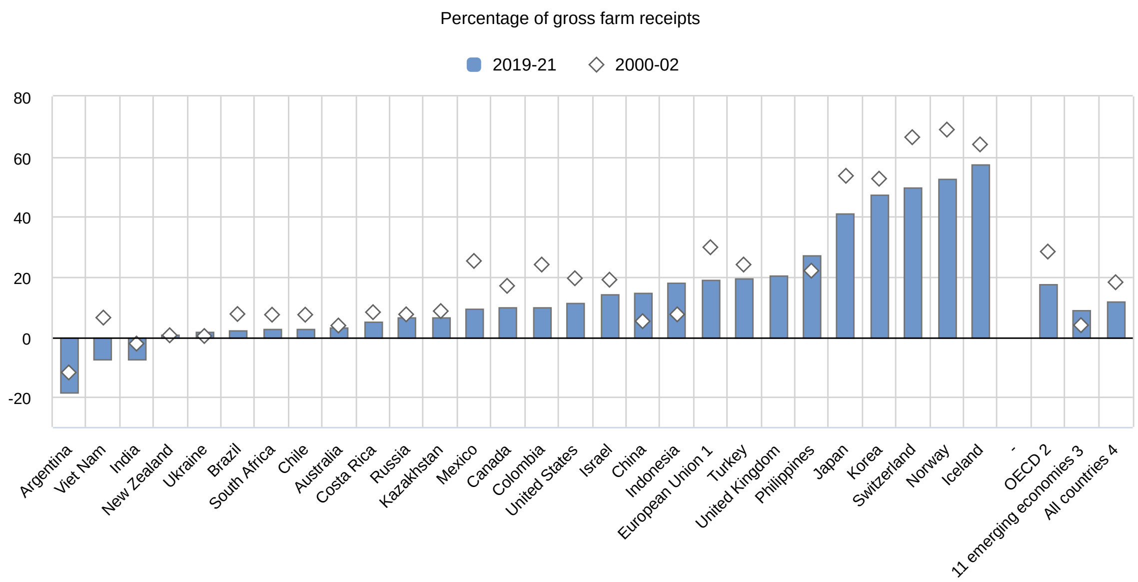


Notes: The two bars relate to the 11 emerging economies and represent a decomposition of PSE into its positive and negative parts.
1. The All countries total includes all OECD countries, non-OECD EU Member States, and the 11 emerging economies.
2. The OECD total does not include the non-OECD EU Member States. Latvia and Lithuania are included only from 2004.
3. The 11 emerging economies include Argentina, Brazil, China, India, Indonesia, Kazakhstan, the Philippines, Russian Federation, South Africa, Ukraine and Viet Nam.
Source: OECD (2022), "Producer and Consumer Support Estimates", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-pcse-data-en.

183. Again, these average numbers mask the persistent diversity in agricultural support within both OECD countries and emerging economies (Figure 2.8). Indeed, average producer support is very low in New Zealand, Ukraine, Brazil, South Africa, Chile and Australia with levels below or close to 3% of GFR. As noted above, three countries, including Argentina, Viet Nam and India, even implicitly tax their producers by providing negative support levels. This is contrasted by Japan, Korea, Switzerland, Norway and Iceland which show PSE levels of between 40% and 57%. In other words, around half of agricultural GFR are generated from public support policies in these countries.

184. Among the emerging economies, only the Philippines (27%) and Indonesia (18%) show levels of producer support that exceed the OECD average. That said, most of the covered emerging economies have increased their support levels since the beginning of the century, most notably Indonesia and China, where the %PSE has risen by 11 and 10 percentage points, respectively to 18% in Indonesia and 15% in China. China's producer support saw a marked increase in 2020 and 2021, in particular in MPS and payments to producers, discussed further below.

Figure 2.8. Producer Support Estimate by country, 2000-02 and 2019-21



Notes: Countries are ranked according to the 2019-21 levels.
1. EU15 for 2000-02, EU28 for 2019, EU27 and the United Kingdom for 2020, and EU27 for 2021.
2. The OECD total does not include the non-OECD EU Member States. Latvia and Lithuania are included only for 2019-21.
3. The 11 emerging economies include Argentina, Brazil, China, India, Indonesia, Kazakhstan, the Philippines, Russian Federation, South Africa, Ukraine and Viet Nam.
4. The All countries total includes all OECD countries, non-OECD EU Member States, and the emerging economies.
Source: OECD (2022), "Producer and Consumer Support Estimates", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-pcse-data-en.

Market price support remains the dominant form of support in most countries

185. Within support to producers, significant transfers continue to be induced by policies that alter domestic market prices. Various policies contribute to higher prices, including both domestic and trade measures, but import tariffs and tariff rate quotas are the most frequently applied. Across all countries covered by this report, support through higher producer prices amounted to USD 317 billion per year on average during 2019-21, equivalent to 8% of annual GFR and more than half of all transfers to producers.

186. The significance of MPS varies strongly across countries. In Norway, Switzerland, the Philippines, Iceland, Japan and Korea, market price support accounts for between 20% and more than 40% of farmers' gross receipts, while these transfers to producers represent less than 5% of farmers' gross receipts in 16 other countries. In turn, three countries, Argentina, India and Viet Nam, significantly tax their producers, with their negative MPS corresponding to between -9% and -19% of gross farm receipts, respectively. This negative MPS is mostly the result of export taxes and other market and trade restrictions.

187. While MPS in China remains somewhat above the average across all countries at close to 11% of GFR, it saw a substantial increase in 2020 and 2021 due to: a) tighter domestic markets mainly for maize and soybeans, related to rebuilding pig herds after the outbreak of African Swine Fever, weather related problems and reduced stock releases; and b) increased minimum purchase prices for rice and wheat; and groundnuts becoming an imported product subject to border tariffs.

188. In addition to the diversity across countries, the average share of price support in gross farm receipts often hide significant variation across commodities within countries (Figure 2.9). Price support often remains particularly important for a subset of commodities, while being more limited, zero or even negative for others. In Korea, Switzerland, Ukraine, Japan and Iceland, MPS corresponds to between 72%

and 82% of commodity gross receipts[33] for the most strongly supported commodities.[34] Put differently, gross farm receipts for these commodities are between 3.5 and 5.6 times higher than what they would be where they priced at border reference prices (Box 2.1 provides information on the estimation of MPS).

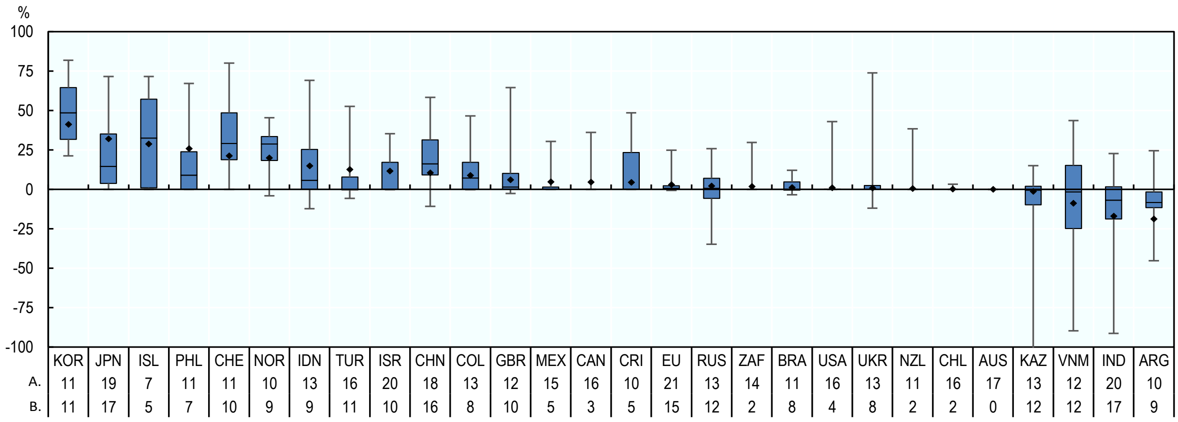
189. Similarly, among those countries with negative MPS, the implicit taxation noted above varies greatly. While in Viet Nam, India and Argentina, average MPS at the national level is negative at between -9% and -19% of gross farm receipts, the most heavily taxed commodities faced negative MPS worth between -45% and -91%.[35] This in effect cuts commodity gross receipts by up to half of what they would have been where they priced at reference border price levels. At the same time, each of these countries also supports the production of at least one other commodity through positive price support.

190. Several of the countries with small total MPS, such as Kazakhstan and Ukraine, also maintain both positive price support for some commodities and negative for others.

191. The low average MPS estimates therefore hide significant positive and negative support rates across commodities, stressing the importance of looking at both positive and negative components of aggregate support levels.

Figure 2.9. Relative magnitude of product-specific market price support by country, 2019-21

Percentage of commodity gross receipts



Notes: A. Number of MPS commodities. B. Number of MPS commodities with non-zero MPS values.
EU refers to EU28 for 2019, EU27 and the United Kingdom for 2020, and EU27 for 2021.
The ends of the whiskers represent the minimum and maximum values across commodities, while the boxes indicate ranges between the first and the third quartiles with the horizontal line inside indicating the median. Diamonds represent the MPS share in GFR for total agriculture.
Minimum values for Kazakhstan are -134%.
Source: OECD (2022), "Producer and Consumer Support Estimates", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-pcse-data-en.

[33] Commodity gross receipts include the commodity-specific value of production, valued at farm gate prices, plus any single-commodity transfers other than the MPS.

[34] For the countries listed, these commodities are soybeans (Korea), poultry meat (Switzerland and Iceland), sugar (Ukraine) and grapes (Japan).

[35] For the countries listed, these commodities are tea (Viet Nam), bananas (India) and soybeans (Argentina).

Box 2.1. Market price support – concept and interpretation

Market price support (MPS) is defined as the "annual monetary value of gross transfers from consumers and taxpayers to agricultural producers, arising from policy measures that create a gap between domestic market prices and border prices of a specific agricultural commodity, measured at the farm gate level" (OECD, 2016[78]). It is calculated for individual commodities, as the gap between the domestic price paid to producers and the equivalent price at the border (market price differential, MPD), multiplied by the quantity produced, and aggregated to the national level.

