1 Agricultural and food markets: Trends and prospects

Following a description of the macroeconomic and policy assumptions underlying the projections, including those related to Russia's war against Ukraine, this chapter presents the main findings of the *Agricultural Outlook*. It highlights key projections for consumption, production, trade, and prices for 25 agricultural products for the period 2022 to 2031. Agricultural demand growth is expected to slow down over the next decade and to be mainly driven by population growth. Varying income levels and income growth projections, as well as cultural preferences around diets and nutrition, will underlie continuing differences in consumption patterns between countries. The slower demand growth for agricultural commodities is projected to be matched by efficiency gains in crop and livestock production, which will keep real agricultural prices relatively flat. International trade will remain essential for food security in food-importing countries, and for rural livelihoods in food-exporting countries. At the end of the chapter, a scenario assesses the level of productivity growth required to achieve the UN's Sustainable Development Goal 2 (SDG-2) on Zero Hunger as well as a considerable reduction in agricultural greenhouse gas emissions by 2030. Over the next decade, weather variability, animal and plant diseases, changing input prices, macro-economic developments and other uncertainties will result in variations around the projections.

Introduction

The *OECD-FAO Agricultural Outlook 2022-2031* is a collaborative effort of the Organisation for Economic Co-operation and Development (OECD) and the Food and Agriculture Organization of the United Nations (FAO). The *Outlook* presents a consistent baseline scenario for the evolution of agricultural commodity and fish markets at national, regional, and global levels for the period 2022 to 2031. This baseline scenario incorporates the commodity, policy, and country expertise of both organisations, as well as input from collaborating Member countries and international commodity bodies.

The baseline projections are based on the OECD-FAO Aglink-Cosimo model, which links sectors and countries covered in the *Outlook* to ensure consistency and global equilibrium across all markets. The projections are influenced by current market conditions (summarised in Figure 1.1), as well as assumptions about macroeconomic, demographic, and policy developments, which are detailed in Section 1.2.

The Russian Federation's (hereafter "Russia") war against Ukraine (hereinafter referred to as "war") is already having considerable impact on agricultural markets, especially for grains and oilseeds, for which Russia and Ukraine are key exporters (Box 1.1). In a number of International organisations, members have expressed their condemnation of Russia's war against Ukraine (e.g. United Nations General Assembly and OECD), and/or affirmed the General Assembly resolutions adopted in this regard (e.g. FAO Council and Regional Conference for Europe)[1]. The *Outlook* projections account for reduced production prospects in Ukraine, and reduced export availability from both Ukraine and Russia, in the marketing year 2022/23. The medium-term impact of the war cannot be assessed based on data that is currently available.

The baseline of the *Outlook* serves as a reference for forward-looking policy planning, and the underlying Aglink-Cosimo model allows simulation analysis, including the assessment of market uncertainties. A detailed discussion of the methodology of the projections, as well as documentation of the Aglink-Cosimo model, are available online at www.agri-outlook.org.

The *Outlook* contains four main parts:

- *Part 1: Agricultural and food markets: Trends and prospects*. Following the description of the macroeconomic and policy assumptions underlying the projections (Section 1.2), this chapter presents the main findings of the *Outlook*. It highlights key projections and provides insights into the main outcomes and challenges facing agri-food systems over the coming decade. The chapter presents trends and prospects for consumption (Section 1.3), production (Section 1.4), trade (Section 1.5), and prices (Section 1.6). In Section 1.7, an illustrative scenario is used to assess the level of productivity growth required at the global level to eliminate hunger and reduce agricultural GHG emissions by 2030.
- *Part 2: Regional briefs*. This chapter describes key trends and emerging issues facing the agricultural sector in the six FAO regions, i.e. Asia and Pacific, which is split into Developed and East Asia (Section 2.2) and South and Southeast Asia (Section 2.3), Sub-Saharan Africa (Section 2.4), Near East and North Africa (Section 2.5), Europe and Central Asia (Section 2.6), North America (Section 2.7), and Latin America and the Caribbean (Section 2.8). It highlights the regional aspects of production, consumption and trade projections and provides background information on key regional issues.
- *Part 3: Commodity chapters*. These chapters describe recent market developments and highlight medium term projections for consumption, production, trade, and prices for the commodities covered in the *Outlook*. Each chapter concludes with a discussion of the main issues and uncertainties that might affect markets over the next ten years. This part consists of nine chapters: cereals (Chapter 3), oilseeds and oilseed products (Chapter 4), sugar (Chapter 5), meat (Chapter 6), dairy and dairy products (Chapter 7), fish (Chapter 8), biofuels (Chapter 9), cotton (Chapter 10), and other products (Chapter 11).

- *Part 4: Statistical Annex*. The statistical annex presents projections for production, consumption, trade and prices for agricultural commodities, fish and biofuels, as well as macroeconomic and policy assumptions. The evolution of markets over the outlook period is described using annual growth rates and data for the final year (2031) relative to a three-year base period (2019-21). The statistical annex is not part of the printed version of the *Outlook* but can be accessed online.

Box 1.1. Russia's war against Ukraine

Russia's war against Ukraine (hereinafter referred to as "war"), including the annexation of Crimea, started in 2014. Policy responses and their economic consequences have shaped global agricultural markets since then. Previously significant, Russian imports of meat, dairy products, as well as fruits and vegetables, from the European Union, North America and several other countries opposing the 2014 annexation virtually ceased as a result of an import ban. On 24 February 2022, this long-standing situation escalated into an open war when Russia invaded Ukraine, further affecting global markets and threatening global food security at the time of already elevated global commodity prices.

Importance of Ukraine and Russia for global agricultural markets

Ukraine and Russia are among the most important producers and exporters of arable crops in the world, particularly of wheat, barley, maize, sunflower seed and rapeseed. Production of animal commodities, however, mainly supplies their domestic markets.

Based on the average of the last five seasons, Russia and Ukraine accounted for 10% and 3% of global wheat production, respectively. Russia and Ukraine are the first and fifth largest wheat exporters, accounting for 20% and 10% of global exports, respectively. Both countries also play a critical role in supplying wheat to global markets, including to the Near East and North Africa region, where wheat is the main staple food.

Russia and Ukraine account for 20% of global barley production, and are the third and fourth largest exporters, respectively. A large share of the barley produced in both countries is used as feed in domestic animal husbandry.

Ukraine is the world's largest producer of sunflower seed, followed by Russia. Together, they account for more than 50% of the global production. Most of the production is crushed domestically into sunflower oil and meal. Sunflower oil is also exported to the global market, making Ukraine the fourth largest exporter of vegetable oil.

For rapeseed, maize and soybean, Ukraine and Russia account for less than 5% of global production, with Ukraine having the larger share. As domestic consumption is limited, most of their production is exported; Ukraine is the third largest exporter of both maize and rapeseed. Ukraine is also the largest exporter of soybean outside the Americas. For all three products, Ukraine plays a specific role in global markets, as it is the largest non-GMO exporter and an important exporter of organic feed.

Developments in global input markets

Russia also plays an important role in global energy and fertiliser markets. Russia is the world's top natural gas exporter, second-largest oil exporter, and the third coal exporter; accounting for 10%, 11% and 18% of global exports, respectively, in 2021 (FAO, 2022[1]). Russia is also the world's top exporter of nitrogen fertilisers, the second leading exporter of potassic fertilisers, and the third leading exporter of phosphorous fertilisers (FAO, 2022[1]), accounting for over 15% of total global fertiliser exports in 2020 (UNTAD, 2022[2]).

Global energy and fertiliser prices increased from their already high levels due to the war and the resulting uncertainty related to the availability of Russian energy and fertiliser globally. As the agri-food sector is highly-energy intensive, rising energy and fertiliser prices are translating into higher production costs and contributing to food price increases, as discussed in Box 1.4.

Impact on Ukrainian production and exports of agricultural commodities

As of May 2022, 8 million people are internally displaced in Ukraine and 6.3 million people fled Ukraine following the start of the war, while 1.9 million Ukrainians have returned to Ukraine during the same period (UNHCR, 2022[3]). This large number of displaced people raises significant food security concerns. For internally displaced people, in particular, domestic logistics channels have to be maintained to provide food and other essential goods and services, including in the areas where a large number of people sought refuge from active fighting. Many initiatives are focusing on addressing these food security needs, both through the direct supply of food and through efforts to ensure distribution channels remain open.

Ukrainian farmers have shown a high degree of resilience to the disruptions caused by the war and, agricultural field security conditions permitting, are continuing to produce crops and livestock products. At about 9 Mha, the area planted with winter crops in autumn 2021 reached levels similar to the 2020 season, with some shifts away from wheat and barley to rapeseed. As of May 2022, winter crop climatic conditions are favourable and, as per agricultural calendar, will require fertiliser application and other maintenance before the harvest starts in late June 2022. The sowing of the 2022 spring crops is nearing completion, with levels expected to be about 20% below last year, especially for the main spring crops i.e. sunflower seed, maize and spring barley. Overall, a smaller harvest is expected due to, among other factors, direct damages on winter crops caused by active fighting, remnants of the war preventing planting of the spring crops, and high input costs. Preliminary forecasts suggest reductions of more than 30% compared to the 2021 harvest (FAO, 2022[1]) (USDA, 2022[4]) but still production is expected to exceed domestic requirements.

The monitoring of animal production is considerably less detailed than that of crops but famers are also continuing to produce. However, the war is likely to affect Ukraine's ability to control animal diseases, notably the African swine fever (ASF), significantly increasing the risk of disease proliferation within Ukraine and in neighbouring countries.

As more than half of the crop production of Ukraine is exported, logistics of the export supply chain play a vital role. Any disruptions could result in substantial export losses. In the past, over 90% of Ukraine crop exports were channelled through seaports at the Sea of Azov and the Black Sea. These ports are currently not accessible due to the ongoing war. Other export channels – road, rail and river ports – do not have the capacity to handle the same quantities as maritime ports. Therefore, current industry estimates suggest that current exports can only reach 20% of normal export quantities. National and global efforts are under way to increase the capacities of alternative export channels, and to find other outlets. Yet larger quantities than usual remained in storage as current logistics constraints have limited exports of the 2021 harvest. The upcoming harvest in June-September 2022 will rapidly produce large quantities that will also need to be stored to avoid significant losses. In addition, some storage and processing facilities have been damaged, further delaying and constraining exports.

Impact on Russian exports of agricultural commodities

The 2021 Russian wheat harvest was below average due to adverse weather in the growing period. As a result, Russia imposed export restrictions, including export taxes, on its wheat before the start of the war. The war led to reduced access to ports, especially at the Sea of Azov, and an increase in export restrictions. However, some export flows from Russia have continued. Sanctions imposed on Russia

have so far not targeted agricultural trade but many international companies, including those active in the agribusiness sector, have reduced their engagement in Russia. Financial sanction, insurance classification, and other economic uncertainties have led to a price discount for Russian wheat compared to other origins. Moreover, any loss of export markets for agricultural commodities could depress farmer incomes, thereby negatively affecting future planting decisions.

Russian agriculture depends on imports of pesticides, veterinary medicines and agricultural technology (e.g. machinery and software). Reduced access to these inputs could affect the future production potential of Russian agriculture.

Global food security impacts

Consumers in many countries depend on cereal, especially wheat and oilseed imports from Ukraine and Russia. Moreover, many farmers rely on Russia for fertiliser exports. The majority of the wheat and a large share of other commodities distributed by the World Food Programme (WFP) was sourced from Ukraine. Market balances as of April 2022 by the G-20's Agricultural Market Information System (AMIS) suggest globally sufficient supplies of wheat and other monitored commodities, although markets remain tight, and any shocks are reflected in the balances. Nevertheless, adjustments in trade flows and increasing energy costs are leading the increases in international agricultural commodity prices. In March 2022, the FAO Food Price Index (FFPI) reached its highest level on record since 1990, at 159.7 points. The FFPI retreated slightly in April 2022, to 158.5 points, though still 30% above its value in the corresponding month in the previous year (FAO, 2022[5]). Particularly exposed to price hikes are vulnerable populations, which spent a large share of their income to food, particularly in the Low-Income Food-Deficit Countries (LIFDCs).

Given necessary adjustments to global cereal trade to find alternative supplies should exports from Ukraine, and to a lesser extent from Russia, remain disrupted, it is important to keep trade in food and fertilisers open to prevent the war from negatively affecting global production and consumption needs. Any policy measures put in place as a response to high prices must be carefully weighed against their potential detrimental effect on international markets in the short term and over the longer term. In addition, global market transparency plays a key role when agricultural commodity markets need to adjust to shocks affecting supply and demand. Initiatives like AMIS play a critical role in improving market transparency.

The war and its economic implications on the world economy are the main uncertainties around the baseline projections in this year's *Outlook*, particularly for the first years of the projection period. The *Outlook* only accounts for the impact of the war in the marketing year 2022/23 and assumes that the recovery starts thereafter. The medium-term impacts of the war on agricultural markets cannot be assessed based on data that is currently available.

Several scenarios have been conducted with the Aglink-Cosimo model that assume different impacts on the harvest and export levels of all crops in Ukraine, and on the export levels of wheat in Russia for the next marketing season (2022/23). Table 1.1 shows the impact of these scenarios on the international wheat price. The full loss of Ukraine capacity to export would lead to a 19% increase in the global wheat price. This highlights the importance of maintaining Ukraine's production and export capacity. In the extreme scenario where Russian exports are also affected, wheat prices would be 34% higher than without the war. In this scenario, Russia and Ukraine would jointly export 36 Mt less wheat, but other countries would increase their exports by 16 Mt due to the higher international prices.

Table 1.1. Relative change in global wheat prices: Scenarios with Aglink-Cosimo for marketing year 2022/23

		Restriction of wheat exports by Russia			
		0%	**-10%**	**-25%**	**-50%**
Reduction of Ukraine exports	**0%**	0	2%	5%	11%
	-25%	4%	6%	10%	16%
	-50%	9%	11%	15%	21%
	-100%	19%	22%	26%	34%

Note: The upper left cell in the table refers to the hypothetical situation where exports from both countries are at the same levels as in the past years, not the data presented in the *Outlook*. Vertically, the production and export of cereals in Ukraine are reduced. Horizontally, the wheat exports of Russia are restricted.
Source: OECD (2022), Scenario calculation with Aglink-Cosimo.

In a separate analysis, based on the development of international prices and the price transmission, the (FAO, 2022[1]) projects undernourishment to increase by about 1% globally in 2022/23, which is equivalent to between about 8 and 13 million people, depending on the assumed severity of the export reduction. A scenario simulating a severe export shortfall from Ukraine and Russia in 2022/23 and 2023/24, and assuming no global production response, suggests an increase in the number of undernourished by close to 19 million people in 2023/24. This adds to the recent increase in global undernourishment following the COVID-19 pandemic.

The described impacts are based on the current situation and only take into account the impact of the war during the marketing years 2021 and 2022. Any prolongation of the war beyond 2022 will add additional complexity to the situation and uncertainty to the ten-year projections.

Figure 1.1. Market conditions for key commodities

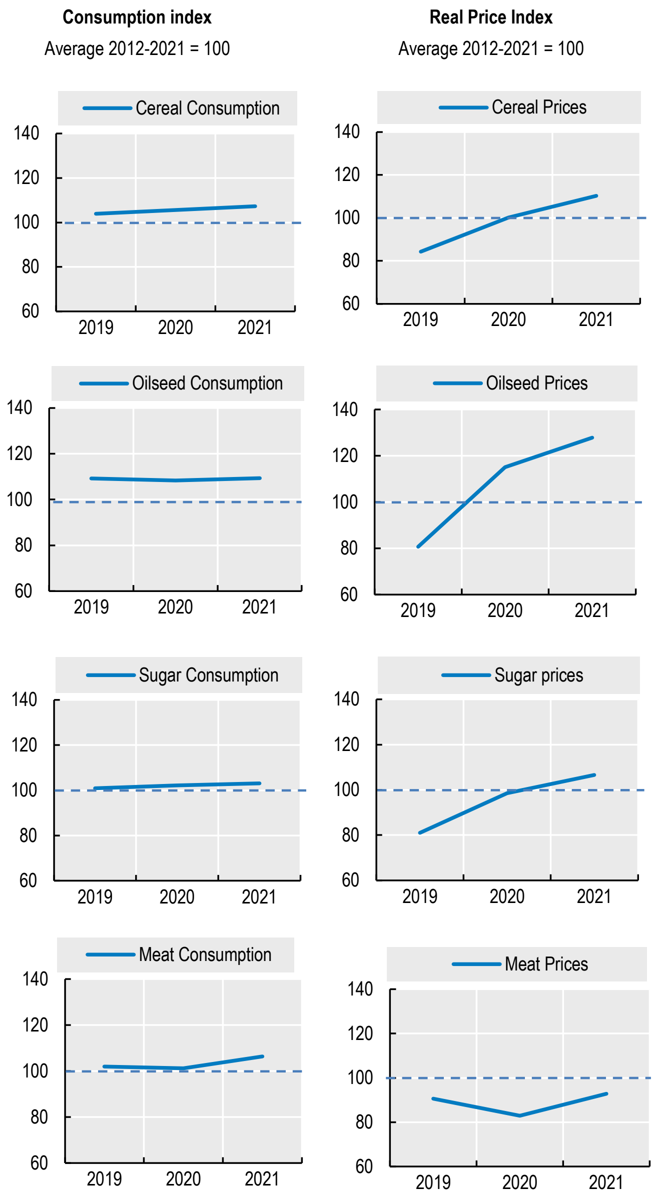
Current market conditions

Cereal: Cereal prices have been increasing since mid-2020, continuing in the 2021/2022 marketing season. Wheat prices increased strongly, following reduced harvests in major producing countries as well as reduced exports from Ukraine. While coarse grain prices also increased strongly, international rice prices in 2021 were on average 4% below their 2020 level as a result of ample supplies.

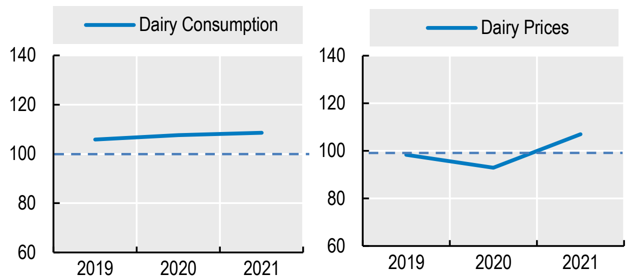
Oilseed: International prices for oilseeds have continued to climb, supported by strong demand for soybean from China amid reduced global production. The rapeseed harvest in Canada is low, while soybean in Latin America was affected by drought and palm oil in Malaysia is still impacted by the Covid-19 pandemic disruptions. Food price inflation is hampering growth in demand for oilseed products.

Sugar: Global sugar consumption continues to rebound from the COVID-19 related downturn, while supply is recovering thanks to better weather conditions in some key producing countries, with the exception of the world's main supplier, Brazil. The surge in crude oil prices is increasing competition from sugarcane-based ethanol production in Brazil and supporting higher international prices of sugar.

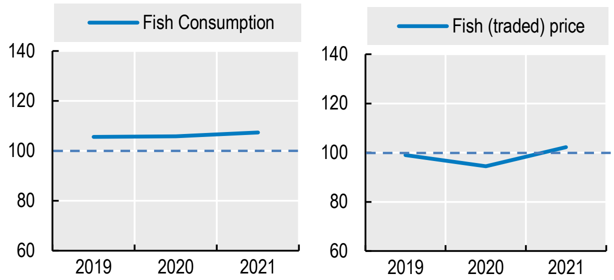
Meat: International meat prices trended upward in 2021, reflecting higher demand due to the economic recovery, and higher marketing and transport costs. However, the meat to feed price ratios fell significantly, putting pressure on sectoral profitability. The ongoing recovery from ASF in China was the largest driver of growth in global meat markets.



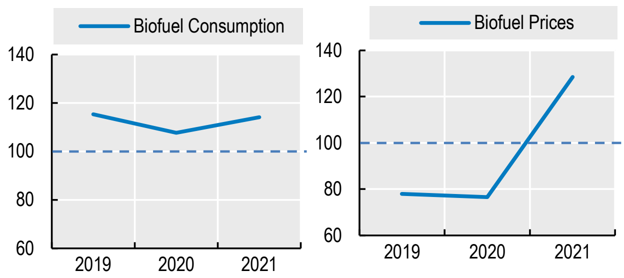
Dairy: Despite lockdowns and transport disruptions caused by the Covid-19 pandemic, the dairy sector has been resilient. Growth in the consumption of dairy products has resumed, supported by strong demand from Asian countries and to a lesser extent the Middle East. Prices of dairy products, which had fallen in 2020, rebounded in 2021, driven by Chinese import demand for cheese and milk powders, met by exports from New Zealand and the European Union.



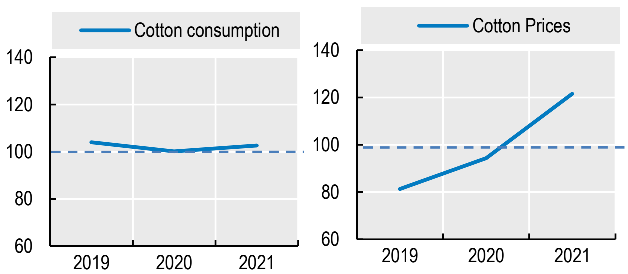
Fish: Efforts to mitigate the spread of COVID-19 resulted in reduced demand for fish, and disruptions in production, supply chains and markets during 2020. In 2021, consumption rebounded, particularly strongly in Europe and America. The rapid reopening of economies after lockdowns leads to a significant recovery in prices of fish products in 2021.



Biofuels: Supported by the economic recovery, demand for fossil fuels, and higher blending mandates in some countries, biofuel consumption is recovering from the drop in demand in the first year of the COVID-19 pandemic. However, costs of raw materials and production are high, which erodes the profitability of biofuels production, such as biodiesel in Argentina. Biofuel prices were historically high in 2021.



Cotton: International prices of cotton increased in 2021, continuing the upward trend that began in May 2020. In early 2022, cotton prices averaged nearly 50% above their 2021 levels. Strong prices were mainly a result of consumption increases in most major textile-producing countries.



Note: All graphs expressed as an index where the average of the past decade (2012-2021) is set to 100. Consumption refers to global consumption volumes. Price indices are weighted by the average global production value of the past decade as measured at real international prices. More information on market conditions and evolutions by commodity can be found in the commodity snapshot in the Annex and the online commodity chapters.
Source: OECD/FAO (2022), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-outl-data-en.

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1.1. Macroeconomic and policy assumptions

1.1.1. Main assumptions underlying the baseline projections

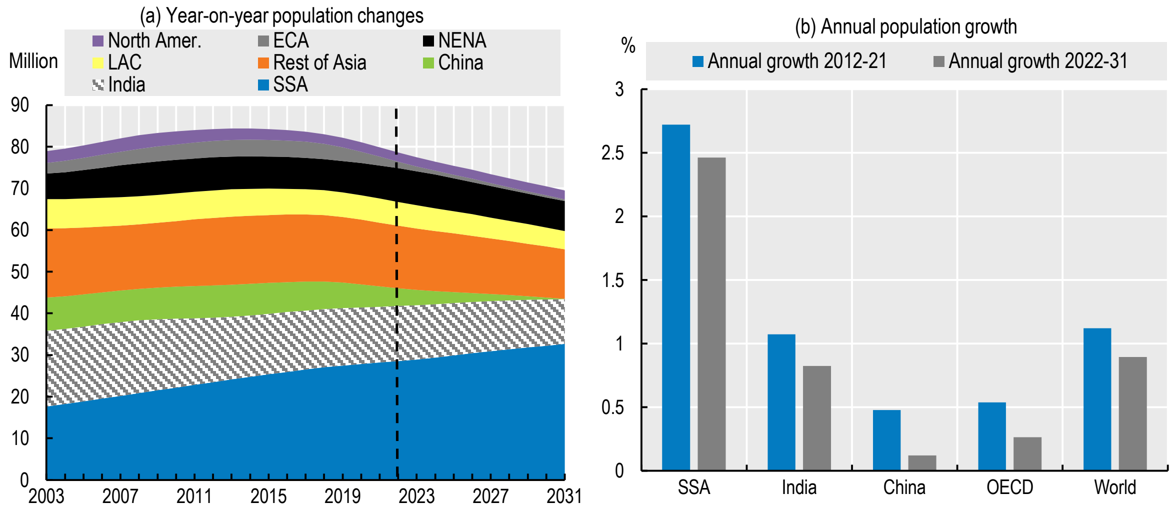
This *Outlook* presents a consistent baseline scenario for the medium-term evolution of agricultural and fish commodity markets based on a set of macro-economic, policy and demographic assumptions. The main assumptions underlying the projections are highlighted in this section. Detailed data are available in the Statistical Annex.

1.1.2. Population growth

The *Outlook* uses the UN Medium Variant set of estimates from the 2019 Revision of the United Nations Population Prospects database.

Over the projection period, world population is expected to grow from 7.8 billion in 2021 to 8.6 billion people in 2031. This corresponds to an average annual growth rate of 0.9%, a slowdown compared to the 1.1% p.a. rate experienced over the last decade. Population growth is concentrated in developing regions, particularly Sub-Saharan Africa, which is expected to have the fastest growth at 2.5% p.a. over the coming decade (Figure 1.2). With a population of 1.51 billion people in 2031, India is expected to overtake the People's Republic of China (hereafter "China") as the most populous country of the world.

Figure 1.2. World population growth



Note: SSA is Sub-Saharan Africa; LAC is Latin America and Caribbean; ECA is Europe and Central Asia; NENA stands for Near East and North Africa, and is defined as in Chapter 2; Rest of Asia is Asia Pacific excluding China and India.
Source: OECD/FAO (2022), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-outl-data-en.

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1.1.3. GDP growth and per capita income growth

National GDP and per capita income estimates for the coming decade are based on the *IMF World Economic Outlook* (April 2022). Per capita incomes are expressed in constant 2010 US dollars.

After a rebound of 5.4% in 2021 following the 2020 recession due to the COVID-19 pandemic, global GDP growth is expected to slowdown in 2022 and 2023 and to stabilise at an average rate of 2.7% over the next decade. However, the path of recovery is expected to differ among countries and regions. The economies of Asia Pacific, North America, and Sub-Saharan Africa had already recovered to their pre-COVID-19 levels in 2021. In Latin America and the Caribbean, Europe and Central Asia, and Near East and North Africa, GDP is projected to return to the 2019 value in 2022. Over the period 2022-31, GDP will continue to grow strongly in the Asia Pacific region, in particular in India, China and Southeast Asia, at an average of about 4% p.a. In Sub-Saharan Africa, and Near East and North Africa, average GDP growth of 4% p.a. and 3% p.a., respectively, is projected over the next ten years. Lower average GDP growth is expected overall in OECD economies, at 1.8% p.a.

