

INNOVATION IN CROP AGRICULTURE IN EUROPE

A REPORT FOR BAYER

OCTOBER 2026

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EXECUTIVE SUMMARY

AGRICULTURE IS A SYSTEM-CRITICAL SECTOR

- A strong agriculture sector is essential to maintaining food security and the EU's strategic autonomy. It supports farmer livelihoods and rural stability, and contributes towards the EU's competitiveness, adaptation to climate change, and resilience to geopolitical shocks.
- Crop agriculture contributes €246 billion to EU GDP, roughly the size of Greece's GDP, and larger than EU industries such as fabricated metals and motor vehicles and parts manufacturers. It employs 4.5 million people and has very strong supply chain linkages. Every €1 billion of crop agriculture supports the output of a further €2 billion to €3 billion in other industries.
- The agriculture sector's future potential and its ability to fulfil its system critical role relies on its competitiveness and resilience, which in turn are impacted by the regulatory environment and the presence of innovation-friendly policies.

CHALLENGES TO COMPETITIVENESS AND RESILIENCE THREATEN THE SECTOR'S OUTCOMES

- The EU experienced relatively lower growth in agricultural productivity and capital investment over the past three decades.
- Crop production growth significantly lagged comparator countries in 2011-2023.
- European farmers have faced significant input cost increases especially since 2022. In 2025, compared to 2020, prices for fertiliser were up by 60%, energy by 51%, and machinery and equipment by 25%.
- Higher input costs can negatively impact the EU's competitiveness in relation to other lower-cost countries, and sustainability measures are expected to further increase input prices over the coming years.
- Climate change is leading to significant crop losses, which are expected to further increase over time, representing a key risk to European food security.
- While the EU is largely self-sufficient in many agricultural products, it is dependent on the imports of some key inputs, such as fertilisers and natural gas, which leave its food system exposed to geopolitical and supply chain disruptions.

INNOVATION GAPS CONSTRAIN PRODUCTIVITY AND ADAPTATION

- While some of the challenges facing the agriculture sector's future development are external to the EU's direct control, such as energy prices, geopolitical developments, and climate change, there are areas where the EU can exert greater influence, including the uptake of innovative technologies.
- Innovation can help the EU improve agricultural productivity, while also working towards its sustainability goals. Timely technological adoption can help reduce input costs, raise yields, and enhance resilience.
- However, modern technologies are rapidly advancing, faster than their adoption in the EU, and are often held back by high regulatory costs, long approval timelines, and public misperceptions.
- Emerging technologies such as new genomic techniques (NGTs) can help address challenges such as climate change and biodiversity loss, but their authorization in the EU has significantly lagged other countries. Their development will also be impacted by regulation and public perception, and therefore public trust in scientists, governments, and developers will be important.

- With regards to crop protection, the EU adopts a relatively restrictive regulatory approach, with farmers losing access to existing tools faster than new products can replace them. This results in a shrinking toolkit to protect their crops, despite continuous scientific progress.
- There is also untapped potential from the adoption of digital technologies, including AI, with lower adoption in the EU than in comparator countries.
- The cost of inaction is potentially high: low innovation adoption represents an opportunity cost in terms of lost productivity gains, impacting the agriculture sector's competitiveness and resilience.

THESIS: INNOVATION MUST BE AT THE CENTRE OF EU AGRICULTURAL POLICY

- In an environment where farmers are facing growing risks from volatile weather conditions and geopolitical price shocks, while competing in an increasingly innovation-driven global market, the EU must ensure they have timely access to a wide toolbox of agricultural technologies to enable their adaptation.
- Moving forward, agriculture must not be siloed off in EU policy discussions but prioritised as a strategic sector with a clear vision, as part of Europe's broader resilience and competitiveness framework.
- Innovation must be at the centre of EU agricultural policy to close the innovation gap, enhance competitiveness, adapt to the impacts of climate change, and strengthen strategic independence.
- As a key determinant, the EU should make the regulatory system more risk-proportionate, weighing actual risk exposure from a technology with its potential benefits for food security and resilience. Regulation must also keep pace with innovation, to avoid the EU falling behind other faster-moving markets.
- There is also a need to move to a more science-based public debate and address public misperceptions on agricultural technologies.

SECTION 1.

INTRODUCTION

1.1. AGRICULTURAL INNOVATION SUPPORTS THE EU'S STRATEGIC OBJECTIVES

The crop agriculture sector is a fundamental part of the food system, providing the cereals, oilseeds, vegetables, fruit and other crops that form the basis of diets. Its economic importance extends well beyond the value of agricultural production itself: it supports demand for upstream industries supplying machinery, fertilisers, seeds, chemicals and other inputs, as well as downstream activities including food processing, logistics and distribution. It also provides essential inputs for animal feed, biofuels, and a range of other industries, meaning that disruptions to crop production can have consequences across the wider economy. Crop agriculture also makes an important contribution to rural economies and employment. The sector therefore generates economic activity well beyond the farm gate. Maintaining a productive and resilient crop agriculture sector can consequently support not only food security, but also the resilience of the wider agri-food supply chain, supporting Europe's strategic autonomy going forward.

The agriculture sector is increasingly recognised by the EU as crucial for overall European sovereignty, security, and competitiveness.¹ However, European farmers are operating in an increasingly challenging environment. They must maintain yields and farm incomes in the face of greater weather volatility and climate-related pressures, while responding to geopolitical shocks and competing in global markets where agricultural producers are increasingly adopting new technologies. Against this backdrop, Oxford Economics was commissioned by Bayer to prepare this research, which outlines the economic importance of a productive and resilient crop sector, the pressures facing European agriculture, and the potential contribution of technological innovation to addressing these challenges. It also examines the policy and regulatory conditions that can support the development and adoption of new agricultural technologies.

The key thesis is that innovation and technology can significantly contribute to the resilience and competitiveness of European crop agriculture. Modern crop protection products, advances in seed breeding and digital agricultural technologies can help farmers protect yields, use inputs more efficiently, and adapt production to changing climatic conditions. However, the benefits of innovation will depend on farmers being able to access new technologies in a timely and economically viable way. Regulatory constraints, lengthy approval processes, and public misperceptions of agricultural technologies can all affect the development and uptake of innovation.

Without sufficient and timely adoption of innovation, European agriculture risks falling behind producers in other markets that are making greater use of new technologies. This could constrain productivity growth, weaken the competitiveness and resilience of European agriculture, and ultimately place additional pressure on farmers and consumers. The European Commission has recognised that "increasing agricultural productivity in a sustainable way is essential to meet the challenges of higher demand in a resource-constrained and climate uncertain

¹ Council of the European Union, General Secretariat, "Securing EU Food Security and Sovereignty in an Uncertain World: Information from the Commission and the Presidency," Note to Delegations, ST 5422/26 (Brussels, January 16, 2026), 7, <https://data.consilium.europa.eu/doc/document/ST-5422-2026-INIT/en/pdf>.

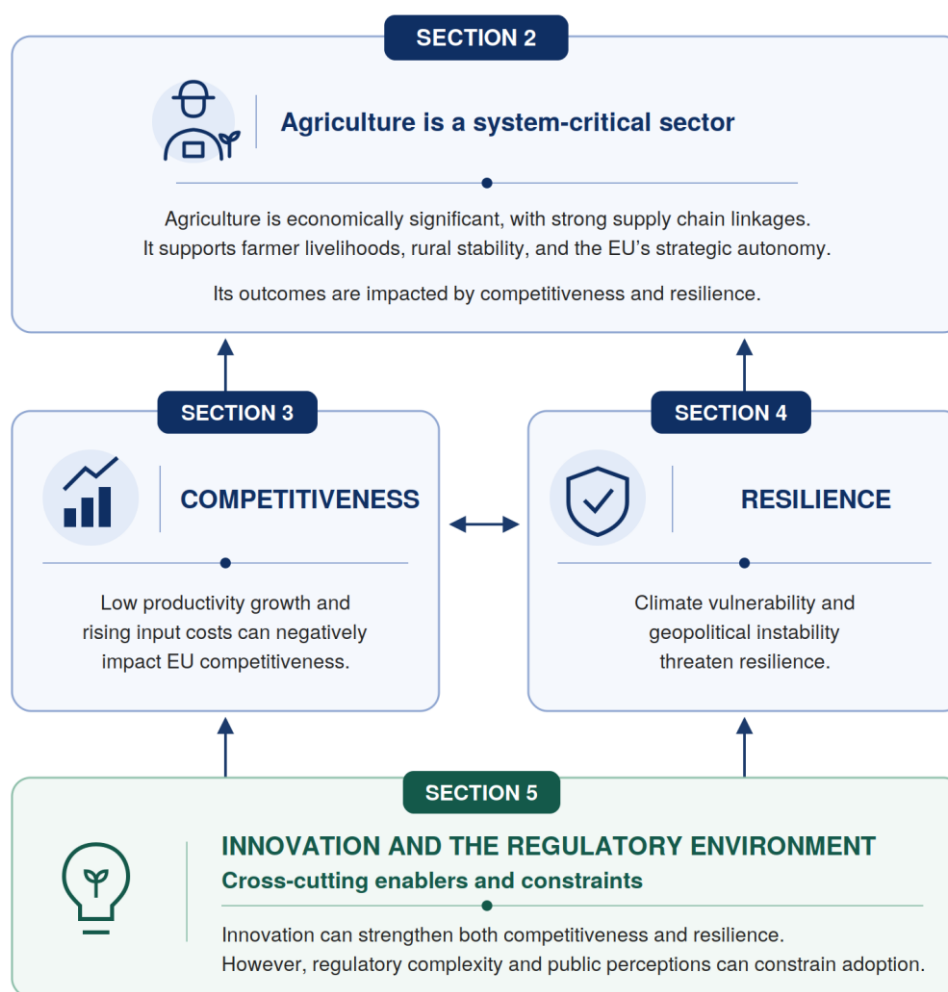
world,”² and that “a strong innovation-based ecosystem is essential to the competitiveness, resilience and sustainability of the agri-food sector.”³

Creating an environment in which agricultural innovation can develop and be adopted effectively will therefore be an important component of strengthening Europe’s food-system resilience and economic competitiveness.

1.2. ANALYSIS FRAMEWORK AND STRUCTURE OF THE REPORT

Figure 1 outlines our analysis framework and the report’s structure, which links the agriculture sector’s outcomes with competitiveness, resilience, and innovation.

Figure 1: Report framework - the links between agriculture sector outcomes, competitiveness, resilience, and innovation



Source: Oxford Economics

² European Commission, 'Increasing competitiveness: The role of productivity', CAP Specific Objectives Brief No. 2.

³ European Commission, New Strategic Approach to Research and Innovation for Competitive, Resilient and Sustainable Agriculture, Forestry, Rural Areas and Food Systems, 2026, <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:52026DC0453>.

Agriculture is a system-critical sector. **Section 2** quantifies the sector's economic contribution, showcasing its strong interlinkages with other key sectors, and its importance for rural livelihoods and social cohesion.

The sector's performance is impacted by its competitiveness and resilience. **Section 3** looks into the risk of low productivity growth and rising input costs that can negatively impact the EU's agricultural competitiveness compared to other countries. **Section 4** outlines the current threats to resilience, including climate vulnerability and geopolitical instability.