This definition contains three key elements. First, it measures the transfers that arise from policy measures that create a price gap (e.g. import tariffs, minimum prices, export taxes, etc.). Second, it measures gross transfers (positive or negative) to agricultural producers from consumers and taxpayers. Third, it is measured at the farm gate level to ensure that MPS values are consistent with the production and price data for the farming sector overall.

The price gap (MPD) for a specific commodity measures the difference between two prices: the average domestic price and a reference price calculated at the same level in the value chain (generally at the farm gate). This reference price corresponds to the country's border price, i.e. the import price (for net-imported commodities) or the export price (for net-exported commodities), or in the absence of that another price indicative of them such as a world price or another country's border price, adjusted for transportation costs and any differences in quality, weight or processing level, to make them comparable to the average domestic price (see below).

The MPD is calculated only if policies exist that can cause the gap such as border measures that restrict or promote imports or exports, and government purchases, sales and intervention prices in the domestic market. If countries do not implement such policies, the MPD is assumed to be zero. A non-zero MPD, whether positive or negative, originates from price-distorting policies. It is important to note that MPS measures the "policy effort" (or level of support to prices), not the policy effect (e.g. the impact on farm income). In addition to policy instruments that restrict price transmission (say, a target price), market developments (such as exchange rate movements affecting world prices expressed in local currencies) may influence the implied policy effort and, hence, the resulting transfers.

The calculation of the MPD for individual commodities based on prices requires information not only on product prices, but also on differences in product qualities, processing and transportation margins, to compare like with like. In some cases, difficulties in identifying and obtaining relevant prices or other required information prevent the MPD calculation from being based on observed price gaps. An alternative option for calculating the MPD is the use of import tariffs or export taxes (OECD, 2016[78]), which is likely to provide accurate MPS estimates only if a uniform tariff or tax rate is the sole border measures in place.

The use of tariffs rather than price gap data comes with a number of complex measurement issues, covering issues such as the composition of product groups across tariff lines and the seasonality of production and trade. Moreover, in order to capture the marginal rather than the average import protection rate, the statutory applied MFN tariffs are used. In light of the growing number of preferential trade agreements (PTAs) engaged in by countries covered by this report, an important caveat therefore relates to the fact that the statutory applied MFN tariffs remain unchanged even when increased quantities of products are imported under preferential tariffs or duty-free within such PTAs. As a consequence, potential liberalising effects of new PTAs are not reflected in the MPS estimates when tariffs are used to calculate them. With the increased relevance of PTAs for international trade, it therefore becomes even more important to base the MPD calculations on price gap calculations whenever data allow.

When interpreting MPS values, it is important to bear in mind that MPS is not a measure of public expenditures but an estimation of implicit or explicit transfers. MPS estimates published by the OECD therefore often differ from, and should not be confused with, those published by other organisations, including by the World Trade Organization, which may use very different concepts to calculate their indicators, despite similar names (Effland, 2011[79]; Brink, 2018[80]; OECD, 2002[81]).

Source: (OECD, 2020[82]).

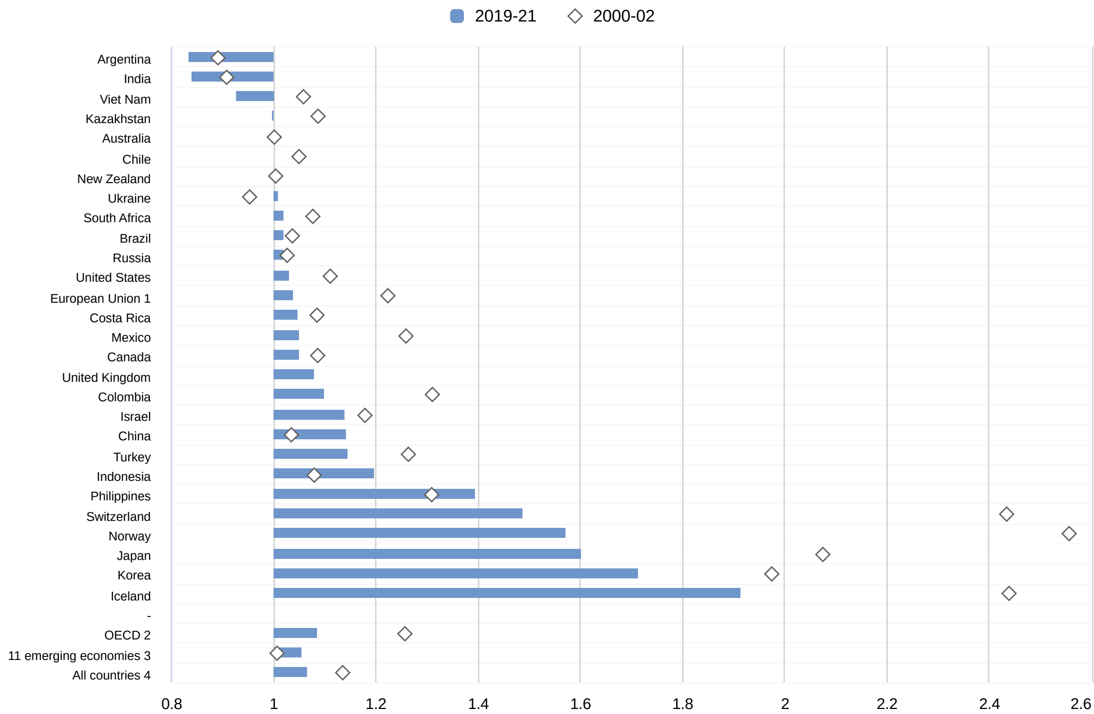
192. Payments provided per unit of output also form part of the effective prices received by producers, and the extent to which these effective prices differ from those on world markets is indicated by the Nominal Protection Coefficient (NPC). In many countries the gap between effective producer prices and world prices has narrowed significantly over time, suggesting that producers receive more of the signals markets provide (Figure 2.10).

193. On average over all OECD countries, the NPC of 1.08 indicates that effective producer prices were 8% higher than those on world markets during 2019-21, down from 26% some 20 years earlier. Progress has been particularly substantial in Norway and Switzerland, where the price gap has declined by more than 90 percentage points, but also in Iceland, Japan, Korea, Colombia and Mexico, all with price gap reductions of more than 20 percentage points.

194. Indeed, there is a high degree of variation amongst countries. Average effective prices during 2019-21 continued to be 40% or more above world market levels in the Philippines, Switzerland, Norway, Japan, Korea and Iceland, while they were closely aligned with world market levels in Kazakhstan, Australia, Chile, New Zealand, Ukraine, South Africa, Brazil and Russia where price gaps are below 2%.

195. Not all countries have seen price gaps decline. NPCs have increased by between 9 and 12 percentage points in the Philippines, China and Indonesia, so average effective producer prices in these countries have been between 14% and 40% higher than on world markets. Driven by those countries, the average price gap measured for all the emerging economies covered in this report, which was close to zero during 2000-02, has increased to almost 6% in 2019-21. That said, average effective prices in Viet Nam, India and Argentina, were below international levels by between 7% and 16% in that period.

Figure 2.10. Producer Nominal Protection Coefficient by country, 2000-02 and 2019-21



Notes: Countries are ranked according to 2019-21 levels.

1. EU15 for 2000-02, EU28 for 2019, EU27 and the United Kingdom for 2020 and EU27 for 2021.
2. The OECD total does not include the non-OECD EU Member States. Latvia and Lithuania are included only for 2019-21.
3. The 11 emerging economies include Argentina, Brazil, China, India, Indonesia, Kazakhstan, the Philippines, Russian Federation, South Africa, Ukraine and Viet Nam.
4. The All countries total includes all OECD countries, non-OECD EU Member States, and the emerging economies.

Source: OECD (2022), "Producer and Consumer Support Estimates", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-pcse-data-en.

The majority of producer support still takes the form of the most distorting measures

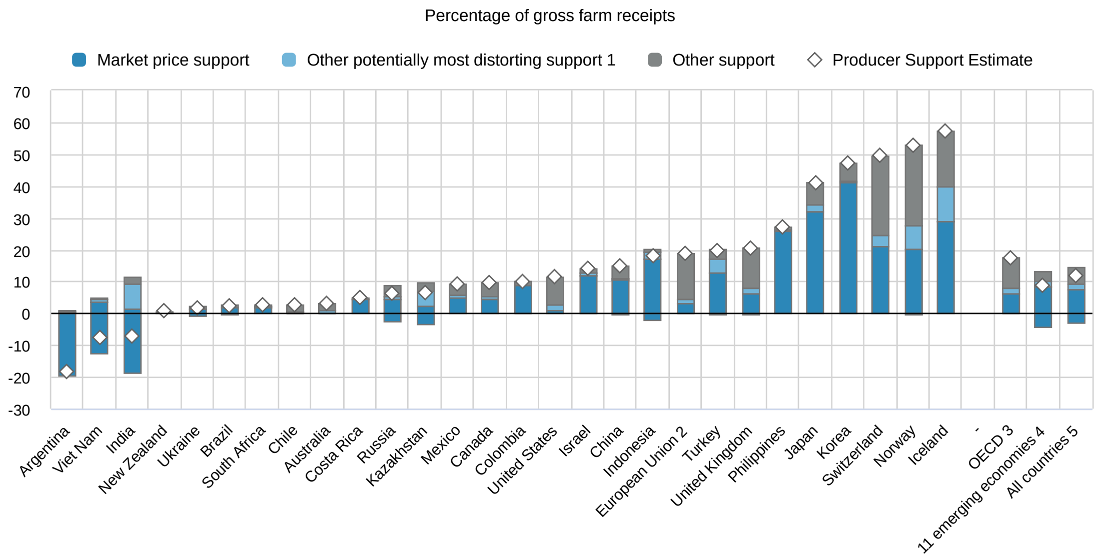
196. The structure of support provided to producers is as important as the overall level of support. Countries have a large portfolio of policy measures at their disposal. In addition to domestic or trade policies that raise or lower domestic market prices, and to payments provided per unit of output (which additionally raise the effective prices received by producers), governments provide subsidies that reduce producers' input costs; or payments on the basis of production area, or animal numbers; or to top up farmers' receipts or incomes. Payments can be made conditional on specific production practices, such as reduced use of production inputs that may be harmful to the environment, such as pesticides or nitrogen fertiliser, or linked directly to the supply of environmental public goods such as ecosystem services.