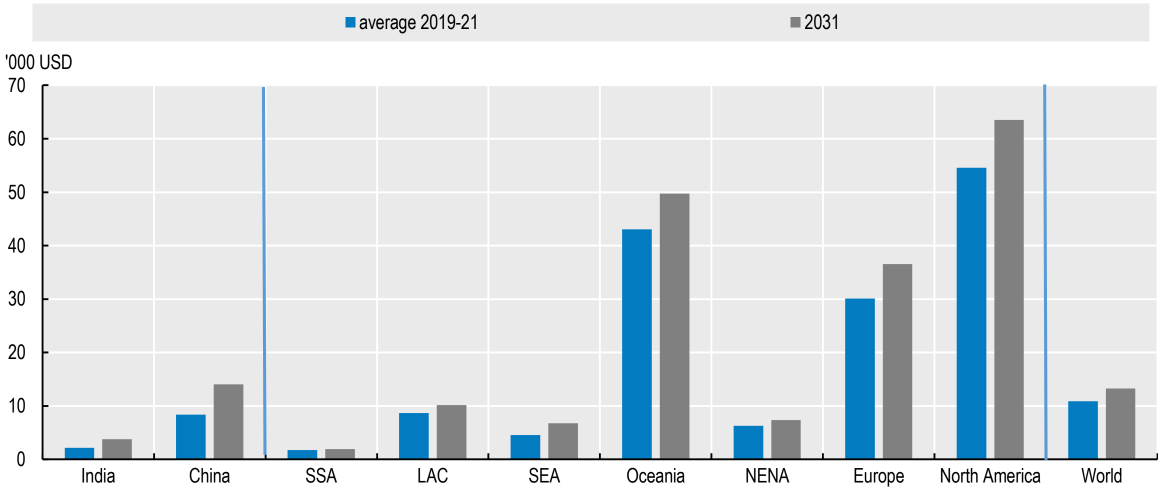
National average per-capita income is approximated in this *Outlook* using per capita real GDP (Figure 1.3). This indicator is used to represent household disposable income, which is one of the main determinants of demand for agricultural commodities. As shown in the World Bank's *Poverty and Shared Prosperity 2020* report, however, national economic growth is unevenly distributed. In particular, in several Sub-Saharan African countries the incomes of the poorest 40% of the population have lagged average income growth. For this reason, national average food demand projections in this *Outlook* can deviate from what might be expected based on average income growth. In addition, the COVID-19 pandemic has deepened income inequalities within countries. In 2020-21, the annual growth rate in per capita income of the poorest 40% of the population declined sharply in all economies (compared to 2012-17 period).

After falling in 2020, global per capita income increased by 4.4% in 2021 but is expected to slow down in 2022 and 2023. Over the next decade, an average annual growth rate of 1.8% in real terms is projected. Strong growth is expected in Asia, with per capita income increasing by 5.3% p.a. in India, and by 4.8% p.a. in China. Growth in per capita income is also expected to be strong in Viet Nam, at 5.8% p.a., and in the Philippines, Indonesia, and Thailand at 4.9%, 4.2% and 3.1% p.a., respectively.

In Sub-Saharan Africa, average per capita incomes are projected to grow slowly at 1.3% p.a. over the coming decade. Real per capita income is projected to stagnate in Nigeria and South Africa but to be robust in Ethiopia, at 3.5% p.a. In the Latin America and the Caribbean, average per capita income growth is projected at 1.6% p.a., driven by high growth in Colombia, Paraguay, and Chile at 2.9% p.a., 2.4% p.a. and 2% p.a., respectively, while an average annual growth rate of 1.5% and 1.7% is expected in Brazil and Argentina, respectively. In the Near East and North Africa region, average per capita income growth is projected at 1.6% p.a., led by the Near East region, especially Jordan, and the Emirates at 2.7% and 3.1% p.a., respectively. Strong growth in per capita income is also expected in Egypt, at 3.8% p.a., while in Saudi Arabia per capita income is expected to grow at 1.6% p.a. over the next ten years.

Average per capita incomes are expected to rise by 1.8% p.a. and 1.3% p.a. in Europe and Oceania, respectively, to 2031. These growth rates are in line with the OECD average, where per capita income is projected to increase at around 1.3% p.a. Among OECD countries, the highest growth is expected for Colombia, followed by Turkey and Korea at 2.9%, 2.6% and 2.5% p.a. respectively, while per capita incomes are expected to grow slowest in Canada at 0.9% p.a. In the European Union, the United States and Japan, per capita incomes are projected to increase at 1.8%, 1.2% and 1.1% p.a., respectively.

Figure 1.3. Per capita income



Note: SSA is Sub-Saharan Africa; LAC is Latin America and Caribbean; SEA is Southeast Asia; NENA stands for Near East and North Africa, and is defined as in Chapter 2. The graph shows per capita GDP in constant 2010 US dollars.
Source: OECD/FAO (2022), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-outl-data-en.

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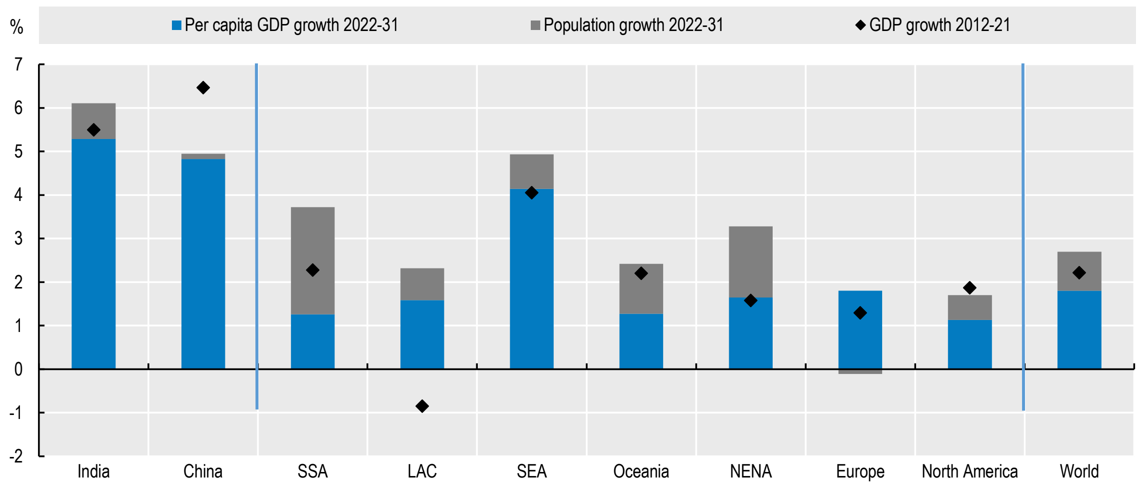
Figure 1.4 decomposes the GDP growth projections into per capita GDP and population growth for key regions and selected countries. Globally, economic growth will be mainly driven by per capita income growth. This is especially the case in OECD countries and China. By contrast, high population growth in Sub-Saharan Africa means that the relatively high rate of economic growth in the region (3.8% p.a.) corresponds to only a modest growth in per capita terms (at around 1.3% p.a.). The same applies to a lesser extent in the Near East and North Africa region. By contrast, the modest economic growth in Europe at 1.7% p.a., where population is expected to decrease over the next ten years, translates into a per capita income growth rate of 1.8% p.a. over the coming decade.

Figure 1.4. Average annual GDP growth rates



Note: SSA is Sub-Saharan Africa; LAC is Latin America and Caribbean; SEA is Southeast Asia; NENA stands for Near East and North Africa, and is defined as in Chapter 2.

Source: OECD/FAO (2022), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-outl-data-en.

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1.1.4. Exchange rates and inflation

Exchange rate assumptions are based on the IMF's World Economic Outlook (April 2022). Nominal exchange rates against the US dollar are primarily determined by differences in inflation against the United States. With high inflation expected in Argentina, Egypt and Ethiopia in particular, the currencies of these countries should depreciate significantly in nominal terms. In real terms, exchange rates are assumed to be more stable for the period 2022-31; but some currencies should appreciate significantly against the US dollar, such as those of Chile, Nigeria, Brazil and China. On the other hand, a significant depreciation in real terms is expected for India.

Inflation projections are based on the private consumption expenditure (PCE) deflator from the *IMF World Economic Outlook* (April 2022). In OECD countries, inflation is projected to be significantly higher than in the previous decade, at 5.2% p.a., with a very high annual inflation rate of 15.8% p.a. in Turkey, and an average rate of 2.1% p.a. for the United States, 2% p.a. for Canada, and 2.1% p.a. for the Euro zone. Among emerging economies, consumer price inflation is expected to remain high at 9% p.a. in Argentina, despite a strong decrease compared to the previous decade. Inflation should ease in India from 4.9% p.a. to 3.9% p.a. and in Brazil, from 6% p.a. to 3% p.a. By contrast, China should experience the same rate of consumer price inflation (2% p.a.) as over the last decade. Inflation is projected to remain high in Sub-Saharan Africa (Ethiopia 13.4% p.a., Nigeria 10.7% p.a. and Ghana 6.3% p.a.). High inflation is also expected in Egypt (7.2% p.a.) and Pakistan (6.5% p.a.).

1.1.5. Input costs

Production projections in the *Outlook* incorporate a composite cost index, which covers seed, energy and fertiliser, as well as various other tradable and non-tradable inputs. It is constructed on the basis of historical cost shares for each country and commodity, which are held constant for the duration of the outlook period. Energy costs are represented by the international crude oil price expressed in domestic currency. The progression of costs of tradable inputs such as machinery and chemicals is approximated by the evolution of the real exchange rate, while the costs of non-tradable inputs (mainly labour) are approximated by changes in the GDP deflator. Seed prices follow the respective crop prices, while an aggregate fertiliser price is approximated by a formula that takes both crop and crude oil prices into account.

Historical data for world oil prices are based on Brent crude oil prices in 2020 from the short-term update of the *OECD Economic Outlook* N°110 (December 2021). For 2021, the annual average daily spot price in 2021 was used. For 2022, an estimate based on the situation in April 2022 is used. For the remainder of the projection period, the reference oil price used in the projections is assumed to follow the growth rate of the World Bank average oil price, which implies an increase from USD 71/barrel in 2021 to USD 89/barrel in nominal terms in 2031, and decrease in real terms to USD 56/barrel in 2031.

1.1.6. Policy assumptions

Policies play a significant role in agricultural, biofuel and fisheries markets such that policy reforms may trigger changes in market structures. The *Outlook* projections are made under the assumption that policies currently in place will remain unchanged throughout the projection period, thus providing a useful benchmark for the evaluation and analysis of future policy changes.

The projections of the *Outlook* do not take into account the planned reform of the European Union (EU) Common Agricultural Policy (CAP), as the European Commission is still reviewing Members States' strategic plans, which describe how the CAP and Green Deal objectives will be achieved. As National Strategic plans will enter into force at the beginning of 2023, for this *Outlook* a continuation of current agricultural and trade policies in the European Union is assumed over the projection period.

The relationship between the EU-27 and the United Kingdom (UK) is based on the EU-UK Trade and Cooperation Agreement provisionally applied from 1 January 2021. A duty-free/quota-free trade relationship between the European Union and the United Kingdom is assumed, with some short-term trade disruptions due to additional border checks and logistical issues considered only for the 2022 projections.

The free trade agreements considered in the *Outlook* are those ratified by the end of December 2021 (e.g. Association of Southeast Asian Nations, United States-Mexico-Canada Agreement, African Continental Free Trade Area) while others (e.g. Regional Comprehensive Economic Partnership, EU-Mercosur) are considered as pending.

The COVID-19 pandemic has added a significant additional element of uncertainty to the macroeconomic assumptions underlying the projections of the *Outlook*. Although the assumptions suggest a continuation of the global economic recovery in the coming period, the actual pace will largely depend on the evolution of coronavirus outbreaks (e.g. spread of new variants) and vaccination rates, as well as policies that support the recovery of businesses and consumer demand. The *Outlook* assumes that the restrictive measures to contain the spread of the COVID-19 pandemic will not be permanent and will be lifted as part of the economic recovery in 2022.

1.2. Consumption

The OECD-FAO Agricultural Outlook projects future trends in the use of the main crop commodities (cereals, oilseeds, roots and tubers, pulses, sugar cane and sugar beet, palm oil and cotton), livestock products (meat, dairy, eggs and fish),[2] and their by-products[3] as food, animal feed, raw materials for biofuels and other industrial uses. For most commodities, food is the main component of overall use. However, non-food uses, mainly feed and fuel, are also important for several commodities (Figure 1.5).

Future demand for food is directly influenced by population and demographic changes, by income growth and distribution, and by food prices. Food demand will also be shaped by socio-cultural and lifestyles changes, including urbanisation and rising female participation in the workforce, as well as increasing consumer awareness of health and sustainability issues. Policies altering the price of agricultural products (e.g. fiscal measures, border measures) and, as far as possible, policies influencing consumption patterns (e.g. food labelling, regulations) are also considered. Taken together, these factors will determine the level and structure of food demand over the next decade.

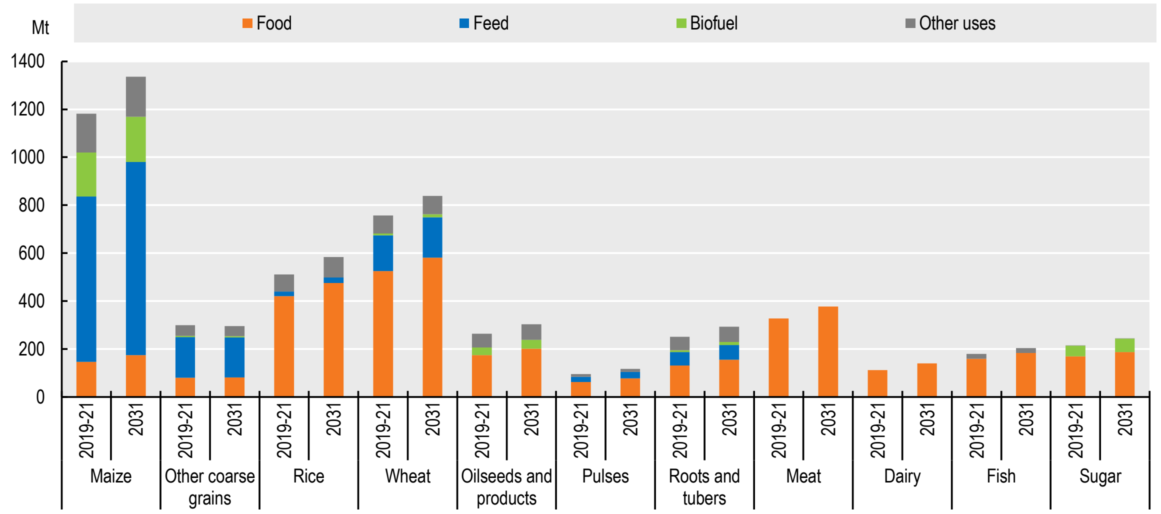
Demand for non-food uses of agricultural commodities is also shaped by a number of specific factors. Feed demand has two main drivers. First, the overall demand for animal products, which determines the production level of the livestock and aquaculture sectors. Second, the structure and efficiency of the production systems, which determine the amount of feed needed to produce a given output of livestock and aquaculture products.

Industrial uses of agricultural commodities – mostly for biofuel production and as input in the chemical industry – are largely influenced by general economic conditions, regulatory policies, and technological change. In the case of biofuels, consumption is highly sensitive to changes in policies, as well as overall demand for transport fuel, which in turn depends on the crude oil price.

The macroeconomic assumptions underlying the projections suggest a widespread economic recovery following the COVID-19 pandemic. However, the actual pace of this recovery will depend on several factors

that cannot easily be anticipated, which introduces uncertainty into the projections of demand for agricultural commodities. The *Outlook* projections also account for reduced export availability from both Ukraine and Russia in the marketing year 2022/23 (Section 1.3.7).

Figure 1.5. Global use of major commodities



Note: Crushing of oilseeds is not reported as the uses of 'vegetable oil' and 'protein meal' are included in the total; Dairy refers to all dairy products in milk solid equivalent units; Sugar biofuel use refers to sugarcane and sugarbeet, converted into sugar equivalent units.
Source: OECD/FAO (2022), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-outl-data-en.

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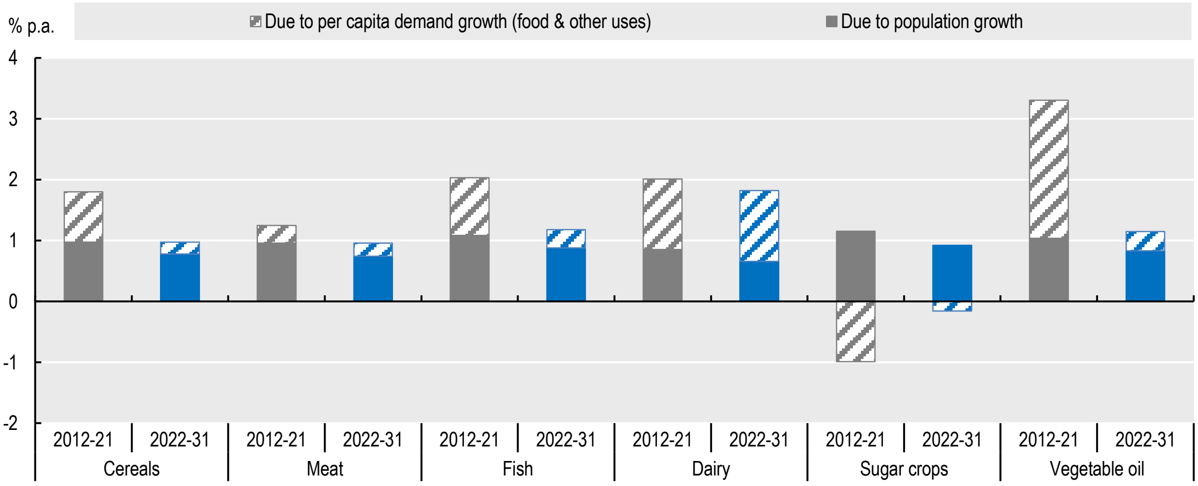
1.2.1. Demand growth is slowing and mostly driven by population

Global demand for agricultural commodities (including for non-food uses) is projected to grow at 1.1% p.a. over the coming decade, well below the growth experienced over the last decade (2% p.a.). This is mainly due to an expected slowdown in demand growth in China (0.6% p.a. compared to 2.3% p.a. over the last decade) and other middle-income countries, and in global demand for biofuels.

For most commodities (except dairy), per capita demand growth will be limited over the next ten years (Figure 1.6). Population growth will thus be the main determinant of demand growth, with the bulk of additional demand originating in regions with high population growth, namely Sub-Saharan Africa, South Asia, Near East, and North Africa.

For cereals and fish, global demand will grow at about half the rate of the past decade, while for vegetable oil only a third of last decade's growth is expected (Figure 1.6). Vegetable oil was the fastest-growing commodity over the last ten years, partly driven by biofuel policies. Over the next decade, demand growth for vegetable oil will be constrained by stagnant to declining biodiesel consumption in the two main markets, the United States and the European Union (Section 1.3.5). Growth in food demand for vegetable oil is also projected to slow down as high-income countries and some middle-income countries, including China, are approaching saturation levels.

Figure 1.6. Annual growth in demand for key commodity groups



Note: The population growth component is calculated assuming per capita demand remains constant at the level of the year preceding the decade. Growth rates refer to total demand (for food, feed and other uses).
Source: OECD/FAO (2022), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-outl-data-en.

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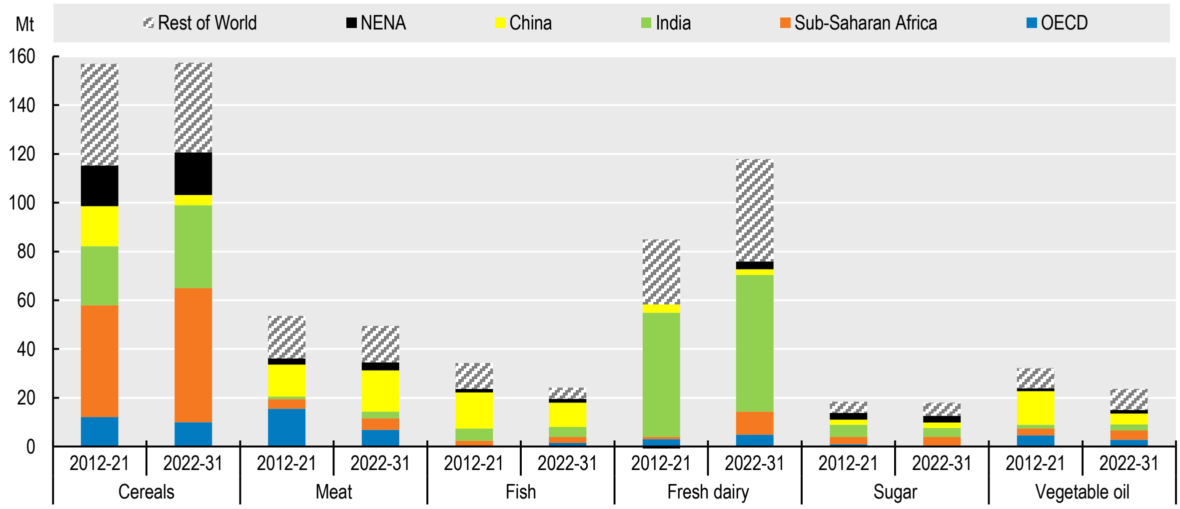
1.2.2. Low- and middle-income countries are driving food demand growth

Global food demand is projected to increase by 1.4% p.a. over the next decade, driven by population and per capita income growth. Most additional demand for food will continue to come from low and middle-income countries, while in high-income countries it will be constrained by slow population growth, and a saturation in the per capita consumption of several commodities (Section 1.3.3).

World population is projected to grow from 7.8 billion in 2021 to 8.6 billion in 2031. Two-thirds of this increase is expected to occur in Sub-Saharan Africa, India and Near East and North Africa (Section 1.2.2). Consequently, these regions will generate a large share of additional demand for food, in particular cereals (two-thirds of additional demand), and other staples (i.e. roots and tubers, and pulses) (Figure 1.7).

Continuing income growth and urbanisation in China, India, and Southeast Asia will also drive food demand growth for several commodities. China is expected to account for 41% and 34% of additional global food demand for fish and meat, respectively, while half of additional global demand for fresh dairy products will be sourced in India (Figure 1.7).

Figure 1.7. Regional contributions to food demand growth, 2012-21 and 2022-31



Note: Each column shows the increase in global demand over a ten-year period, split by region, for food uses only. NENA stands for Near East and North Africa, and is defined as in Chapter 2.
Source: OECD/FAO (2022), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-outl-data-en.

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1.2.3. Convergence in diets expected to be limited over the coming decade

UN Sustainable Development Goal of Zero Hunger by 2030 will be a challenge

Globally, average food availability per person is projected to grow by 4% to reach over 3 070 kcal/person/day in 2031. Staples and animal products will account for 70% of additional calories (Figure 1.8). Food availability is the closest indicator to food consumption available in the Aglink-Cosimo model. It is higher than actual consumption because some of the food that is potentially available to consumers is lost or wasted along the supply chain. The term food consumption is used for food availability for ease of interpretation.

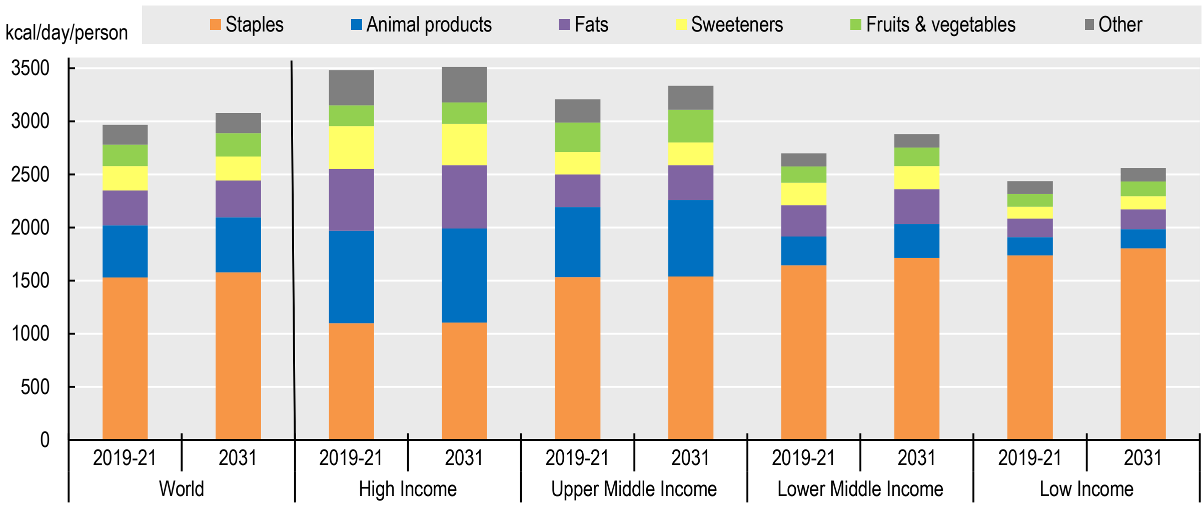
Global average food consumption per person masks important differences between regions and countries. While consumers in middle-income countries are expected to increase their food consumption and diversify their diets in the coming decade, diets in low-income countries will remain largely unchanged. Therefore, the projections suggest that it will be challenging to meet the Sustainable Development Goal (SDG) 2 on Zero Hunger by 2030 (United Nations, n.d.[6]). In Section 1.7, an illustrative scenario assesses the level of productivity growth that would be required to achieve SDG2 as well as a considerable reduction in agricultural greenhouse gases (GHG) emissions by 2030.

Per capita food consumption will level off in high-income countries over the next decade as it is already at high levels for the different food groups, and an ageing population and more sedentary lifestyles limit additional calorie requirements (Figure 1.8). However, income growth and changing consumer preferences will increase the substitution away from staples and sweeteners, towards nutritious foods, including fruits and vegetables, and to a lesser extent, animal products. The projected decline in per capita consumption of sweeteners reflects growing consumer concerns about the negative health effects of excessive sugar consumption. Several countries (e.g. France, United Kingdom, and Norway) have implemented measures

to discourage the consumption of caloric sweeteners over the last decade, which are assumed to remain in effect over the projection period and reduce demand for these products.

In upper-middle income countries, per capita food consumption is expected to increase by 4% by 2031 (Figure 1.8). Given the expected high-income growth and the strong preference to consume more meat in several of these countries, including China, 45% of additional calories will be provided by animal products and 20% by fats. Per capita food consumption is projected to increase by almost 7% in lower-middle income countries over the next decade, the largest gain of all income groups. Staples and animal products will account for two-thirds of this increase, and fats for 18%. The projected increase in fats consumption in middle-income countries is underpinned by ongoing urbanisation and changing lifestyles (e.g. increasing tendency to eat outside the home), which favour higher consumption of processed and convenience foods.

Figure 1.8. Per capita calorie availability of the main food groups, by country income group



Note: Estimates are based on historical time series from the FAOSTAT Food Balance Sheets database, which are extended with the *Outlook* database. Products not covered in the *Outlook* are extended by trends. The 38 individual countries and 11 regional aggregates in the baseline are classified into the four income groups according to their respective per-capita income in 2018. The applied thresholds are: low: < USD 1 550, lower-middle: < USD 3 895, upper-middle: < USD 13 000, high: > USD 13 000. Staples includes cereals, roots and tubers and pulses. Animal products include meat, dairy products (excluding butter), eggs and fish. Fats include butter and vegetable oil. Sweeteners include sugar and HFCS. The category others include other crop and animal products.
Source: FAO (2022). FAOSTAT Food Balances Database, http://www.fao.org/faostat/en/#data/FBS; OECD/FAO (2021), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-outl-data-en.