Innovation can help increase productivity, while also enhancing resilience to climate change and the impact of external shocks. Regulations determine which technologies are available to farmers, and the speed of their adoption. The regulatory environment can therefore shape the pace and direction of technological uptake across the sector, impacting competitiveness and resilience. **Section 5** discusses how innovation can help address the EU's strategic challenges, and the current barriers to improved innovation outcomes, which include the regulatory environment and public misperceptions.

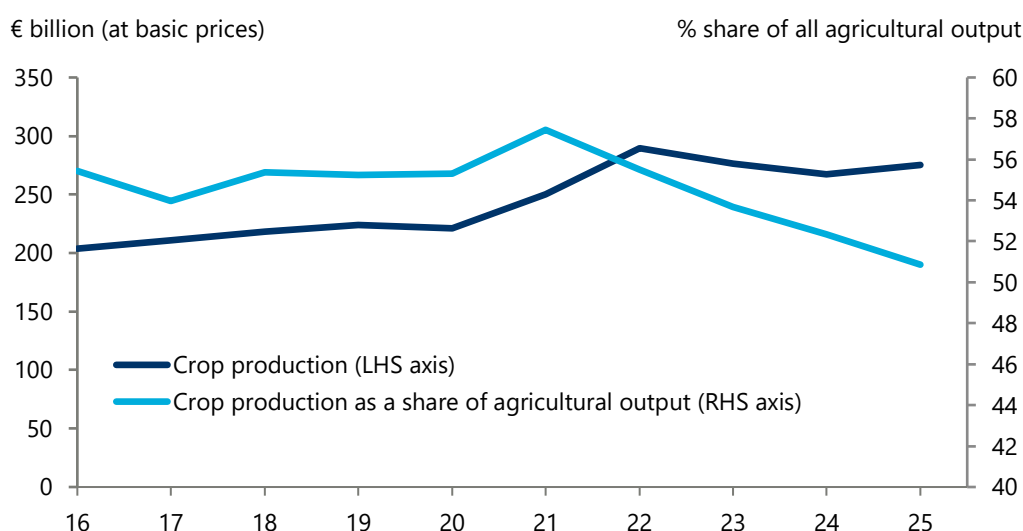
Section 6 concludes and examines the policy implications.

SECTION 2. AGRICULTURE IS A SYSTEM-CRITICAL SECTOR

2.1. CROP PRODUCTION IS ECONOMICALLY SIGNIFICANT

In 2025, crop production in the EU was valued at approximately €276 billion (Figure 2).⁴ It accounted for around one-half (or 50.9%) of the total value of agricultural output.⁵ Although the value of crop production has increased over the past decade, from around €204 billion in 2016, its share of total agricultural output has declined from around 55% in 2016 to just over 50% in 2025, reflecting relatively faster growth in the value of livestock production. In the UK, crop output recorded £11.4 billion (€13.5 billion) in 2025, representing 30% of total agricultural output.^{6,7}

Figure 2: Production value of crop agriculture and its share of total agricultural production in the EU



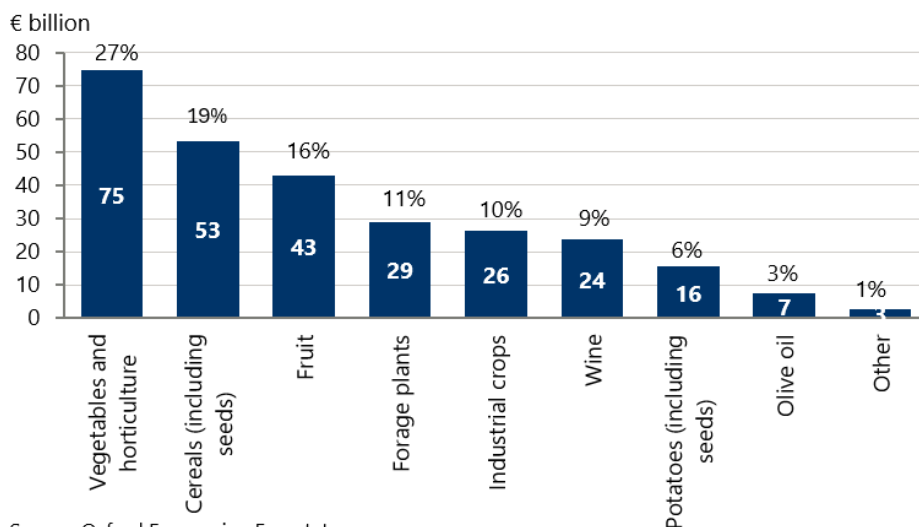
Source: Oxford Economics; Eurostat

Crop production is spread across a diverse range of crops, although a relatively small number of crop categories account for the majority of output (Figure 3). Vegetables and horticultural products are the largest segment, accounting for around 27% of the value of EU crop production in 2025. Cereals represent a further 19%, while fruit contributes around 16%. Together, these three categories account for approximately 62% of total crop production. Forage plants (11%), industrial crops (10%), and wine (9%) also make important contributions.

⁴ Production is valued at the price received by the farmer as the product leaves the farm gate.

⁵ Department for Environment, Food & Rural Affairs. *Total income from farming in the UK in 2025*.

⁷ This figure is not directly comparable to the EU one as some of the DEFRA statistics are quoted at market rather than basic prices. They therefore include sales taxes like VAT, but exclude production subsidies.

Figure 3: Production value of different crop agricultural commodities in the EU in 2025 (at basic price)

Source: Oxford Economics; Eurostat

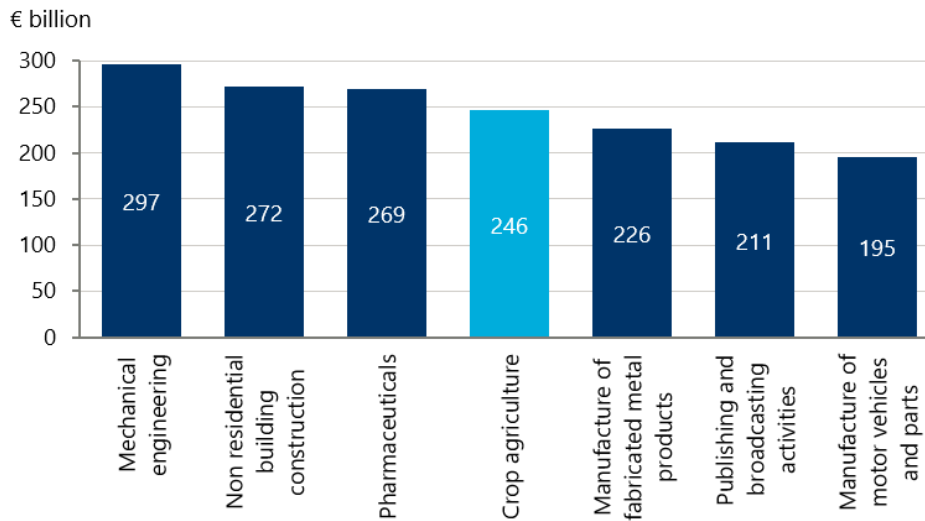
2.2. CROP AGRICULTURE IS AN IMPORTANT CONTRIBUTOR TO GDP AND EMPLOYMENT

Crop agriculture is an important contributor to the European Union economy. In 2025, the sector's gross value added directly contributed €246 billion to EU GDP.^{8,9} To give a sense of scale, the sector's output is nearly as large as the GDP of Greece (which recorded €248 billion in 2025). Crop agriculture output is also larger than the EU's manufacture of fabricated metal products, publishing and broadcasting, and motor vehicle and parts manufacturing industries (Figure 4). In the UK, crop agriculture is estimated to contribute £4.8 billion (€5.7 billion) to GDP.

⁸ Gross value added is the contribution an individual firm or industrial sector makes to gross domestic product (GDP), the metric used to compare the size of economies and the rate at which they are growing. It is easiest thought of as the value its output is sold for minus the costs of the bought-in goods and services used up in its production. Summing all the gross value added generated by all the economic entities in a country calculates a nation's GDP, plus taxes on product minus subsidies on products.

⁹ Gross value added created by the crop agricultural sector is not published by Eurostat/ONS. To calculate the estimate, we have pro-rata-ed the gross value added produced by the total agricultural sector, by the production value of crop agriculture (at basic price) divided by the production value of total agriculture (at basic prices) using data from Eurostat/ONS economic accounts for agriculture.

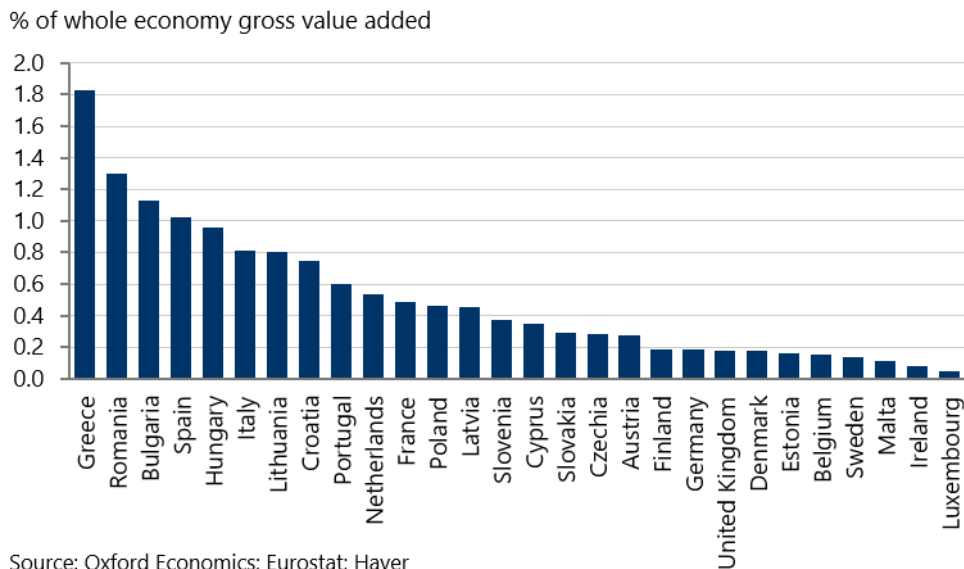
Figure 4: Gross value-added contributions of selected industries in the EU in 2025



Source: Oxford Economics

The sector's importance varies considerably between countries. Crop agriculture contributed almost 2% of Greek GDP in 2025 (Figure 5). It contributed more than 1% in countries including Romania, Bulgaria, and Spain, reflecting the greater role agriculture continues to play in these economies. By contrast, the sector accounted for only a small proportion of economic activity in more industrialised and services-oriented economies such as Malta, Ireland, and Luxembourg.