197. Past and ongoing OECD work shows that how support is provided matters for how it affects production, farm incomes and markets, but also for the performance of the agricultural sector with respect to environmental and other outcomes of social interest, such as nutrition. Market price support, and payments based on output and on the unconstrained use of variable inputs have long been identified as having the highest potential to distort production decisions and markets. More recent work has shown that these measures also have a particularly high potential to harm the environment by drawing additional resources, including natural resources, into the production process (Henderson and Lankoski, 2019[83]). In contrast, measures largely decoupled from production decisions are much more efficient in transferring income to farmer households than those that stimulate production and input use, as significant shares of

the latter transfers actually flow to the owners of purchased production factors and to producers of those inputs (OECD, 2002[84]).

198. Most countries still provide producer support in the most distorting forms (Figure 2.11). Across all countries, these policies account for almost three-quarters of all transfers to agricultural producers, and for more than 9% of aggregate gross farm receipts. In addition, the negative MPS in Argentina, India and Viet Nam (as well as, less significant, in a few other countries) also distorts markets in the inverse sense. On average, the share of these potentially most distorting transfers in gross farm receipts in the OECD area is slightly lower than in the 11 emerging economies, at 8% and 10%, respectively.

Figure 2.11. Potentially most distorting transfers and other support by country, 2019-21



Notes: Countries are ranked according to the %PSE levels.
1. Support based on output payments and on the unconstrained use of variable inputs.
2. EU28 for 2019, EU27 and the United Kingdom for 2020 and EU27 for 2021.
3. The OECD total does not include the non-OECD EU Member States.
4. The 11 emerging economies include Argentina, Brazil, China, India, Indonesia, Kazakhstan, the Philippines, Russian Federation, South Africa, Ukraine and Viet Nam.
5. The All countries total includes all OECD countries, non-OECD EU Member States, and the emerging economies.
Source: OECD (2022), "Producer and Consumer Support Estimates", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-pcse-data-en.

Half of producer support is tied to the production of individual commodities

199. Together with market price support, other forms of support are specific to individual commodities – or can be, depending on the implementation of the policy. By construction, output payments, which are paid for each unit of production, are commodity specific. Payments based on the use of inputs may be product specific, e.g. if support for fertilisers is granted only if those fertilisers are used for the production of a given commodity. Area payments are also often specific to particular commodities, but may also be defined across groups of commodities or even all crops. Similarly, headage payments can be specific to certain types of livestock, or paid for livestock groups such as beef and dairy cattle.

200. Support specific to individual commodities distorts production decisions as production factors and inputs are redirected from less to more supported products. Whether this distortion increases or decreases environmental pressures depends on which products are more strongly supported, as GHG emission

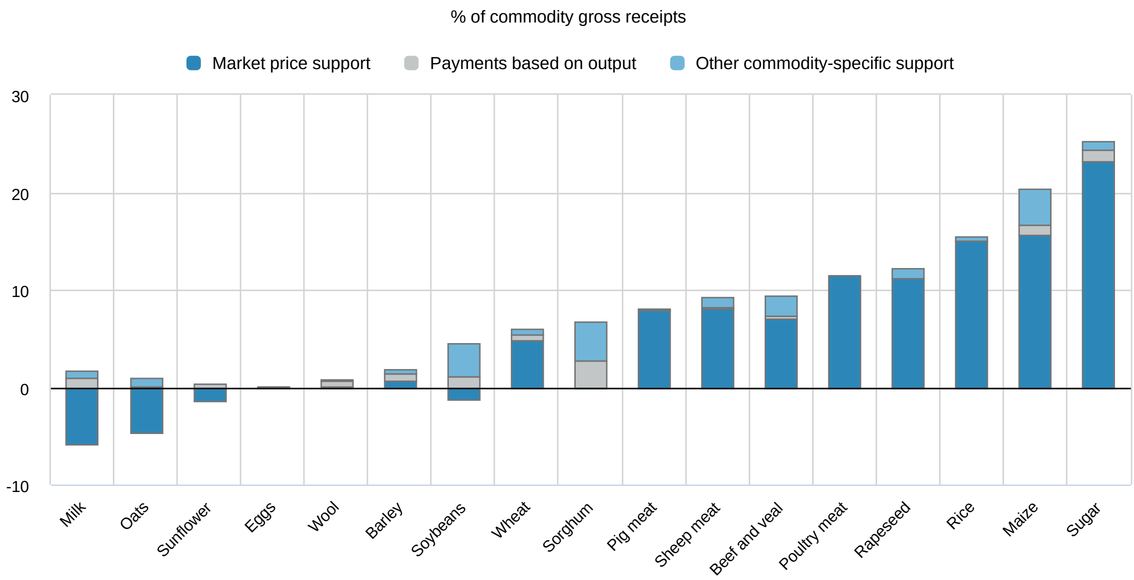
intensities and other pressures vary. They tend, for example, to be higher for livestock than for crops (although emission intensities of rice tend to be high as well) and to differ within those groups.

201. On average across all countries covered in this report, these single-commodity transfers (SCTs) accounted for half the support provided directly to producers, corresponding to 6% of their gross receipts, in 2019-21. Both counts are below those two decades ago, when those shares were 65% and 13%, respectively. However, while the importance of single-commodity transfers has declined across the OECD area (representing 49% of producer support and 9% of commodity gross receipts on average in 2019-21), they have gained relevance in gross receipts in a number of emerging economies (52% of producer support and 5% of commodity gross receipts on average).

202. SCTs are particularly high for a few products, including sugar and maize where they represent more than 20% of the respective gross receipts for these commodities. Rice also receives high support, with positive MPS and other commodity-specific support together accounting for 21% of commodity gross receipts, while negative MPS in some countries generate negative SCT worth 6%. Rapeseed and poultry meat also receive specific support worth more than 10% of their commodity gross receipts, with small negative support provided in some countries. Support for beef and veal, sheep meat, pig meat and sorghum is closer to, albeit still higher than, the average of 6.3% across all commodities. Milk, in contrast, is most strongly taxed implicitly at more than 4% of commodity receipts, as the negative MPS for milk notably in India and Argentina, corresponding to -12% of total commodity gross receipts for this commodity, more than offsets positive MPS in other countries and other product support (+8% of commodity gross receipts).

203. Negative SCTs are applied only in several emerging economies in the form of depressed domestic market prices (see above). Within the OECD, in contrast, SCTs are positive and reach up to 55% of commodity receipts in the case of rice, the most supported commodity in the OECD area.

Figure 2.12. Transfers to specific commodities (SCT), all countries, 2019-21



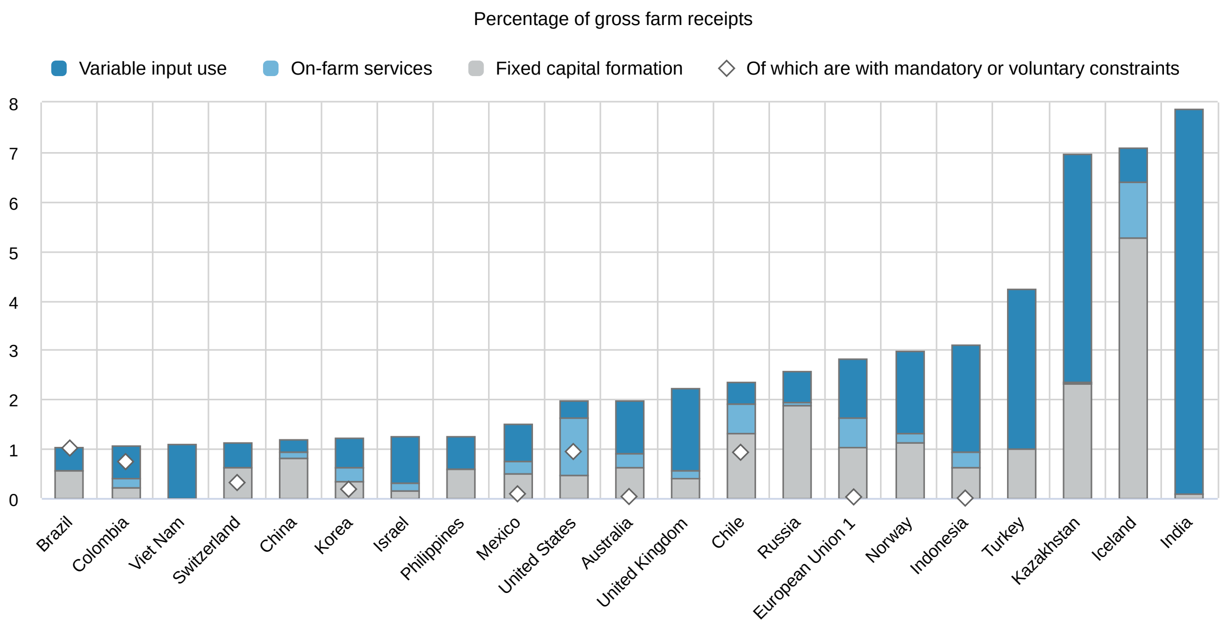
Note: Data refer to the All countries total, including all OECD countries, non-OECD EU Member States, and the 11 emerging economies.
Source: OECD (2022), "Producer and Consumer Support Estimates", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-pcse-data-en.

Support based on the use of production inputs is important in some countries

204. Next to market price support and payments based on output volumes, those related to the use of variable inputs without constraints have high potential not only to distort production decisions and trade, but also to contribute to environmental pressures, including but not limited to increased GHG emissions, by incentivising the use of those inputs beyond optimal levels. Such support for variable inputs – which include fuel and fertilisers, but also water and electricity – forms an important share of transfers to producers in a number of countries, including in particular India where they accounted for close to 8% of gross farm receipts in 2019-21. Significant support for variable inputs are also provided in Kazakhstan, Turkey, Indonesia, the United Kingdom, Norway, the European Union, Viet Nam and Australia, where it represented between 1% and 5% of GFR. Input constraints, that would reduce their distorting and environmentally harmful characteristics, apply to none or only insignificant shares of the payments in these countries.