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In low-income countries, average food consumption is projected to increase by 5% to reach 2 560 kcal/person/day in 2031 (Figure 1.8). Average diets in low income-countries will remain heavily based on staples, which are projected to account for more than half of additional calories and will continue to provide 70% of calories by 2031. Strong growth in per capita consumption of sweeteners (11% of additional calories) is driven by ongoing urbanisation, which favours higher consumption of sugar-rich confectionery products and soft drinks. However, given the low base level, per capita consumption of sweeteners in these countries will remain well below those of middle and high-income countries by 2031. Growth in the consumption of animal products and other nutritious foods (e.g. fruits and vegetables) will be limited due to income constraints, exacerbated by the COVID-19 pandemic. Given the higher cost of these food items, consumers in low-income countries will only slightly increase the diversity of their diets.

Aligning global diets with the World Health Organization (WHO) guidelines on the intake of sugar and fat would improve food security and nutrition, and environmental sustainability, but could negatively affect farmer livelihoods, as explained in Box 1.2.

Box 1.2. Potential impact of dietary changes on the triple challenge facing food systems

Global dietary patterns have changed substantially over the past 50 years, with people increasingly consuming resource-intensive and energy-dense foods. Changes in dietary patterns have contributed to a double burden of malnutrition, with more than 1.9 billion people overweight in 2016 and, of these, over 650 million were obese (WHO, 2021[7]) and nearly 768 million people undernourished in 2020 (FAO et al., 2021[8]). Growing population and per capita food consumption have also increased environmental resource pressure and degradation and led to a rise in GHG emissions from the agriculture, forestry and other land use sector. Current dietary and population growth trends will exacerbate risks to both people and the planet. A dietary shift toward healthy diets and more sustainable food systems could contribute to achieving many of the 17 UN SDGs by 2030, and countries' commitments under the 2015 Paris Agreement (COP21).

Using the Aglink-Cosimo model and indicators of the triple challenge – namely food security and nutrition, livelihoods, and environmental sustainability (Tallard et al., 2022[9]) – look at the potential impacts on food systems of aligning global diets with the WHO guidelines on the intake of sugar and fat. Specifically, this scenario assesses the impact of reducing the consumption of free sugars and fat to a maximum of 10% and 30% of an appropriate caloric intake, respectively.[1] These changes in diets are simulated to be implemented over ten years across all of the population in each country, excluding undernourished individuals.

Following implementation of this dietary change, the model estimates that global per capita calories consumed from sugar fall by 8%, calories from HFCS fall by 16%, and calories from fat fall by 11% in 2030, compared to the baseline of the 2020-29 *Outlook* (OECD/FAO, 2021[10]).

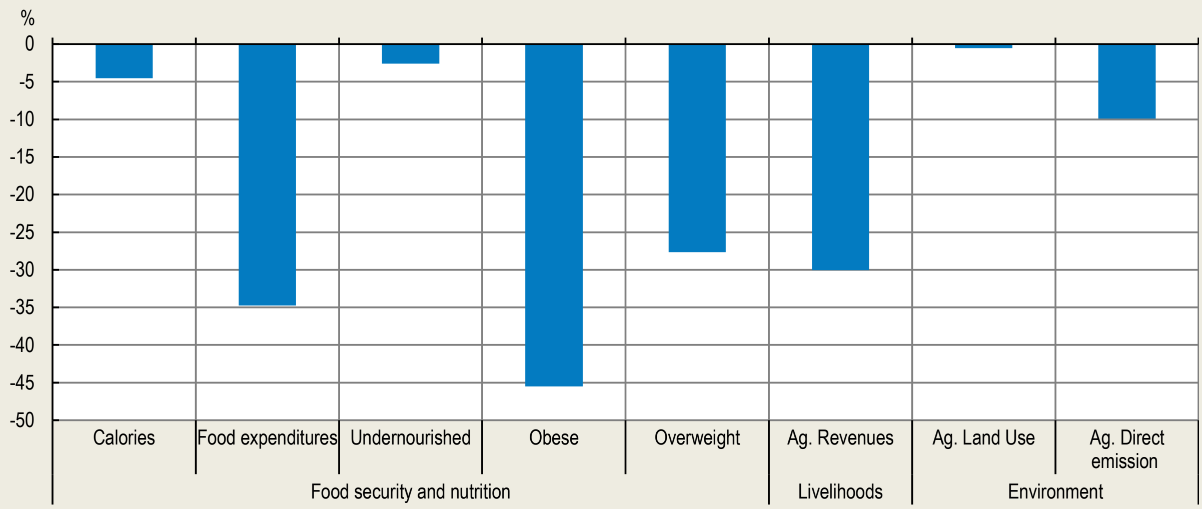
Such a change in diets has a large impact on food security and nutritional outcomes, with the prevalence of obesity and overweight declining by 46% (638 million people) and 28% (1 billion people), respectively, compared to the baseline. Moreover, as prices fall for most commodities, global food expenditure decreases by 35%, resulting in a 3% decline in the prevalence of undernourishment at the global level (20 million people) (Figure 1.9).

This dietary change also has significant impact on farmer livelihoods and environmental sustainability. Strong price declines for sugar (-28%), poultry (-44%), pork (-62%), beef (-63%), butter (-73%), and cheese (-53%), result in a 30% drop in agricultural revenues relative to the baseline. Lower production of several commodities, including emission-intensive products such as meats and dairy, result in a 10% decline in GHG emissions from agriculture (-532 MtCO2-eq). The impact on global land use, however, is small (-0.5%) (Figure 1.9).

The analysis indicates that it is the reduction in fat consumption that drives most of the impacts on the triple challenge indicators, given the size of the vegetable oil and livestock sectors, the importance of these products in diets, and the substantial gap between current levels of fat consumption and the WHO recommendations (Tallard et al., 2022[9]).

Figure 1.9. Global change in Indicators of the triple challenge: Sugar and fat scenario

% change relative to the baseline



Source: Tallard et al. (2022[9]).

https://stat.link/q6pets

Overall, achieving WHO's targets on the intake of sugar and fat would have a positive impact on food security and nutrition, leading to a decline in both over-nourishment and undernourishment, as well as on environmental sustainability. However, the reduction in food prices and global production resulting from this change in diets negatively affects farmers' livelihood. This suggests that when designing food policies, potential synergies and trade-offs need to be taken into account in order to develop a coherent mix of policies that benefit agriculture, human health and the environment.

Note: [1] To translate WHO recommendations into specific values, this scenario rely on the Average Daily Energy Requirement, which captures the average calorie intake requirements of an average individual, taking into account a range of factors such as demographics and levels of physical activity.
Source: Tallard et al. (2022[9]).

Continuing differences in the main sources of protein between countries

Average per capita consumption of protein is projected to increase by 4% to reach 87g/person/day in 2031. Income-related and cultural differences in the composition of protein consumption are expected to persist, with lower middle- and low-income countries remaining heavily dependent on proteins from plant sources. Populations in high-income countries will continue to derive the majority of their proteins from animal sources.

In high-income countries, average per capita consumption of proteins is not expected to expand much over the next decade, due to near saturation in consumption, and heightened concerns about health and the environment (Figure 1.10). These concerns, together with ethical considerations regarding the welfare and eating of animals, could also boost demand for plant-based proteins and alternative protein sources (e.g. insects, cultured meat), as discussed in Section 1.3.7.

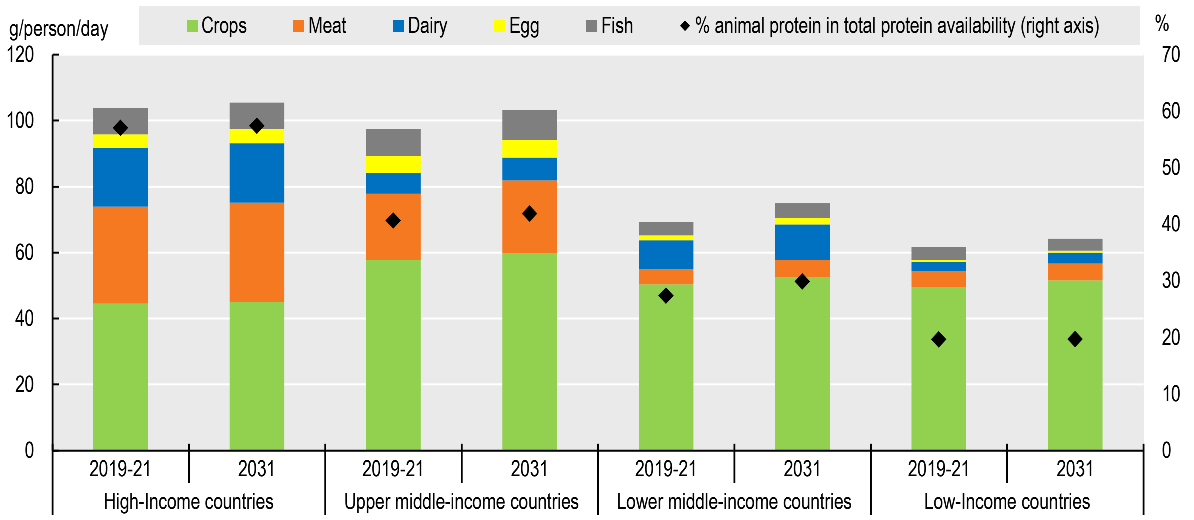
Strong growth in per capita consumption of proteins is expected in upper and lower middle-income countries, by 6% and 8%, respectively; with about 60% of additional proteins being provided by animal

products (Figure 1.10). This will bring average per capita consumption of proteins in upper-middle income countries close to the levels of high-income countries by 2031. Much of this convergence is driven by a strong growth in per capita consumption of animal protein (mainly meat) in China.

Despite significant growth in per capita consumption of animal protein (mainly dairy) in lower middle-income countries, their consumption levels will remain well below those of upper middle and high-income countries given their low base level. India's traditionally low consumption of animal protein, especially of meat, is the main contributor to this trend.

Per capita consumption of proteins is projected to increase by 4% in low-income countries (Figure 1.10). Additional proteins will come almost entirely from plants, which will continue to provide more than 80% of available proteins by 2031. Per capita consumption of animal protein is low and is expected to grow slowly over the coming decade, mainly due to relatively low growth in per capita incomes following the COVID-19 pandemic. Supply chain problems (e.g. lack of a cold chain infrastructure) also remain a constraint in some areas, whereas dietary preferences for non-animal protein sources continue to limit demand growth in others. Per capita consumption of fish protein is even projected to decline over the next decade, as population growth in Africa is projected to outpace the expansion in supply.

Figure 1.10. Per capita protein availability, by country income group



Note: Crops include cereals, pulses, and roots and tubers.
Source: OECD/FAO (2022), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-outl-data-en.

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1.2.4. Feed use efficiency gains and intensification

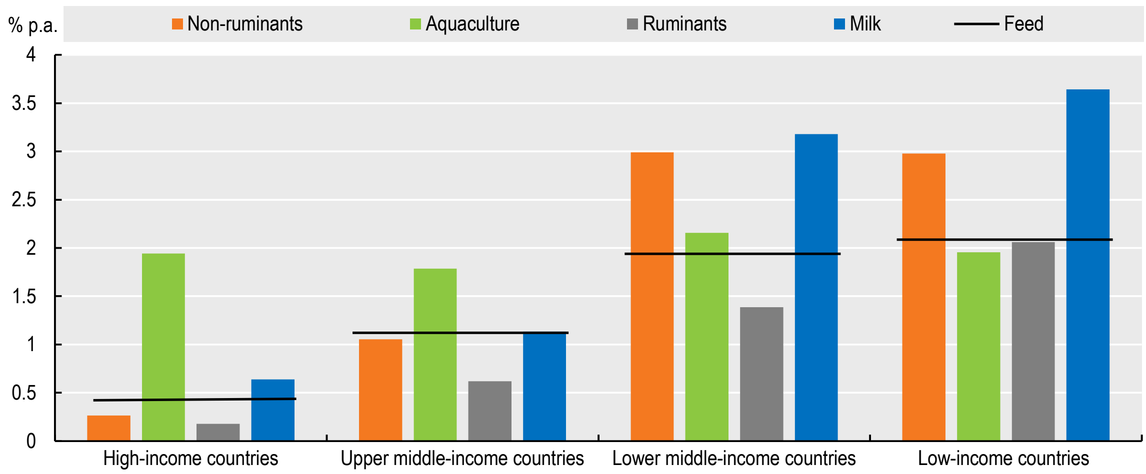
Low- and middle-income countries drive growth in feed use

The evolution of global consumption patterns towards more animal products in diets requires growing crops and other agricultural products as feed. In 2019-21, about 1.7 billion tonnes of cereals, protein meals and processing by products (e.g. cereals bran) were used as animal feed. Global feed use is projected to increase by 1% p.a. over the coming decade, reaching 2 billion tonnes in 2031.[4]

In lower middle and low-income countries, feed use is projected to grow faster, at about 2% p.a. over the next ten years, reflecting the rapid expansion in non-ruminant and aquaculture production, as well as intensification in feed use due to the shift away from backyard production to more commercialised production systems. Developments in ruminants and milk production in these countries are less closely linked to commercial feed use, as most production is pasture-based (Figure 1.11).

In upper-middle income countries, feed use is projected to grow at 1.1% p.a. over the next decade, in line with growth in livestock and aquaculture production. Developments in feed use are highly influenced by China, the world's largest feed consumer. However, China's feed use growth is projected to significantly decelerate compared to the last decade (1% p.a. vs 3.7% p.a.), due to slower growth in livestock production (except for pigmeat), and improvements in feeding efficiency. These feed efficiency gains, owing to better management practices and animal genetics, will enable a reduction in feed use per unit of livestock output (Figure 1.11).

Figure 1.11. Annual change in feed use and livestock production, 2022-2031



Note: Ruminants include beef and veal and sheepmeat. Non-ruminants include poultry and pigmeat. The bars show annual changes in production volumes for the different livestock products. The black line shows annual changes in feed use.
Source: OECD/FAO (2022), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-outl-data-en.

StatLink https://stat.link/wprvh4

In high-income countries, feed use is projected to grow slowly, at only 0.4% p.a., reflecting slow growth in livestock production but also feed efficiency gains, stemming from improvements in animal genetics, feed technology, and herd management (Figure 1.11).

Despite slower growth in feed use in upper middle and high-income countries, these countries will remain the largest feed consumers, overall accounting for 80% of global feed use by 2031 (Figure 1.12). Together, China, the United States, and the European Union will continue to account for half of total feed use by the end of the decade.

Changes in the structure of feed use in low- and middle-income countries

The composition of feed use, shown in Figure 1.12 as the share of high, medium and low protein feed in total feed use, varies significantly between countries due to differences in production technologies. Over

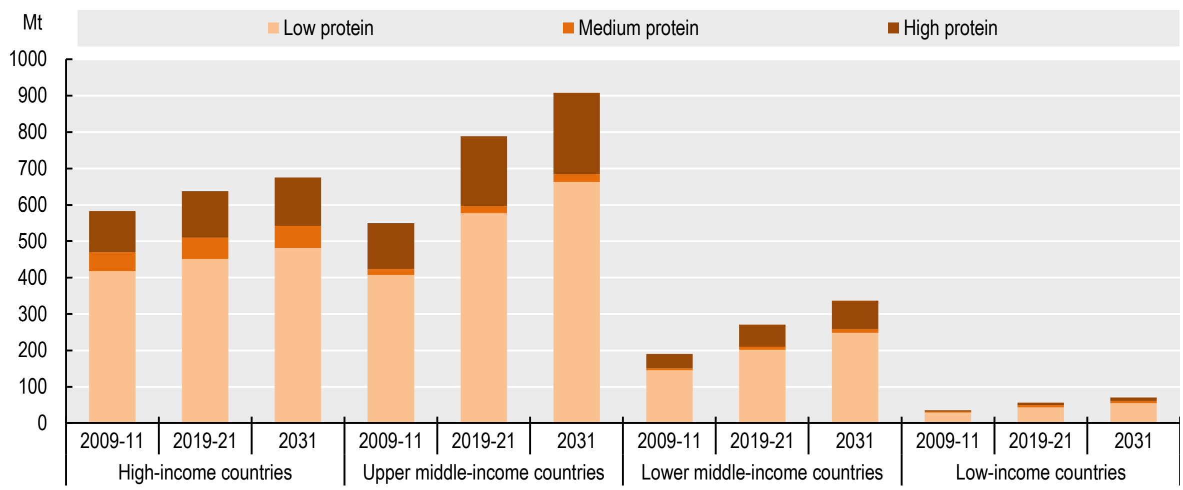
the next decade, intensification in livestock production in lower-middle- and low-income countries is expected to increase their use of high-protein feed, albeit starting from a low base.

Livestock farming in low-income countries is largely reliant on small-scale, locally produced feed systems. Commercial feed use is low and dominated by low protein feed (i.e. cereals, roots and tubers). However, the share of high protein feed (i.e. mainly oilseed meals) in total feed use is projected to slightly increase from 13% in 2019-21 to 14% in 2031, as these countries adopt more commercialised and feed intensive production systems. Lower-middle income countries use a higher share of high protein feed but this will only marginally increase from 2019-21 to reach a projected 23% by 2031.

Upper middle-income countries have the highest consumption and share of high protein feed, which has surged over the last decade (from 22% to over 24%), with a shift to compound feed production systems, but is expected to remain stable over the next decade. China's use share of high protein feed is already high, exceeding those of both the European Union and the United States. Moreover, the liberalisation of the grain market in China since 2016 has led to a drop in feed grain prices, which favours the use of maize (relative to protein meal) in the feed mix. However, rebuilding pig herds from ASF, which is characterised by the installation of modern, feed-intensive production facilities, could result in additional demand for high protein feed (see Chapter 4 on oilseeds).

High-income countries rely on intensive livestock production systems and use substantial amounts of high and medium protein feed. Over the next decade, the structure of feed demand is not expected to change significantly. Demand for high protein feed is projected to increase slowly due to sluggish growth in livestock production and ongoing improvements in feed conversion ratios, whereby less high protein feed is used per unit of livestock product. This slow growth also reflects the ongoing shift to organic and non-genetically modified (GM) based livestock production in the European Union, which is projected to lead to a reduction in its demand for high protein feed in favour of other sources (e.g. grass, pulses).

Figure 1.12. Structure of feed use, by country income group



Note: Low protein feed includes maize, wheat, other coarse grains, rice, cereal brans, beet pulp, molasses, roots and tubers. Medium protein feed includes dried distilled grains, pulses, whey powder. High protein feed includes protein meal, fish meal, and skim milk powder.
Source: OECD/FAO (2022), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-outl-data-en.

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1.2.5. Sharp slowdown in demand for biofuels

Sugarcane will dominate feedstock for biofuels, with smaller share from maize

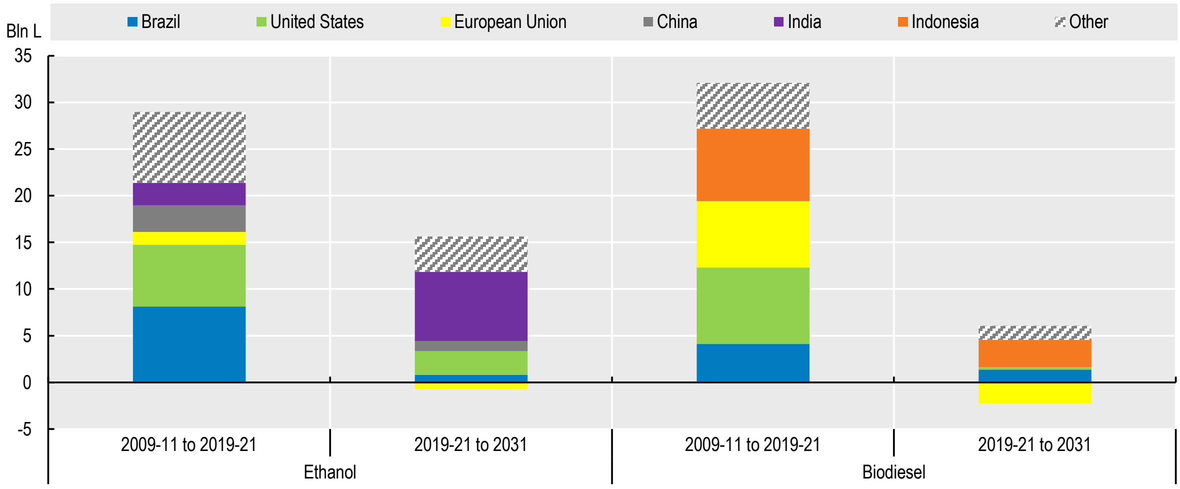
Since the early 2000s, demand for biofuels (ethanol and biodiesel) increased significantly following the implementation of policies to: (i) support national commitments to reduce carbon dioxide (CO_2) emissions, (ii) reduce the dependency on imported fossil fuels, and (iii) create additional demand for feedstock crops to support domestic producers.

Over the next decade, biofuel demand is projected to increase by 0.6% p.a., significantly below that experienced over the last decade (4% p.a.), mainly due to declining fuel use and weaker policy incentives in high-income countries. Most additional demand will originate in middle-income countries, driven by higher blending rates and subsidies supporting domestic production.

Ethanol consumption is projected to increase by 12% between 2019-21 and 2031, with India accounting for half of additional consumption (Figure 1.13). India's ethanol blending rate is assumed to reach 11% by 2025 and 20% by 2031, supported by increasing domestic production of sugarcane-based ethanol. However, for this *Outlook* it is assumed that India will not reach the E20 target set by the government for 2025, due to limited supply of feedstock. Ethanol consumption will also continue increasing in Brazil, although at a considerably lower rate than over the last decade, driven by a high blend rate and growing fuel consumption. Growing global ethanol consumption will result in an increase in the use of sugarcane for biofuel production; biofuel increasing its share of total sugar cane use to 23% by 2031 (Figure 1.14). Biofuel use of molasses, a by-product of sugarcane production and the main feedstock for ethanol production in India and other Asian countries, is also projected to increase, with the biofuel sector increasing its share of total molasses use to 51% by 2031 (Figure 1.14).

In China and the United States, growth prospects for ethanol consumption are limited (Figure 1.13). In China, ethanol consumption will increase with higher fuel use but the growth rate will decrease significantly compared to the last decade. The government of China is not expected to implement a nationwide E10 mandate, as proposed in 2017, as this depends on maize stocks, which have decreased since 2017. Therefore, for this *Outlook* it is assumed that China will maintain a lower 2% blending rate over the projection period. In the United States, declining gasoline use, together with the 10% ethanol blend wall[5], will constrain the growth in ethanol consumption. Biofuel use of maize – the main feedstock for ethanol production in China and the United States – will grow slowly over the coming decade, with the biofuel share of maize dropping from 15.5% in 2019-21 to 14% in 2031 (Figure 1.14).

Figure 1.13. Changes in biofuel consumption in key regions



Source: OECD/FAO (2022), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-outl-data-en.

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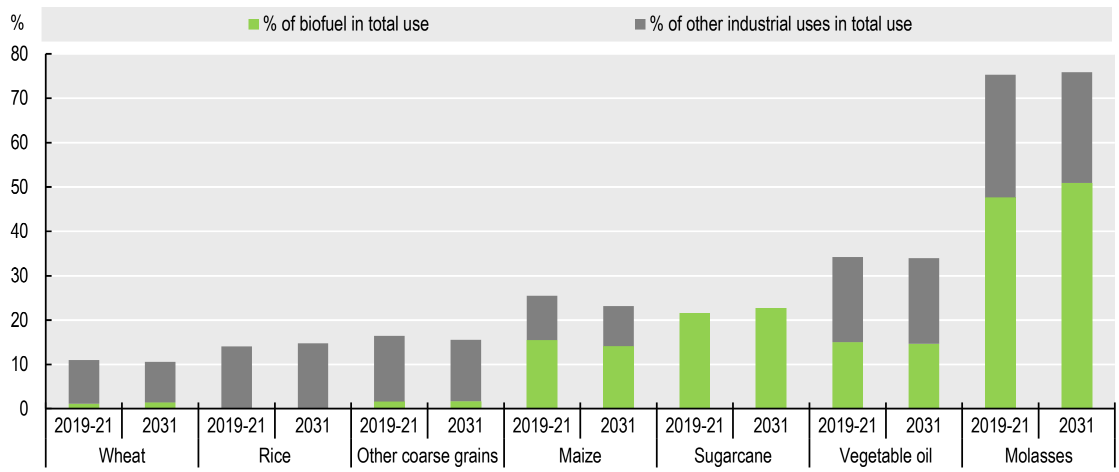
Biodiesel consumption is projected to increase by 7% between 2019-21 and 2031, with Indonesia accounting for 77% of additional consumption (Figure 1.13). As the blending rate in Indonesia is assumed to remain at 30% over the projection period – the target of the 2020 B30 programme – biodiesel demand is expected to increase along with overall fuel consumption. In the United States and the European Union, however, declining diesel use will constrain the growth in biodiesel consumption. In the European Union, biodiesel consumption will be further dampened by the Renewable Energy Directive II, which sets limits on the use of biofuel feedstock (mostly palm oil) grown in carbon-capturing ecosystems such as forests, wetland and peatland. Based on projected developments in biodiesel consumption, the use of vegetable oils feedstock is expected to increase by 14% to 2031, maintaining its biofuel share at around 15% (Figure 1.14).

Figure 1.14. Share of biofuel and other industrial uses in total use of agricultural commodities



Source: OECD/FAO (2022), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-outl-data-en.

StatLink https://stat.link/jcqx82

1.2.6. Other uses for agricultural commodities

Buoyant prospects for rice and vegetable oil used for non-food products

Agricultural commodities covered in the *Outlook* are also used for a broad range of products and processes. The *Outlook* combines seed, postharvest losses, waste and all industrial applications, except biofuel, into the category “other uses’’. Over the next decade, demand for other uses is projected to increase annually by 0.7%. Agricultural commodities and their by-products used as industrial feedstock contribute to reduce dependence on fossil fuels and enhance bio-resource value, including by recycling waste.

Cotton fibre for yarn is used for the production of garments and other textile products. Over the next decade, demand for cotton is projected to increase at a higher rate than global population (at 1.6% p.a.), underpinned by ongoing income growth. However, strong competition from synthetic fibres, mainly polyester, will continue to constrain demand for cotton. This trend could be partly offset by growing consumer interest in more sustainable fabrics, provided that cotton is produced sustainably (see Chapter 10 on cotton). Wool – a by-product of some sheepmeat production – is also used in the textile industry but is not considered in the *Outlook* projections.

Molasses are used as industrial raw products in the production of yeast, vinegar, citric acid, vitamins, amino and lactic acid and their use is projected to grow by 1.5% over the next ten years. This is far lower than the projected growth in biofuel use of molasses. As a result, the “other uses” share of molasses is projected to drop from 28% in 2019-21 to 25% in 2031 (Figure 1.14).