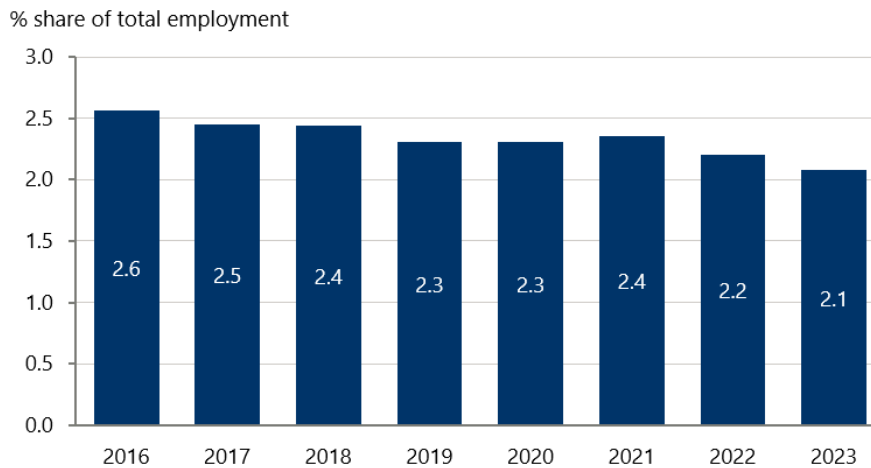
Figure 5: Crop agriculture's share of whole economy gross value added in 2025



Source: Oxford Economics; Eurostat; Haver

Crop agriculture is also a significant source of employment. The latest data (2023) show that the sector employed just over 2% of all people in employment in the EU (Figure 6), equating to 4.5 million people. In the UK, the sector is estimated to employ over 120,000 people.¹⁰ The crop sector's greater contribution to employment than gross value added shows its relatively low level of labour productivity.

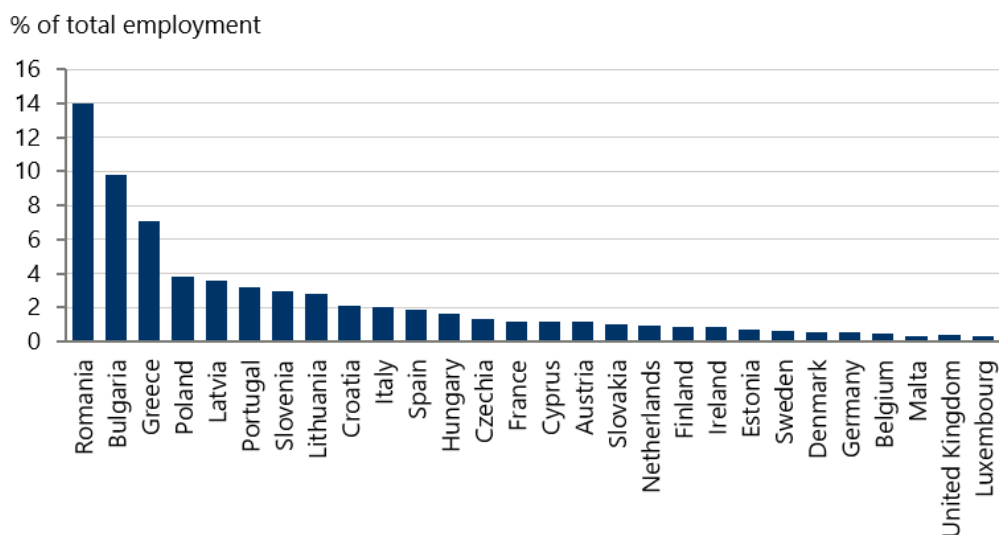
Figure 6: Employment in crop agriculture as a share of total employment in the EU



Source: Oxford Economics; Eurostat

Crop agriculture's importance as a provider of employment varies markedly across countries. In 2023, 13% and 8% of all those employed in Romania and Bulgaria worked in crop agriculture, respectively (Figure 7). Broadly speaking, it played a more important role as a provider of employment in eastern European countries. It contributed less than 0.5% of all employment in Belgium, Malta, the UK, and Luxembourg.

Figure 7: Crop agriculture's share of total employment in 2023



Source: Oxford Economics; Eurostat; ONS

¹⁰ Estimated using official statistics for agriculture employment, multiplied by the share of crop output from total agriculture output.

2.3. CROP AGRICULTURE HAS STRONG ECONOMIC INTERLINKAGES WITH THE WIDER EU ECONOMY

The crop agriculture sector does not exist in isolation. It is heavily interlinked with the wider EU economy and critical industrial sectors within it.

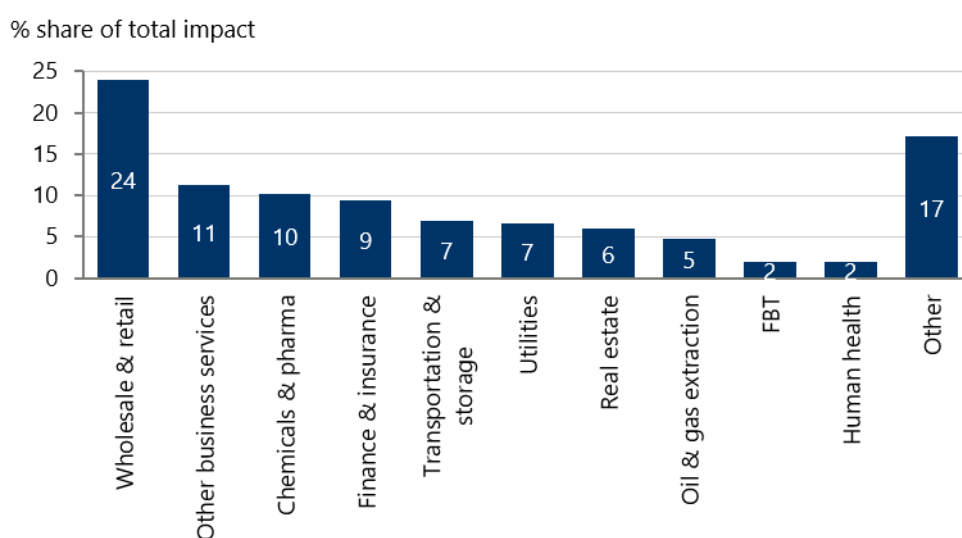
2.3.1. THE CROP AGRICULTURE SECTOR'S SUPPLY CHAIN

Beyond its direct economic contribution, crop agriculture plays a central role within the wider European economy through its extensive supply chain. The sector purchases a broad range of intermediate goods and services, stimulating economic activity and employment across a wide range of industries. In 2025, 87% and 89% of the economic activity and employment stimulated along the EU crop agriculture supply chain, respectively, are estimated to have occurred within the EU. This demonstrates the sector's strategic importance domestically, supporting a wide network of other EU industries.

The sector which receives the greatest stimulus to its gross value added is wholesale and retail, which accounts for 24%, highlighting the importance of distribution activities in supplying agricultural businesses (Figure 8). Other business services (11%), chemicals and pharmaceuticals (10%), and finance and insurance (9%) also receive significant stimulus, while transportation and storage, utilities, and real estate each account for between 6% and 7% of the total impact.

The EU crop agriculture sector's procurement also supports substantial employment across a diverse range of industries. Wholesale and retail accounts for the largest share of employment stimulated, at 33% of the total, underlining its importance in the agricultural supply chain. This is followed by other business services (14%), transportation and storage (8%), and accommodation and food services (7%). The differences between the share of the gross value added supported and the employment share reflect differences in labour productivity across industrial sectors.

Figure 8: Industry share of gross value added stimulated by the EU crop agriculture sector's procurement



Source: Oxford Economics

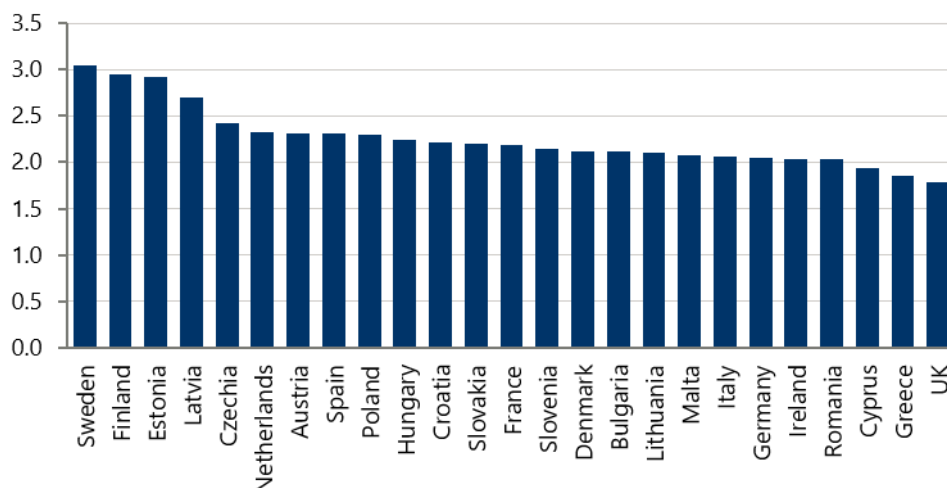
2.3.2. THE CROP AGRICULTURE SECTOR'S ROLE AS A SUPPLIER OF INPUTS

The downstream importance of crop agriculture is equally significant. Input-output analysis shows that agricultural output acts as a critical input into numerous industries, with every €1 billion of crop agriculture

output supporting approximately €2 billion to €3 billion of downstream production, depending on the country (Figure 9). The ranking of countries partly reflects the crops that are grown as those sold directly to households for consumption do not directly support economic activity in other sectors.

Figure 9: Amount of economic output dependent on €1 billion of crop agriculture output

€ billion of total output dependent on €1 billion of agriculture output



Source: Oxford Economics; OECD

The industries that benefit the most from crop agricultural inputs are other agriculture such as livestock farming (at 53% of the dependent output), followed by the manufacture of food products, beverages and tobacco products (26%), the manufacture of wood and of products of wood and cork, accommodation and food service activities, and human health and social work (all 2%).

2.4. AGRICULTURE SUPPORTS RURAL LIVELIHOODS AND SOCIAL COHESION

The agriculture sector is a major source of livelihoods for rural communities, where over 20% of Europeans live.¹¹ There exists a widening rural-urban divide in the EU, which contributes to discontent and lower political trust among rural communities.¹² Income gaps between rural and urban areas grew by 20% between 2012 and 2021, with disparities in employment, education, digital skills, and public service provision. These inequalities undermine morale and social cohesion, with rural residents often feeling less valued and recognised by political institutions than their urban counterparts and having lower levels of satisfaction with democracy. Discontent can lead to lower trust in EU political institutions and civil unrest, with far-right political groups taking advantage of rural discontent to secure parliamentary seats. EU evidence shows high eurosceptic voting (anti-EU values) in many rural areas in the EU.¹³ Discontent in rural communities can therefore erode social cohesion, deepen polarisation and support for anti-EU political parties, and heighten tensions between urban and rural communities.

¹¹ Eurostat. *Urban-rural Europe - demographic developments in rural regions and areas*. Statistics Explained. Retrieved August 18, 2026, from https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Urban-rural_Europe_-_demographic_developments_in_rural_regions_and_areas

¹² Eurofound, *Europe's widening rural-urban divide may make space for far right*. Eurofound, 2023 <https://www.eurofound.europa.eu/en/podcast-and-blog/all/europes-widening-rural-urban-divide-may-make-space-far-right>

¹³ Jennifer McGuinn et al, *Rural areas and the geography of discontent*. European Committee of the Regions, 2024. <https://doi.org/10.2863/87913>

The wave of farmer protests in 2023–2024 across many EU member states has also demonstrated the importance of rural livelihoods. Among the most frequently expressed grievances by protesting farmers were financial strain, burdens from bureaucracy, and policy dissatisfaction.¹⁴ Therefore, when agricultural livelihoods weaken, that erosion can translate into political volatility. Consequently, investing in the living standards of rural communities, including farmers, is vital for social stability and maintaining European social cohesion.