205. In contrast, support related to capital investments or on-farm services typically do not distort production decisions or trade to the same extent. These types of support represent a smaller share of transfers to producers in most countries. However, capital support is the main form of input support in Iceland (more than 5% of GFR in 2019-21), Russia, Chile, Switzerland and Brazil, while in the United States, support for on-farm services is emphasised. On average, input support represents 2.2% of GFR across the OECD area and 2.5% across the 11 emerging economies covered.

Figure 2.13. Use and composition of support based on input use in selected countries, 2019-21



Notes: Figure presents countries having share of payments based on input use above 1% of gross farm receipts for 2019-21 period. Countries are ranked according to the total share of payments.

1. EU28 for 2019, EU27 and the United Kingdom for 2020, and EU27 for 2021.

Source: OECD (2022), "Producer and Consumer Support Estimates", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-pcse-data-en.

Use of partly or fully decoupled payments has increased

206. Other types of support have become more prominent in a range of countries, where past reforms have resulted in some re-instrumentalisation. This includes payments related to production variables other

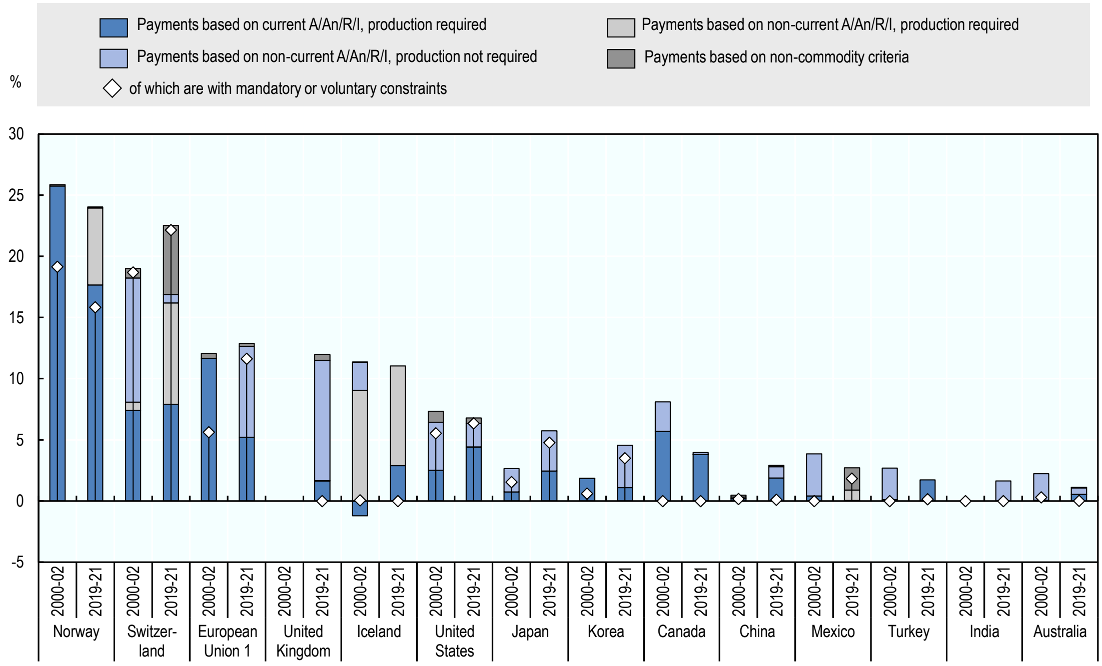
than output or input use, such as payments based on area, animal numbers, revenues or incomes. Such payments may be based on current levels of those variables, or related to some historical data. If based on historical entitlements, they may or may not require recipients to actually produce. Payments may also be based on criteria unrelated to current or past commodity production, but instead be linked to long-term resource retirement or to the supply of specific non-commodity outputs, such as ecosystem services.

207. Across the OECD area, these less distorting payments to producers accounted for 8% of GFR in 2019-21, only slightly above the levels seen at the beginning of the century, but well above the 3.6% measured for 1986-88. This is due to reforms in several OECD countries in the context of the World Trade Organization (WTO) Agreement on Agriculture (AoA), which generated a significant reduction in market interventions in favour of area and headage payments. That said, through the first decade of this century, reforms continued, with some further decoupling of payments. While payments based on current area, animal numbers, receipts or incomes represented more than 5% of GFR two decades ago across OECD countries, this percentage has declined to less than 4% in recent years. In contrast, payments based on historical entitlements have gained importance and represented close to 4% in 2019-21, up from less than 2% two decades earlier. Most of these payments to not require production to be received, and hence do not generate any direct production incentives, thus minimising distortions.

208. This development is particularly visible in the European Union and Korea, where such payments had been all but inexistent in 2000-02 but represented more than 7% and 3.5% of GFR in the most recent period, respectively. In Switzerland, where such decoupled payments were important already in 2000-02, some of these have been made subject to production requirements. At the same time, however, payments for specific non-commodity outputs such as ecosystem services now represent almost 6% of Swiss farmers' gross receipts. These latter payments also exist in Norway, the European Union and the United Kingdom; but, while in the European Union these are larger than in Switzerland in absolute terms, they account for only 0.2% or less of GFR in these three regions.

Figure 2.14. Use and composition of support that is less coupled to production, selected countries, 2000-02 and 2019-21

Percentage of gross farm receipts



Notes: Figure presents countries having share of payments based on area, animal numbers, farm receipts or farm income and on non-commodity criteria above 1% for 2019-21 period. Countries are ranked according to the total share of payments for 2019-21.
1. EU15 for 2000-02, EU28 for 2019, EU27 and the United Kingdom for 2020 and EU27 for 2021.
Source: OECD (2022), "Producer and Consumer Support Estimates", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-pcse-data-en.

Continued market price support is financed by consumers

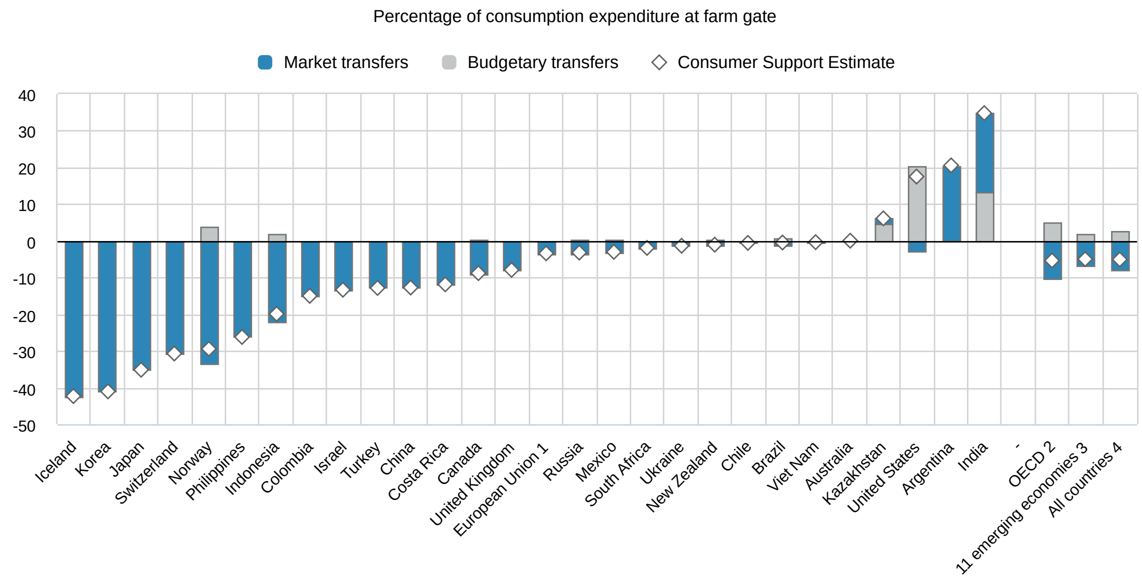
209. Consumers are affected by agricultural policies in two ways. First, they pay higher prices when MPS is positive, which effectively taxes those purchasing the products, including both the processing food industry and final consumers. Where the MPS is negative, consumers pay lower prices than what they would otherwise. Second, consumers may benefit from budgetary expenditures supporting them, either to offset the effect of a positive MPS or to provide more targeted support to poor consumers, for instance through large programmes in India and the United States.

210. On average across all 54 countries, agricultural policies result in a negative support to consumers, representing about -5% of their gross expenditures measured at farm gate prices (%CSE) in 2019-21. In most countries, support to consumers relative to gross expenditures at farm gate prices (%CSE) mirrors the level of market price support in the set of support measures for agricultural producers (Figure 2.15). High levels of MPS in Iceland, Korea, Japan, Switzerland, Norway, the Philippines and Indonesia result in a corresponding high taxation of consumers in these countries, corresponding to 22% of gross expenditures or more. Among these countries, Norway and Indonesia provide some budgetary support to their consumers which offset a small part of this taxation.

211. At the other end of the spectrum, policies in Argentina and India provide support to their consumers through depressed commodity prices. However, the significant food subsidies in India result in a particularly high %CSE of almost 35% of gross expenditures. The largest budgetary benefits accrue to

food consumers in the United States, where despite their effective taxation due to some positive MPS the %CSE is at more than 15% of gross expenditures. Kazakhstan also provides food subsidies, resulting in overall consumer support of about 6% of gross expenditures.

Figure 2.15. Composition of the Consumer Support Estimate by country, 2019-21



Notes: Countries are ranked according to percentage CSE levels. A negative percentage CSE is an implicit tax on consumption.
1. EU28 for 2019, EU27 and the United Kingdom for 2020 and EU27 for 2021.
2. The OECD total does not include the non-OECD EU Member States.
3. The 11 emerging economies include Argentina, Brazil, China, India, Indonesia, Kazakhstan, the Philippines, Russian Federation, South Africa, Ukraine and Viet Nam.
4. The All countries total includes all OECD countries, non-OECD EU Member States, and the emerging economies.
Source: OECD (2022), "Producer and Consumer Support Estimates", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-pcse-data-en.