Industrial uses of cereals include the production of industrial starch and spirituous liquors, and applications in the paper, textile, pharmaceutical, and cosmetic industries. Rice, for instance, is increasingly used as an ingredient in the production of face washes, shower soaps and hair products, especially in Asia. Over the coming decade, other uses of rice are projected to increase by 19%, and their share in total use of rice is expected to slightly expand to 15% in 2031. Maize, on the other hand, has a growing importance in the production of bioplastic – a substitute for petroleum-based product. Other uses of maize, other coarse grains and wheat are expected to grow at a slower pace than other uses of rice; and their shares in total use of agricultural commodities are projected to decline over the outlook period (Figure 1.14).

Vegetable oils are also used as ingredients in cosmetics and personal care products, lipid-based excipients in pharmaceutical products, and in pet feed additives. Other uses of vegetable oils are projected to expand by 17% over the next ten years, maintaining its share at about 19% by 2031 (Figure 1.14).

1.2.7. The next decade could see unprecedented shifts in food consumption patterns

A key source of uncertainty in the short term relates to Russia’s war against Ukraine. Reduced export availability from these countries is pushing up international food and feed prices. Larger price increases can be expected if the war keeps energy and fertilisers prices at high levels and prolongs the two countries’ reduced global export availabilities (FAO, 2022[1]). Higher agricultural commodity prices would have negative consequences for global food security and nutrition, particularly for poor households (Box 1.1).

The macroeconomic assumptions underlying the projections suggest a continuation of the global economic recovery following the COVID-19 pandemic (Section 1.2). The actual pace of this recovery will, however, depend on several factors that cannot easily be anticipated. These include the evolution of COVID-19 outbreaks (e.g. spread of new variants), vaccination rates and other public health measures, and of policies that support the recovery of business and consumer demand. Moreover, the shift away from food services and restaurants to home eating induced by the pandemic is assumed to be reversed as the economy recovers and control measures are lifted. However, alternative pathways, could alter the projections of

food demand, particularly for products that are mainly consumed outside the home such as fish and some meat cuts.

Another source of uncertainty on the demand side relates to evolving consumer preferences. Consumers' purchasing decisions are increasingly driven by factors beyond prices, culture and taste, such as health and environmental concerns, and ethical considerations regarding the welfare and eating animals and their products. This trend is reflected by the increase in vegetarian, vegan or "flexitarian" lifestyles in high-income countries, particularly among young consumers. Meat and dairy markets would be most affected by a shift to plant-based proteins, or alternative protein sources (e.g. insects, cultured meat). Feed markets could also be impacted as lower quantities of arable crops are needed to produce these alternative sources of protein (Oonincx, Van Broekhoven and Van Huis, 2019[11]) (Kearney, n.d.[12]). However, as the consumption shares of these products are expected to remain very small over the next decade, the *Outlook* does not explicitly take them into account, which nevertheless introduces some uncertainties in the demand projections.[6]

Policy developments also constitute a continuing source of uncertainty. Several countries have introduced (or are planning to) policies to reduce overall calorie consumption or to foster a shift towards healthy diets. These measures include fiscal policies (e.g. tax on sugar or saturated fat, subsidies for nutritious food products), labelling schemes, product reformulation in collaboration with the industry, updated dietary guidelines and educational programmes (e.g. for school meals). These policies could affect both the overall demand for food as well as the relative demand for different food products in ways that are difficult to foresee.

Biofuel policies are a significant source of uncertainty. Changes in blending mandates, enforcement mechanisms, tax exemptions and subsidies for biofuels and fossil fuels could alter demand for biofuel and feedstock crops. Policies and technologies emerging in the transport sector will also influence biofuel demand. Over the last decade, a variety of policies to support electric vehicles and charging infrastructure have been introduced in major markets (i.e. China, Europe and the United States), and helped to stimulate strong growth in electric car sales (IEA, 2021[13]).[7] Faster deployment of electric vehicles than assumed in this *Outlook* could affect biofuel demand. Increasing production and use of sustainable aviation fuel (SAF), on the other hand, could underpin demand for biofuels and feedstock crops over the next decade and beyond. Several European countries and the United States have already introduced policies supporting SAF as a mean of reducing CO_2 emissions from the aviation sector (see Chapter 9 on biofuels).

1.3. Production

1.3.1. Introduction

The projections in the *Outlook* cover the crops and livestock products listed in Section 1.3. The *Outlook* explains the impact of future trends in yield, land use intensity, and agricultural land use on crop production and links changes in herd size and output per animal to livestock production trends.

The projections are based on the assumption that the measures on social distancing to contain the COVID-19 pandemic will have mostly ended by the beginning of 2022 and will not affect agricultural production as from 2022. Furthermore, the *Outlook* projections account for reduced production prospects in Ukraine in the marketing year 2022/23.

1.3.2. Low and middle-income countries drive global production growth

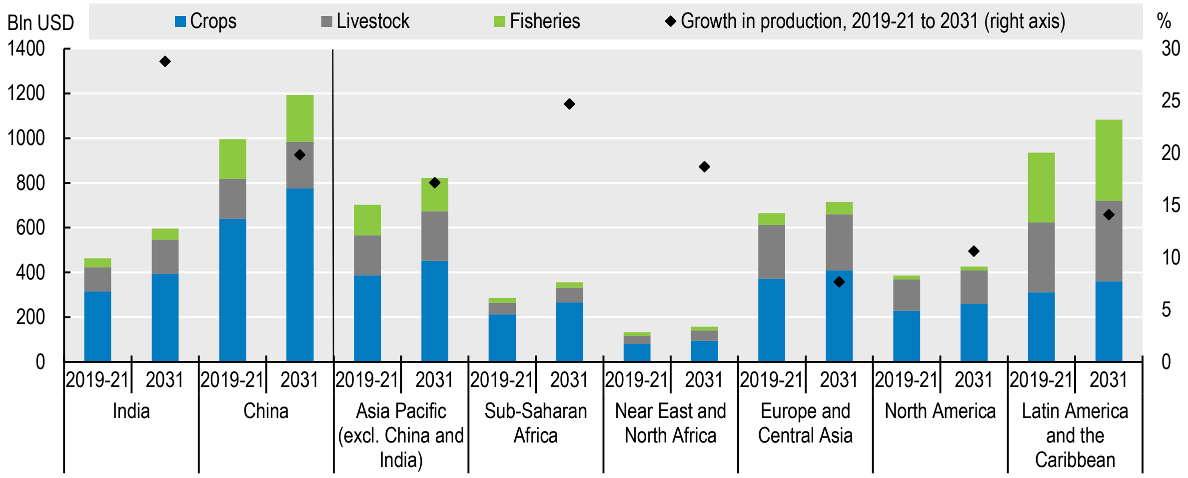
Over the coming decade, global agricultural production[8] (measured in constant prices) is projected to increase by 17%. That growth will be predominantly located in middle- and low-income countries including

India, China and other Asian countries (Figure 1.15). It will be driven by productivity-increasing investments in agricultural infrastructure and research and development; the mobilisation of production resources (e.g. agricultural land and irrigation water); more intense use of agricultural inputs; and improved management skills.

Production in Sub-Saharan Africa is expected to grow significantly, although from a low base. It will be underpinned by a combination of area expansion, changing crop mix, and productivity gains from investments in locally adapted, improved crop varieties, better management practices, and expansion and intensification of poultry flocks. The strong production growth in Near East and North Africa is expected to be driven by higher crop intensity, substantial crop yield gains and growth in poultry meat production.

Production growth in North America and in Western Europe is expected to be limited, largely due to tighter regulations related to environmental sustainability and animal welfare.

Figure 1.15. Trends in global agricultural production



Note: Estimates are based on historical time series from the FAOSTAT Value of Agricultural Production domain which are extended with the *Outlook* database. Remaining products are trend-extended. The Net Value of Production uses own estimates for internal seed and feed use. Values are measured at constant USD of the period 2014-2016.
Source: FAO (2022). FAOSTAT Value of Agricultural Production Database, http://www.fao.org/faostat/en/#data/QV ; OECD/FAO (2022), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-outl-data-en.

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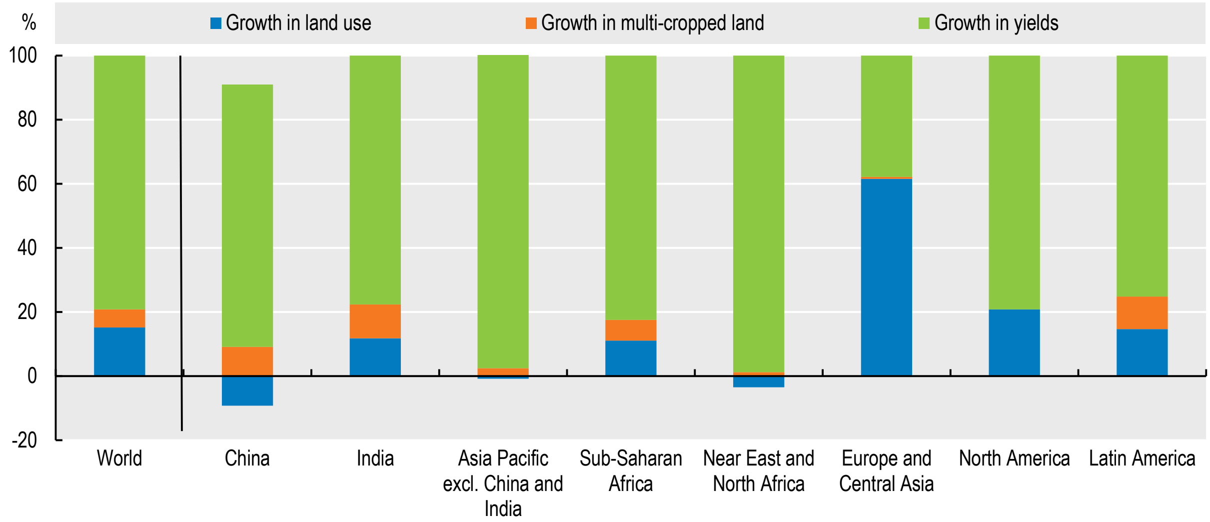
1.3.3. Crop production growth mainly due to yield increases

Global crop production is expected to grow by 18% over the coming decade,[9] mainly sourced in China (30%), India (17%) and the rest of the Asia and Pacific region (14%). Sub-Saharan Africa is expected to contribute 12% of the additional output, followed by Latin America (11%), and Europe and Central Asia combined (8%). The contribution of North America is projected to be around 7%, and the Near East and North Africa region to add only about 3% of the global growth in crop production.

The projected trends in crop production are mainly due to increasing crop yields, with some contribution from land use intensity (i.e. multi-cropping) and cropland use, as depicted in Figure 1.16.

Figure 1.16. Sources of growth in crop production, 2022 to 2031



Note: Figure shows the decomposition of total production growth (2012-21 and 2022-31) into growth in land use, land intensification through growth in multi-cropped land, and growth in yields. It covers the following crops: cotton, maize, other coarse grains, other oilseeds, pulses, rice, roots and tubers, soybean, sugarbeet, sugarcane, wheat and palm oil.
Source: OECD/FAO (2022), "OECD-FAO Agricultural Outlook OECD Agriculture statistics (database)", http://dx.doi.org/10.1787/agr-outl-data-en.

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Crop yields

Yield improvements will account for 80% of the projected production growth in the crops covered in the *Outlook* over the next decade. Growth in the Near East and North Africa, in China and in the Asia Pacific region (excluding India and China), is entirely based on yield growth, because of the foreseen decline in the harvested area of cereals, oil crops, sugar crops, pulses, cotton, and roots and tubers.

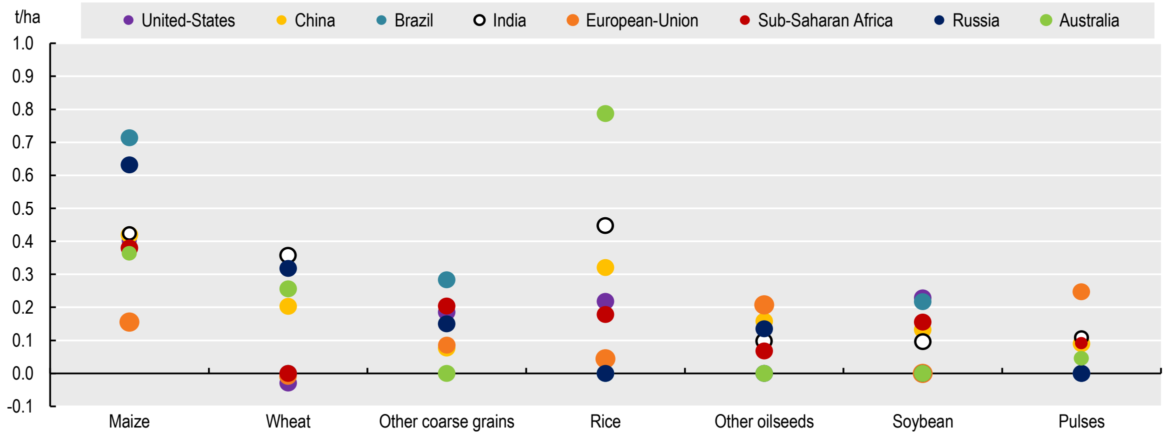
Projected yield growth rates differ between regions and countries, due to differences in production technologies and agro-climatic conditions (Figure 1.17). Notable increases in yields are expected in Brazil, in India and in China for most of the commodities covered in the *Outlook*, with yields in 2031 reaching or exceeding yields in high-income countries. Convergence, however, in yields between Sub-Saharan Africa and other regions is expected to be slow.

The *Outlook* projections are made under the assumption that yield growth in high-income countries will be based on better farm management practices as well as the adoption of precision farming technology (namely optimization in the use of agricultural inputs such as fertiliser and chemicals) and improvements in cultivated varieties. Nevertheless, yield growth will be limited, as yields in these countries are already at high levels and further options are subject to stricter environmental and food safety policies.

In Sub-Saharan Africa, as well as in other low-income and lower middle-income countries, yield growth is expected to come from the use of improved crop varieties, increased use of fertiliser and pesticides, as well as better farm management due to mechanization and improved agronomic skills acquired by farmers through education and extension services.

It should be noted that all the projected yield increases are subject to the input cost trends over the coming decade. Higher than expected energy and fertiliser prices would limit input use and subsequently depress yield growth. Box 1.3 discusses the impact of increased input prices on agricultural production and food markets.

Figure 1.17. Change in projected yields for selected crops and countries, 2022 to 2031



Source: OECD/FAO (2022), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-outl-data-en.

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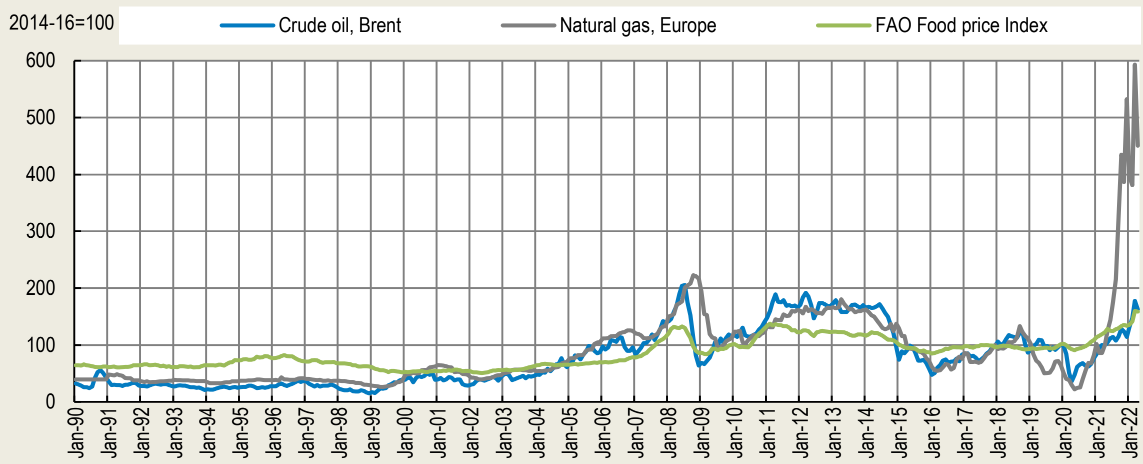
Box 1.3. Rising input prices are raising concern for global food security

The agri-food sector is energy-intensive, by using high amounts of energy directly through on-farm fuel, natural gas and electricity, or indirectly by using agrichemicals such as fertilisers, pesticides and lubricants. The recent surge in agricultural input prices is raising concerns about rising costs of food production. Rapidly increasing input prices, especially those of energy derived from fossil fuels, has put upward pressure on food prices, with negative consequences for global food security. The impacts on prices are apparent in the rising FAO Food Price Index (FFPI), which in March 2022 reached its highest level on record since 1990. This appears to be substantially underpinned by trends in input prices (Figure 1.18 and Figure 1.19).

Figures 1.18 and 1.19 suggest that the rapid rise and the current all-time high in international agricultural commodity prices are coincidental with an equally rapid rise and a multiyear high in (variable) production costs. The closely synchronized change in revenues and costs keeps overall farm profitability in check. This coincidental trend between agricultural product prices and input prices is a general feature that has characterized international markets for past decades. However, the difference between the food prices and input prices should not be construed as absolute (gross) margins as it can only capture changes in gross margins. As such, its evolution over time suggests that all other things being equal, producer gains from rising farm and food prices are swiftly offset by rapidly rising input costs. While changes in production costs generally trigger changes in output prices, a closer inspection of the two series suggests that input costs can also follow output prices. Moreover, the overall global picture is likely to mask large regional and sector-specific differences within the agri-food sector. For instance, most soybean producers are presently operating at relatively large positive gross margins, with lower need for currently expensive (nitrogen) N-fertiliser and, at the same time, enjoying high product prices. Pig producers, by contrast, face low meat prices and high feed costs, often resulting in low gross margins and even negative net margins.

Figure 1.18. Natural gas price vs. crude oil price, 2014-16=100



Source: FAO (2022), "FAO Food Price Index"; https://www.fao.org/worldfoodsituation/foodpricesindex/en/; World Bank (2022), "World Bank Commodities Price Data (The Pink Sheet)", https://www.worldbank.org/en/research/commodity-markets.

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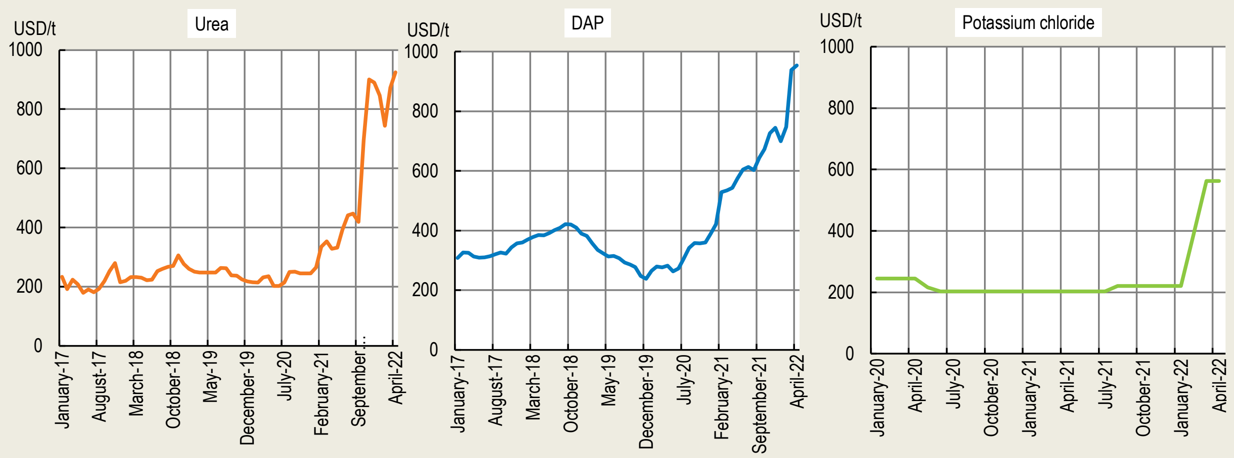
Figure 1.19. Recent trends in fertiliser prices



Note: DAP (diammonium phosphate), spot, f.o.b. US Gulf ,Urea, (Ukraine), f.o.b. Black Sea, Potassium chloride (muriate of potash), f.o.b. Vancouver.
Source: World Bank (2022), "World Bank Commodities Price Data (The Pink Sheet)", https://www.worldbank.org/en/research/commodity-markets.

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Just as many parts of the world have reopened their economies in the aftermath of the COVID-19 pandemic to stimulate economic growth, the current rise in food and fuel prices is highly regressive, compounding economic stress and negatively impacting on producers and consumers. Changes in production costs readily translate into changes in product prices, and hence food prices. For producers, it means that potentially larger profit margins are generally eroded by higher production costs. While this is to be

expected as a concept, it is remarkable to see how much this is confirmed by empirical evidence, including during the current price hikes (FAO, 2021[14]).

For consumers, it means that food prices will inevitably rise with higher production costs, and to do so rapidly. This is also the case in the current period of price rises, particularly impacting on those consumers who already spend high shares of their household budgets on food and fuel. For policymakers, it means that rising costs for agricultural inputs, notably energy, will inevitably translate into higher food prices, unless new models of production can be found to make agriculture less energy-intensive and, importantly, less energy-dependent on fossil fuels.

Source: FAO (2021[14]).

Land use intensity

Globally, the more intense use of arable land, through multiple harvests per year, would account for only 6% of the expected crop production growth (Figure 1.16). The increase in cropping intensity will be facilitated by innovative crop rotations, more widespread adoption of short season varieties, and no-till farming techniques.

In Latin America, the increase in cropping intensity over the next decade is expected to be based on expanded double cropping of soybeans with maize or wheat. In Asian countries, it will be due to the expansion of double cropping of paddy rice with other cereals, pulses, and vegetables as a second crop. In Sub-Saharan Africa, expanding irrigation will extend the growing season to allow for multiple crops, as well as the adoption of mixed cropping practices (for example, maize and cassava or millet and pulses). In North America, Europe and Northern Asia, the potential to further increase land use intensity will remain limited due to weather conditions.

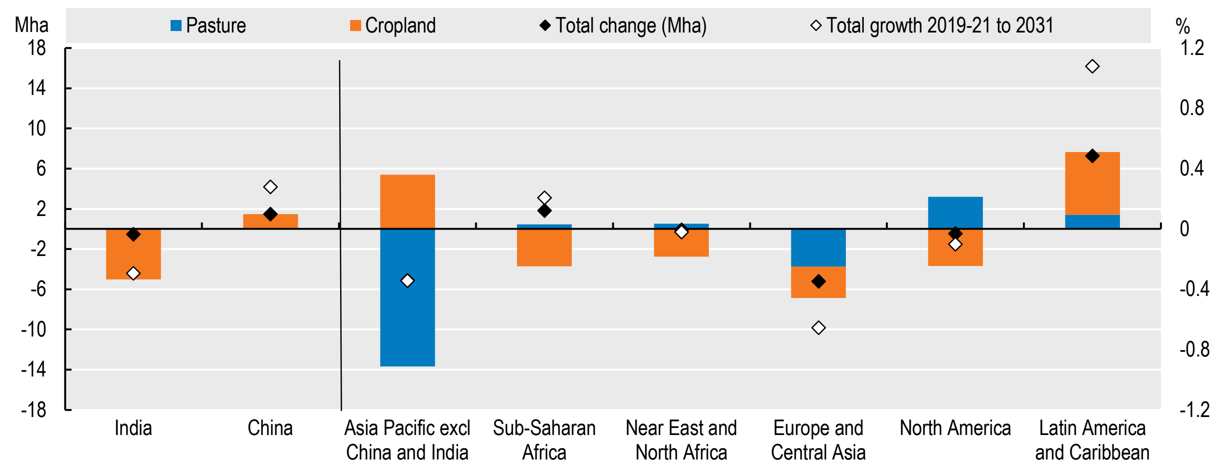
Land use

The expansion of cropland is projected to account for 15% of the projected crop production growth. Figure 1.20 shows the changes in total crop land over the coming decade. Cropland is expected to expand mainly in Asian countries (by 9 Mha), apart from China and India, and in Latin America (6.2 Mha). In Asia and the Pacific, pasture is expected to be converted into cropland, whereas in Latin America and in Sub-Saharan Africa, mainly non-agricultural land will be brought into use.

In the Near East and North Africa, the expansion of cropland will be constrained by natural conditions. Low rainfall is a barrier to rain fed agriculture and the cost of irrigation is prohibitive in most places. In North America and Western Europe, cropland is projected to decrease, since any increase in crop production is tightly regulated by policies on environmental sustainability, and as land use for fruits, vegetables and other crops that are not covered in the *Outlook* is expected to decline.

Pastureland is expected to decrease in Asia and Pacific, excluding China and India, by 14 Mha, due to the expected transition from pasture-based beef, sheep, and goat production to more intensive production systems for pigs and poultry. The ruminant production is also assumed to shift to more feed-intensive production systems, which require less pastureland. Pasture land is projected to increase slightly in North America, due to the projected expansion of the cattle herd.

Figure 1.20. Change in agricultural land use 2019-21 to 2031



Source: OECD/FAO (2022), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-outl-data-en.

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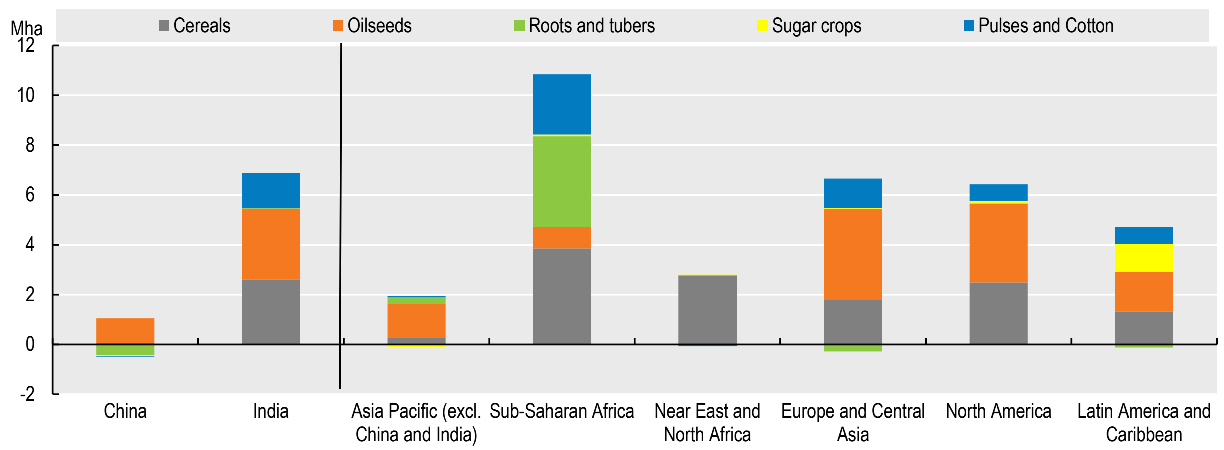
Most of the expansion of cropland will involve the cultivation of cereals and oilseeds, as shown in Figure 1.21.

Figure 1.21. Change in cropland use, main crops, 2019-21 to 2031



Source: OECD/FAO (2022), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-outl-data-en.