KEY MESSAGES

- Agriculture is a system-critical sector that impacts the EU's overall economic competitiveness, resilience, and food security.
- Crop agriculture directly contributes €246 billion to EU GDP and €5.7 billion to UK GDP, with every €1 billion of crop agriculture output further supporting €2 billion–€3 billion of downstream production in other sectors.
- Crop agriculture employs 2% of all EU workers (around 4.5 million people), and up to 13% of all workers in Romania and 8% of workers in Bulgaria.
- Agriculture is also a cornerstone of rural livelihoods, helping maintain political stability and social cohesion.

¹⁴ Doris Läßle et al, Farmers' voices in European protests: Diverse complaints, emotional tones, and policy responses. *Food Policy*, 138, 102999, 2026.

SECTION 3.

BENCHMARKING EUROPEAN COMPETITIVENESS

3.1. AGRICULTURAL PRODUCTIVITY GROWTH IN THE EU HAS BEEN SLOWER THAN PEERS

Historically, productivity growth in agriculture has led to food becoming more abundant and affordable, even as the global population continued to grow. One of the key measures of agricultural productivity is Total Factor Productivity (TFP).¹⁵ TFP measures how efficiently inputs (such as land, labour, capital, and materials) are converted into outputs (such as crops and animal products). If output grows faster than inputs, it indicates that TFP is growing. Unlike other productivity measures such as yield per hectare or value-added per worker, TFP accounts for a wider range of production inputs, capturing the combined average productivity of all these agricultural inputs. It can therefore signal overall progress in the agriculture sector's technology and efficiency.¹⁶

Over the past 60 years, productivity gains have driven growth in output worldwide, compensating for a significant decrease in agriculture labour and a reduction in land use. In the EU, between 1960 and 2023, the value of EU agricultural output grew by 44%, while the total use of inputs fell by 16%, recording an estimated 72% rise in TFP. This was also accompanied by an 84% fall in agricultural labour. Over the same period, the gross value of crop production grew by 33%, while cropland area fell by 21% and the use of fertilisers by 6%.¹⁷

Productivity growth therefore contributes to food security and strengthens the agriculture sector's competitiveness, creating economic value for farmers. Productivity enhancements that decrease the use of inputs can also support achieving the EU's sustainability goals.¹⁸

In recent times, however, crop output growth in the EU has significantly lagged comparable countries, according to data from the United States Department of Agriculture (USDA).¹⁹ Between 2011 and 2023, average annual crop production growth was estimated at only 0.1% in the EU, in contrast with 1% in the United States, a 2% world average, and 2-3% in China, Canada and India. Brazil was one of the fastest growing markets, averaging 3.3% growth over the period (Figure 10). Overall, average production in 2011-2023, compared to the decade prior (2000-2010), was just 2% higher in the EU, compared to 16% in the United States, 44% in Canada, and 51% in Brazil.

¹⁵ "International Agricultural Productivity," Economic Research Service, US Department of Agriculture, accessed September 30, 2026, <https://www.ers.usda.gov/data-products/international-agricultural-productivity>.

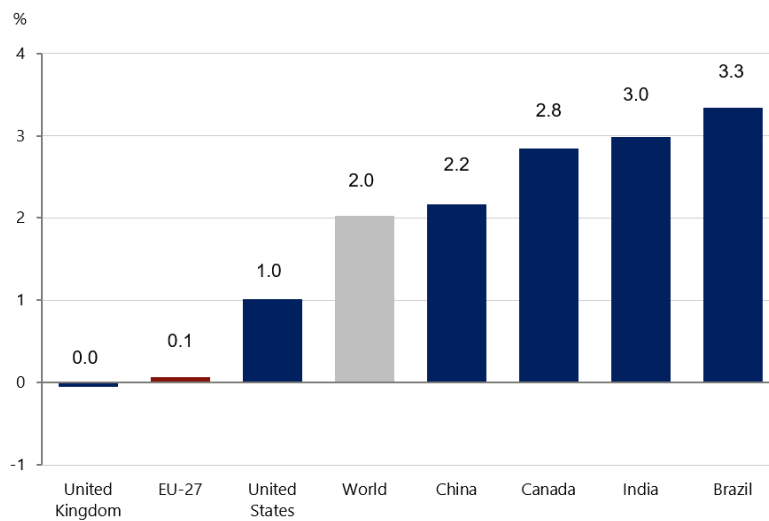
¹⁶ OECD, Policies for the Future of Farming and Food in the European Union, OECD Agriculture and Food Policy Reviews, OECD Publishing, Paris, 2023 <https://doi.org/10.1787/32810cf6-en>

¹⁷ USDA Economic Research Service, "International Agricultural Productivity," last updated January 2026, <https://www.ers.usda.gov/data-products/international-agricultural-productivity>.

¹⁸ OECD, Policies for the Future of Farming and Food in the European Union, OECD Agriculture and Food Policy Reviews, OECD Publishing, Paris, 2023 <https://doi.org/10.1787/32810cf6-en>

¹⁹ USDA Economic Research Service, "International Agricultural Productivity," last updated January 2026, <https://www.ers.usda.gov/data-products/international-agricultural-productivity>.

Figure 10: Average annual growth in crop production (2011-2023)



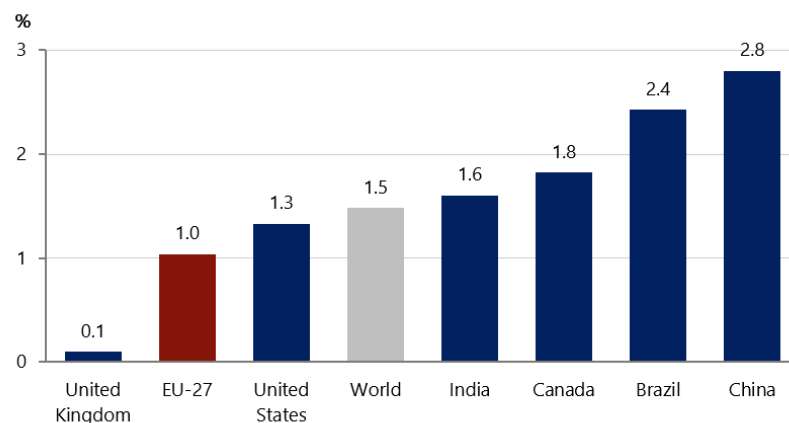
Source: Oxford Economics calculations based on USDA data.

Note: EU-27 excludes the UK as of 2021. Data includes gross value of 162 crop commodities as per FAO statistics.

Low growth in crop production is likely impacted by multiple factors, including the impacts of climate change and extreme weather volatility, rising input costs, environmental constraints, and a small fall in arable land area..²⁰ However, low productivity growth in recent decades may have also played a role.

While internationally comparable TFP levels are difficult to construct, TFP growth estimates allow us to compare the pace of efficiency gains in different countries. From a historical perspective, the EU's agricultural TFP growth outpaced the world average in the 1980s and was broadly in line with that of the United States, Canada, and China, all averaging between 1.6%-2.1%. However, starting the 1990s, the EU's productivity growth has slowed.

Figure 11: Average annual growth in agricultural total factor productivity (TFP) (1990–2023)



Source: USDA. Includes output from crops, livestock and aquaculture

Notes: EU-27 data exclude the UK as of 2021.

²⁰ Eurostat, "Agri-Environmental Indicator – Cropping Patterns," Statistics Explained, European Commission, September 4, 2026, <https://ec.europa.eu/eurostat/statistics-explained/SEPDF/cache/14654.pdf?v=3111348447904198>.

Between 1990 and 2023, agricultural productivity in the EU (measured by TFP) grew by an average of 1% annually, compared to 1.3% in the US, 1.8% in Canada, and up to 2.4% in Brazil and 2.8% in China (Figure 11).²¹ Lower EU productivity growth reflects several factors (including climatic ones).²² In part, it reflects that the EU agricultural sector started from a high level of productivity, reflecting the use of high-quality inputs and capital equipment. Some emerging countries (such as Brazil and China) started from a lower baseline, facilitating faster growth by catching up on technology and skills.

The EU's relatively smaller-sized farms may have also hindered the exploitation of economies of scale. Average farm size in the EU is only around 17.8 ha, compared to 189 ha in the US, and 327 ha in Canada.^{23, 24, 25} In addition, countries such as Canada, the United States, China and Brazil adopted advanced biotech crops starting the late 1990s, with limited cultivation in the EU. Less stringent environmental regulations in other countries may have also facilitated higher yields over sustainability considerations relative to the EU.

Lower capital investment could also be constraining Europe's agricultural productivity growth. In the period 1990-2023, EU capital stock rose by just 0.1% annually on average, compared to 0.4% in the United States, 0.8% in Canada, and 2.1% in the UK, according to USDA data. Low growth in capital investment may undermine future productivity growth in the EU and widen the gap with more capital-intensive agricultural sectors.²⁶

Looking forward, productivity growth is largely driven by innovation and the adoption of technologies that can increase production for the same level of inputs, such as machinery, digital/precision agriculture, improved seeds, better farming practices and climate adaptation technologies. Given that resources such as land and water are finite, productivity growth is the most sustainable source of long-term agricultural growth.

Government regulations and institutions play a key role in enabling agricultural growth and productivity. They impact the cost of production and the degree to which farms can benefit from trade and investment. Unnecessary burdens can hinder the sector's potential. Policies that support innovation and technical change can have a significant impact on TFP growth. For example, research shows that strong TFP growth in emerging markets such as Brazil, China, and India can be credited to strong investments in agricultural research.²⁷ These countries continue to rapidly grow, gradually catching up with the EU.

In the EU, regulations related to innovation and technological adoption—such as those on genetic engineering and synthetic crop protection—are more restrictive than competitor countries, which among the factors mentioned above, can impact productivity outcomes (as discussed further in Section 5).

²¹ USDA Economic Research Service, "International Agricultural Productivity," last updated January 2026, <https://www.ers.usda.gov/data-products/international-agricultural-productivity>.

²² European Commission, 'Increasing competitiveness: The role of productivity', CAP Specific Objectives Brief No. 2.

²³ Eurostat, "Farms and Farmland in the European Union - Statistics," Statistics Explained, European Commission, April 30, 2026, <https://ec.europa.eu/eurostat/statistics-explained/SEPDF/cache/73319.pdf>.

²⁴ USDA Economic Research Service, "Number of U.S. Farms Continues Slow Decline," April 9, 2025, <https://ers.usda.gov/data-products/charts-of-note/111304>.

²⁵ Statistics Canada, "Land Tenure, Census of Agriculture Historical Data," Table 32-10-0228-01, 2022, <https://doi.org/10.25318/3210022801-eng>.