Support to general services is declining in relative terms

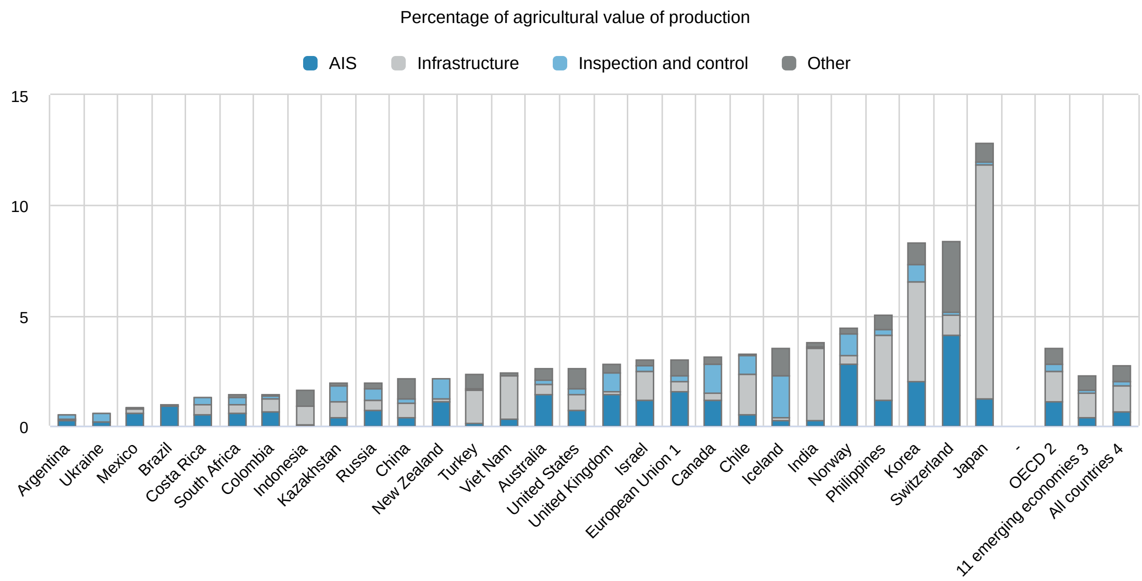
212. General services to the agricultural sector are forms of support that benefit agricultural producers collectively rather than individually. Across all countries covered in the report, public expenditures for general services (GSSE) have grown over the past two decades in nominal terms, but significantly less so than the sectors themselves. Relative to the value of agricultural production, support to general services has declined from 4.6% in the early 2000s to 2.7% in the most recent years. This relative decline is found both across the OECD and among emerging economies; in 2019-21, support to general services was equivalent to 3.5% of the value of production in OECD countries, and 2.3% in emerging markets. Relative to the size of the sector, general services support was particularly high in Japan, Switzerland, Korea and the Philippines where they amounted to between 5% and 13% of the value of agricultural production. Above-average support in 2019-21 is also estimated for India, Iceland, Chile, Canada, the European Union, Israel, and the United Kingdom (Figure 2.16).

213. Investments in general services can provide the required enabling environment for agricultural sectors to become more productive, more sustainable and more resilient. Three types of investments have a particularly high potential for doing so, including the agricultural innovation systems, inspection and control for biosecurity services, and rural infrastructure. Investments in agricultural innovation systems include expenditures for research and development, agricultural education and training, and extension

services. Appropriate and sufficiently funded biosecurity systems provide for the necessary product safety and inspection services, pest and disease control, and control and certification of the inputs used. Rural infrastructure investments comprise irrigation and drainage networks, storage and marketing facilities and institutional infrastructure, but also investments to reform farm structures. Governments also support marketing and promotion activities, as well as public stockholding.[36]

214. Across all countries covered in this report, investments in innovation, biosecurity and infrastructure accounted for three-quarters of all general services support – slightly less in the OECD, slightly more across the emerging economies. Priorities differ across countries, however: in half of all countries covered (including the European Union counted as one), agricultural innovation systems received the largest public support, while in nine countries, investments in rural infrastructure dominate. This in particular includes several south and south-east Asian countries where investments in irrigation infrastructure, often for the production of rice, are important. Biosecurity expenditures dominate in Iceland, Canada, Kazakhstan and Ukraine, while expenditures for public stockholding are particularly important in China.

Figure 2.16. Composition of the General Services Support Estimate, 2019-21



Notes: "AIS" refers to the Agricultural knowledge and innovation system. "Other" includes the marketing and promotion, cost of public stockholding, and miscellaneous categories of the GSSE. Countries are ranked according to the share of total GSSE in agricultural value of production.
1. EU28 for 2019, EU27 and the United Kingdom for 2020, and EU27 for 2021.
2. The OECD total does not include the non-OECD EU Member States.
3. The 11 emerging economies include Argentina, Brazil, China, India, Indonesia, Kazakhstan, the Philippines, Russian Federation, South Africa, Ukraine and Viet Nam.
4. The All countries total includes all OECD countries, non-OECD EU Member States, and the emerging economies.
Source: OECD (2022), "Producer and Consumer Support Estimates", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-pcse-data-en.

The COVID-19 pandemic has led to significant additional public expenditures for the sector

215. An important context for the developments in support over 2019-21 has been the COVID-19 pandemic. The following provides a preliminary assessment of the implications the COVID-19 pandemic

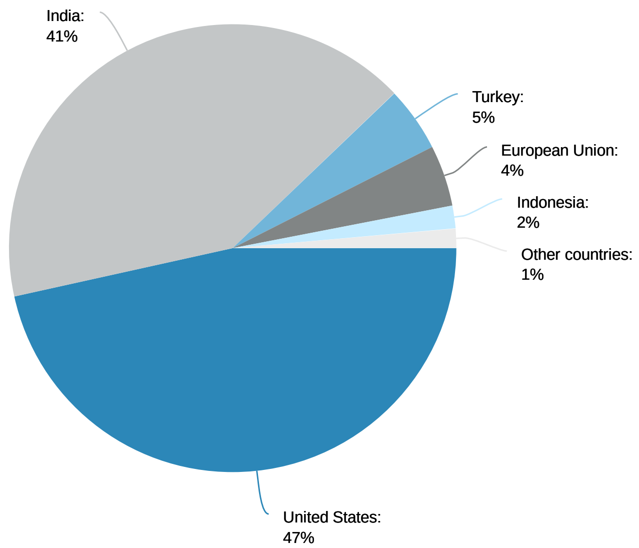
[36] These cover the cost of storage or disposal of agricultural commodities, as well as their depreciation.

on government support to the agricultural sector. In contrast to earlier assessments (OECD, 2021[85]) it looks at actual expenditures rather than earmarked funds. It focuses on policy measures where a clear correspondence to relevant categories of support in the OECD database could be identified. This has two immediate implications. First, recovery and support programmes targeting beneficiaries across sectors or even the whole economy are not considered in this assessment. It therefore does not discuss all measures which may have also and among others benefited agricultural producers or consumers. Second, it was not possible to identify all COVID-19 related programmes within the OECD support database, even though qualitative information on measures in response to the pandemic is available (see country chapters), and for a number of countries, no COVID-19 related measures could be identified. As a consequence, the estimates shown should be seen as a lower bound of governments' responses in terms of agricultural support.

216. Overall, additional expenditures in response to the pandemic and identified within the database were significant: at USD 55.5 billion[37] in 2020 and USD 70.4 billion in 2021, they represented 7.6% and 9.4% of the aggregate Total Support Estimate for the countries covered in this report, respectively, and 10.4% and 13.2% of all the budgetary support in these years.

217. The distribution of this support that could be identified in the database is highly concentrated: the United States and India account for 47% and 41% of the total across both years, with most of the remainder provided by Turkey, the European Union and Indonesia.

Figure 2.17. Distribution of estimated agricultural support in response to COVID-19 by country, 2020-21



Note: Figure only covers support data from the database for which the link to COVID-19 could be identified, and may therefore exclude other support that was provided in response to the pandemic, but for which no quantification was possible.
Source: OECD (2022), "Producer and Consumer Support Estimates", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-pcse-data-en.

218. A key part of these expenditures was to help consumers cope with supply disruptions, regional shortages or income difficulties following job losses. In India, the totality of the measured support responding to the pandemic was through domestic food subsidies, while in the United States, some two-

[37] This compares to a total of USD 157 billion originally earmarked for COVID-19 related support (OECD, 2021[85]).

fifths of the additional support was through its Supplemental Nutrition Assistance Program benefiting lower-income consumers. Expenditures for domestic food assistance were also provided as a response to the pandemic in Canada, New Zealand, and the United Kingdom. In the European Union, additional funds for crisis distillation are also included in this consumer support. Overall, consumer help represented more than three-fifths of the additional expenditures identified.

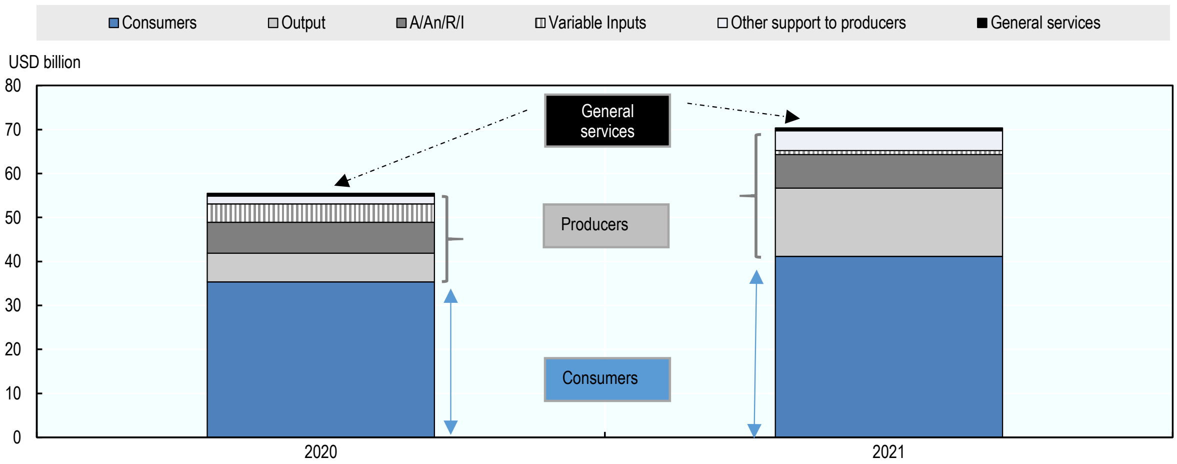
219. Countries also provided different forms of disaster aid in the form of income supplements or area payments to producers who were negatively affected. This includes large parts of the US Coronavirus Food Assistance Programs 1 and 2 (CFAP1 and CFAP2); crop insurance aid, different disaster crop and livestock payments in Canada, the European Union and Japan; compensation payments to herb growers in Israel; and subsidies for cows and young cattle in Ukraine. In addition, part of the CFAP1 and CFAP2 support in the United States, and support through the price stabilisation fund in Japan, was provided in the form of output payments. Overall, support provided as output payments and related to area, animal numbers, receipts or incomes, accounted for 18% and 12% of the expenditures related to the pandemic in the two years, respectively.