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1.3.4. Livestock and fish production concentrated in a few countries

Global livestock and fish production is expected to expand by 16% over the next decade, with most of this growth (85%) originating in middle- and low-income countries (Figure 1.22). However, a few countries or regions will continue to dominate global livestock and fish production, producing almost 60% of the global

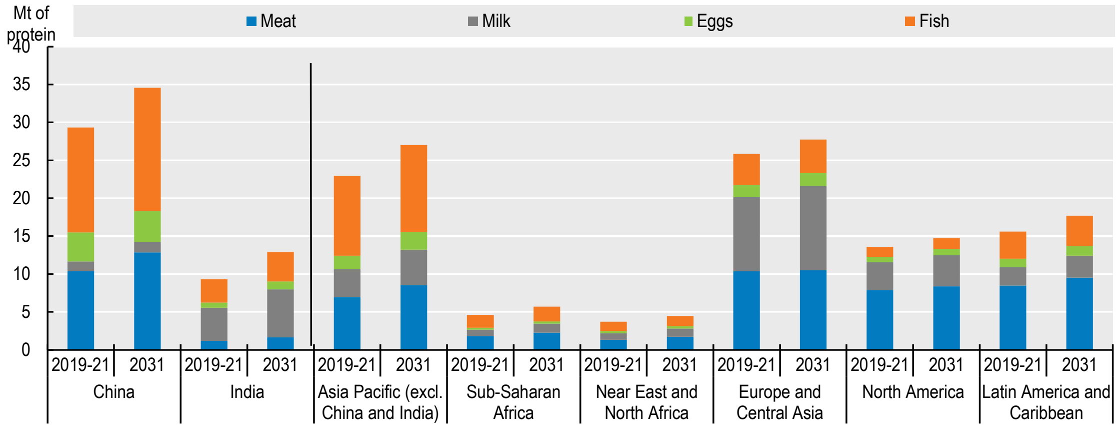
animal output, namely China, India, Brazil, the United States, and the European Union. Their share in global livestock and fish is expected to remain unchanged over the next decade.

China is projected to expand its livestock and fish production by 17% and India by 37%, respectively, together accounting for about half of global growth. In China, the expansion will be underpinned by the recovery from the African Swine Fever (ASF) and in India by the strong growth in dairy production.

In Latin America, livestock and fish output is projected to increase by 12%, which accounts for 11% of global output growth, mainly arising from Brazil's export-oriented livestock sector.

Livestock and fish production in Sub-Saharan Africa is expected to increase by 24%, albeit from a low base, in particular from growth in poultry and milk. The global output share of Sub-Saharan Africa will remain at 4% by 2031. In the Near East and North Africa, livestock and fish production is expected to increase by 20%, due to fast growth in poultry meat, but as this is from a low base, the region will only account for about 3% of global animal output by 2031 (Figure 1.22).

Figure 1.22. Global livestock and fish production on a protein basis



Source: OECD/FAO (2022), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-outl-data-en.

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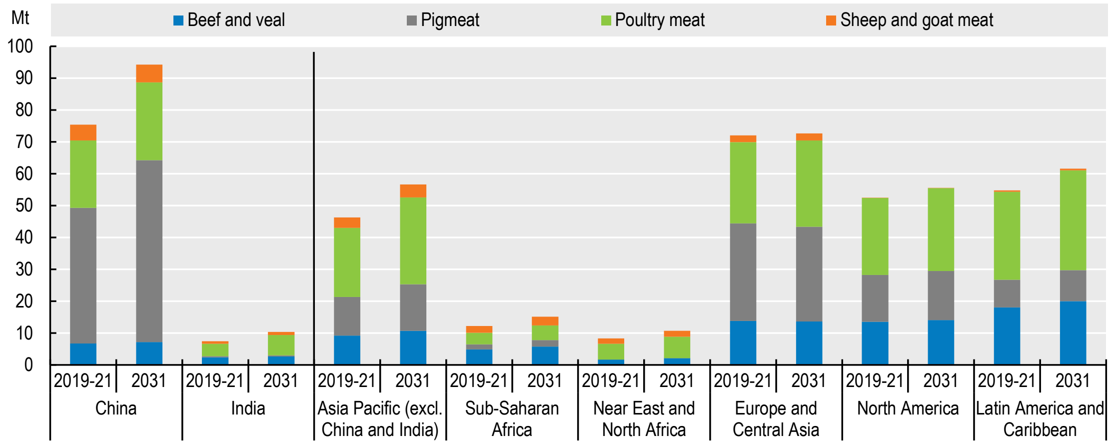
1.3.5. Poultry to account for more than half of the global growth in meat production

Over the coming decade, global meat production is expected to increase by 15%, due to an increase in the number of animals and improved productivity per animal. Higher fertility rates and a faster, more efficient weight gain are assumed to be achieved through more intense feeding, improved genetics, and better herd management.

Poultry meat is projected to increase by 16% (21 Mt) over the next ten years, accounting for 45% of global growth in meat production, given expected sustained profitability as a result of growing demand and favourable meat-to-feed price ratios compared to other non-ruminants and to ruminants (Figure 1.23). The Asia and Pacific region is expected to account for about half of the global poultry meat production growth, with China contributing 15%. The United States will account for 8% of the global poultry meat production growth, due to intensification of production, whereas Brazil will account for 5%, from flock expansions and increased output per animal. In Europe, poultry meat production is expected to grow by only 4% as no expansion of the flock is foreseen, and output per animal will remain high.

Figure 1.23. Global meat production in carcass weight equivalent



Source: OECD/FAO (2022), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-outl-data-en.

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Global pork production is projected to increase by 17% (18 Mt) by 2031, relative to the ASF affected base period 2019-21 (Figure 1.23). Pork will account for 38% of global meat production growth. The sector is assumed to recover from ASF by 2023, so that almost all of the projected growth will come early in the next decade. Most additional pigmeat production is expected to originate in China by 2023, as well as in the Philippines and Viet Nam, where production is expected to recover from the losses of the ASF outbreak in the next two to three years. Production in the European Union is expected to decline over the next decade because tighter environmental and animal welfare regulations are expected to increase production costs, whereas public health and sustainability concerns will limit demand.

Beef production is expected to expand by 8% (6 Mt) and to contribute 12% to global meat production growth (Figure 1.23). Latin America is projected to expand production by 11%, accounting for 33% of the additional global output. North American production is expected to expand by only 4%, because of low profitability expectations due to sluggish demand, as consumers shift to white meat, which will depress investment in new production and result in modest herd expansion. In Europe, beef production is expected to decrease over the next decade (by 8%) on the account of a smaller herd size, in response to reduced export opportunities and high costs from stricter GHG emission reducing measures.

Global sheep and goat meat production is expected to increase by 16% (2 Mt) over the next decade, which accounts for only 5% of global meat production growth (Figure 1.23). Production will increase by 29% in Sub-Saharan Africa, contributing 26% to global growth, mainly achieved by herd expansion, since production is based on semi-nomadic production systems, which is non-intensive. Production in New Zealand – the world's main sheep meat exporter – will remain constant, because of ongoing competition for pastureland from the beef and dairy sectors.

1.3.6. Dairy will be the fastest growing livestock sector

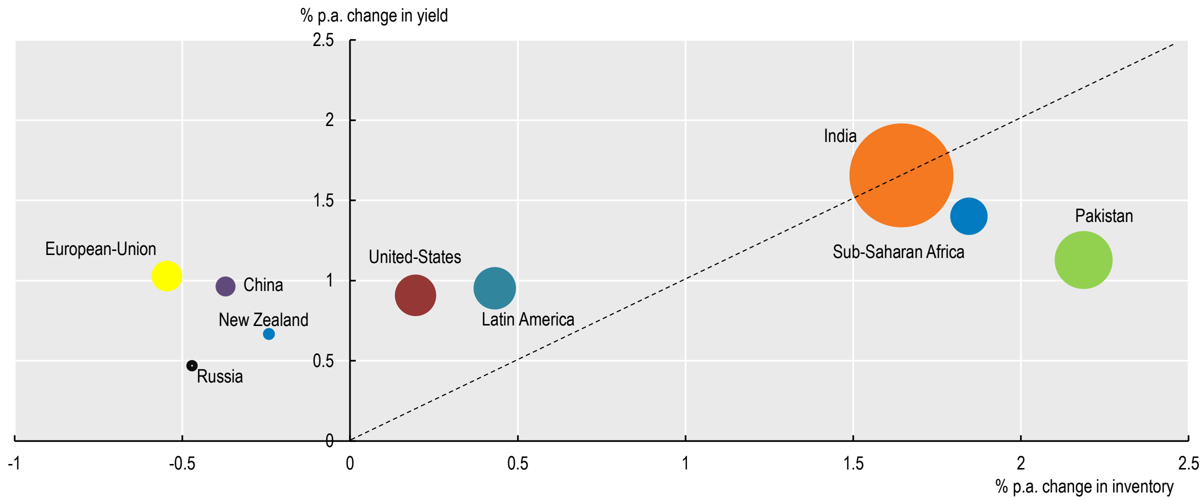
Dairy is expected to be the fastest expanding livestock sector over the next decade, with global milk supply projected to increase by 23%. The number of milk cows is projected to increase by 14%, especially in regions with low yields such as Sub-Saharan Africa, and in major milk producing countries such as India and Pakistan. Milk yields are assumed to grow steadily during the next decade, especially in Near East and North Africa, and in Southeast Asia.

About half of the growth in milk production will originate in India and in Pakistan, which together will account for 33% of the global milk output in 2031. This growth will be due to herd expansion and, to a lesser extent, higher yields (Figure 1.24). Raw milk will be only lightly processed into fresh dairy products for the fast-growing domestic market in these countries.

Growth in the European Union, the second largest milk producer globally, is expected to remain limited, constrained by policies on sustainable production, and the lower-yielding expansion of organic and pasture-based production systems. Herds are expected to decline, limiting growth to 5% by 2031. Growth in the United States, the third largest milk producer, is expected to be stronger than in the European Union, as a result of yield increases. Milk production growth rates in New Zealand, a key dairy exporter, are expected to be similar to the European Union, with herds expected to decline by around 5%. Yield growth in these high intensity production systems are due to optimisation of milk production management systems, improved animal health, feeding, grass management, and genetics (Figure 1.24).

Substantial milk production growth (39%) is expected in Sub-Saharan Africa, mainly through herd expansion. Production will continue to be based mainly on small ruminants and pastoralist production systems resulting in low milk yields, and thus the region will contribute only 6% to the global increase of milk production (Figure 1.24).

Figure 1.24. Changes in inventories of dairy herds and yields, 2022 to 2031



Note: The size of the bubble reflects absolute growth in dairy production between 2019-21 and 2031.
Source: OECD/FAO (2022), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-outl-data-en.

StatLink https://stat.link/wogptd

Globally, most milk is consumed in the form or fresh dairy products, fresh or fermented milk, such as yoghurt. Only a small proportion is industrially processed into butter, cheese, skim or whole milk powder.

Production of butter is expected to grow by 21% by 2031, and to mainly come from ghee production in India and in Pakistan. The European Union will maintain its dominance in global butter production, although it is expected to grow by only 4%, with its share in global butter production falling from about 20% in 2019-21 to 15% by 2031.

Global production of skimmed and whole milk powder are each projected to grow by 20% and 15%, respectively. The European Union and the United States are expected to continue to dominate the global production for skimmed milk powder. New Zealand, China, and the European Union produce the bulk of

whole milk powder. Global cheese production is projected to grow by 13% with the European Union and the United States expected to each account for about 30% of additional production by 2031.

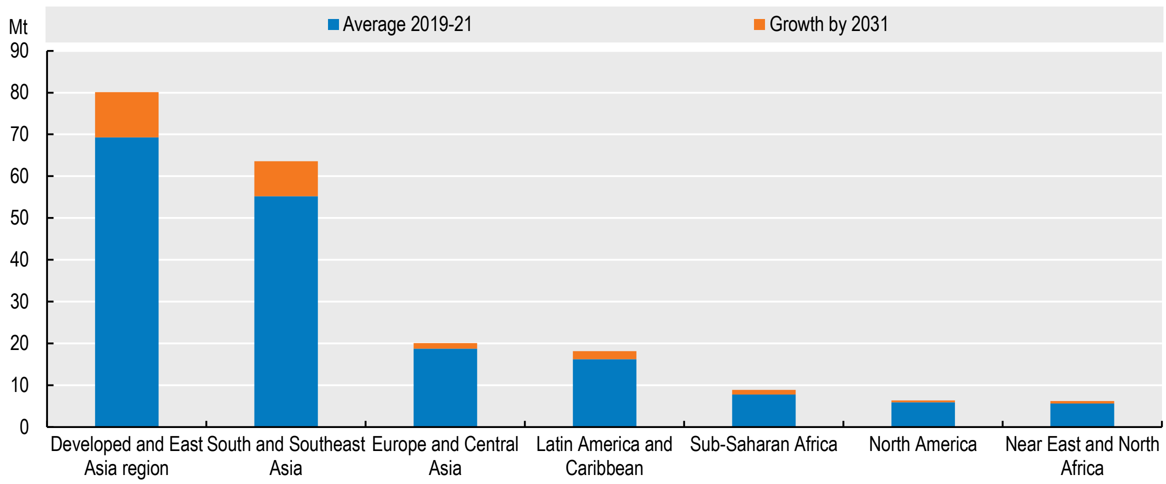
1.3.7. Higher feed prices and environmental regulations slow growth in aquaculture

World fish production is projected to grow by 14% over the next ten years, to reach 203 Mt in 2031. This rise is mainly driven by the continuing growth in aquaculture production, by 23% over the outlook period, while modest growth is expected for capture fisheries (5%).

However, growth in aquaculture production is projected to be lower than the previous decade (56%), reflecting large increases in the cost of feed at the beginning of the outlook period, and more stringent environmental regulations in China. Aquaculture is expected to overtake capture fisheries by 2023, to account for 53% of global fish production by 2031.

Fish production is projected to expand in all regions, with most of the growth occurring in Asia Pacific (Figure 1.25). The Developed and East Asia, and South and Southeast Asia regions will consolidate their position as the main global producer, accounting for 44% and 34% of additional fish produced, respectively. Within Asia Pacific, the largest contributors to output growth are expected to be China, the fish largest producer, followed by India, Indonesia, and Viet Nam.

Figure 1.25. Regional fish production



Note: The regions Developed and East Asia, and South and Southeast Asia are defined as in Chapter 2.
Source: OECD/FAO (2022), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-outl-data-en.

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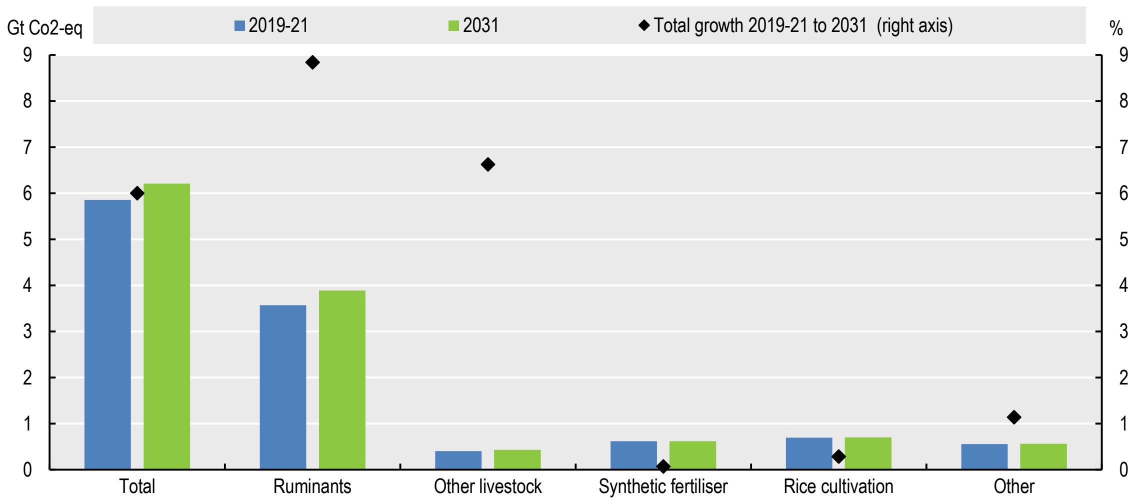
1.3.8. The carbon intensity of agricultural production is on track to decrease

Direct emissions from agriculture accounted for about 11% of global GHG emissions in 2019 (IPCC, 2022[15]). Direct agricultural GHG emissions are projected to grow by 6% over the next decade, assuming no change in current policies and on-trend technological progress (Figure 1. 26).[10] Livestock will account for 90% of this increase.

GHG emissions from agriculture are set to increase but growth will be lower than of production, suggesting a decline of the carbon intensity of agriculture over the next decade (Figure 1.27). This is expected to be the case in all regions. Yield improvements together with a declining share of ruminant production in total agricultural output will contribute to this outcome. Most of the projected increase in direct GHG emissions are expected to occur in middle- and low-income countries in Asia and the Pacific and in Sub-Saharan Africa due to the higher output growth in production systems that are emission-intensive. Sub-Saharan Africa, in particular, is expected to account for 17% of global direct GHG emissions in 2031 but only for 7% of global production. Asia and Pacific is expected to account for about 44% of direct GHG emissions from agriculture in 2031 and more than half of global crop and livestock production.

In Europe and Central Asia, on the other hand, emissions are projected to decrease by 5%, while agricultural output is expected to increase by 4%. Further reductions in the carbon intensity of agricultural production could be achieved by large-scale adoption of emission reducing technologies and agricultural practices.

Figure 1. 26. Direct GHG emission from crop and livestock production, by activity



Note: Estimates are based on historical time series from the FAOSTAT Emissions Agriculture databases which are extended with the *Outlook* database. Emission types that are not related to any *Outlook* variable (organic soil cultivation and burning Savannahs) are kept constant at their latest available value. The category "other" includes direct GHG emissions from burning crop residues, burning savannah, crop residues, and cultivation of organic soils.
Source: FAO (2022). FAOSTAT Emissions-Agriculture Database, http://www.fao.org/faostat/en/#data/GT ; OECD/FAO (2022), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-outl-data-en.

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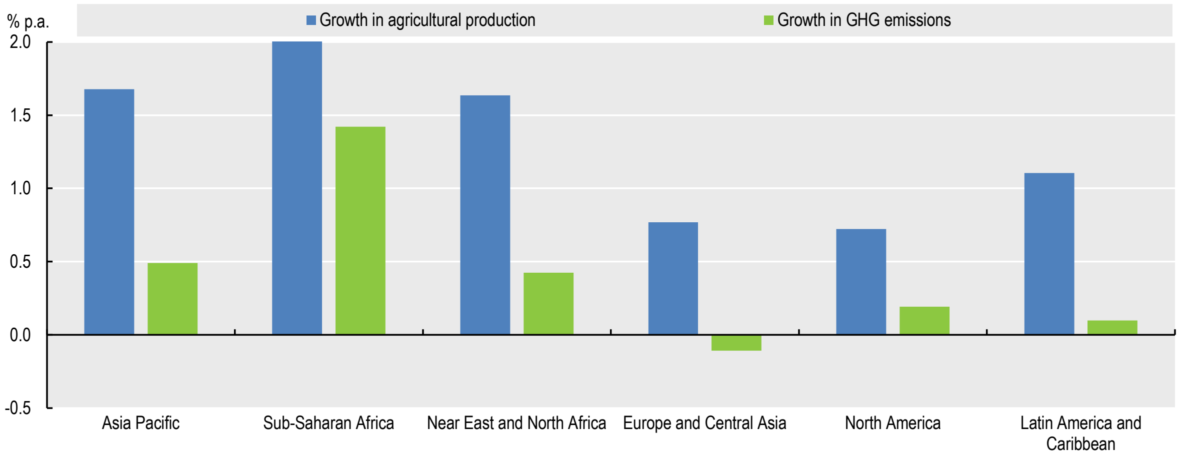
Figure 1.27. Annual change in agricultural production and direct GHG emissions, 2022 to 2031



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. Emission types that are not related to any *Outlook* variable (organic soil cultivation and burning Savannahs) are kept constant at their latest available value. The category "other" includes direct GHG emissions from burning crop residues, burning savannah, crop residues, and cultivation of organic soils. The Net Value of Production uses own estimates for internal seed and feed use
Source: FAO (2022). FAOSTAT Emissions-Agriculture Database, http://www.fao.org/faostat/en/#data/GT; OECD/FAO (2022), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-outl-data-en.

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1.3.9. Weather variability, crop and livestock diseases likely to be main sources of uncertainty in the medium term

The most significant short-term uncertainties relate to the impact of Russia‘s war against Ukraine on agricultural production in Ukraine as well as on fertiliser markets. Expectations for production could be lower than published in the *Outlook*, depending on the duration and severity of the crisis. Given the importance of both countries for cereals, oilseeds and fertilisers globally, lower production levels could affect global availability (Box 1.1).

The direct and indirect impact of the COVID-19 pandemic on agricultural production also remain uncertain. The projections are based on the assumption that the measures on social distancing to contain the COVID-19 pandemic will not affect the *Outlook*, as they will not be extended beyond 2021. However, it remains unclear if measures to contain the spread of COVID-19 will have to be reinstated locally, which may limit the availability of agricultural labour and other inputs.

The production of agricultural commodities remains vulnerable to plant and animal diseases. The recent ASF outbreak lead to significant losses in pork production in East Asia and a desert locust infestation caused significant production losses in East Africa in 2020. The *Outlook* does not assume a recurrence of these or similar events, but the success of measures to combat diseases and pests remains a concern.

Weather events have a significant impact on agriculture, which are the foremost source of uncertainty in crop production. The projections assume that weather conditions will not disrupt or favour production in any given location or year. But actual weather patterns do deviate from this assumption leading to yield fluctuations. Although climate change may shift established weather patterns, thus causing higher variability, the *Outlook* projections are made under the assumption that this will be mitigated by adaptive

measures. However, as these variability effects cannot be reliably quantified, no specific quantitative assumptions can be made.

Productivity developments are based on the assumption that technological progress and structural change are going to follow established trends and patterns over the coming decade. However, any changes, for example, in government regulations, public spending or private investments in agriculture affecting the pace of these trends, would impact on agricultural productivity and overall output of the sector. Section 1.7 presents the results of a simulation scenario, which assesses the level of productivity growth required to achieve SDG2 on Zero Hunger as well as a considerable reduction in agricultural GHG emissions by 2030.

1.4. Trade

International agricultural trade plays a critical role in improving the efficiency of food systems by enabling the flow of products from countries that are relatively well-endowed in natural and other resources to processors and consumers in less well-endowed countries. Agricultural trade is therefore essential to ensure food security in some regions, and an important source of income in others.

Over the coming decade, some countries are projected to experience large population and/or income-driven increases in food demand but without sufficient resources to supply that demand. Moreover, socio-cultural and lifestyle-driven changes are transforming consumption patterns in most regions.

Divergent productivity growth, climate change, and the prevalence of crop and animal diseases will affect production. Trade will help smooth food supply fluctuations and share production risks across countries, acting as a buffer in case of shocks to domestic or international markets.

In this context, a well-functioning, transparent and predictable international trading system will be essential to mitigate emerging regional imbalances and support sustainable global development, particularly to achieve SDG2 on Zero Hunger.

1.4.1. Growth in agriculture and fish trade is slowing

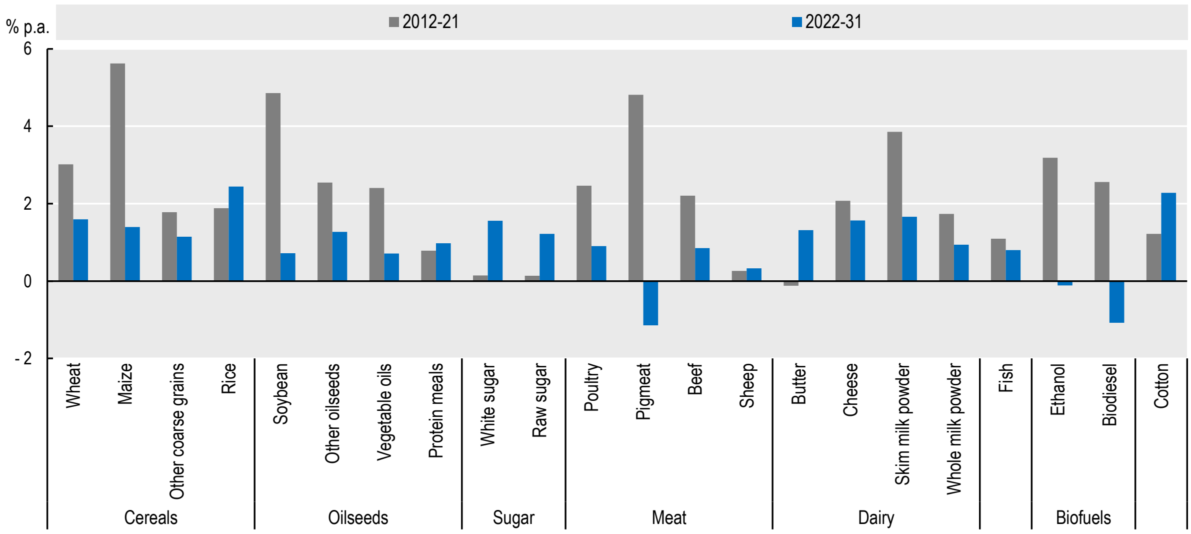
Agricultural trade is projected to continue expanding over the next decade, but in line with slower growth in demand and production, it will grow at a significantly slower pace than the last ten years.

Trade had grown rapidly since the early 2000s, facilitated by a lowering of agro-food tariffs, some reform to trade-distorting producer support in the wake of the Uruguay Round, and the signing of multiple trade agreements. Agricultural trade has also been supported by strong economic growth in China and other middle-income countries, and by the rapid growth of the biofuel sector. This strong growth in import demand for agricultural commodities was largely met by additional export supplies from Latin America, North America, and Eastern Europe.

The expected slowdown in growth in agricultural trade is due to slower growth in import demand from China and other middle-income countries, and limited growth in global import demand for biofuels given declining fuel use and weaker policy incentives in some regions. Moreover, the *Outlook* projections are made under the assumption of a diminishing impact of previous trade liberalisation that boosted agricultural trade, as efforts to reduce multilateral tariffs and reforms to trade-distorting producer support have largely stalled.

Figure 1.28 shows the average annual growth in trade volumes for commodities covered in the *Outlook*. For some commodities, including soybean, maize, and pigmeat, trade volumes grew strongly over the last decade, at about 5% p.a. Over the next decade, the highest projected growth rate is 2.5% p.a. (for rice), while several commodities will register trade growth below 1% p.a. (e.g. soybean, vegetable oil, sheep meat, poultry meat, fish, WMP) or a decline in trade volumes (e.g. biofuels, pigmeat).

Figure 1.28. Growth in trade volumes, by commodity



Note: Annual growth rate of trade volumes as calculated from 2014-16 reference prices.
Source: OECD/FAO (2022), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-outl-data-en.