²⁶ OECD, Policies for the Future of Farming and Food in the European Union, OECD Agriculture and Food Policy Reviews, OECD Publishing, Paris, 2023 <https://doi.org/10.1787/32810cf6-en>

²⁷ Keith Fuglie, *Long-term productivity growth in agriculture varies across countries*. U.S. Department of Agriculture, Economic Research Service. <https://www.ers.usda.gov/data-products/charts-of-note/102790>, December 2021

3.2. EU FARMERS ARE FACING HIGH COSTS OF PRODUCTION

European farmers are facing high input costs, especially since the Russian invasion of Ukraine in 2022. The EU's high reliance on imports of natural gas and fertilisers from Russia has been a major source of food price volatility (as discussed in Section 4.2). Disruptions from the war, the subsequent energy crisis, and sanctions significantly raised fertiliser prices, which have not fully eased since. As of 2025, compared to a 2020 baseline, fertiliser prices were up by 60%, energy by 51%, plant protection products by 17%, and machinery and equipment by 25%.²⁸

The Strait of Hormuz closure in 2026 has further led to a significant impact on fertiliser prices. According to the European Commission, nitrogen fertiliser prices were 71% higher in April 2026 than their 2024 average. Given that fertilisers represent 7%–8% of the agriculture sector's input costs, higher prices reduce farmers' profits. They can also sometimes lead to less fertiliser use and therefore lower crop yields. These price increases continue to add pressures on producer margins. Over time, higher input costs can negatively impact the EU's competitiveness in relation to other lower-cost countries.²⁹

3.3. BALANCING SUSTAINABILITY AND COMPETITIVENESS IS A CHALLENGE

Improving competitiveness while simultaneously advancing the EU's sustainability aims represents a policy challenge, as recognised by the European Commission.³⁰ The EU has a wide range of environmental measures in place, aimed at reducing greenhouse gas emissions, improving soil and water quality, protecting biodiversity and promoting more sustainable farming practices. While these measures are important for addressing long-term environmental challenges, their implementation can often be costly and add administrative burden onto farmers.

Under the Common Agricultural Policy (CAP), EU farmers receiving support must comply with "conditionality" requirements, including rules on environmental protection such as water quality and soil protection measures. Failure to comply can result in reduction in CAP payments. A 2025 EU CAP Network survey found that farmers spent an estimated 5.6–8.7 working days a year on administrative tasks, and reliance on paid external advisory services increased from 43% in 2019 to 78% in 2025.³¹

In addition, the EU's Carbon Border Adjustment Mechanism (CBAM), which has been applied from January 2026, will add increasing pressure on fertiliser prices over the coming years. A 2026 study, modelling the combined effects of the CBAM and the phase out of EU Emissions Trading System (ETS) free emission allowances, estimates that mineral fertiliser prices would nearly double in 2030 compared to a reference scenario where these policies are not in place. This is due to an increase in the prices of both imported and domestically produced fertilisers and is estimated to reduce EU agricultural factor income by 7.7%.³²

²⁸ European Commission, Eurostat. (2026). *Purchase prices of the means of agricultural production (apri_pi_ina)* [Data set]. Eurostat Data Browser. https://ec.europa.eu/eurostat/databrowser/view/apri_pi_ina_custom_22404931/default/table

²⁹ European Commission, Ensuring availability and affordability of fertilisers, 2026. https://agriculture.ec.europa.eu/common-agricultural-policy/agri-food-supply-chain/ensuring-availability-and-affordability-fertilisers_en

³⁰ Joint Research Centre (JRC), "EU Agriculture 2040: No Easy Fix for Environmental and Socio-Economic Aspects," European Commission, October 27, 2025, https://joint-research-centre.ec.europa.eu/jrc-news-and-updates/eu-agriculture-2040-no-easy-fix-environmental-and-socio-economic-aspects-2025-10-27_en.

³¹ European Commission – Directorate-General for Agriculture and Rural Development – Unit A.3. Study on simplification and administrative burden for farmers and other beneficiaries under the CAP. 2025. https://eu-cap-network.ec.europa.eu/publications/study-simplification-and-administrative-burden-farmers-and-other-beneficiaries-under_en

³² Davit Stepanyan et al., "Fertilising Climate Policy: The Dual Impact of CBAM on EU Agricultural Emissions and Regional Disparities," *Journal of Agricultural Economics* (2026): 1–17, <https://doi.org/10.1111/1477-9552.70060>.

KEY MESSAGES

- In 2011-2023, crop output growth has significantly lagged peer countries.
- The EU experienced relatively lower growth in agricultural productivity and capital investment over the past three decades, which may undermine the sector's future growth.
- Agricultural input costs have significantly risen, especially since the Russian invasion of Ukraine in 2022.
- In 2025, compared to 2020, prices for fertiliser were up by 60%, energy by 51%, and machinery and equipment by 25%.
- Sustainability measures may raise input prices even further in coming years.
- Higher input costs can negatively impact the EU's competitiveness in relation to other lower-cost

SECTION 4.

THREATS TO EUROPEAN RESILIENCE

4.1. CLIMATE VULNERABILITY IS A KEY RISK TO EUROPE'S FOOD SECURITY

Climate impacts are becoming increasingly noticeable. The 2026 summer crop harvest in the EU has been substantially worse than normal due to extreme heat and drought, with impacts uneven across regions and crops.^{33, 34}

Just as in other regions of the world, climate change impacts on food production represent a key risk to European food security, weighing on food affordability and leading to higher price volatility. Heatwaves are now happening on almost a yearly basis, leading to droughts that have pushed crop losses in the last decade 30% higher than earlier trends predicted.³⁵

The economic impact from climate risks is significant and is expected to increase over time. Annual average loss from climate risks is currently estimated at €17.4 billion (or 6.4% of EU crop production), with large regional variations. By 2050, these figures are estimated to reach between €24.8 billion and €28.9 billion.³⁶ Analysis by the European Commission's Joint Research Centre (JRC) projects that wheat crop yields in Southern Europe will fall by up to 49% by 2050.³⁷

In 2024, the European Environment Agency reported that European agriculture is heading into a decade where climate risk and economic fragility are increasingly becoming intertwined.³⁸ Climate resilience is therefore not just an environmental priority, but also an economic one.

To compensate for large yield losses due to recent extreme weather events, governments are providing costly aid packages to farmers. For instance, in September 2026, the French government announced €1 billion in support to farmers who have experienced severe heat and drought. Economic losses due to climate change can therefore add pressures on already strained government budgets, which are ultimately paid by taxpayers.

³³ Agreste, "Forte chute de la production de maïs attendue en 2026", August 2026. https://agreste.agriculture.gouv.fr/agreste-web/download/publication/publie/IraGcu2698/2026_98inforapgdscultures.pdf

³⁴ European Commission, JRC MARS Bulletin - Crop monitoring in Europe - August 2026 - Vol. 34 No 7, 2026. <https://publications.jrc.ec.europa.eu/repository/handle/JRC146187>

³⁵ European Environment Agency (EEA), *The European biomass puzzle: Challenges, opportunities and trade-offs around biomass production and use in the EU*. EEA Report No 08/2023, Publications Office of the European Union, Luxembourg, 2023. <http://doi.org/10.2800/834565>

³⁶ European Investment Bank (EIB), *Insurance and Risk Management Tools for Agriculture in the EU*. fi-compass (Market analysis), 2025. <https://www.fi-compass.eu/library/market-analysis/insurance-and-risk-management-tools-agriculture-eu>

³⁷ European Commission, Joint Research Centre (JRC), *Analysis of climate change impacts on EU agriculture by 2050*. JRC PESETA IV Project — Task 3, EUR 30078 EN. Publications Office of the European Union, Luxembourg, 2020. <https://doi.org/10.2760/121115>

³⁸ European Environment Agency (EEA), *European climate risk assessment*. Publications Office, 2024. <https://data.europa.eu/doi/10.2800/8671471>

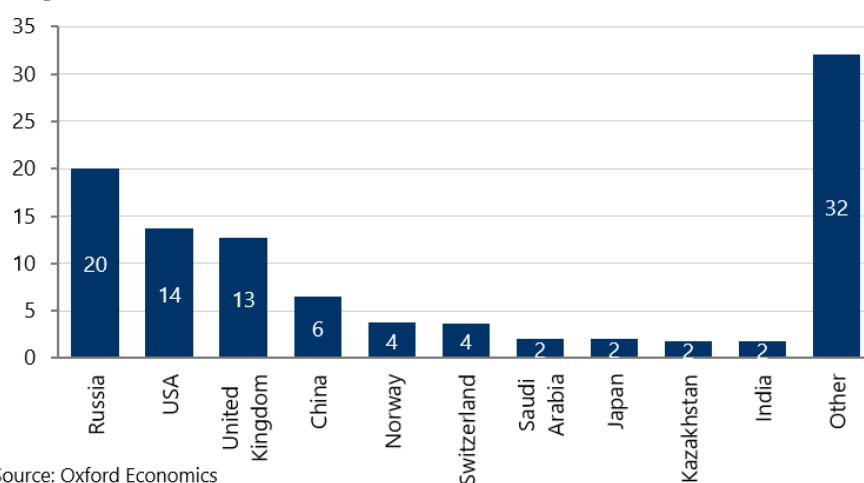
4.2. GEOPOLITICAL INSTABILITIES AND IMPORT DEPENDENCIES ARE A SOURCE OF VULNERABILITY

The EU's food system exhibits some import dependencies for key agricultural inputs, including energy, fertilisers, animal feed, and vegetable oils..³⁹

Overall, of the economic activity stimulated outside the EU along the agricultural supply chain, 20% occurs in Russia and a further 6% in China (Figure 12). This concentration creates vulnerabilities, as disruptions to trade with either country could affect the availability and cost of critical agricultural inputs and increase risks to the resilience of the EU food supply chain..⁴⁰

Figure 12: Share of economic activity stimulated by the EU crop sector's procurement outside of the EU

% of gross value added stimulated outside of the EU



Source: Oxford Economics

Fertiliser consumption is particularly import-dependent, with imports accounting for 70% of phosphatic fertilisers, around 40% of potassium fertilisers, and 30% of nitrogen fertilisers used in the EU..⁴¹

Dependency on fertilisers from Russia is particularly high, accounting for 29% of the EU's fertiliser imports in 2021. Due to food security considerations, they were initially excluded from the EU's sanctions post-2022 and continued to account for 22% of fertiliser imports in 2025 (Figure 13). In mid-2025, the EU introduced new tariffs on Russian fertilisers, with the aim of reducing this import dependency..⁴² These are likely to reduce but not eliminate reliance on Russian imports.