220. Variable input support has been provided in Canada, Costa Rica, Indonesia and Turkey, together amounting to 4% of the additional support recorded. Other support to producers accounts for 5% of the additional support.

221. Several countries provided general services support. Support in Australia, the European Union and Japan helped to keep supply chains open and supported processing and marketing activities, while some investments in storage infrastructure were made in Japan. New Zealand ramped up the budget to control wilding pines and financed a programme to control wallabies, but also invested in additional training in the context of its *Jobs for Nature* programme. Overall, however, general services accounted for just 1% of the additional expenditures identified in the context of the pandemic.

222. Overall, these additional funds for support to producers and consumers not only represent an important share in the TSE measured for 2020 and 2021. They also account for the majority of the growth in expenditures seen after 2019. Budgetary expenditures benefiting agricultural producers either individually or collectively, and those benefiting consumers, in 2020 and 2021 are estimated to be USD 98.5 billion and USD 101.3 billion higher than those calculated for 2019. The majority of this increase was related to measures in response to the COVID-19 pandemic.

Figure 2.18. Distribution of estimated agricultural support in response to COVID-19 by support category, 2020 and 2021



Note: A/An/R/I: Payments based on land area, animal numbers, receipts or income. Figure only covers support data from the database for which the link to COVID-19 could be identified, and may therefore exclude other support that was provided in response to the pandemic, but for which no quantification was possible

Source: OECD (2022), "Producer and Consumer Support Estimates", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-pcse-data-en

Summary and conclusion: Reforming agricultural support for better addressing public objectives

223. Government intervention and support to the agricultural sector is often aimed at addressing the triple challenge facing the food systems: ensuring food security and nutrition for growing global population, providing livelihoods to farmers and others along the food chain, and using natural resources sustainably while reducing greenhouse gas (GHG) emissions. While major achievements have been made on all three dimensions, significant problems remain as malnutrition persists, farmers are under pressure to adjust, and natural resource pressures remain high.[38]

Progress in reforming agricultural policies and reducing support has stalled

224. Across the 54 countries covered in this report, for 2019-21, agricultural policies generated USD 817 billion per year in transfers towards agriculture, more than twice the volume of transfers registered for 2000-02 but about a quarter less when expressed relative to the value of agricultural production. Three-quarters of this total, USD 611 billion, was transferred to individual producers, both through higher prices and through payments. In turn, some countries implicitly tax their producers through policies that depress domestic market prices.

225. The net support to the sector (total support estimate or TSE), representing USD 700 billion per year, costs the economy some 0.9% of combined GDP across all countries covered in this report, a slight decline from 1.0% during 2000-02, partly reflecting the smaller economic weight of the sector.

[38] The 2021 edition of the *OECD Agricultural Policy Monitoring and Evaluation* (OECD, 2021[85]) has highlighted that, overall, most current support policies are not serving the wider needs of food systems. This section complements the assessment made in Chapter 1 of that report by looking at the support provided in recent years.

226. In spite of strong increase in nominal terms, producer support as a share of gross farm receipts (%PSE) has declined for much of the past two decades and in 2019-21 averaged 12% across the 54 countries, down from more than 18% at the beginning of the century. Within the OECD, producer support declined from 28% of gross farm receipts (GFR) in 2000-02 to 17% in 2019-21. Most of this decline has happened in the 2000s, while progress in reducing support has been limited in recent years. While lower than the OECD average, support to producers more than doubled from 3.8% to 8.8% during the same period in the 11 emerging economies represented in this report.

227. Market price support continues to represent a major part of support to agricultural producers in many countries. Totalling to USD 317 billion per year, average positive market price support represented 7.6% of the combined GFR during 2019-21. At the same time, several countries have implemented policies that suppress market prices, generating an implicit taxation worth USD 117 billion per year away from producers, corresponding to 2.8% of combined GFR.

228. In addition to market price support, governments provide payments to farmers that differ in terms of the specific implementation and conditions for receiving them. USD 74 billion per year were provided as payments either on the basis of output quantities or linked to the unconstrained use of variable inputs. Together with the positive price support, a total of USD 391 billion per year was thus transferred to producers in the potentially most distorting forms.

229. Other payments are less coupled to production decisions and amounted to USD 220 billion per year during 2019-21. Of this, USD 81 billion were linked to historical rather than current production parameters and hence have no direct link to current production decisions at all. However, only USD 1.7 billion of payments to producers were conditional on the provision of well-defined public goods, including ecosystem services.

230. In addition to support to producers individually, governments provide support for the sector as a whole. This “general services support” (GSSE) amounted to USD 106 billion per year in 2019-21 or 21% of budgetary support to the sector. Relative to the sector’s size, this represented 2.7% of its aggregate value of production, a significant decline from the 4.6% measured for 2000-02. In particular, this total includes investments in public goods for the sector, such as the agricultural knowledge and innovation system, off-farm infrastructure and biosecurity services, which received a combined USD 80 billion per year. However, it also includes support with a potential to distort markets, such as aid for marketing and promotion activities and support for public stockholding (USD 24 billion).

231. Finally, subsidies for consumers, including for food assistance programmes, averaged USD 100 billion per year in 2019-21 and hence represented 20% of all budgetary support. On average, however, consumers were still taxed by agricultural policies, as these subsidies were smaller than the increase in food expenditures due to persistent market price support in many countries.

232. Within both country groups, there is significant variation in support levels across countries. On average during 2019-21, levels of producer support ranged from about 3% of GFR or less in New Zealand, Ukraine, Brazil, South Africa, Chile and Australia, to between 40% and almost 60% in Japan, Korea, Switzerland, Norway and Iceland. Net producer support was negative in Argentina, Viet Nam and India.

The COVID-19 pandemic has led to a significant increase in expenditures for the sector

233. In response to the COVID-19 pandemic, governments have implemented additional measures to keep food supply chains functioning, help producers cope with disruptions and provide additional food aid to poor consumers. Available data suggests that this additional support represented a substantial share of total support provided to the sector.

234. In 2020 and 2021, governments spent an extra USD 55 billion and USD 70 billion, respectively, representing 10% and 13% of all budgetary support in these years. This estimate is likely a lower bound

of actual extra expenditures, as it includes only support for which the link to the pandemic could be clearly identified.

235. The majority of these funds, or 61%, targeted consumers who needed to cope with supply disruptions or income difficulties following job losses. Such emergency help was among the temporary relief measures identified in (OECD, 2021[85]) which should include sunset clauses. In the longer run, structural measures to help consumers increase their purchasing power might be available to increase their resilience against market shocks.

236. Countries also provided emergency assistance to agricultural producers, often directly or indirectly based on income or revenue losses incurred. Indeed, 38% of the additional funds went to agricultural producers who suffered losses of revenues, faced shortages of seasonal workers or difficulties in input supplies. However, in some cases this additional support was provided on the basis of output or the use of variable inputs, thus adding to the group of potentially most distorting and environmentally harmful support. The remaining 1% was used to help the functioning of supply chains.

Much of current support to the sector has negative implications for its performance

237. Both positive market price support and the implicit taxation of producers in some countries have increased, and averaged USD 317 billion and USD 117 billion per year in 2019-21, respectively. Both have negative implications for global food security as they hamper the efficient allocation of resources and weaken the balancing role of trade in ensuring the necessary product flows from surplus to deficit regions. Constraining trade also contributes to increasing price volatility on international markets. Moreover, some countries have imposed additional export restrictions in response to the COVID-19 pandemic, often aiming to improve the domestic supply situation.

238. Market price support as well as payments linked to output or to the unconstrained use of variable inputs have been identified as the potentially most distorting support, which now amounts to USD 391 billion per year. Such support is inefficient in transferring income to producers, as a large share of the transfers are leaked in the form of higher prices for and larger use of inputs, or capitalised into land values. As this support is tied to production, it also tends to be inequitable by benefiting larger producers most. Moreover, the incentive to increase production and input use may contribute to higher resource pressures.

239. Other forms of producer support, amounting to USD 220 billion per year in 2019-21, create lower distortions at the margin and hence have less adverse effects for global food security. Given the less pronounced distortions of producer incentives, they also contribute less to pressures on natural resources. Moreover, while such support may still be inequitably distributed, their efficiency in transferring incomes to producers is significantly higher due to lower leakage to input suppliers and non-farm landowners. However, few of the payments to farmers are based on assessed needs of farm households based on their overall income from all sources.

240. As part of this more decoupled farm support, the amount of transfers linked directly to the provision of environmental goods has increased to USD 1.7 billion per year. However, this remains a small fraction of the USD 293 billion of budgetary support to producers and continues to be limited to a small number of countries.