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Over the next decade, the growth in the global rice trade will be supported by production surpluses in India, as output is expected to grow at a higher rate than domestic demand. India's rice surplus will be mainly directed to Sub-Saharan Africa, where rice imports are projected to increase by 5% p.a. Trade in cotton is also expected to expand faster than over the last decade reflecting the growing demand for raw cotton by the textile industry, which is mostly located in countries with limited production potential (e.g. Bangladesh, Viet Nam). High import demand for raw cotton will be largely met by growing exports from the United States, Brazil, and Sub-Saharan Africa.

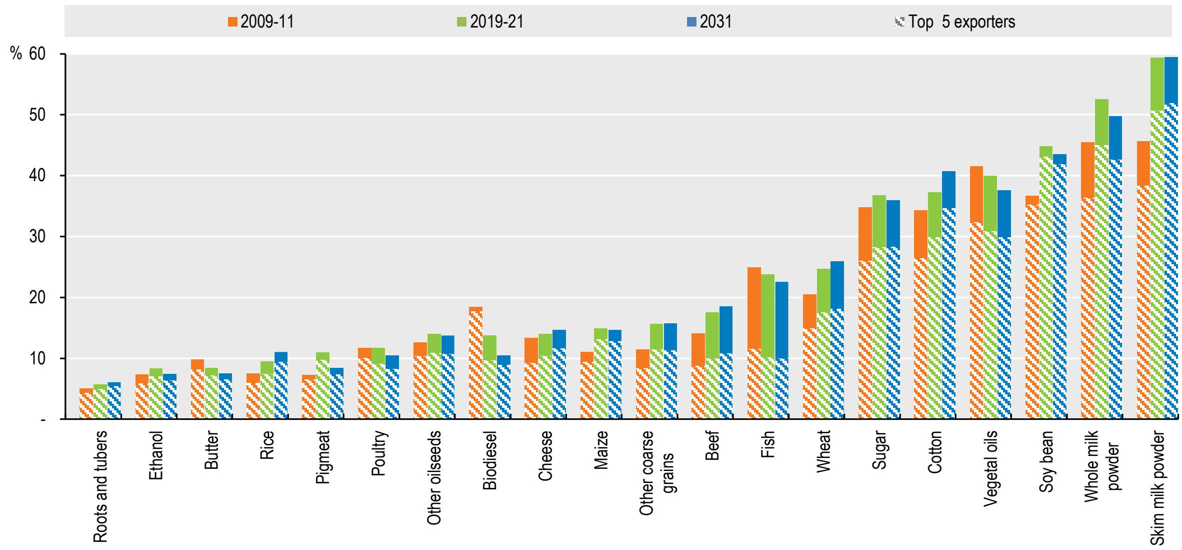
1.4.2. Trade share of production is stabilising

The share of production traded for the commodities covered in the *Outlook* has been gradually increasing over time, rising from an average of 15% in 2000, to 23% in 2019-21, and reflects a trade sector that has been growing at a faster pace than agricultural production. Assuming a diminishing impact of previous trade liberalisation that boosted global agricultural trade and no major changes in policies, the trade share of production is projected to stabilise over the next decade, with growth in trade and production being more closely aligned.

However, there are major differences in the importance of trade by commodity (Figure 1.29). For many commodities, most production is used domestically. Only for some does trade represent at least one-third of global production. This is the case for cotton, sugar, soybean, vegetable oils and milk powders, which are imported for further processing.

Over the coming decade, the share of production that is traded will not change significantly for the commodities covered in the *Outlook*, as no major shifts in trading patterns are expected. The trade share of some commodities is projected to decline marginally, reflecting weakness in import demand, or increasing domestic use or, in the case of biodiesel, both tendencies. On the other hand, for cotton, wheat and rice, trade is expected to expand at a higher pace than global output, resulting in an increase in the share of their production that is traded (Section 1.5.1).

Figure 1.29. Share of production traded, by commodity



Note: The solid bar in the graph is computed as global exports over global production (in volume). The hatched bar is computed as exports of the top five exporters over global exports (in volume).
Source: OECD/FAO (2022), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-outl-data-en.

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1.4.3. Agricultural exports remain concentrated among a few players

For commodities covered in the *Outlook*, the five largest exporting countries generally account for 70% or more of global export volume, a trend that is expected to continue over the next decade. For soybean this share exceeded 95% in 2019-21. Even for commodities with relatively less concentrated exports, such as fish and beef, the five leading exporters accounted for 43% and 57% of global exports in 2019-21, respectively. The export share of the top five exporters is shown in Figure 1.29.

For several commodities, export concentration is expected to increase over the coming decade. The five-country export concentration ratio of rice is projected to rise from 78% in 2019-21 to 85% in 2031, mainly due to strong export growth in India and Thailand. The export share of the top five biodiesel exporters is also projected to increase, from 70% in 2019-21 to 85% in 2031, due to growing exports of biodiesel from recycled cooking oil from Singapore and soybean-oil based biodiesel from the United States. The export share of China's biodiesel, on the other hand, is expected to drop due to limited growth in its production from recycled cooking oil.

Dairy exports are also expected to become more concentrated, with growing dominance from key suppliers in high-income countries. For cheese and butter, the export share of the top five exporters is projected to rise from 74% to 79%, and from 85% to 87%, respectively, mainly driven by strong export growth in the European Union. The five-country export concentration ratio of SMP is also projected to increase, mainly due to strong growth in exports from the United States. The latter is projected to account for 35% of global SMP exports in 2031, up from 32% in 2019-21. The five-country export concentration ratio of WMP is projected to stabilise at 86%.

Cereal exports (excluding rice), on the other hand, are projected to become less concentrated. The export share of the top five wheat exporters is projected to drop from 71% in 2019-21 to 69% in 2031, mainly due to lower exports from the European Union, as its domestic production is not expected expand over the next decade. The five-country export concentration ratio of maize is projected to drop by one percentage

point, due to the United States exports staying below their peak of 2019-21. The maize export share of Ukraine is also projected to be lower in 2031 than in the base period, while Russia's wheat and maize export shares will continue increasing, although at a slower pace than in the last decade.

This high concentration creates a risk of significant impacts on global markets if exports are interrupted due to adverse production shocks (e.g. poor harvests), policy changes in the major exporting countries or armed conflict, as discussed in Section 1.5.6. Such interruptions could affect prices and availability of agricultural commodities, with serious implications for global food security. Such risks are large for highly traded commodities (Figure 1.29).

Compared to exports, agricultural imports are more dispersed with agricultural trade typically flowing from a small number of exporters to a large(r) number of importers. For most commodities covered in the *Outlook*, the top five importers account for less than 60% of global import volume.

1.4.4. Increasing differentiation between net exporting and net importing regions

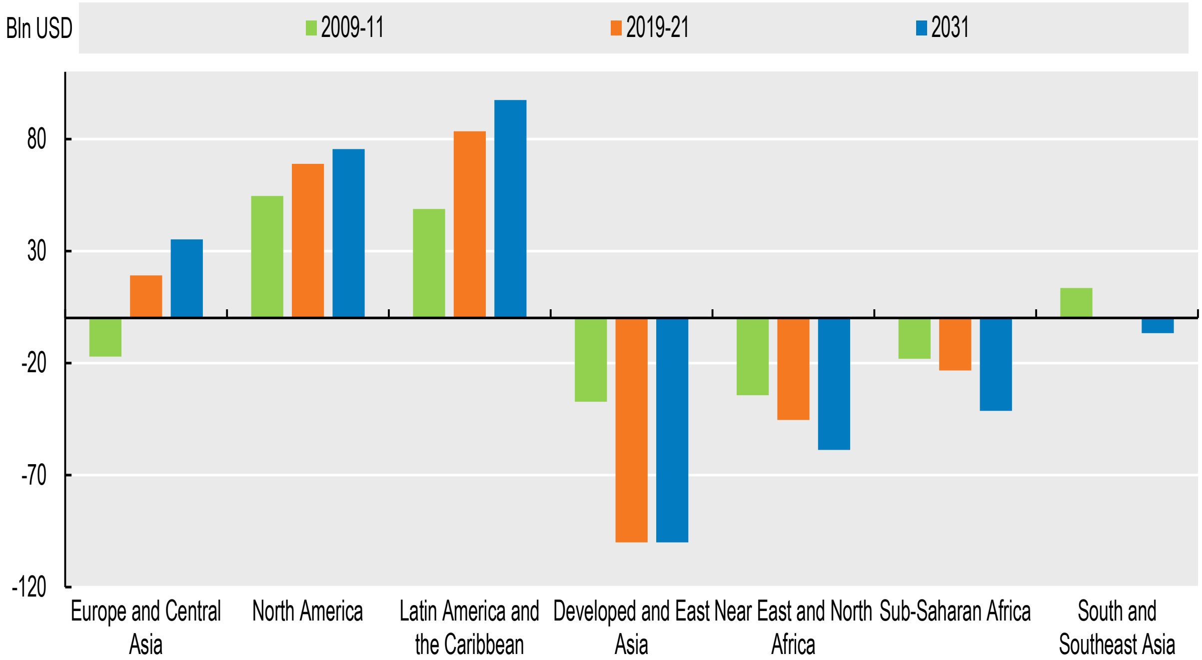
Agricultural trade is projected to continue growing over the next decade (Section 1.5.1). A large share of this increase will occur within regions, supported by regional trade agreements, which will enhance regional integration. However, inter-regional trade is also expected to expand, with increasing differentiation between net exporting and net importing regions. Established net exporters of agricultural commodities are expected to see larger trade surpluses while net imports could increase in regions with significant population growth or natural resources constraints (Figure 1.30).

Traditional exporters increase trade surpluses

Latin America and the Caribbean is expected to reinforce its position as the world's prime exporter of agricultural commodities. Exports from the region are projected to continue increasing at a higher rate than imports, facilitated by growing production of maize, soybean, sugar, poultry, and beef. As a result, net exports are projected to increase by 17% between 2019-21 and 2031. Net exports from North America, the second leading exporter of agricultural commodities to world markets, are expected to expand at a slower pace (by 10% between 2019-21 and 2031), due to lower growth in output. Maize and soybean exports from North America, which have been growing strongly over the last decade, are expected to stagnate over the next ten years.

Europe and Central Asia moved over time from being net importers of agricultural commodities to net exporters in 2014. This is mainly due to strong productivity and production growth in Ukraine and Russia which, in the span of a few years, have become competitive exporters of wheat and maize. Limited domestic demand, due to stagnating population and flat per capita consumption for several commodities, were also contributory factors. Over the coming decade, net exports from Europe and Central Asia are projected to almost double, largely due to higher exports from Russia and Ukraine. However, the war could result in lower than projected growth in their production and exports, as discussed in Section 1.5.6.

Figure 1.30. Net trade by region, in constant value



Note: Net trade (exports minus imports) of commodities covered in the *Agricultural Outlook*, measured in constant 2014-16 USD. Net trade figures include intra-regional trade but exclude intra-EU trade. The regions Developed and East Asia, and South and Southeast Asia are defined as in Chapter 2.
Source: OECD/FAO (2022), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-outl-data-en.

StatLink https://stat.link/mwgyhk

Rising import demand among countries with rapid population growth and/or natural resource constraints

Net imports by the largest net importing region, Developed and East Asia, are projected to stabilise over the coming decade. China is the region's main importer. China's imports of agricultural commodities (as measured in constant 2014-16 USD) more than doubled over the last ten years, peaking in 2020 as an ASF outbreak caused a surge in imports, while exports have been broadly stable. Over the next decade, China's imports and exports are projected to broadly grow in tandem, due to slow population growth, near saturation in food consumption for some commodities, and growth in domestic production. Australia and New Zealand are traditional net exporters of agricultural commodities from the Developed and East Asia region but their net exports are expected to grow slowly over the next ten years, due to reduced production growth.

The South and Southeast Asia region is a significant trader but its net trade is low as imports and exports in and from the region are almost balanced. In the coming decade, imports are projected to grow at a higher rate than exports due to strong demand growth. Net importers such as Pakistan, Iran and Asian least developed countries are expected to increase their net imports mainly due to population growth. In Southeast Asia, a traditional net exporter of agricultural commodities, growth in imports (mainly of cereals and meat) is also expected to outpace growth in exports (rice, palm oil), due to strong growth in domestic demand, stemming from population and income growth. In India, on the other hand, domestic production is expected to keep pace with growing population and incomes, with little change in its overall net trade

position. For instance, India's strong growth in both consumption and production of dairy products is expected to have little effect on global trade (see Chapter 7 on dairy).

Sub-Saharan Africa and Near East and North Africa are large importers of agricultural commodities, in particular cereals, which contribute to food security both directly and through their use as animal feed. In Sub-Saharan Africa, intra-regional trade is expected to increase over the next decade, supported by the implementation of the African Continental Free Trade Agreement. However, imports into the region (mainly of cereals and soybean) are projected to grow more strongly than exports to the rest of the world, as population growth is expected to outpace output growth, resulting in an increase in net imports (+77% by 2031). While Sub-Saharan Africa is a large net importer of commodities covered in the *Outlook*, it is a net exporter of cocoa, coffee, tea, fruits, and vegetables.

In Near East and North Africa, imports into the region are projected to keep expanding over the next decade, while exports are expected to decline. Strong growth in population and limited growth in domestic production due to natural resources constraints underpin this rising trend in net imports (+30% by 2031), deepening the region's dependence on international markets.

1.4.5. Trade plays a key role in ensuring food security and farmer livelihoods

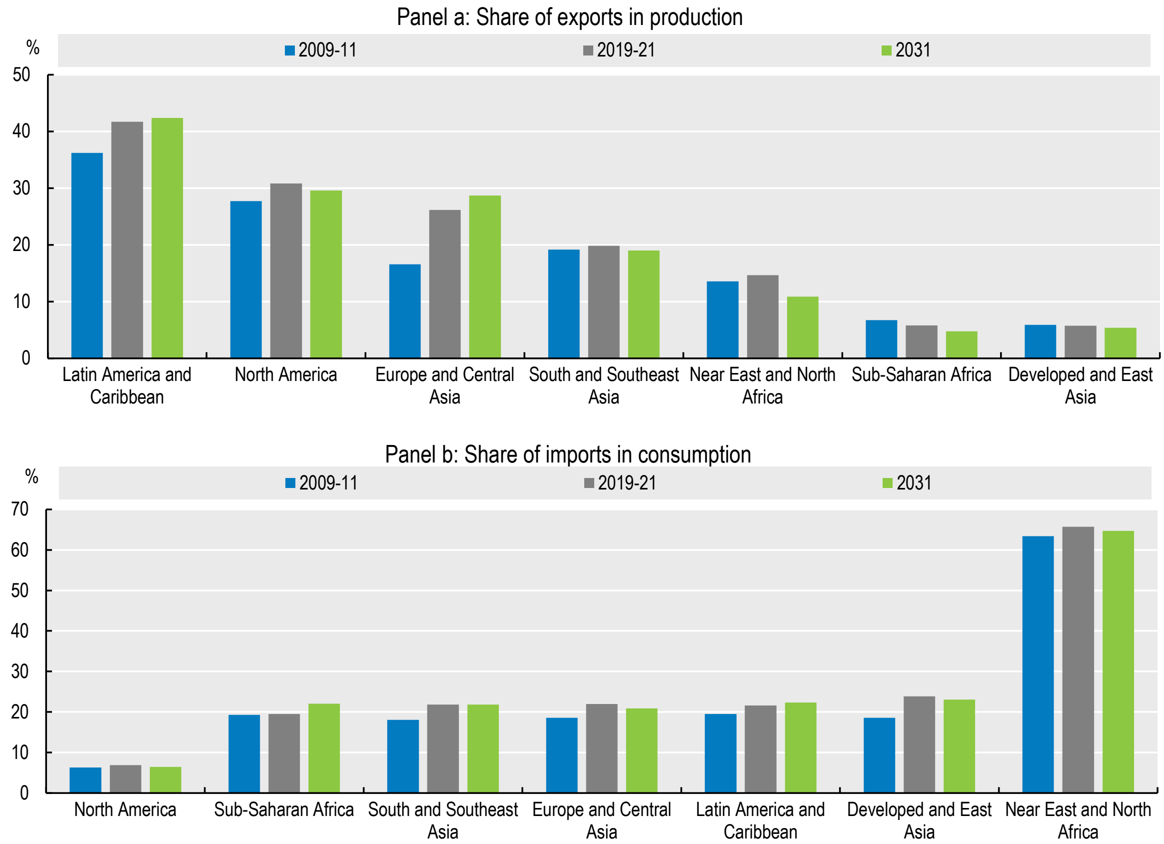
Trade can improve the availability and affordability of food offering diversity and wider choice for consumers. In particular, resource-constrained countries are highly dependent on imports of agricultural commodities. In several other countries, exports of agricultural commodities account for a large share of domestic production and are an important source of income.

Figure 1.31 shows the share of imports in total consumption, and the share of exports in total production for selected regions, measured in calorie equivalents. At the global level, these shares rose from 19% in 2009-11 to 22% in 2019-21 but are projected to remain broadly stable over the next decade. However, these averages mask important differences in the role of trade between regions and individual countries.

Large producing regions such as North America, and Latin America and the Caribbean, exported 31% and 42% of their domestic production, respectively, in 2019-21. In Latin America and the Caribbean, this share is projected to reach nearly 43% in 2031. A substantial increase in the share of exports in domestic production is also projected in Europe and Central Asia, from 26% in 2019-21 to 29% in 2031 (Figure 1.31, panel a). However, even large net exporting regions import a share of domestic consumption. In Latin America and the Caribbean, for instance, imports account for about 22% of total consumption for commodities covered in the *Outlook* (Figure 1.31, panel b). This estimate includes intra-regional trade, which is significant in the region.

In Near East and North Africa, where population is growing strongly and water resource constraints limit production response, imports play a significant role in complementing domestic food and feed production. Imports accounted for 66% of total consumption of agricultural commodities in 2019-21, a share that is expected to remain stable over the next decade. In Sub-Saharan Africa, the share of imports in total consumption is lower, at 19% in 2019-21, but is expected to reach 22% by 2031, as growth in domestic production will not keep up with rising population (Figure 1.31, panel b).

Figure 1.31. Trade as a share of total production and consumption by region, in calorie equivalents



Note: Calculations using average calorie content of commodities included in the *Outlook*. Note that exports/imports include feed and availability includes processing of commodities which may be re-exported. Exports include intra-regional trade but exclude intra-EU trade. The regions Developed and East Asia, and South and Southeast Asia are defined as in Chapter 2.
Source: OECD/FAO (2022), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-outl-data-en.

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1.4.6. International trade will be under strain in responding to the evolution of Russia's war against Ukraine

Russia's war against Ukraine is a major source of risk and uncertainty for agricultural trade, given the importance of these countries in global agricultural and input markets. In 2021, Russia and Ukraine were the 1st and 5th largest wheat exporters, together accounting for 27% of global wheat exports. The two countries also accounted for a combined share of 12.5% of global maize exports in 2021, and are large exporters of barley, rapeseed, sunflower seed and oil. Moreover, Russia ranked as the top exporter of nitrogen fertilisers in 2021, and the second leading supplier of both potassic and phosphorous fertilisers (FAO, 2022[1]) (Box 1.1).

Given this high export concentration, disruptions to production and exports from Ukraine and Russia is already having a significant impact on global markets. The *Outlook* has taken into account reduced export availability from these two countries in the marketing year 2022/23, in line with the Agricultural Market Information System (AMIS) market data. However, with a continuation or escalation of the war this would result in lower production and exports from these countries than projected in this *Outlook*, both in 2022

and in subsequent years. Some redirection in trade flows can also be expected, as other countries will try to expand their production and exports to fill the gap in global cereals and oilseeds supplies.

Rising oil prices and rerouting efforts as a result of the war could also lead to additional increase in maritime transportation costs, further adding to prices paid by consumers for imports. Transportation costs, which are an important component of trade costs, have been increasing since mid-2020, due to rising oil prices and trade disruptions linked to the COVID-19 pandemic. Although for this *Outlook* it is assumed that trade facilitation costs will return to their pre-crisis values from 2022 onwards, the evolution of trade costs remains subject to a high degree of uncertainty. For context, Box 1.4 looks at the dispersion and evolution of maritime transportation costs in the grains and oilseeds sector between 2007 and 2021, and at the importance of these costs in the final price paid by consumers.

The impacts of the COVID-19 pandemic and the war on international markets is also leading to renewed discussions about food self-sufficiency and reshoring. More localised production is perceived by some governments as a way of providing greater security against disruptions to domestic supply. Consumer concerns about environmental sustainability could also support growing preference for ''zero mile'' or ''short supply chain'' products, which can be seen as a way of reducing the environmental footprint of food transportation, obtaining seasonal and fresh products, and supporting the local economy. These trends could potentially result in slower growth in agricultural trade than projected in this *Outlook*.

Digital technologies have the potential to boost agricultural trade over the coming decade, by improving the efficiency, transparency and traceability of trading systems. The adoption of electronic certificates (e-certificates), for instance, can facilitate trade by replacing paper documentation, enabling faster border procedures, and reducing the risk of trade fraud, all which reduce costs. E-certificates can also make trade systems more accessible for businesses, including small businesses in developing countries. Empirical analysis using a gravity model shows that digital technologies such as sanitary and phytosanitary (SPS) e-certificates have positive effects on trade volumes, notably for plant-based, vegetables, and processed food products (OECD, 2021[16]). Countries have been increasingly using e-certificates within their SPS systems and the disruptions caused by the COVID-19 pandemic have accelerated their adoption.[11] E-certification systems have helped countries minimise the negative effects of social distancing measures on trade by reducing the need for personal contact and handling of paper documents. While the pandemic presents an opportunity to increase the uptake of e-certification and other digital technologies, several challenges to their adoption need to be overcome. These include improving digital and physical infrastructure, building capacity to improve digital skills, establishing clear and enabling regulatory frameworks, and promoting the interoperability and equivalence between legacy systems and new technologies.

Finally, major developments in trade policies that will be negotiated and implemented over the coming decade could have important impact on agricultural trade. The *Outlook* only includes policies and trade agreements currently in place, unchanged over the medium term. This constitutes a source of uncertainty, as policy changes occurring over the next decade will alter the projections. New trade agreements (e.g. Regional Comprehensive Economic Partnership, EU-Mercosur) could increase intra-regional and inter-regional trade. Trade restrictive policies (e.g. an import/export tax or ban) would hinder trade and have a negative impact on global food security and livelihoods not only in the short term, but also in the longer term by undermining supply capacity.

Box 1.4. Maritime transportation costs in the grains and oilseeds sector

More than 80% of global trade in grains and oilseeds is by maritime transport. A detailed analysis of maritime transportation costs, by commodity and country over time, is now possible thanks to a database on ocean freight rates developed by the International Grains Council (IGC). The dataset selected for the OECD study covers over 300 bilateral routes at the port level and captures around 70% of global trade flows of soybeans, wheat, sorghum, maize and barley.

Figure 1.32 uses boxplots to show the dispersion of freight rates by exporter for barley and HSS (heavy grains (wheat, durum), sorghum and soybeans) between 2007 and 2021. Freight rates for barley and HSS averaged at USD 33/t and USD 35/t, respectively, over this period. However, there is considerable variation around the average, even for a single exporting country, freight rates for HSS originating from Canada ranging between USD 7/t and USD 135/t, for instance (Figure 1.32). Freight rates are influenced by several factors and the empirical analysis in the study shows that distance is the most important determinant of freight rates; a 10% increase in the distance between two ports is estimated to lead to a 2.5% increase in freight rates. Thus, Russia's war against Ukraine could lead to an increase in freight rates, as importers might have to import from more distant suppliers.

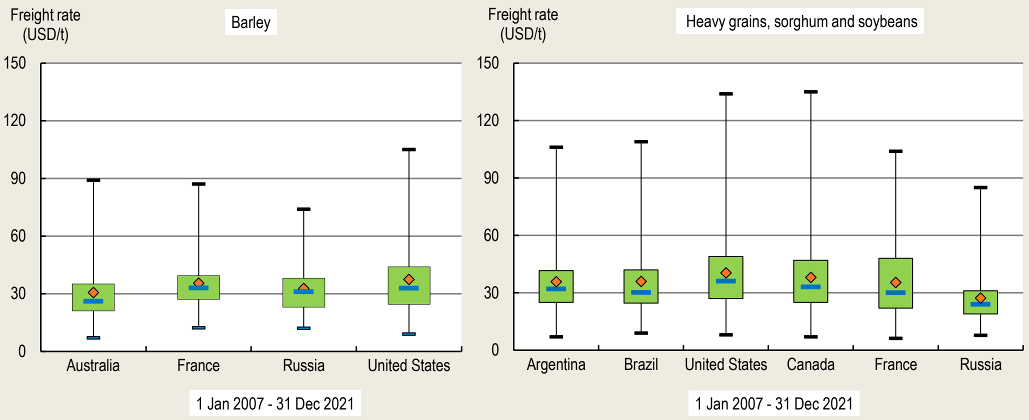
For most exporters, the maximum value for freight rates was reached during the food price crisis of 2007-08. Average freight rates for HSS and barley[1], across all trade routes, more than doubled between January 2007 and June 2008 (from USD 42/t to USD 86/t) and then plummeted to USD 20/t in January 2009. Freight rates recovered after January 2009, but never returned to their previous peaks. Freight rates for HSS and barley increased strongly in the second half of 2020, and peaked at USD 57/t, on average, in October 2021, the record value for the last decade. However, this is only two-thirds of the value reached in June 2008. Volatility in freight rates - as measured by the coefficient of variation – was also at its highest during the food price crisis. Freight rates declined after October 2021, but started increasing again from February 2022, partly due to the increase in the crude oil price. In March 2022, fuel costs were estimated to account for 30% of the total freight costs for grains and oilseeds.

To gain insights into the importance of maritime freight rates in the final price of grains and oilseeds, the share of freight rate in the cost and freight price (C&F) was computed.[2] Maritime transportation costs accounted for 11% of the C&F price during the period 2007-2021, on average. However, this average hides large variations between trade routes and commodities over time, the share ranging between 2% and 43%, demonstrating the potentially large impact of freight rates on final prices.

Figure 1.33 shows the evolution of this share by commodity between 2007 and 2021. For all commodities except barley, the share of freight rates in C&F prices peaked between mid-2007 and the end of 2008. This share then dropped between late 2008 and early 2009 for all commodities but rose again between mid-2009 and mid-2010. Between the end of 2010 and June 2021, the share of freight rate in C&F prices remained between 5% and 15% for all commodities, reaching a low point in May 2020, at 8%, on average, across all commodities. From May 2020 onwards, however, this share has once again been increasing, reaching ten-year record values in the second half of 2021.

Figure 1.33 also illustrates the differences in the share of freight rate in C&F price between commodities. This share is lower for soybean than for sorghum and wheat, for instance, because although these commodities have the same freight rate (i.e. the freight rate for HSS cargoes), soybean has a higher free on board (fob) price than sorghum and wheat.

Figure 1.32. Dispersion of freight rates by cargo and exporter over the long term (January 2007 – December 2021)



Note: These boxplots have several components. The green box indicates the range where 50% of the observations are situated; the lower bar of the box is the first quartile (Q1/25th percentile), the middle bar is the median (Q2/50th percentile), and the top bar is the third quartile (Q3/75th percentile). The triangle is the mean. The maximum (minimum) value is situated at the end of the top (bottom) whisker.
Source: Authors' calculations based on IGC (2022[17]).