Reliance on Russian natural gas has also been a major source of food inflation. Fertiliser production relies heavily on natural gas, both as a raw material and an energy source for production. Natural gas therefore accounts for

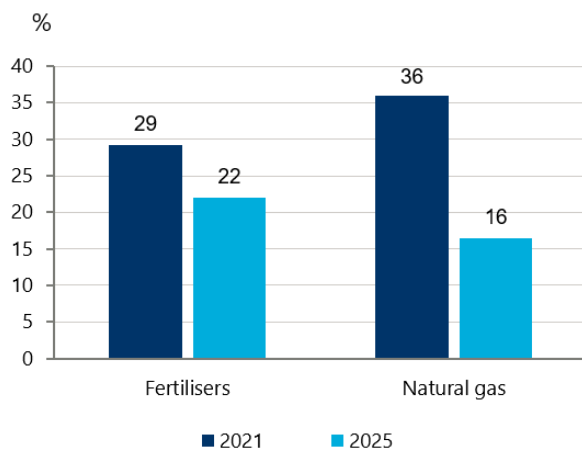
³⁹ European Environment Agency (EEA), *Europe's environment and climate: Knowledge for resilience, prosperity and sustainability* (EEA Report No. 11/2025). <https://doi.org/10.2800/3817344>

⁴¹ European Commission, *Ensuring availability and affordability of fertilisers*. Agriculture and Rural Development. Retrieved August 13, 2026, from https://agriculture.ec.europa.eu/common-agricultural-policy/agri-food-supply-chain/ensuring-availability-and-affordability-fertilisers_en

⁴² Council of the European Union, "Trade: EU Adopts New Tariffs on Russian and Belarusian Agricultural Goods and Fertilisers," press release, June 12, 2025, <https://www.consilium.europa.eu/en/press/press-releases/2025/06/12/trade-eu-adopts-new-tariffs-on-russian-and-belarusian-agricultural-goods-and-fertilisers/>.

70% of the cost of producing fertilisers..⁴³ In 2021, the EU imported 36% of its natural gas from Russia, which fell amid EU sanctions but remains significant, accounting for 16% of imports in 2025 (Figure 13).

Figure 13: Russia's share in EU imports



Source: Eurostat

These dependencies leave the EU's food system exposed to geopolitical and supply chain disruptions. In recent years, the energy and commodity price shocks introduced by the Russian invasion of Ukraine led to annual food inflation recording 19.6% in March 2023, with cereal prices rising by 26.6% for consumers in the EU. In June 2026, food prices in the EU were 30% higher than they were pre-war at the start of 2022..⁴⁴

KEY MESSAGES

- Climate vulnerability is a key risk to European food security and is becoming increasingly intertwined with economic fragility.
- Annual average loss from climate risks is currently estimated at €17.4 billion (or 6.4% of EU crop production) and is expected to increase over time.
- By 2050, wheat crop yields in southern Europe are projected to fall by up to 49%.
- In addition, the EU is dependent on imports of some key inputs, such as fertilisers and natural gas, which leave its food system exposed to geopolitical and supply chain disruptions.

⁴³ European Commission. Ensuring availability and affordability of fertilisers, 2026. https://agriculture.ec.europa.eu/common-agricultural-policy/agri-food-supply-chain/ensuring-availability-and-affordability-fertilisers_en

⁴⁴ European Commission, Eurostat. Food price monitoring tool (prc_fpmt_m) [Data set], 2026. https://ec.europa.eu/eurostat/databrowser/view/prc_fpmt_m_custom_22408501/default/table

SECTION 5.

THE ROLE OF INNOVATION AND CURRENT BARRIERS

5.1. INNOVATION CAN HELP MAINTAIN COMPETITIVENESS AND RESILIENCE

Modern agricultural technologies are critical for addressing the EU's strategic challenges, including food security and environmental sustainability. Innovations such as genetic engineering, crop protection solutions, and digital technologies can significantly improve productivity and the efficiency of land use..⁴⁵

Raising productivity growth can improve the sector's competitiveness in relation to other countries, supporting food security and resilience, while productivity enhancements that decrease the quantity of inputs used can promote environmental sustainability..⁴⁶ Innovation can also unlock climate resilience through investments in technologies that support adaptation, helping Europe with future preparedness for increasing climate pressures.

However, some of the current barriers to the wider expansion of agricultural innovation include the regulatory environment and public perceptions, necessitating the move towards a more science-based public debate.

5.2. MODERN AGRICULTURAL TECHNOLOGIES ARE ADVANCING FASTER THAN THEIR ADOPTION IN THE EU

5.2.1. GENETICALLY MODIFIED CROPS (GMOS)

GMOs are plants whose DNA has been edited using genetic engineering, often through introducing a gene from another species to produce a new, desirable trait. For example, the development of insect-resistant crops has helped minimise crop losses due to insect pests, one of the major causes of crop losses worldwide.

Genetically modified (GM) crops help solve various practical farming problems, such as through better controlling weeds, reducing crop losses from insects, and resisting plant diseases. As such, GM technology adoption has been estimated to reduce the use of chemical pesticides by 37%, raise crop yields by 22%, and increase farmer profits by 68%..⁴⁷

While developing a new plant variety with a useful trait can usually take 10-25 years using conventional breeding methods, advanced genetic engineering methods can significantly speed up the process, reducing it to 7-10 years..⁴⁸ Faster breeding methods help farmers deal with emerging challenges sooner, reducing crop losses through the use of crops that can better withstand diseases, insects, and weather stressors.

⁴⁵ Xie Chen, The role of modern agricultural technologies in improving agricultural productivity and land use efficiency. *Frontiers in Plant Science*, 16. 2025 <https://www.frontiersin.org/journals/plant-science/articles/10.3389/fpls.2025.1675657/full>

⁴⁶ OECD, Policies for the Future of Farming and Food in the European Union, OECD Agriculture and Food Policy Reviews, OECD Publishing, Paris, 2023 <https://doi.org/10.1787/32810cf6-en>

⁴⁷ Wilhelm Klümper and Matin Qaim, A meta-analysis of the impacts of genetically modified crops. *PloS one*, 9(11), e111629. 2014

⁴⁸ Marcos Basso et al, Insights into genetic and molecular elements for transgenic crop development. *Frontiers in Plant Science*, 11, 509. 2020 <https://doi.org/10.3389/fpls.2020.00509>

GM crops were first commercialised in the 1990s and are widely used in many leading agriculture economies. In the US, over 90% of corn, cotton, soybeans, canola, and sugar beets are currently produced using genetically engineered varieties.⁴⁹ Brazil also produces 99% of its soybeans and cotton from biotech varieties, which contributed to the country being the largest soybean and cotton exporter globally.⁵⁰ As of 2025, 30 countries plant GM crops, amounting to 216 million hectares, with Ghana being the most recent addition through its cultivation of GM cowpea. Overall, around 90% of crop area currently comes from the US, Brazil, Argentina, Canada, and India, with China also expanding its cultivation in recent years.⁵¹

Since their adoption, GM crops have produced significant economic benefits for farmers through improved yields,⁵² but the EU has largely missed out on this technology. The adoption of the “precautionary principle” under EU law, in addition to public misperceptions regarding the safety of GM crops, have contributed to the EU historically maintaining one of the strictest regulatory systems for GMOs and very limited adoption (as further discussed in Section 5.2.1).

The EU largely adopts a *process-based regulatory system* for GM crops, rather than the *product-based system* used in many countries such as Canada and Brazil. A *product-based system* regulates a plant according to its final traits, applying scrutiny proportional to the risks the trait introduces, regardless of whether the product was produced through genetic engineering, conventional breeding, or other breeding methods. Regulators who adopt this method argue that a new trait can create the same risks regardless of the breeding method used. In contrast, the *process-based system* adopted in the EU regulates the *technological process* used to develop the product. This approach automatically subjects GMOs to a stricter regulatory pathway just because of the technique used, regardless of the resulting trait’s actual risk profile. Therefore, under the EU’s process-based system, a genetically edited crop with a trait, indistinguishable from one created through conventional breeding, has historically faced the full regulatory burden reserved for GMOs, while under a product-based system it would have not. However, the EU is currently moving to a more hybrid system, with new rules recently introduced for new genomic techniques (NGTs), as discussed in the following section.

5.2.2. GENOME EDITING / NEW GENOMIC TECHNIQUES (NGTS)

New genomic techniques (NGTs) are newer approaches to genetic modification, which can make highly precise changes to a plant’s DNA, often without inserting foreign DNA. NGT-edited crops can closely resemble plants that could have been produced naturally through conventional breeding methods, but they are developed much faster and more precisely.

The EU’s regulatory framework for agricultural biotechnology has been slow to adapt to scientific developments, remaining largely static over the past two decades. Until recently, all plants produced with any form of gene editing were treated the same as traditional GMOs, relying on outdated legislation dating back to 2001. However, in April 2026, the European Council adopted new rules specifically for NGTs, which are expected to take effect from mid-2028. This regulatory development came years later than in peer countries. NGT regulation was introduced in 2018 in Brazil, 2019 in the United States, 2022 in China, and 2023 in Canada.⁵³

The new EU regulations distinguish between two categories. Products falling into the NGT-1 category are those that can be considered equivalent to conventional varieties and producers will only need to seek verification on the initial product, offspring will not need to be checked, and products do not need to be labelled except for

⁴⁹ U.S. Department of Agriculture, Economic Research Service. (2025, December 12). *Biotechnology*. <https://www.ers.usda.gov/topics/farm-practices-management/biotechnology>

⁵⁰ United States Department of Agriculture USDA. *Biotechnology and Other New Production Technologies Annual*. 2025.

⁵¹ AgbioInvestor, “Global GM Crop Area Review”, May 2025. <https://gm.agbioinvestor.com/downloads/9>

⁵² Graham Brookes and Peter Barfoot, “Economic Impact of GM Crops: The Global Income and Production Effects 1996–2012,” *GM Crops & Food* 5, no. 1 (2014): 65–75, <https://doi.org/10.4161/gmcr.28098>.

⁵³ Agnès Ricoch et al., “Global Status of Genome Editing versus Transgenesis Legislation in Plants and the Current EU Situation,” *npj Science of Plants* 2, no. 1 (2026): 3, <https://doi.org/10.1038/s44383-025-00016-2>.

seeds and other reproductive material. On the other hand, NGT-2 products, resulting from more complex genetic modifications, remain subject to the same rules of authorisation, labelling, and traceability as traditional GMOs.⁵⁴

Gene editing has the potential to address EU challenges such as climate change and biodiversity loss, and improve food security, and nutrition. However, the development and potential benefits of NGTs will likely depend on regulation, consumer preferences, supply chains, and intellectual property right strategies.⁵⁵

According to the UN Food and Agriculture Organization (FAO), public perception and social acceptance can also significantly impact the development of NGT products, and therefore public trust in scientists, governments, and developers will be important.

5.2.3. CROP PROTECTION PRODUCTS

Crop pathogens and pests result in significant losses of major crops, leading to large economic losses and a reduction in food security. Experts estimate that globally, pests and pathogens lead to yield losses of 21.5% of wheat, 22.5% of maize, 30% of rice, 17.2% of potatoes, and 21.4% of soybeans.⁵⁶

Crop protection products – such as herbicides, insecticides, fungicides, and biological controls – aid farmers in protecting their crops from pests, diseases and weeds. Their responsible use helps farmers increase food production and improve crop quality. Crop protection products can be broadly divided into biological and synthetic chemical pesticides.

The EU adopts relatively restrictive regulations for pesticides, through the use of “hazard-based cut-offs” (as further discussed in Section 5.2.1), with targets set to reduce the use and risk of chemical pesticides by 50% by 2030 (against a 2015–2017 baseline).⁵⁷ EU policy direction has therefore led to the number of authorised active ingredients falling significantly over time. While over 1,000 active substances were authorised in the EU in the early 2000s,⁵⁸ this figure has now fallen to 420 substances according to 2025 analysis by the German Agriculture Society (DLG).⁵⁹ In addition, approval of new substances has been slow, resulting in a shrinking toolkit for farmers (as discussed further in Section 5.3.2).