241. In addition to these payments to producers, a number of other instruments have potentially significant positive effects on all three aspects of the triple challenge as they makes important contributions to food security, farm incomes and resource protection. These fall within the category of general services for the agricultural sector (GSSE), and particularly include investments in agricultural knowledge and innovation systems, inspection and control for biosecurity services, and infrastructure. Together, expenditures for general services have increased to USD 106 billion per year. While this increase is laudable, it falls short of increases in support with less potential to positively impact on the performance of

the food systems. In 2019-21, expenditures for general services represented just 15.2% of total net support to the sector (TSE), down from some 17% during 2000-02. Within the OECD, this share was lower still at only 13% in recent years. More importantly, the increase in the support to general services strongly declined relative to the size of the sector, from 3.6% of its value of production in 2000-02 to 2.3% in 2019-21 across all countries covered in this report. Agricultural knowledge and innovation systems received just USD 26 billion of that (0.7% of the sector's production value, down from 0.9% in the early 2000s), despite evidence of high returns of such investments, and expenditures for biosecurity services and infrastructure accounted for USD 9 billion and USD 45 billion per year (0.2% and 1.2% of the agricultural production value), respectively.

Countries should reinvigorate reform ambitions aiming to better address the challenges facing the sector

242. Across the OECD, agricultural policies have undergone significant changes which have both reduced overall support to producers and changed the way this support is provided. Put together, the types of support with the strongest potential to distort markets and to harm the environment have been reduced and partly replaced by payments that have higher income transfer efficiencies and add less to environmental pressures, or that incentivise the supply of ecosystem services and other public goods. A larger share of producer support has also been linked to stricter environmental constraints, thus lifting the reference levels for agricultural practices and limiting the overuse of natural resources.

243. That said, the pace of such reforms has slowed down significantly, and little further progress has been observed in the OECD area over the past decade. Together with the increase in potentially harmful support in a number of emerging economies, renewed efforts are therefore required to better align agricultural policies and support to the sector's needs in light of the ongoing triple-challenge of food and nutrition security, incomes and livelihoods, and the sustainable use of natural resources. Boosting sustainable productivity growth and improving resilience in agriculture remain key levers for addressing all three challenges and should therefore be central to future reform ambitions.

244. These reforms should target the reduction of potentially negative effects of current support, an acceleration of investments in public goods, and improved and more targeted efforts to help farm households in need.

245. Price interventions and other market distorting support are known for their negative implications for food security and the environment, and for being both inefficient and untargeted to providing support to those households in need. These policies should therefore be phased out over a well-defined timeline. Accompanying and transitional assistance and social safety nets may be needed to buffer the income loss implied for some of the producers by the removal of positive price support and associated trade protection, and to help them adjust to the new policy environment. Conversely, targeted income transfers and strengthened safety nets may be required to help low-income households and consumers suffering higher domestic prices due to the removal of price-depressing policies in some countries.

246. Public expenditures should be re-oriented towards investments in public goods and services that can improve both the sustainability and the resilience of the sector. Innovation is essential for improving the environmental sustainability while fostering productivity growth. Public investments should therefore prioritise the agricultural innovation system, which includes the development and adoption of new technologies, practices and systems. Public research and development as well as public-private partnerships need to complement private investments while allowing a demand driven innovation process. The market and policy environment should send clear signals of the environmental priorities to steer the innovation system towards sustainable productivity growth. Investments on knowledge and skills, including digital skills, can foster the synergies between the digital and environmental transformation of the sector. These investments currently represent only a small share of budgetary support to the sector, but should be made both central to it and better targeted to innovations that link productivity growth to the reduced

use of natural resources. Investments in biosecurity systems and off-farm infrastructure are also key for the sector's performance. Investments in these three areas could be increased significantly by redirecting market distorting payments.

247. Well-defined safety nets can contribute to sector resilience in a world of diverse systemic risks that go beyond natural disasters and include the consequences of the COVID-19 pandemic and Russia's large-scale aggression against Ukraine. Investments that can contribute to improved resilience also include training and skills for risk management, data and evidence based risk assessments, climate and disaster-proof infrastructures and an improved diversification of farm households' income sources. Finally, agriculture continues to be faced by numerous uncertainties and risks. Agricultural policies have an important role to play in ensuring that producers and other market participants have access to data and tools required to manage small and medium-size risks. However, there will also a continued need to cover large-scale risks that cannot be covered by farmers themselves or by risk markets.

248. Given their role for the maintenance and care of much of countries' land area, a significant contribution can be made by farmers in providing public goods, including ecosystem services and other environmental benefits of value to the society. Governments should consider increasing targeted and tailored payments to producers to facilitate the supply of such public goods, while at the same time generating additional income opportunities to farm households.

249. A significant share of current support aims at supporting low-income farm households, but predominantly benefits those that enjoy comparatively high income and wealth due to their larger size. Income support should be better targeted to those in need, which would improve both efficiency of public fund use and the equity of their distribution. However, data on the wealth and total incomes of farm households, which would already benefit from payments for the supply of public goods, will need to be collected more systematically to provide the basis for such targeted support.

Annex 2.A. Definition of OECD indicators of agricultural support

Nominal indicators used in this report

Producer Support Estimate (PSE): The annual monetary value of gross transfers from consumers and taxpayers to agricultural producers, measured at the farm gate level, arising from policy measures that support agriculture, regardless of their nature, objectives or impacts on farm production or income. It includes market price support, budgetary payments and budget revenue foregone, i.e. gross transfers from consumers and taxpayers to agricultural producers arising from policy measures based on: current output, input use, area planted/animal numbers/receipts/incomes (current, non-current), and non-commodity criteria. PSE categories are defined in Box 2 A.1.

Market Price Support (MPS): The annual monetary value of gross transfers from consumers and taxpayers to agricultural producers arising from policy measures that create a gap between domestic market prices and border prices of a specific agricultural commodity, measured at the farm gate level. MPS is available by commodity, and sums of negative and positive components are reported separately where relevant along with the total MPS.

Producer Single Commodity Transfers (producer SCT): The annual monetary value of gross transfers from consumers and taxpayers to agricultural producers, measured at the farm gate level, arising from policies linked to the production of a single commodity such that the producer must produce the designated commodity in order to receive the payment. This includes broader policies where transfers are specified on a per-commodity basis. Producer SCT is also available by commodity.

Group Commodity Transfers (GCT): The annual monetary value of gross transfers from consumers and taxpayers to agricultural producers, measured at the farm gate level, arising from policies whose payments are made on the basis that one or more of a designated list of commodities is produced, i.e. a producer may produce from a set of allowable commodities and receive a transfer that does not vary with respect to this decision.

All Commodity Transfers (ACT): The annual monetary value of gross transfers from consumers and taxpayers to agricultural producers, measured at the farm gate level, arising from policies that place no restrictions on the commodity produced but require the recipient to produce some commodity of their choice.

Other Transfers to Producers (OTP): The annual monetary value of gross transfers from consumers and taxpayers to agricultural producers, measured at the farm gate level, arising from policies that do not require any commodity production at all.

Consumer Single Commodity Transfers (consumer SCT): The annual monetary value of gross transfers from (to) consumers of agricultural commodities, measured at the farm gate level, arising from policies linked to the production of a single commodity. Consumer SCT is also available by commodity.

Consumer Support Estimate (CSE): The annual monetary value of gross transfers from (to) consumers of agricultural commodities, measured at the farm gate level, arising from policy measures that support agriculture, regardless of their nature, objectives or impacts on consumption of farm products. If negative, the CSE measures the burden (implicit tax) on consumers through market price support (higher prices), that more than offsets consumer subsidies that lower prices to consumers.

General Services Support Estimate (GSSE): The annual monetary value of gross transfers arising from policy measures that create enabling conditions for the primary agricultural sector through development of private or public services, institutions and infrastructure, regardless of their objectives and impacts on farm production and income, or consumption of farm products. The GSSE includes policies where primary agriculture is the main beneficiary, but does not include any payments to individual producers. GSSE transfers do not directly alter producer receipts or costs or consumption expenditures. GSSE categories are defined below.

Total Support Estimate (TSE): The annual monetary value of all gross transfers from taxpayers and consumers arising from policy measures that support agriculture, net of the associated budgetary receipts, regardless of their objectives and impacts on farm production and income, or consumption of farm products.

Total Budgetary Support Estimate (TBSE): The annual monetary value of all gross budgetary transfers from taxpayers arising from policy measures that support agriculture, regardless of their objectives and impacts on farm production and income, or consumption of farm products.

Gross Farm Receipts (GFR): The annual monetary value of production, to which budgetary transfers to individual producers are added (i.e. VP + PSE – MPS).

Commodity Gross Receipts: The annual monetary value of production for an individual commodity, to which budgetary transfers to producers of that commodity are added (i.e. VP + producer SCT – MPS).

Ratio indicators and percentage indicators

Percentage PSE (%PSE): PSE transfers as a share of gross farm receipts (including support in the denominator).

Percentage SCT (%SCT): Single Commodity Transfers as a share of gross receipts for the specific commodity (including support in the denominator).

Share of SCT in total PSE (%): Share of Single Commodity Transfers in the total PSE. This indicator is also calculated by commodity.

Producer Nominal Protection Coefficient (producer NPC): The ratio between the average price received by producers (at farm gate), including payments per tonne of current output, and the border price (measured at farm gate). The Producer NPC is also available by commodity.

Producer Nominal Assistance Coefficient (producer NAC): The ratio between the value of gross farm receipts including support and gross farm receipts (at farm gate) valued at border prices (measured at farm gate).

Percentage CSE (%CSE): CSE transfers as a share of consumption expenditure on agricultural commodities (at farm gate prices), net of taxpayer transfers to consumers. The %CSE measures the implicit tax (or subsidy, if CSE is positive) placed on consumers by agricultural price policies.

Consumer Nominal Protection Coefficient (consumer NPC): The ratio between the average price paid by consumers (at farm gate) and the border price (measured at farm gate). The Consumer NPC is also available by commodity.

Consumer Nominal Assistance Coefficient (consumer NAC): The ratio between the value of consumption expenditure on agricultural commodities (at farm gate) and that valued at border prices.

Percentage TSE (%TSE): TSE transfers as a percentage of GDP.

Percentage TBSE (%TBSE): TBSE transfers as a percentage of GDP.

Percentage GSSE (%GSSE): Share of expenditures on general services in the Total Support Estimate (TSE).

Share of potentially most distorting transfers in aggregated gross producer transfers (%): represents the sum of positive MPS, the absolute value of negative MPS, payments based on output and payments based on unconstrained use of variable inputs, relative to the sum of positive MPS, the absolute value of negative MPS, and all budgetary payments to producers.