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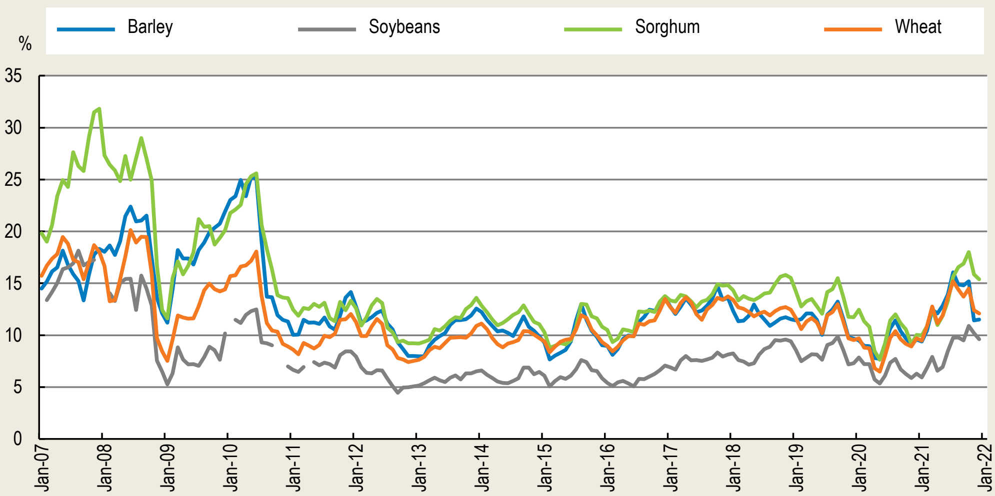
Figure 1.33. Share of freight rate in the cost and freight price, by commodity (January 2007 – December 2021)



Notes: 1. The average freight rate is a simple average calculated using the set of triplets (exporter/importer/cargo combinations) for which the IGC database has complete data series over the long term (January 2007-December 2021); it therefore only considers HSS and barley and a selected set of exporters and importers.
2. The share of freight rate in the cost and freight price is defined as the freight rate divided by the sum of the freight rate and the free on board price (for a given date and trade route).
Source: Authors' calculations based (IGC, 2022[17]).

StatLink https://stat.link/5uya1x

Source: Deuss, Maggi and Frezal (2022[18]).

1.5. Prices

1.5.1. Introduction

The *OECD-FAO Agricultural Outlook* uses prices in major commodity markets as international reference prices. These observed market prices reflect both fundamental supply and demand conditions during the base period 2019-21 as well as short-term demand or supply shocks causing temporary price movements. Shocks range from normal weather fluctuations to extreme weather events, pests and animal diseases, and natural disasters, and include the impact of economic and political events (e.g. armed conflicts, and the COVID-19 pandemic). Furthermore, as these prices are observed at trade exchanges, speculation can influence current prices, since agricultural commodities form part of investment portfolios. As the effects of these shocks are largely unpredictable and cannot be incorporated into the projections, prices in the *Outlook* are assumed to converge to a path determined by demand and supply fundamentals.

1.5.2. Agricultural price trends and the main drivers

Production expected to continue to supply demand at lower real prices

Over the coming decade, real agricultural prices (i.e. adjusted for inflation) of the commodities covered in the *Outlook* are projected to remain broadly flat or decline slightly (Figure 1.34).

Agricultural prices in real terms have been on a declining trend since the 1960s as the result of productivity improvements in agriculture and related industries, lowering the marginal production costs of food commodities. The "green revolution" during the 1960s and the emergence of new technologies during the 1990s resulted in substantial yield increases in major producing countries. Marginal production costs have been significantly reduced, resulting in a reduction in prices despite rising food demand growth induced by global population and per capita income growth. While there have been deviations from this general trend, such as the price spike in the 1970s or several price peaks during 2007-14, these have been temporary and did not alter the long-term declining trend.

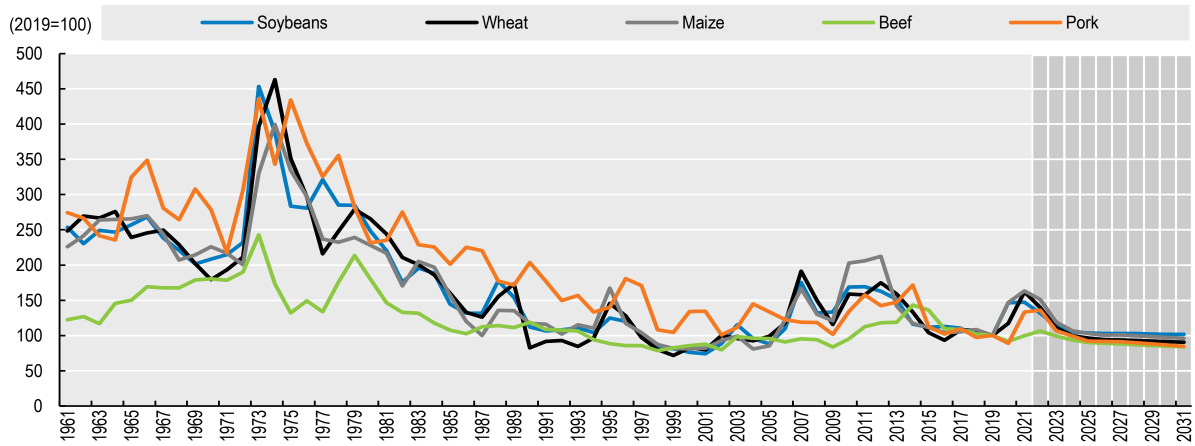
Agricultural prices in real terms increased through much of 2020 and 2021. This was due to tight global supplies and increased production costs (in particular due to COVID-19-related supply chain disruptions which raised energy prices and labour costs), poor harvests in important producing countries, and demand shifts due to the pandemic and slowdown in economic growth, as well as trade policy uncertainties, which all occurred during this period.

The *Outlook* projections are made under the assumption that the current price rally will be temporary. While prices of the commodities covered in the *Outlook* may remain high in the 2022/23 marketing year, they are expected to subsequently resume their long-term declining trend.

The agricultural price projections are thus consistent with the supply and demand fundamentals expected over the next decade. These take into account income and population growth combined with prevailing consumer trends influencing demand, and continued productivity-increasing supply. Over the *Outlook's* medium term, it is assumed that, at the global level, mobilising natural resources will continue at declining real prices, while the expansion and intensification of production capacity will not be constrained from meeting the upper limits of projected demand. Of importance, the supply and demand projections assume an efficient and sustainable global trading system.

The FAO Food Price Index (FPI) summarizes developments in the international reference prices of major traded food commodities in a single indicator (Figure 1.35).

Figure 1.34. Long-term evolution of commodity prices, in real terms



Note: Historical data for soybeans, maize and beef from World Bank, "World Commodity Price Data" (1960-1989). Historical data for pork from USDA QuickStats (1960-1989).
Source: OECD/FAO (2022), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-outl-data-en.

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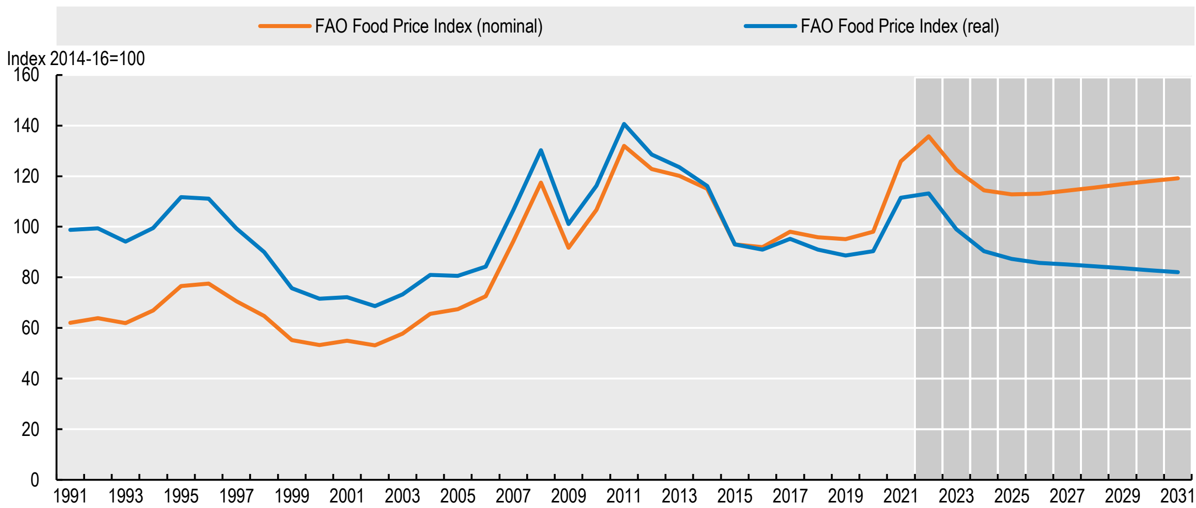
Figure 1.35. FAO Food Price Index



Note: Historical data is based on the FAO Food Price Index, which collects information on nominal agricultural commodity prices; these are projected forward using the OECD-FAO Agricultural Outlook baseline. Real values are obtained by deflating the FAO Food Price Index by the US GDP deflator (2014-16=1).
Source: OECD/FAO (2022), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-outl-data-en.

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1.5.3. Commodity price trends

Commodity prices in real terms are expected to resume long-term downward trends after current market disruptions. Prices of wheat, maize and coarse grains increased in 2021 and reached their highest levels of the last nine years. On the other hand, prices for rice were below their levels of 2020 as ample exportable

supplies intensified competition among exporters. Prices for all cereals are expected to remain high in 2022 before gradually resuming their long-term declining trend (Figure 1.36).

With cereal prices reverting to their long-term declining trend, the co-movement of wheat and maize prices; other coarse grains and maize prices; and wheat and rice prices, will maintain or return to their established ratios (Figure 1.37). However, as cereals prices revert back to their long-term declining trend at different speeds, the established price ratios will only be restored in the medium term. Market disruptions in the early years of the outlook period, such as export quotas on wheat and tight wheat and maize exports from the Black Sea region, are assumed to be temporary and will gradually cease as prices are determined by underlying supply and demand conditions.

Oilseed prices increased rapidly in 2021 due to strong import demand, especially for soybeans in China due to the rebuilding of hog herds following the ASF outbreak and limited domestic supply growth. Oilseed prices are expected to start declining already during the first years of the *Outlook*, as production is expected to start outpacing demand. Production prospects are enhanced due to the incentives of current high prices. Subsequently, they are expected to continue their long-term declining trend as the assumed real price of crude oil and economic growth following the recovery from the COVID-19 pandemic will underpin oilseed and oilseed product prices (Figure 1.36).

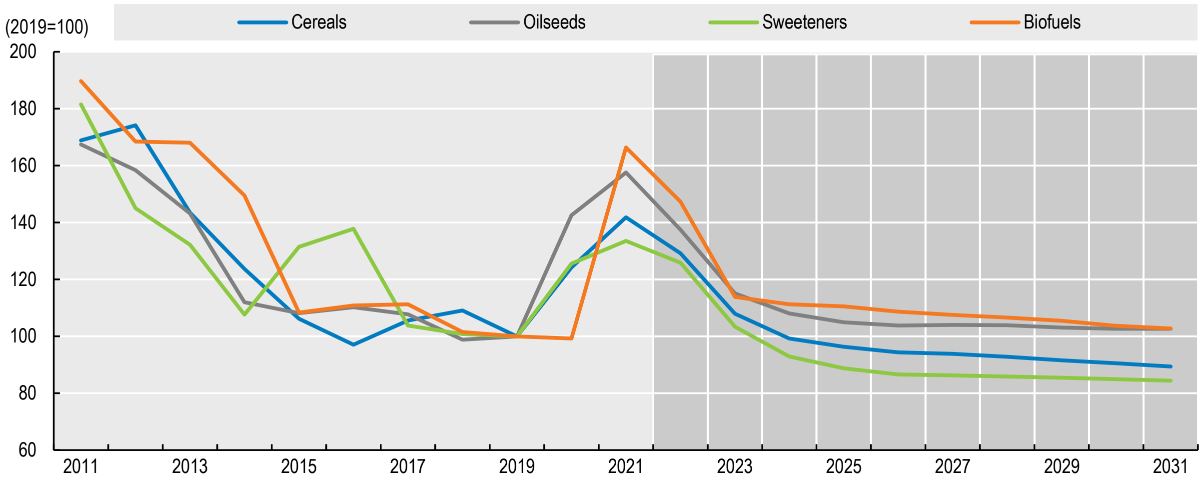
Real sugar prices also peaked in 2021, due to reduced export availabilities from Brazil combined with strong global demand. They are expected to trend downwards over the next decade as productivity gains will increase production while the growth in demand is expected to slow down (Figure 1.36).

In spite of stagnant global demand for biofuels, real prices peaked in 2021. This reflects high feedstock prices, and increasing labour and input costs. However, real feedstock prices – namely sugarcane, molasses, maize and vegetable oil – are expected to return to their long-term declining trend over the projection period, with real biofuel prices following the same path (Figure 1.36). Notwithstanding, biofuels prices will remain heavily influenced and shaped by policies, such as domestic support, consumer tax credits, and blending mandates that combine fossil fuels and biofuel consumption.

Historically high biofuel prices in 2021 reflected a delayed reaction to the increasing feedstock prices witnessed in 2020. Biodiesel was the most affected, with vegetable oil prices nearly doubling from 2019 to 2020. Owing to the 2020 increasing feedstock prices, the ratio of feedstock to biofuel prices increased significantly, although falling back in 2021. Over the projection period, these price ratios are projected to stabilise, although the ratio of "vegetable oil to biodiesel" prices will remain above the historical trend, reflecting the pressure on global markets for vegetable oil and the increasing demand for biodiesel (Figure 1.38).

In 2020 and 2021, the high biofuels to fossil fuel (crude oil) price ratio reflects high feedstock prices combined with relatively low oil prices. However, over the projection period, as feedstock prices decline, biofuel prices should re-establish their historical relation with fossil fuels (Figure 1.38). In this regard, the assumption in the *Outlook* of mandates that bind the demand for biofuels with fossil fuels, will contribute to the stability of their relative prices.

Figure 1.36. Medium-term evolution of crop-based commodity prices, in real terms



Source: OECD/FAO (2022), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-outl-data-en.

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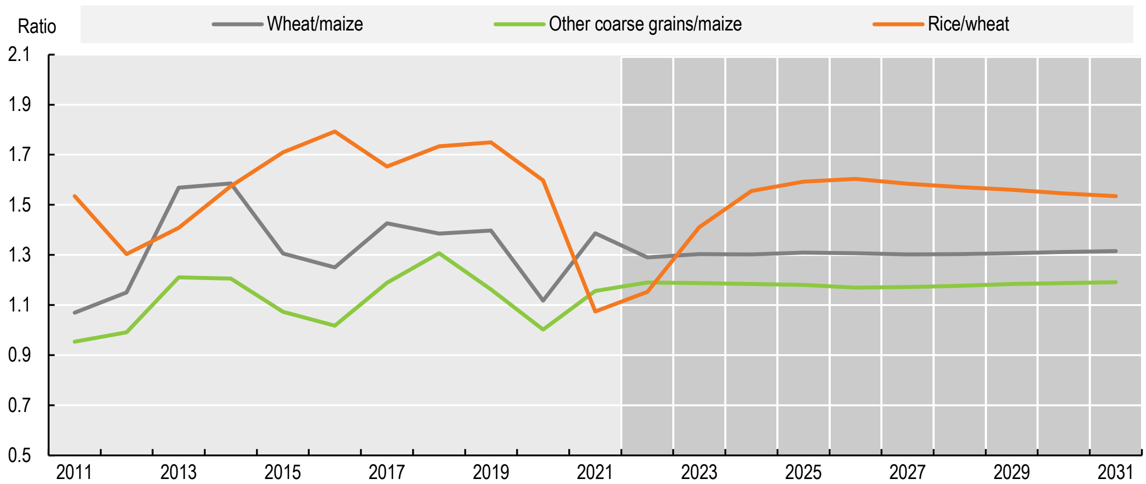
Figure 1.37. Cereals' price ratios



Source: OECD/FAO (2022), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-outl-data-en.

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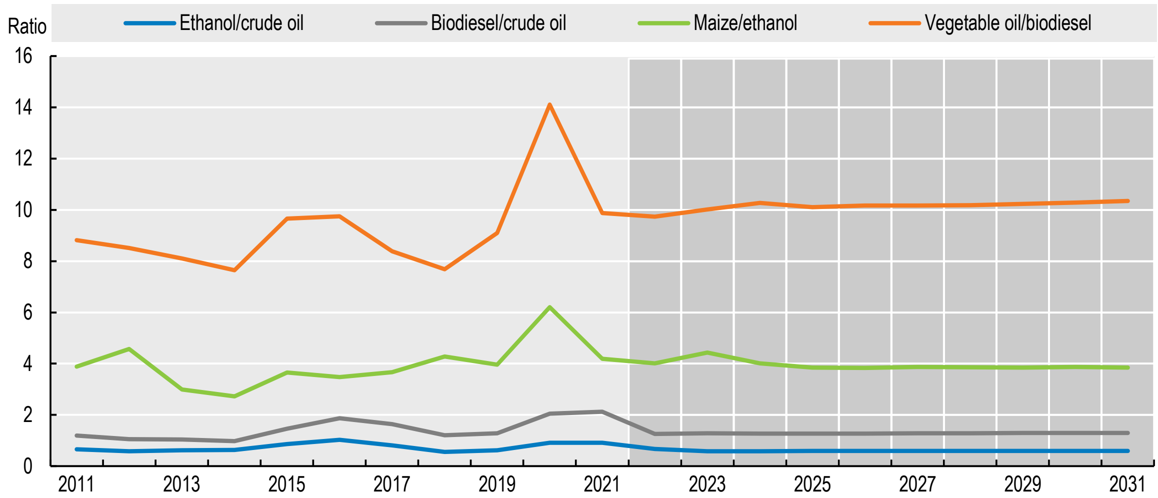
Figure 1.38. Biofuel price ratios



Source: OECD/FAO (2022), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-outl-data-en.

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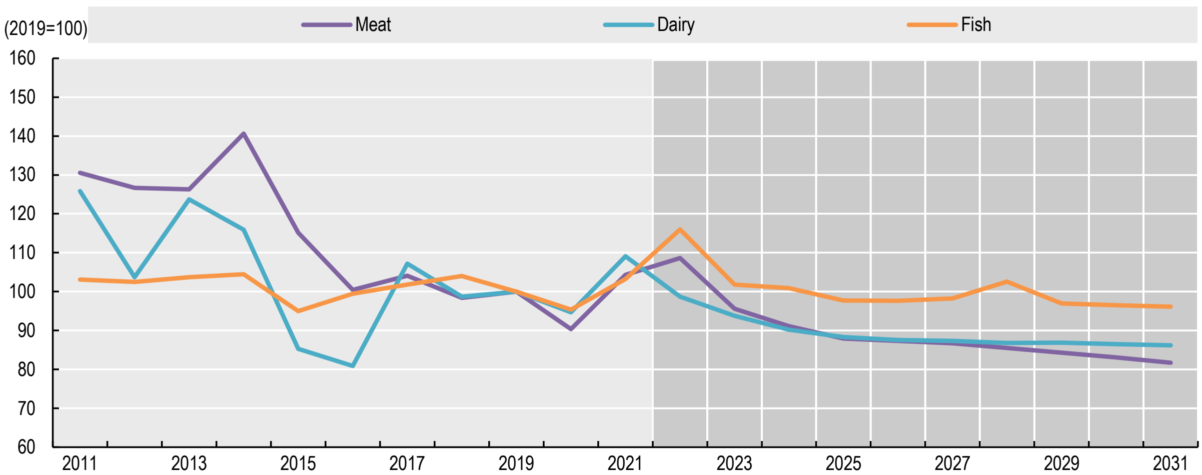
Real meat prices rebounded in 2021, not only reflecting higher demand following the economic recovery from the COVID-19 pandemic but also increased transportation and marketing costs. They are expected to remain high in the first years of the *Outlook* as higher feed costs will limit the scope for expanding supply, whereas high packaging and transportation costs will impact on meat supply chains. Meat prices are projected to decrease once supply chains stabilise and feed costs decrease (Figure 1.39). Pig meat prices are expected to decline more than for other meats due to the recovery of production following the ASF outbreak, especially in China, Viet Nam, and the Philippines.

Figure 1.39. Medium-term evolution of animal-based commodity prices, in real terms



Source: OECD/FAO (2022), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-outl-data-en.

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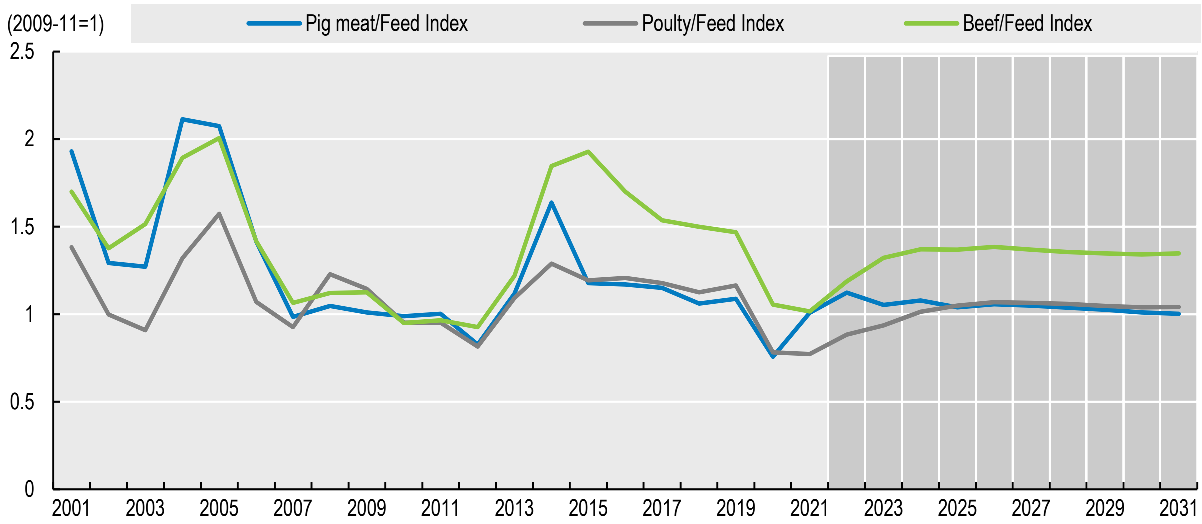
The ratio of meat prices to a feed price index is expected to stabilise and to resume a slight downward trend (Figure 1.40). Beef prices, however, are less affected by feed costs, since most of the global beef production is pasture-based. Pork and poultry prices show a strong link to feed costs, as their production uses more grain- and protein meal-based feed. The tendency is for the ratio of meat to feed prices to remain within a relatively narrow band.

Figure 1.40. Meat to feed price ratios



Source: OECD/FAO (2022), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-outl-data-en.

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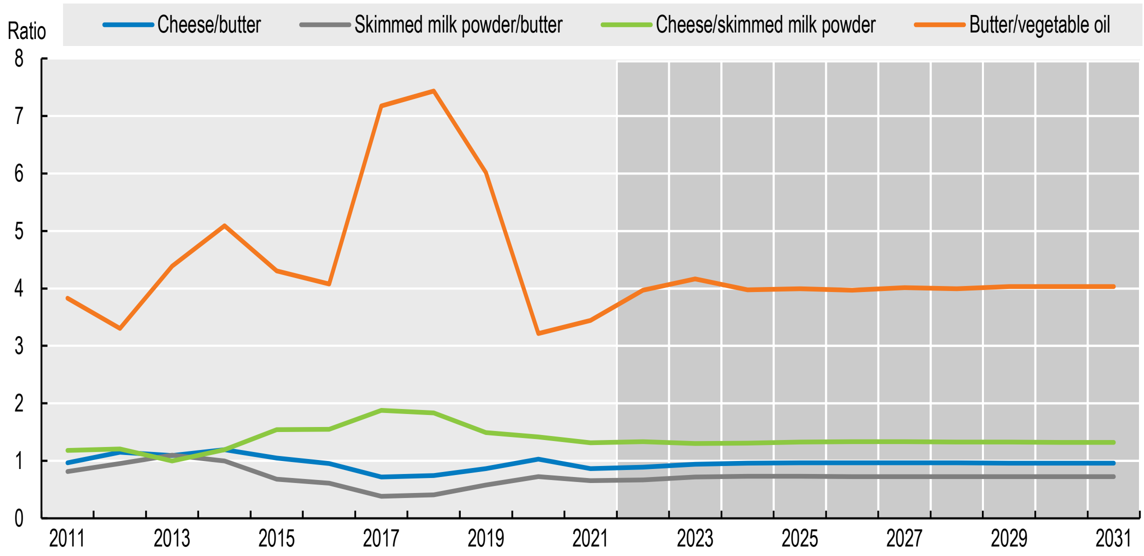
Approximately only 7% of global milk production is traded internationally, most milk being consumed domestically in the form of fresh, unprocessed or lightly processed (e.g. pasteurized or fermented) dairy products. As such, producers and consumers are mainly affected by developments in domestic dairy markets, so that international dairy price trends are less important. Local prices of fresh dairy products are assumed to follow overall price trends of slightly falling real marginal production costs of milk. However, prices are subject to high variability caused by seasonal weather effects and local market conditions.

Global price developments in the dairy sector are mainly determined by trends in the international prices of butter and SMP, which set the value of milk fat and non-fat milk solids, respectively (Figure 1.39). Both SMP and butter prices peaked in 2021 due to robust demand and limited supply. They are expected to remain high in 2022 mainly due to high production costs and strong demand, the latter also affected by high vegetable oil prices, with prices of butter increasing more than vegetable oils through 2022 (Figure 1.41). SMP and butter prices are expected to start decreasing thereafter and to resume their long-term declining trend as supplies respond to current price signals. Real prices of cheese and WMP also track developments of butter and SMP prices, respectively.

Figure 1.41. Dairy price ratios



Source: OECD/FAO (2022), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-outl-data-en.

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Real fish prices rose in 2021 due to high demand at both household and food service levels, following the economic recovery from the COVID-19 pandemic, and the modest increase in supply. They are, however, subsequently expected to decline with increasing supply as a response to growing demand. After 2024, real fish prices are projected to decline as policy changes in China, globally the largest capture fisheries and aquaculture producer, will limit the growth of production worldwide up to 2023, followed by faster growth until 2031. These policy changes focus on environmental protection and diversification of production, with an increased emphasis on producing species for the domestic market. Despite the longer term declining real prices fish, fluctuations over the next decade will be due to the effects of *El Niño* (Figure 1.39).