Over time, many pests develop resistance to crop protection agents. Farmers therefore need a wide range of active substances to be available for the different crop protection purposes, and to adapt to emerging challenges. There are also cases when the withdrawal of effective crop protection tools can increase the cost and intensity of pest management, especially where alternatives are less effective. For example, research in Hungary found that following the withdrawal of neonicotinoids for sugar beet production due to their harmful impact on bees, farmers increased their reliance on less effective alternative insecticides which required multiple treatments.

⁵⁴ Council of the EU, *New genomic techniques: Council adopts new rules to boost sustainable and competitive EU food systems*. 2026. <https://www.consilium.europa.eu/en/press/press-releases/2026/04/21/new-genomic-techniques-council-adopts-new-rules-to-boost-sustainable-and-competitive-eu-food-systems/>, accessed 13 July 2026.

⁵⁵ Stéphane Lemarié and Stéphan Marette, The socio-economic factors affecting the emergence and impacts of new genomic techniques in agriculture: A scoping review. *Trends in Food Science & Technology*, 129, 38-48. 2022

⁵⁶ Savary, S., Willocquet, L., Pethybridge, S.J. *et al.* The global burden of pathogens and pests on major food crops. *Nat Ecol Evol* 3, 430–439 (2019). <https://doi.org/10.1038/s41559-018-0793-y>

⁵⁷ European Commission, “Pesticide Reduction Targets – Progress,” accessed September 21, 2026, https://food.ec.europa.eu/plants/pesticides/sustainable-use-pesticides/pesticide-reduction-targets-progress_en.

⁵⁸ European Commission: Directorate-General for Health and Food Safety, Ramboll and Arcadia International, [Directorate-General for Health and Food Safety, Ramboll, Arcadia International], *Study supporting the evaluation of Directive 2009/128/EC on the sustainable use of pesticides and impact assessment of its possible revision – Evaluation – Abstract*, Publications Office of the European Union, 2022, <https://data.europa.eu/doi/10.2875/943244>

⁵⁹ DLG Committee for Crop Protection. (2025). *Why we need modern crop protection*. DLG e.V. <https://www.dlg.org/en/mediacenter/position-papers/why-we-need-modern-crop-protection>

More frequent application of alternative chemicals has led to higher environmental stress and honeybee mortality, in addition to increasing the time and production costs spent by farmers.⁶⁰

5.2.4. DIGITAL AGRICULTURE (INCLUDING AI-ENABLED TECHNOLOGIES)

The use of digital technologies can have a significant impact on farm efficiency and productivity. Smart irrigation can boost water efficiency by 40%–60%, while automation and robotics mitigate labour shortages and reduce costs by 25%. Precision agriculture, through the use of GPS technology, drone monitoring, and IoT-connected sensors, can boost crop yields by 20%–30% while reducing waste in inputs by about 40%–60%.⁶¹ AI-driven analytics improve decision-making, delivering forecasting and resource-allocation accuracy that exceeds 90%. However, these advantages are sometimes held back by high implementation costs, limited technical know-how among users, and regulatory hurdles. These barriers fall hardest on small-scale farmers trying to adopt the technology.

Farmers in Europe lag peers in adopting technology. According to McKinsey's Global Farmer Insights Survey, only 46% of European farmers surveyed in 2024 report using at least one technology, compared to 74% in the United States and 53% in Brazil. This is likely driven by smaller average farm sizes in Europe, given that larger farms have a higher adoption of advanced technologies. Similarly, in a further 2026 study, 13% of surveyed European farmers reported using Generative AI, compared with 23% in North America, and 26% in Latin America.⁶²

Digital connectivity is a prerequisite for the adoption of many advanced farming technologies. However, the European Commission's Joint Research Centre found that 15% of farms, primarily in rural areas, still faced poor internet access, inhibiting their ability to adopt digital technologies.⁶³ In addition, although 93% of EU farms used basic information technologies, more advanced technologies such as automatic steering systems or soil sensors lay within the range of 9%–25%.

The EU has established an ambitious policy agenda, including the Common European Agricultural Data Space and the integration of artificial intelligence into agriculture. However, the OECD notes that implementation remains at an early stage.⁶⁴ Especially with the regard to AI, uptake is still limited, with investment in robotics and autonomous agricultural systems particularly lagging the US and China.⁶⁵

This suggests that expanding digital and AI capabilities, improving access to finance, and accelerating deployment of advanced technologies will be essential if the EU is to remain competitive on the global stage.

Figure 14: Summary of the EU's adoption of agricultural technology relative to peers

Domain		EU position relative to peers
Traditional GMOs		Essentially absent (one crop, two countries). ⁶⁶ ; US/Brazil/Argentina/ Canada/India dominate globally, accounting for over 90% of global GM crop area in 2025. ⁶⁷
New genomic techniques (NGTs)		Newly authorised in the EU as per 2026 regulation, but will not apply until 2028. ⁶⁸ ; Late adopter compared to the US, Brazil, China and Canada. Commercialisation of genome edited crops started as early as 2019 in the US. ⁶⁹
Crop protection (synthetic)		Lower regulatory tolerance; rapidly declining number of approved active ingredients. ⁷⁰
Crop protection (biological)		Increasingly used, but there are regulatory bottlenecks. ⁷¹ ⁷²

Domain	EU position relative to peers
Digital/AI	 Less adoption of digital technologies than in North America and Latin America; Ambitious dataspace and sustainability-linked AI framework still being built. ⁷³ ; Robotics investment and integration currently lag behind the most digitised US/Chinese large-scale operations.. ⁷⁴

 = low adoption/highly restrictive regulations
 = medium adoption/somewhat restricted

5.3. EU AGRICULTURAL INNOVATION FACES SEVERAL BARRIERS

5.3.1. THE 'PRECAUTIONARY PRINCIPLE', PUBLIC MISPERCEPTIONS, AND TRUST IN SCIENCE

EU agricultural policy is heavily influenced by the “precautionary principle”, a fundamental principle under EU law which allows policymakers to take preventative measures when there is uncertainty about a potential risk from a new product, even before there is scientific evidence of harm.

The precautionary principle has contributed to the EU adopting a stricter stance on various technologies compared to peer countries. With regards to pesticides, the EU uses “hazard-based cut-offs”, which means that if a product has a property deemed hazardous, it can be excluded from approval even if the exposure could potentially be kept very low. On the other hand, major agricultural producers, including the US, Canada, Australia, and Brazil, use a more “risk-based” approach which considers not just how hazardous the substance is, but also how much people and the environment are actually exposed to it..⁷⁵ Some products may be permitted with restrictions if realistic exposure can be demonstrated to be sufficiently low and assessed to demonstrate an

⁶⁰ Jócsak, I., Csima, F., Pál-Fám, F., Somfalvi-Tóth, K. and Keszthelyi, S. 'Plant protection consequences in Hungary of the withdrawal of systemic active substances from sugar beet seed treatment' *Sec Pest Management*. 6. 2024.

<https://doi.org/10.3389/fagro.2024.1363950>

⁶¹ Xie Chen, The role of modern agricultural technologies in improving agricultural productivity and land use efficiency. *Frontiers in Plant Science*, 16. 2025 <https://www.frontiersin.org/journals/plant-science/articles/10.3389/fpls.2025.1675657/full>

⁶² McKinsey & Company, "Global Farmer Insights 2026," 2026, <https://www.mckinsey.com/industries/agriculture/our-insights/global-farmer-insights>.

⁶³ European Commission, 'The state of digitalisation in EU agriculture - Insights from farm surveys'. 2025, accessed 25 July 2026

⁶⁴ OECD, Progress in Implementing the European Union Coordinated Plan on Artificial Intelligence (Volume 2): Uptake in High-Impact Sectors, OECD Publishing, Paris, 2026. <https://doi.org/10.1787/3ac96d41-en>.

⁶⁵ Council of the European Union, *From screens to fields - Publications Office of the EU*, 2024

⁶⁶ OECD (2026) 'A comparison of the innovation and regulatory environments for biotechnology and biosolutions across the European Unions and the United States', p. 322026, accessed 23 July 2026]

⁶⁷ Haolui Liet al., 'Global trends in the commercialization of genetically modified crops in 2024' *Journal of Integrative Agriculture* 25(4) pp. 1308-1309, 2026

⁶⁸ *New Genomic Techniques: Council adopts new rules to boost sustainable and competitive EU food systems* Council of the EU (2026)

⁶⁹ Alexios Polidoros et al., 'Genome-Editing Products Line up for the Market: Will Europe Harvest the Benefits from Science and Innovation?' p. 6, 2024

⁷⁰ European Commission *Plant Protection Product Regulations*

⁷¹ European Commission Food Safety 2025 *Pesticides and MRLs Legislation*

⁷² OECD *Biological Pesticide Regulation Comparison*

⁷³ OECD, Progress in Implementing the European Union Coordinated Plan on Artificial Intelligence (Volume 2): Uptake in High-Impact Sectors, OECD Publishing, Paris, 2026 <https://doi.org/10.1787/3ac96d41-en>.

⁷⁴ Council of the European Union, *From screens to fields - Publications Office of the EU*, 2024

⁷⁵ Health Canada, "Risk-Based and Hazard-Based Approaches to Pesticide Assessment," Canada.ca, last modified June 16, 2026, <https://www.canada.ca/en/health-canada/services/consumer-product-safety/pesticides-pest-management/public/protecting-your-health-environment/pesticide-registration-process/risk-hazard-based-approaches-assessment.html>.

acceptable level of risk. The use of hazard-based cut-offs leads to the EU market having significantly fewer approved active ingredients than peers such as the US.

Public misperceptions regarding the safety of some agricultural technologies are also prevalent. For example, although scientific evidence does not support claims that GM crops are harmful to human health,⁷⁶ there are widespread public misperceptions leading to highly strict regulations. While debates on NGTs have also been polarised in the EU,⁷⁷ they have been authorised in 2026. However, this approval came much later than in comparable countries, which deprived the EU of their productivity and sustainability benefits for many years. Overall, the EU's regulatory process, combined with public misperceptions, often leads to political considerations overriding scientific evidence.^{78, 79}

Europeans value science and technology, with 83% believing their overall influence is positive, and 67% agreeing they make lives healthier and more comfortable. In addition, 72% think that governments should ensure new technologies benefit everyone.⁸⁰ These views suggest that EU citizens would likely be supportive of more science-based regulation.

While 58% of Europeans are interested in learning more about scientific developments, 53% think that science is too complicated and that they lack sufficient understanding about it. In addition, despite EU citizens generally trusting science, those actively distrusting can have a disproportionate impact on public conversations related to science,⁸¹ impacting policy and the spread of misinformation. Both governments and scientific institutions can therefore play a role in maintaining public trust in science through better communication and public engagement.

5.3.2. REGULATORY COMPLEXITY: HIGH COSTS AND LONG APPROVAL TIMELINES

In the EU, the complex regulatory system is one of the major challenges facing the adoption of innovation from technological advancements.