Annex Box 2.A.1. Definitions of categories in the PSE classification

Definitions of categories

Category A1, Market price support (MPS): Transfers from consumers and taxpayers to agricultural producers from policy measures that create a gap between domestic market prices and border prices of a specific agricultural commodity, measured at the farm gate level.

Category A2, Payments based on output: Transfers from taxpayers to agricultural producers from policy measures based on current output of a specific agricultural commodity.

Category B, Payments based on input use: Transfers from taxpayers to agricultural producers arising from policy measures based on on-farm use of inputs:

- ***Variable input use*** that reduces the on-farm cost of a specific variable input or a mix of variable inputs.
- ***Fixed capital formation*** that reduces the on-farm investment cost of farm buildings, equipment, plantations, irrigation, drainage, and soil improvements.
- ***On-farm services*** that reduce the cost of technical, accounting, commercial, sanitary and phytosanitary assistance and training provided to individual farmers.

Category C, Payments based on current A/An/R/I, production required: Transfers from taxpayers to agricultural producers arising from policy measures based on current area, animal numbers, revenue, or income, and requiring production.

Category D, Payments based on non-current A/An/R/I, production required: Transfers from taxpayers to agricultural producers arising from policy measures based on non-current (i.e. historical or fixed) area, animal numbers, revenue, or income, with current production of any commodity required.

Category E, Payments based on non-current A/An/R/I, production not required: Transfers from taxpayers to agricultural producers arising from policy measures based on non-current (i.e. historical or fixed) area, animal numbers, revenue, or income, with current production of any commodity not required but optional.

Category F, Payments based on non-commodity criteria: Transfers from taxpayers to agricultural producers arising from policy measures based on:

- ***Long-term resource retirement:*** Transfers for the long-term retirement of factors of production from commodity production. The payments in this subcategory are distinguished from those requiring short-term resource retirement, which are based on commodity production criteria.
- ***A specific non-commodity output:*** Transfers for the use of farm resources to produce specific non-commodity outputs of goods and services, which are not required by regulations.
- ***Other non-commodity criteria:*** Transfers provided equally to all farmers, such as a flat rate or lump sum payment.

Category G, Miscellaneous payments: Transfers from taxpayers to farmers for which there is a lack of information to allocate them among the appropriate categories.

Note: A (area), An (animal numbers), R (receipts) or I (income).

Definitions of labels

With or without current commodity production limits and/or limit to payments: Defines whether or not there is a specific limitation on current commodity production (output) associated with a policy providing transfers to agriculture and whether or not there are limits to payments in the form of limits to area or animal numbers eligible for those payments. Applied in categories A–F.

With variable or fixed payment rates: Any payments is defined as subject to a variable rate where the formula determining the level of payment is triggered by a change in price, yield, net revenue or income or a change in production cost. Applied in categories A–E.

With or without input constraints: defines whether or not there are specific requirements concerning farming practices related to the programme in terms of the reduction, replacement, or withdrawal in the use of inputs or a restriction of farming practices allowed. Applied in categories A–F. The payments with input constrains are further broken down to:

- Payments conditional on compliance with basic requirements that are mandatory (with mandatory);
- Payments requiring specific practices going beyond basic requirements and voluntary (with voluntary).
    - Specific practices related to environmental issues.
    - Specific practices related to animal welfare.
    - Other specific practices.

With or without commodity exceptions: defines whether or not there are prohibitions upon the production of certain commodities as a condition of eligibility for payments based on non-current A/An/R/I of commodity(ies). Applied in Category E.

Based on area, animal numbers, receipts or income: defines the specific attribute (i.e. area, animal numbers, receipts or income) on which the payment is based. Applied in categories C–E.

Based on a single commodity, a group of commodities or all commodities: defines whether the payment is granted for production of a single commodity, a group of commodities or all commodities. Applied in categories A–D.

Drivers of the change in PSE

Decomposition of PSE

Per cent change in PSE**:** Per cent change in the nominal value of the PSE expressed in national currency. The per cent change is calculated using the two most recent years in the series.

Contribution of MPS to per cent change in PSE**:** Per cent change in nominal PSE if all variables other than MPS are held constant.

Contribution of price gap to per cent change in the PSE**:** Per cent change in nominal PSE if all variables other than gap between domestic market prices and border prices are held constant.

Contribution of quantity produced to per cent change in the PSE: Per cent change in nominal PSE if all variables other than quantity produced are held constant.

Contribution of budgetary payments (BP) to per cent change in PSE: Per cent change in nominal PSE if all variables other than BP are held constant.

Contribution of BP elements to per cent change in PSE: Per cent change in nominal PSE if all variables other than a given BP element are held constant. BP elements include Payments based on output, Payments based on input use, Payments based on current A/An/R/I, production required, Payments based on non-current A/An/R/I, production required, Payments based on non-current A/An/R/I, production not required, Payments based on non-commodity criteria and Miscellaneous payments.

Change in Producer Price

Per cent change in Producer Price: Per cent change in Producer Price (at farm gate) expressed in national currency. The per cent change is calculated using the two most recent years in the series.

Decomposition of the change in the Border Price

Per cent change in Border Price: Per cent change in Border Price (at farm gate) expressed in national currency. The per cent change is calculated using the two most recent years in the series.

Contribution of Exchange Rate to per cent change in Border Price: Per cent change in the Border Price (at farm gate) expressed in national currency if all variables other than Exchange Rate between national currency and USD are held constant.

Contribution of Border Price expressed in USD to per cent change in Border Price: Per cent change in the Border Price (at farm gate) expressed in national currency if all variables other than Border Price (at farm gate) expressed in USD are held constant.

Note: The producer price change and the border price change are not calculated when the negative price gap occurs at the commodity level for the current or previous year.

Definition of GSSE categories

Agricultural knowledge and innovation system

- ***Agricultural knowledge generation***: Budgetary expenditure financing research and development (R&D) activities related to agriculture, and associated data dissemination, irrespective of the institution (private or public, ministry, university, research centre or producer groups) where they take place, the nature of research (scientific, institutional, etc.), or its purpose.
- ***Agricultural knowledge transfer***: Budgetary expenditure financing agricultural vocational schools and agricultural programmes in high-level education, training and advice to farmers that is generic (e.g. accounting rules, pesticide application), not specific to individual situations, and data collection and information dissemination networks related to agricultural production and marketing.

Inspection and control

- ***Agricultural product safety and inspection***: Budgetary expenditure financing activities related to agricultural product safety and inspection. This includes only expenditures on inspection of domestically produced commodities at first level of processing and border inspection for exported commodities.

- ***Pest and disease inspection and control:*** Budgetary expenditure financing pest and disease control of agricultural inputs and outputs (control at primary agriculture level) and public funding of veterinary services (for the farming sector) and phytosanitary services.
- ***Input control:*** Budgetary expenditure financing the institutions providing control activities and certification of industrial inputs used in agriculture (e.g. machinery, industrial fertilisers, pesticides, etc.) and biological inputs (e.g. seed certification and control).

Development and maintenance of infrastructure

- ***Hydrological infrastructure:*** Budgetary expenditure financing public investments into hydrological infrastructure (irrigation and drainage networks).
- ***Storage, marketing and other physical infrastructure***: Budgetary expenditure financing investments to off-farm storage and other market infrastructure facilities related to handling and marketing primary agricultural products (silos, harbour facilities – docks, elevators; wholesale markets, futures markets), as well as other physical infrastructure related to agriculture, when agriculture is the main beneficiary.
- ***Institutional infrastructure***: Budgetary expenditure financing investments to build and maintain institutional infrastructure related to the farming sector (e.g. land cadastres; machinery user groups, seed and species registries; development of rural finance networks; support to farm organisations, etc.).
- ***Farm restructuring***: Budgetary payments related to reform of farm structures financing entry, exit or diversification (outside agriculture) strategies.

Marketing and promotion

- ***Collective schemes for processing and marketing***: Budgetary expenditure financing investment in collective, mainly primary, processing, marketing schemes and marketing facilities, designed to improve marketing environment for agriculture.
- ***Promotion of agricultural products***: Budgetary expenditure financing assistance to collective promotion of agro-food products (e.g. promotion campaigns, participation on international fairs).
- ***Cost of public stockholding***: Budgetary expenditure covering the costs of storage, depreciation and disposal of public storage of agricultural products.
- ***Miscellaneous***: Budgetary expenditure financing other general services that cannot be disaggregated and allocated to the above categories, often due to a lack of information.

More detailed information on the indicators, their use and limitations is available in *OECD's Producer Support Estimate and Related Indicators of Agricultural Support: Concepts, Calculation, Interpretation and Use* (the PSE Manual) available on the OECD public website (http://www.oecd.org/agriculture/topics/agricultural-policy-monitoring-and-evaluation/documents/producer-support-estimates-manual.pdf).

OECD indicators of support	
ACT	All Commodity Transfers
CSE	Consumer Support Estimate
GCT	Group Commodity Transfers
GSSE	General Services Support Estimate
MPS	Market Price Support
NAC	Nominal Assistance Coefficient
NPC	Nominal Protection Coefficient
OTP	Other Transfers to Producers
PSE	Producer Support Estimate
SCT	Single Commodity Transfers
TBSE	Total Budgetary Support Estimate
TSE	Total Support Estimate

Currencies	
ARS	Argentinian peso
AUD	Australian dollar
BRL	Brazilian real
CAD	Canadian dollar
CLP	Chilean peso
COP	Colombian peso
CHF	Swiss frank
CNY	Chinese yuan renminbi
CRC	Costa Rican colon
EUR	Euro
GBP	British pound
IDR	Indonesian roupiah
INR	Indian rupee
ILS	Israeli shekel
ISK	Icelandic krona
JPY	Japanese yen
KRW	Korean won
KZT	Kazakh tenge
MXN	Mexican peso
NOK	Norwegian krone
NZD	New Zealand dollar
PHP	Philippines peso
RUR	Russian rouble
TRY	New Turkish lira
UAH	Ukrainian hryvnia
USD	United States dollar
VND	Vietnamese dong
ZAR	South African rand

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