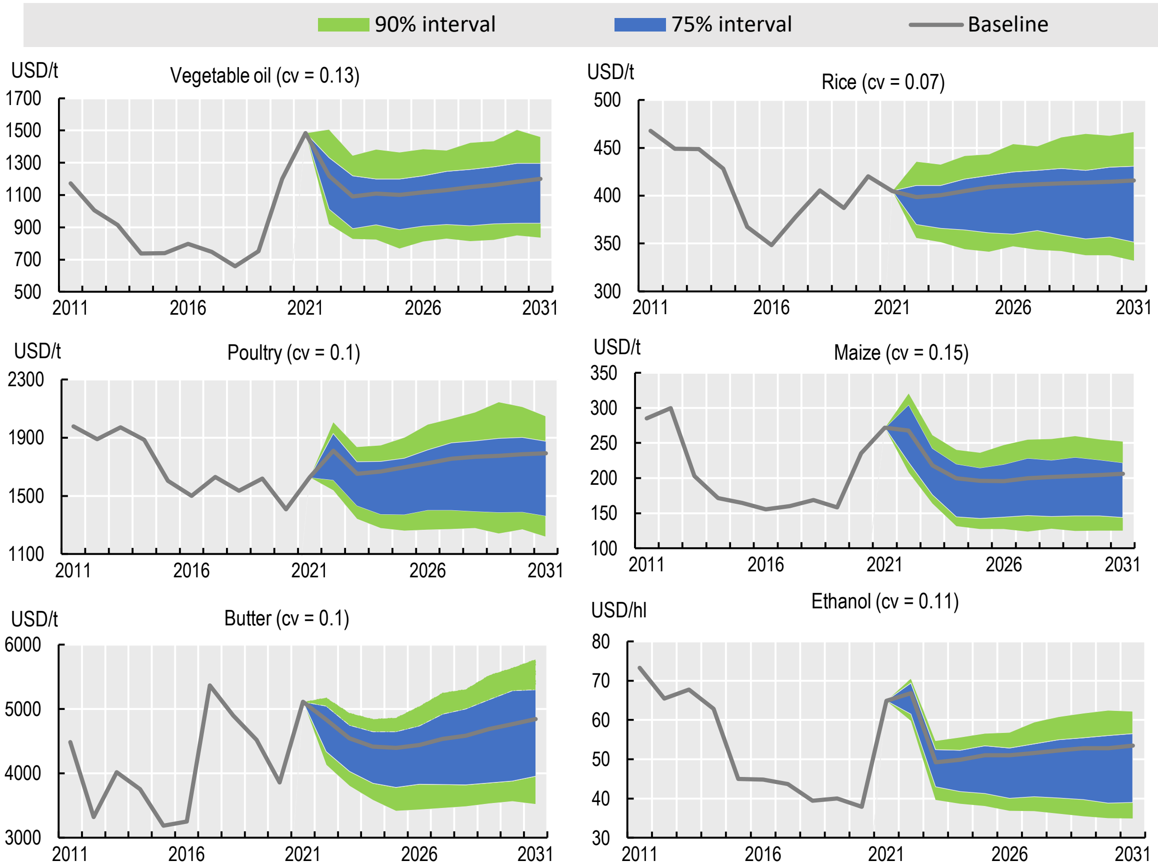
1.5.4. Many uncertainties in the next decade mean price projections need to be interpreted with caution

Price projections presented in this *Outlook* result from the interplay of fundamental supply and demand factors under normal weather, macroeconomic and policy assumptions. The *Outlook* is based on the best information available, but there is unavoidably a degree of uncertainty attached to the projections and to the underlying assumptions. The impacts of Russia's war against Ukraine on agricultural production in Ukraine and on agricultural trade, of climate change on agricultural productivity, of a higher incidence of animal and crop diseases and of weather variability on agricultural production, of changing consumer preferences and macroeconomic developments on demand, as well as the influence of domestic and trade policies, all heighten risks and create uncertainty. These factors are elaborated in Sections 1.3.7, 1.4.9 and 1.5.6.

The assumption of 'normality' in this *Outlook* results in a smooth trajectory for most projected variables, deviations from the assumed trends causing price volatility. To assess the impact of such deviations, a partial stochastic analysis (PSA) was performed on the baseline projections. The PSA simulates the potential future variability of main price determinants using observed past variability. The analysis includes global macroeconomic drivers and specific agricultural crop yields. Variability related to animal diseases

or policy changes is not considered. The aggregated results of multiple PSA simulations indicate the sensitivity of the baseline price paths (Figure 1.42). With a likelihood of 75%, prices will remain within the blue range in any given year, while they are expected to remain with a probability of 90% within the green range. An extreme event that would cause a price to fall entirely outside these ranges occurs with a probability of 40% at least once during the projection period.

Figure 1.42. Baseline and stochastic intervals for selected international reference prices



Note: Expected evolution of nominal prices under the baseline scenario of the Outlook (solid line) in relation to the stochastic outcomes shown in the blue 75% and green 90% confidence intervals.
Source: OECD/FAO (2022), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-outl-data-en.

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Overall, the price variability range tends to be larger around crops than livestock products, given the susceptibility of crop yields to weather conditions. The price of rice varies the least among the *Outlook* crops, as it is typically less prone to weather shocks than other crops. Crops that are grown in crop rotation systems, such as maize and soybeans in the Americas, show similar levels of variation. In general, prices of livestock products are less susceptible to weather shocks because feed price variability is not fully transmitted, mainly due to substitutability between different feeds. The variability in ethanol and biodiesel prices is in addition to variability of feedstock prices also closely related to that of the crude oil price, because of the complementary consumption relationship.

It should be noted that international reference prices that characterize global markets rarely have a direct impact on actual production or consumption decisions, which are mainly driven by domestic producer and consumer prices. While each individual producer or consumer cannot influence prices, their aggregate behaviour in home markets determine the domestic reference prices and, in turn, at the global level aggregated production and consumption decisions drive international reference prices.

The relationship between global reference prices and actual producer and consumer prices depends on a number of transmission processes that are at the source of uncertainty. The *Outlook* projections are made under the assumption that transmission of price signals between the global and domestic markets depends on the level of integration of a domestic market into the global trading system. Policies, such as minimum producer prices or administered consumer prices can distort the transmission. Furthermore, the simplification of using one representative producer and consumer price for each commodity in each country, and changes in the domestic price transmission, can influence international reference price, which leads to some caution in the calculation and interpretation of the price projections.

Besides uncertainties coming from geographical price transmission, shifts in the price transmission along food value chains are another source of uncertainty. The *Outlook* projections are made under the assumption that consumption is formed on the basis of a representative consumer price, which is based on a given level of product processing at the retail level, and income of a representative consumer. Shifts in income distribution, retail structures or food safety regulations may alter these factors. For example, as consumers reach higher income levels, they may prefer to consume more processed food products or with added services, such as home delivery and eating out. Considering these factors would influence the price transmission from producers to consumers and thus alter the projections.

1.6. Can Zero Hunger be achieved sustainably?

Eliminating hunger is a significant ongoing challenge. Increasing agricultural production that is available to feed an increasing global population can help to reduce global hunger. At the same time, agriculture is a significant source of global GHG emissions and other environmental impacts. Agricultural productivity growth is thus an important strategy for reconciling the need to produce more food while lowering the sector’s environmental footprint.

The *Outlook* projections suggest that, without additional efforts, the 2015 UN SDG 2.1 on Zero Hunger will not be achieved by 2030, and agricultural GHG emissions will continue to increase. This scenario quantifies the level of agricultural productivity growth required at the global level to eliminate hunger, while also putting the sector on track to contribute to limit global warming to below 2 degrees by 2050 as agreed in the 2015 Paris Agreement.

Current estimates suggest that in 2020 nearly 768 million people were chronically undernourished, equivalent to 9.9% of the world population. At the same time, some 2 billion people are estimated to be malnourished through excess consumption (WHO, 2021[7]). But, crucially, the world is not on track to achieve the SDG 2.1 on Zero Hunger, with projections suggesting that the number of chronically undernourished people will decline to only about 660 million by 2030 (FAO et al., 2021[8]).

Direct greenhouse gas (GHG) emissions from agriculture account for 11% of global emissions (IPCC, 2022[15]). Assuming no change in policies and ‘on-trend’ technological progress, the *Outlook* projects a continuing increase in direct GHG emissions from the sector over the next decade (Section 1.4.8).

The path breaking scenario analysis in the *Outlook* defines two targets, namely Zero Hunger and a 6% reduction in direct GHG emissions from agriculture by 2030, and then assesses the level of productivity growth required to simultaneously achieve these targets.

Target 1: Zero Hunger – Prevalence of undernourishment below 2.5%

The SDG 2.1 on Zero Hunger targets to "end hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round by 2030''.

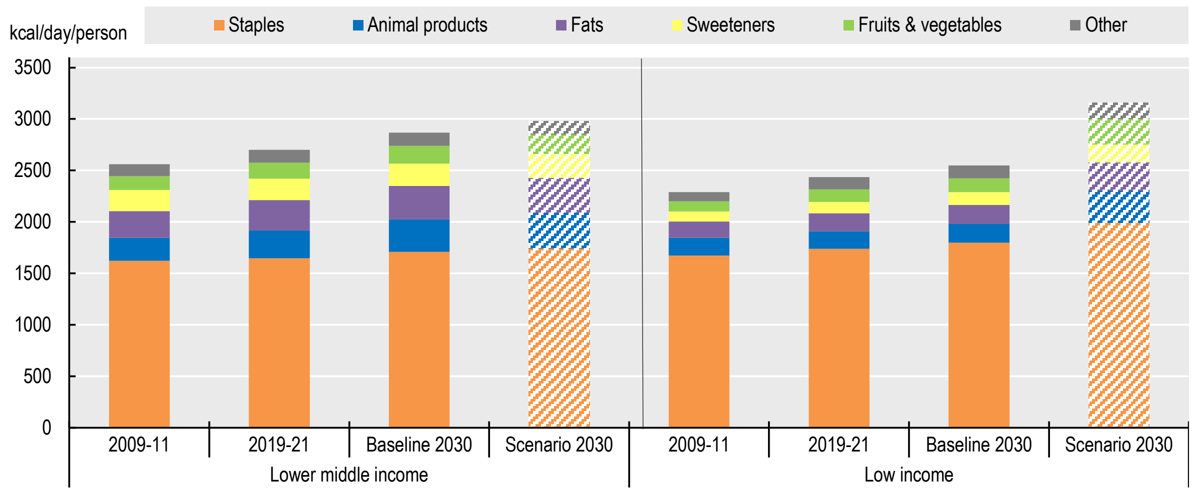
The two indicators used to monitor progress towards SDG 2.1 are indicator 2.1.1 on the prevalence of undernourishment (PoU), and indicator 2.1.2 on the prevalence of moderate or severe food insecurity in the population. The scenario in the *Outlook* focuses on the PoU, which is an estimate of the proportion of the population whose habitual food consumption is insufficient to provide the dietary energy levels that are required to maintain a normal active and healthy life (Global SDG Indicator Platform, 2022[19]).

To threshold to achieve the SDG 2.1 Zero Hunger target is set at a PoU level of below 2.5% in each country. In 2020, global PoU was estimated at 9.9%, a strong indication that significant further efforts are needed to achieve the Zero Hunger goal (FAO et al., 2021[8]).

In this stylised scenario, the Zero Hunger target is reached by increasing average per capita availability of calories in all countries (mainly lower middle and low-income countries) where PoU is projected be above 2.5% in 2030 in the baseline, to bring it below 2.5%. Food is assumed to be affordable to all, and calorie distribution to remain stable in the next decade. Food consumption in food-secure countries remains as in the baseline.

In lower-middle income countries, the necessary increase in average calorie availability to reach the Zero

Figure 1.43. Average per capita availability of main food groups (calorie equivalent), by country income group



Note: Estimates are based on historical time series from the FAOSTAT Food Balance Sheets database which are extended with the Outlook database. Products not covered in the Outlook are extended by trends. The 38 individual countries and 11 regional aggregates in the baseline are classified into the four income groups according to their respective per-capita income in 2018. The applied thresholds are: low: < USD 1 550, lower-middle: < USD 3 895, upper-middle: < USD 13 000, high: > USD 13 000. Staples includes cereals, roots and tubers and pulses. Animal products include meat, dairy products (excluding butter), eggs and fish. Fats include butter and vegetable oil. Sweeteners include sugar and HFCS. The category others includes other crop and animal products.
Source: FAO (2022). FAOSTAT Food Balances Database, http://www.fao.org/faostat/en/#data/FBS; OECD/FAO (2022), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-outl-data-en.

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Hunger target is estimated at 10% (283 kcal/person/day) between 2019-21 and 2030. In low-income countries, a 30% (720 kcal/person/day) rise in average calorie availability to 2030 is required. This ensures that at least 97.5% of the population consume more than the Minimum Dietary Energy Requirement (MDER) in 2030 (Figure 1.43).

In addition, the scenario assumes that the structure of diets in lower middle and low-income countries changes as food consumption increases, with a growing share of diverse nutritious foods (mainly animal source foods) in the diet.

Target 2: Reduction in direct GHG emissions from agriculture

Agriculture is a major driver of climate change via two main channels: 1) emissions from the sector itself, linked to production, and 2) emissions related to land use, land use change and forestry (LULUCF). Together, these elements – agriculture and LULUCF – are referred to as agriculture, forestry, and other land use (AFOLU).

In 2019, average annual net GHG emissions from AFOLU represented 22% of total global anthropogenic GHG emissions. Of this, on-farm emissions linked to agricultural production accounted for 11% of global GHG emissions, while emissions from LULUCF accounted for an additional 11% (IPCC, 2022[15]).

Given its important share of global GHG emissions, the AFOLU sector needs to contribute to global efforts to reduce GHG emissions to limit global warming to below the 2 degrees – and preferably to 1.5 degrees Celsius - by 2050, as agreed in the 2015 Paris Agreement.[12] Several countries have recently set emission reduction targets within their AFOLU sector, either as part of their Nationally Determined Contribution (NDC) or, more typically, in national climate mitigation strategies to support their NDCs (Henderson, Frezal and Flynn, 2020[20])

In this *Outlook* scenario, a 6% decline in direct GHG emissions from agriculture by 2030 is the target. This is half of the 12% reduction in direct GHG emissions the agricultural sector could deliver by 2030, at carbon prices consistent with economy-wide efforts to achieve the 2 degree goal of the Paris Agreement (Henderson et al., 2021[21]).

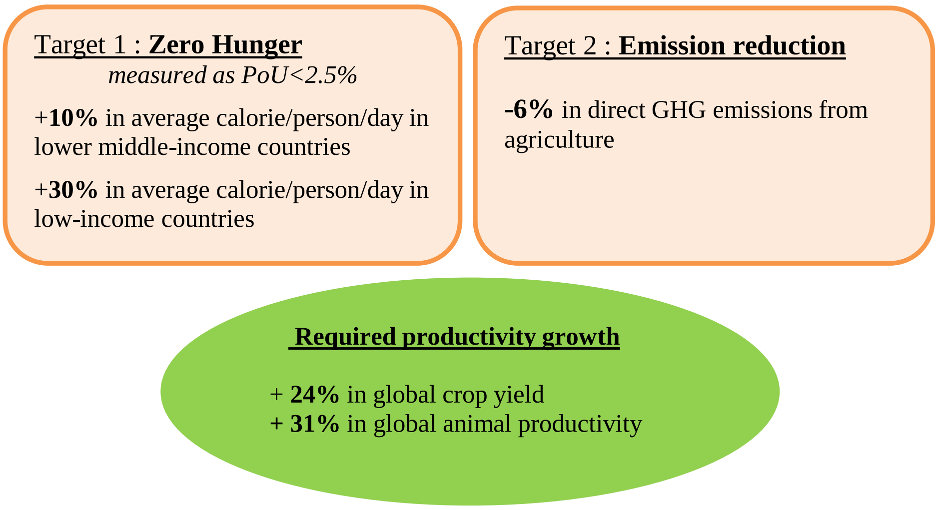
1.6.1. Productivity growth required at the global level

The scenario thus quantifies the level of productivity growth required at the global level to support the necessary increase in food consumption to achieve SDG 2.1 on Zero Hunger by 2030 (target 1), while also substantially reducing agricultural GHG emissions (target 2). Figure 1.44 summarizes the two targets considered in this analysis, along with the level of productivity growth required to achieve them.

This scenario assumes a similar level of productivity growth across the different crops and livestock products, along with a catch-up in the productivity of middle and low-income countries with high-income countries. Moreover, most food production growth required to reach the Zero Hunger target in countries where PoU is currently above 2.5%, is assumed to come from productivity increases within each of those countries. In other words, the assumed convergence in productivity between countries causes most of the increases in food availability to be sourced from domestic agricultural productivity gains, rather than from food imports.

It should be noted that the investments in R&D and innovation that would be necessary to support technological change and other drivers of productivity improvements are not specified in this scenario analysis. The potential increase in non-land resources that may be needed to increase production (such as water) are also not taken into account.

Figure 1.44. Key results of the scenario analysis



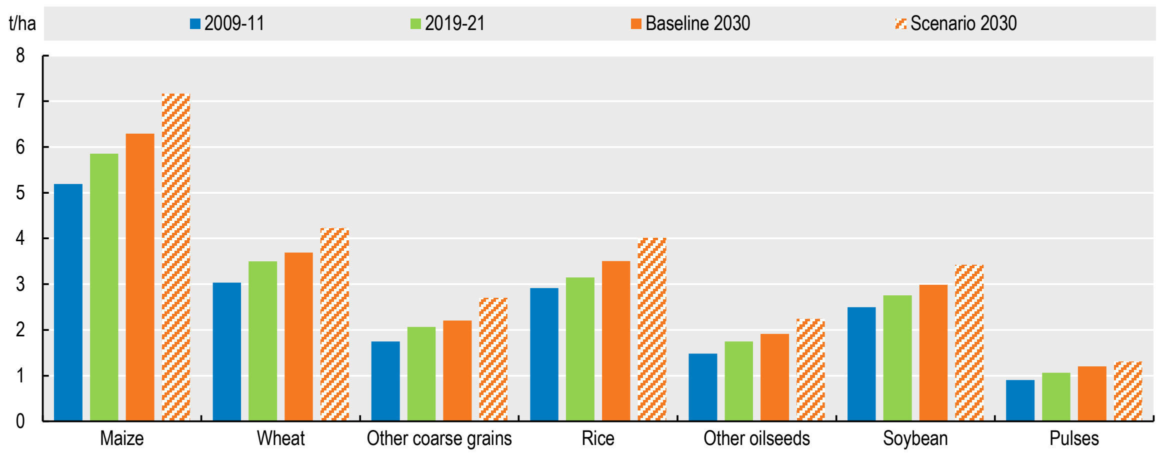
Note: Reported % are absolute growth between 2019-21 and 2030 in the scenario. Average crop and animal productivity are calculated as the calorie output per ha and per animal, respectively.
Source: OECD/FAO (2022), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-outl-data-en.

Crop productivity

The average global growth in crop yields necessary to achieve Zero Hunger and a 6% reduction in direct GHG emissions is estimated to be 24%. This is more than double the growth than the world is currently set to achieve in absence of additional measures. For comparison, the *Outlook* projects a global yield growth of only 10% over the next decade. Achieving both targets would also require an acceleration of productivity growth compared to the last decade, where crop yields grew by 13%.

The required growth in global crop yields ranges between 21% for wheat and 31% for other coarse grains between 2019-21 and 2030, always exceeding last decade's observation (Figure 1.45).

Figure 1.45. Average yields for selected crops



Source: OECD/FAO (2022), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-outl-data-en.

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Growth in crop yields enables the decoupling of crop production growth and land use change. In this scenario, a similar absolute increase in yields is assumed in all countries to enable a reduction in the relative yield gap between middle and low-income countries and high-income countries. This translates into higher percentage increase in yields in middle and low-income countries where absolute yields tend to be lower.

Global yield growth in the scenario would be associated with a 20% increase in crop production over the next decade, together with a 5% decline in crop area. This reduction in crop area could slow deforestation and/or accelerate afforestation implying that LULUCF GHG emissions would fall, which would mean additional emission reductions.

To be sustainable, yield improvement should ideally come from more efficient use of all inputs (i.e. growth in total factor productivity (TFP)) or from a substitution away from emission intensive inputs, rather than rely on potentially unsustainable increase in the use of synthetic inputs (e.g. fertilisers, pesticides). In practice, TFP growth can be achieved through the adoption of more efficient farm management practices, new crop varieties and breeds, as well as digital innovations (e.g. precision farming).

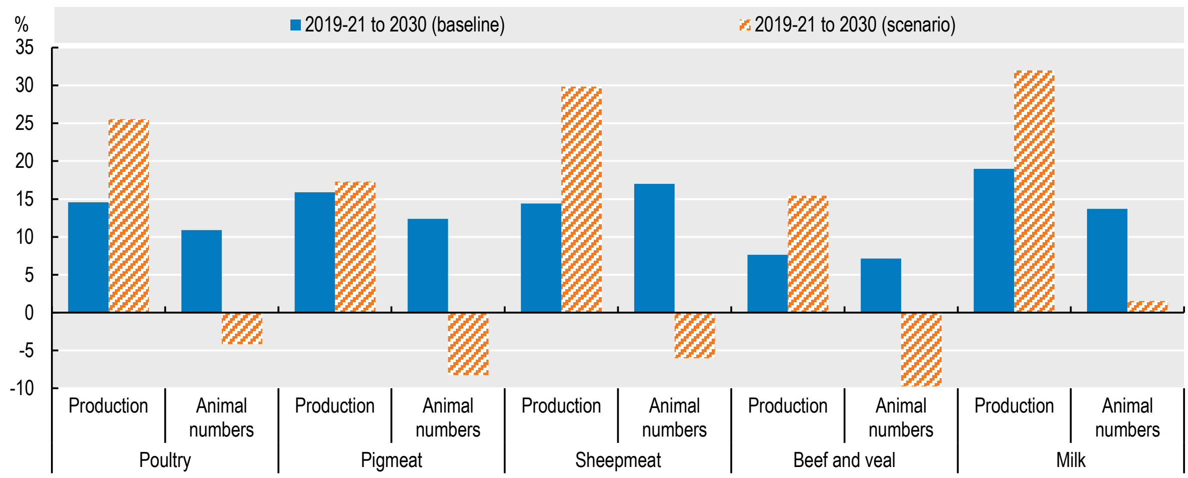
Animal productivity

As for crops, the scenario assumes an increase in livestock productivity to meet targets 1 and 2. This productivity growth is modelled by an increase in annual production per animal stock. In practice, growth in animal productivity growth can be achieved through improved feeding practices, animal genetics, and herd management.

To achieve targets 1 and 2, global animal productivity would have to increase by 31%, on average, between 2019-21 and 2030. This is significantly higher than the growth projected in the baseline – at 5% on average – or zero growth recorded over the last decade.

As shown in Figure 1.46, to achieve such growth in animal productivity, production would have to increase at a higher rate than in the baseline for all livestock products, while animal numbers would need to decline, compared to continuing growth in the baseline.

Figure 1.46. Growth in global livestock production and animal numbers



Source: OECD/FAO (2022), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-outl-data-en.

StatLink https://stat.link/qdgvby

1.6.2. Conclusion and limitations

The scenario results suggest that a substantial acceleration in productivity growth would be required to simultaneously eliminate global hunger and put agriculture on track to contribute to reach the Paris Agreement reduction in GHGs. To simultaneously achieve these targets, average global agricultural productivity would need to increase by 28% over the next decade. For crops, the necessary 24% increase in average global yields – which acts as a proxy for crop productivity – is close to double the increase achieved over the past decade (13%). Global animal productivity would have to increase by 31%, on average, vastly exceeding the growth recorded during the last decade. The required productivity growth, in particular for livestock, is significantly higher than either that experienced over the last decade or projected in the *Outlook*.

Thus, achieving both targets in less than ten years only through productivity improvement would be very challenging, suggesting that other actions need to be taken in parallel. These include direct policy measures to mitigate GHG emissions from the sector, reduce food loss and waste, and limit excess calorie and protein intake in higher income countries (particularly from animal sources). Improving food access through the provision of social safety nets and food distribution programmes for undernourished people, especially the most vulnerable, would also be key to reduce global hunger.

Nevertheless, it is evident that actions to boost agricultural productivity should be taken, including public and private investments in innovation, R&D, and infrastructure as well as policies to foster the adoption of sustainable new technologies, and enable the transfer of knowledge, technology, and skills. Redirecting market-distorting payments towards investments in public goods – in particular innovation systems – would underpin more productivity-enhancing investments.[13]

It should be noted that the impact of the assumed supply and demand shocks on agricultural commodity prices is not analysed, because the scenario does not demonstrate how consumers are able to afford the increase in food consumption, nor does it provide estimates of investments or public spending needed to raise productivity, as poverty reduction, investment and fiscal cost considerations are outside the scope of Aglink-Cosimo.

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Notes

1 Relevant reference documents are for OECD: OECD 24.02.2022 Statement of OECD Council on the Russian aggression against Ukraine; and for the UN: UN General Assembly 1.03.2022 Resolution on Aggression against Ukraine https://digitallibrary.un.org/record/3958976/files/A_ES-11_L.1-EN.pdf

[2] Meat includes beef and veal, poultry, pigmeat and sheepmeat. Dairy products include butter, cheese, fresh dairy products, skimmed and whole milk powder. Fish includes both fish from capture fisheries and aquaculture.

[3] By-products of crop production include cereal bran, beet pulp, dried distilled grains, and molasses. By-products of livestock production mainly include meat and bone meals.

[4] Feed use includes commercial feed use and direct feeding of crops.

[5] The blend wall is the maximum ethanol blend that will not damage the engines and fuel systems of vehicles.

[6] In 2019, plant-based alternatives represented only 0.7% of the meat market and 2.5% of the dairy market in the European Union and the United Kingdom. The market share for meat and dairy alternatives is set to increase to 1.3% and 4.1%, respectively, by 2025 (ING, 2020[22]). In 2021, plant-based meat accounted for 1.4% of the retail meat market in the United States (Good Food Institute, 2022[23]). Cultured is only commercialised in one restaurant in Singapore since December 2020. High production costs and low consumer acceptance remain a challenge for its commercialisation and adoption.

[7] Between 2010 and 2020, the global stock of electric vehicles has increased a thousand-fold, from 10,000 to over 10 million (IEA, 2021[13]).

[8] Hereafter agricultural production refers to crop, livestock and fish production.

[9] This figure refers to the growth of the net value of crop commodities covered in the Outlook, whereby the net value is expressed in billion USD, measured at constant 2014-16 prices.

[10] Global land use change emissions are not projected in the *Outlook*.

[11] Reports from the ePhyto Hub, the International Plant Protection Convention (IPPC) system for the centralised exchange of phytosanitary e-certificates, demonstrate a significant increase in countries exchange of e-certificates for plant products in early 2020.

[12] 196 countries have signed the Paris agreement, a legally binding international treaty on climate change. Its goal is to limit global warming to well below 2, preferably to 1.5 degrees Celsius, compared to pre-industrial age levels.

[13] In 2018-20, 54 OECD and non-OECD countries provided USD 720 billion annually to support their agricultural sectors. Only 17% of total budgetary support was directed to research and innovation, public investment in infrastructure and biosecurity. This share could be almost doubled by a redirection of market distorting payments towards investments in public goods – in particular innovation systems (OECD, 2021[24]).