While many chemical pesticides have been gradually phased out from EU authorisation in the past years, approval of new substances has been slow. According to CropLife Europe—a trade body representing Europe's crop industry—farmers have lost access to 92 crop protection solutions, conventional pesticides and biopesticides over the last seven years, while only one new conventional pesticide was released on the market during that time. In addition, over half of new crop protection solutions are held up in the EU's regulatory approval process, according to CropLife Europe.⁸² Farmers are therefore losing access to existing crop protection tools much faster than new innovations can replace them. As a result, their toolkit is shrinking, leaving them with fewer options to protect their crops, despite continuous scientific progress and novel solutions.

Registration of agricultural technologies is often more complex in the EU than in competitor countries due to the combination of EU-level and Member State-level procedures, resulting in longer and more expensive processes. Registration costs for bringing a new agrochemical active ingredient to market in the EU are estimated

⁷⁶ Ah Young Kim et al., Genetically modified foods and human health: a comprehensive review and cross-national time-trend analysis. *GM Crops & Food*, 17(1), 2634489, 2026. <https://doi.org/10.1080/21645698.2026.2634489>

⁷⁷ European Commission, *Commission Staff Working Document: Impact Assessment Report Accompanying the Document Proposal for a Regulation of the European Parliament and of the Council on Plants Obtained by Certain New Genomic Techniques and Their Food and Feed, and Amending Regulation (EU) 2017/625*, SWD(2023) 412 final (Brussels, July 5, 2023), <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52023SC0412>.

⁷⁸ Stuart J. Smyth et al., Removing politics from innovations that improve food security. *Transgenic research*, 30(5), 601-612, 2021. <https://doi.org/10.1007/s11248-021-00261-y>

⁷⁹ Stuart J. Smyth, Regulatory barriers to improving global food security. *Global food security*, 26, 100440, 2020. <https://doi.org/10.1016/j.gfs.2020.100440>

⁸⁰ European Commission, *European citizens' knowledge and attitudes towards science and technology*, Eurobarometer survey. 2025. <https://europa.eu/eurobarometer/surveys/detail/3227>

⁸¹ RAND Europe, *Public trust in science: overview findings on trust and scientific trustworthiness*, 2026. https://cms.wellcome.org/sites/default/files/2026-06/Wellcome_Rand_Public_Trust_in_science_Report_1_Summary.pdf

⁸² CropLife Europe, *Farmers' toolbox*. Retrieved August 12, 2026, from <https://croplifeeurope.eu/farmers-toolbox/>

at \$21.4 million, compared to \$14 million in the US, as per a 2020-2023 survey of five major EU/US agricultural technology companies.⁸³

The survey also found that re-registration costs for active ingredients cost \$15.3 million in the EU, roughly ten times higher than in the US (\$1.5 million) and more than 17 times higher than in other jurisdictions. However, this may be partially impacted by higher requirements in the EU, making the data prepared for the European application process sometimes sufficient for applications in other countries.

Overall, the lead time from product synthesis to commercialisation of an active ingredient in the EU/US market was estimated to have increased from 9.8 years in 2005-2008 to 11.4 years in 2020-2023, with a total cost of \$307 million (€276 million). The study suggests that contributing factors to the longer lead time include the increasing amount and complexity of data required by regulatory bodies, and the impact of Brexit given that the UK had been a key contributor in the regulatory approval process.

Agricultural technology companies invest significant amounts in researching, developing, and registering new products. For a product to be viable, companies must be able to recover these costs once the product reaches the market. In addition, given that patent protection is time-limited, long processes limit the time a company is able to recover its innovation spend.

Lengthy and costly regulatory processes therefore lead to an innovation bottleneck, pushing companies to commercialise in faster-moving markets, which can negatively impact the EU's future agricultural productivity. Every year added to the regulatory clock is a year EU farmers operate with a narrower toolkit than competitor countries, leading to lower yields, higher production costs, and reduced resilience against pests and disease.

Streamlining approval timelines, reducing registration costs, and adopting a risk- rather than a hazard-based system—without abandoning safety standards—would allow the EU to capture the productivity and efficiency gains its competitors already enjoy, boosting domestic production and reducing reliance on imports in an increasingly volatile global market.

5.4. SLOW, RESTRICTIVE INNOVATION ADOPTION REPRESENTS AN OPPORTUNITY COST

Slow and restrictive regulations have a cost in terms of lost productivity gains, with potential impacts on the agriculture sector's competitiveness and resilience. In a 2026 communication, the European Commission reports that while Europe produces high-quality scientific output in agriculture and food systems, insufficient private investments in research and innovation can hinder competitiveness.⁸⁴ In addition, low regulatory agility makes it harder for the agriculture sector to adapt to a rapidly changing global competitive environment.

Without sufficient and timely adoption of innovation, European agriculture risks falling behind producers in other markets that are making greater use of new technologies. This could constrain productivity growth, weaken the competitiveness and resilience of European agriculture, and ultimately place additional pressure on farmers and consumers. Therefore, expanding digital and AI capabilities, improving access to finance, and accelerating deployment of advanced technologies will be essential if the EU is to remain competitive on the global stage.

⁸³ AgbioInvestor. *Time and cost of new agrochemical product discovery, development and registration: Study results*. CropLife International. 2026 <https://croplife.org/wp-content/uploads/2026/05/AgbioInvestor-The-Cost-of-New-Agrochemical-Product-Discovery-Development-and-Registration.pdf>

⁸⁴ European Commission, *New Strategic Approach to Research and Innovation for Competitive, Resilient and Sustainable Agriculture, Forestry, Rural Areas and Food Systems*, 2026, <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:52026DC0453>.

In 2023, the Alliance for Science estimated that not adopting NGTs in the EU represented a significant economic opportunity cost, ranging between €72 billion and €123 billion annually for agriculture and food applications..⁸⁵ Slow innovation adoption can therefore hinder the potential benefits from emerging technologies.

KEY MESSAGES

- Innovation can help improve competitiveness, while promoting the EU's sustainability objectives, through technologies that reduce input costs, raise productivity, and enhance resilience.
- However, modern agricultural technologies are rapidly advancing, faster than their approval and adoption in the EU.
- NGTs can help address challenges such as climate change and biodiversity loss, but their authorization in the EU has significantly lagged other countries.
- For crop protection, the EU adopts a more restrictive regulatory approach, using "hazard-based cut-offs", which lead to fewer approved ingredients compared to peer countries. EU farmers are also losing access to existing tools faster than new products can replace them, resulting in a shrinking toolkit to protect their crops, despite continuous scientific progress.
- There is also untapped potential from the adoption of digital technologies, including AI, with lower adoption in the EU than in comparator countries.
- Technological adoption is constrained by regulatory barriers, the "precautionary principle" and public misperceptions.
- Registration of agricultural technologies in the EU often involves more complex procedures, which can lead companies to commercialise in faster-moving markets.
- Slow and restrictive regulations represent an opportunity cost in terms of lost productivity gains, impacting the agriculture sector's performance.

⁸⁵ Alliance for Science, The €3 trillion cost of saying no: How the EU risks falling behind in the bioeconomy revolution, 2023. https://allianceforscience.org/wp-content/uploads/2023/10/Foregone-benefits-of-gene-editing-in-the-EU_FINAL.pdf

SECTION 6.

CONCLUSIONS AND WAY FORWARD

6.1. CONCLUSIONS

Crop agriculture is a system-critical, strategic sector. It makes significant contributions to GDP and employment, in addition to strong supply chain linkages with other sectors. It impacts the EU's overall competitiveness, resilience, and food security, while being a cornerstone of rural livelihoods and a determinant of food availability and affordability.

Agricultural competitiveness in the EU is undermined by low productivity growth and rising input costs. In recent decades, agriculture productivity in the EU grew slower than in comparable countries, with crop output flatlining over the last decade. In addition, input prices have significantly risen, especially since 2022. The EU's sustainability measures are likely to lead to further input price increases in the coming years. Higher input costs and low productivity can lead to a loss in the EU's competitiveness compared to other faster growing, lower-cost countries.

Resilience is increasingly threatened by climate vulnerabilities and geopolitical instability. Climate change is leading to significant crop losses, and the impact is expected to increase over time. In addition, the EU's import dependence on some agricultural inputs such as fertilisers and natural gas has led to vulnerabilities and large price shocks in recent years.

More access to modern technologies can support farmers in addressing these significant challenges, strengthening the agriculture sector's competitiveness and resilience. To compete in an increasingly innovation-driven global market, while maintaining resilience against climate impacts and geopolitical shocks, and working towards sustainability targets, the EU must ensure farmers have access to a wide toolbox of agricultural technologies in a timely manner.

Competitiveness and resilience are also interconnected. A more productive agriculture sector helps maintain food security and affordability, and is more resilient to external shocks. On the other hand, a more resilient agriculture sector that can withstand emerging threats can remain more competitive.

However, regulatory barriers and public misperceptions are constraining technology adoption. Slow and restrictive regulations result in European farmers having a more limited toolbox than competitor countries, especially for synthetic crop protection and genetically engineered crops. Lags in technology adoption are an opportunity cost in terms of lost productivity gains, impacting competitiveness and resilience.

6.2. POLICY IMPLICATIONS

1. **Agriculture policy should not be siloed off in policy discussions, but prioritised as a strategic sector with a clear vision as part of Europe's broader resilience and competitiveness framework.** In 2024, Mario Draghi's report on *The Future of European Competitiveness* outlined recommendations for boosting Europe's productivity and identifying "growth engines" that could address pressing challenges related to trade, energy and defence. However, agriculture was not addressed as one of the 10 sectors receiving specialised sectoral chapters. While agriculture policy prospects were discussed in a separate report, the *Strategic Dialogue on the Future of EU Agriculture*, they are siloed off from the EU's top competitiveness agenda. As this report has argued, the agriculture sector is critical to food security, economic resilience, and competitiveness. Therefore, it must be further recognised as one of Europe's key strategic sectors, with a clear and ambitious vision to push the sector to the next level.
2. **Innovation must be at the centre of agricultural policy, with regulation keeping pace with technological developments.** While large resources are dedicated to the Common Agricultural Policy (CAP), they are mostly directed towards income support to farmers rather than promoting technology and innovation. Further strengthening agricultural innovation systems in Europe can contribute towards achieving the EU's Competitiveness Compass' aims to close the innovation gap and reduce dependencies. It is also vital for adapting to the impacts of climate change and strengthening resilience against global shocks.

The EU's regulatory framework has delayed the adoption of various technologies that are widely used in other countries. While new laws on NGTs have been recently introduced, they have lagged years behind competitors. The speed of implementation of these laws will therefore be crucial to make use of their benefits, including their potential to address pressing challenges such as climate change.

With regards to crop protection solutions, when products are discontinued, policy should ensure there are viable, timely alternatives to ensure farmers have a sufficient toolbox to tackle new agronomic challenges as they arise.

3. **There is a need to make the regulatory system more risk-proportionate, weighing the exposure to risk with the potential benefits for food security and resilience.** The EU relies heavily on the precautionary principle, which often leads to a restrictive stance on some of the modern biotechnologies. While risks must be assessed, potential security and resilience benefits must also be taken into consideration. There is also a need to move to a more science-based public debate and address public misperceptions on agricultural technologies. Overall, farmers need access to a broader toolkit to be able to address emerging agronomic challenges and maintain their competitiveness.

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