CETEX

Centre for Economic Transition Expertise

Research and Policy at **LSE**

Rooted in resilience: crop insurance as a fiscal tool for climate adaptation and nature restoration in the EU agri-food system

Wallis Greenslade, Daisy Jameson and Madeleine Tron

Policy report

May 2026

LSE Global School of Sustainability

CETEx — the Centre for Economic Transition Expertise — was established in 2024 at the London School of Economics and Political Science as a specialised research and policy centre to support the ambitious reforms required to deliver sustainable, inclusive and resilient economies and financial systems across Europe and emerging markets. The Centre is hosted by the Global School of Sustainability and has founding funding from the Sequoia Climate Foundation, ClimateWorks Foundation, Children's Investment Fund Foundation, Sunrise Project and European Climate Foundation. www.cetex.org

About the authors

Wallis Greenslade is a Policy Fellow at CETEx.

Daisy Jameson is a Senior Policy Fellow at CETEx.

Madeleine Tron is an Occasional Research Assistant at CETEx.

Acknowledgements

The authors would like to thank Leo Mercer, Isabel Lara Miranda, Maria Waaifoort, Mikael Mikaelsson, Anne Chataigné, Erin Leonard, David Baldock, Anna Lóránt, and Guillaume Morauw for their thoughtful comments and review. Georgina Kyriacou edited the report.

CETEx's Research Integrity Council provides editorial oversight of all the Centre's policy reports.

AI usage declaration: The authors used Claude Sonnet 4.6 for language editing and structural refinement. The tool was used only to make minor improvements to the clarity and readability of draft sections. No substantive arguments, analytical conclusions or empirical claims were generated by the tool. All outputs were reviewed and, where necessary, corrected by the authors, who remain fully responsible for the content of this report.

The authors declare no conflict of interest in the preparation of this report. The views in this report are those of the authors and do not necessarily represent those of the reviewers, host institutions or their funders. Any errors and omissions remain those of the authors.

This report was first published in May 2026 by CETEx at the London School of Economics and Political Science.

Suggested citation: Greenslade W, Jameson D and Tron M (2026) *Rooted in resilience: crop insurance as a fiscal tool for climate adaptation and nature restoration in EU agri-food systems*. London: Centre for Economic Transition Expertise, London School of Economics and Political Science.

DOI: 10.21953/researchonline.lse.ac.uk.00138509

Contents

Summary

Climate change and nature degradation are creating increasingly frequent and severe impacts on the agri-food system in the European Union. This is driving crop losses across Member States, affecting local labour markets, supply chains, rural lending and related economic activities. These losses are largely uninsured, leaving crop farmers without the financial resilience to respond to these risks or prepare for future risks. Underinsurance in the crop sector has important implications for EU Ministries of Finance in their role in dampening the potential macroeconomic effects of agri-food shocks, maintaining rural sustainability and avoiding undue fiscal pressure from post-disaster expenditure. However, Ministries have several levers they can utilise to promote crop insurance as a fiscal tool for climate adaptation and nature restoration.

Climate change and nature degradation are increasing crop yield losses across the EU. Existing evidence shows that four primary hazards (or 'perils', in insurance-industry terminology) drive 80% of total agricultural losses; these are drought, excess rainfall, frost and hail. These hazards are set to worsen under both moderate greenhouse gas emissions and business-as-usual (i.e. high) emissions scenarios in 2050. Without climate change adaptation, average crop losses could increase by up to 66% by 2050, delivering divergent effects across Member States.

Risk to the crop sector translates into risk to the macroeconomy through several channels, including food price inflation, wider supply chain disruptions, financial market instability and labour market changes. Existing analysis shows that the EU's agricultural sector is losing over €28 billion annually due to extreme weather, with this amount set to increase as climate- and nature-related risks intensify. The EU's agri-food sector is also a central player in the global food system, meaning these risks can cascade beyond EU borders. The macroeconomic consequences of sudden and severe impacts, or 'shocks', from climate change and nature degradation to the agri-food system mean that food system resilience can no longer be considered exclusively the remit of environmental and agricultural policymakers.

In the EU, 70-80% of all climate-related crop losses are not covered by insurance. Thus there is a significant gap in crop insurance coverage. This insurance protection gap is driven by limited availability of appropriate policies, high premium prices, other, non-financial, barriers to insurance in the form of a dearth of information and high administration costs, and the prevalence of high-frequency, low-intensity weather events that cause costs that fall below insurance payout thresholds for farmers. Without insurance to serve as a financial buffer, farmers are left acutely vulnerable to extreme weather events, and large-scale or persistent losses can become a regional or national policy issue.

As climate and nature risks intensify, governments will have to step in more after a disaster to protect farm viability, taking on the role of 'insurer of last resort'; this will become a growing threat to fiscal sustainability. The agri-food sector's political influence, cultural significance in national identity, strategic importance for food security, and lobbying capacity, generates strong incentives for elected officials to provide emergency relief following catastrophic events. As climate change and nature degradation amplify the severity and frequency of extreme weather events, by taking on the role of insurer of last resort governments will create undue fiscal pressure from unbudgeted and unplanned expenditure. In recognition, governments should shift towards supporting proactive ex-ante risk mitigation and adaptation approaches for the crop sector.

Crop insurance: a tool to reduce risk for governments and farmers

Crop insurance is a promising yet underutilised risk management mechanism that can be used to shift fiscal risk off the public balance sheet. This type of insurance is a useful risk management tool for farmers, acting as a buffer or safety net after an extreme weather event. It can also provide some protective capacity for the agri-food system and financial system against the systemic risks presented by escalating climate- and nature-related shocks.

Ministries of Finance can use three key levers to explore crop insurance as a fiscal tool for climate adaptation and nature restoration in EU agri-food systems:

1. **Increasing public spending on climate change adaptation in the crop sector could reduce overall risk to the agri-food system.**

Public investment in adaptation for the crop sector in the EU could increase food system resilience by reducing farm and supply chain vulnerability to hazards and therefore reduce both threats to on-farm business continuity and macroeconomic risks. Currently, Pillar II of the Common Agricultural Policy (CAP), the EU's flagship agricultural policy, and national co-financing programmes are the major contributors to funding for adaptation in the EU's agricultural sector. However, resilience needs to be boosted further and financing for adaptation in the crop sector falls short; current levels will not be sufficient under higher warming scenarios. Member State Ministries of Finance should increase investment in adaptation for the crop sector.

2. **Boosting uptake of crop insurance would increase protection and spread risk across multiple economic actors.**

By spreading risk across diverse portfolios and geographical areas, concentrated exposure to shocks for specific economic actors is reduced. To mitigate the burden of unbudgeted ex-post disaster aid at the EU level, the Commission has committed to shifting towards a proactive ex-ante model that leverages private and mutual insurance. Such investments enable risk to be shifted off public balance sheets and towards a structured public–private risk-pooling market. At the Member State level, Ministries of Finance should critically evaluate the role and structure of subsidies for crop insurance.

3. **Shaping insurance underwriting practices to incentivise adaptation would further reduce potential macroeconomic risks.**

Another central imperative for the EU is to move beyond a reactive, grant-based model to proactively shape crop insurance markets to incentivise adaptation in their underwriting practices and de-risk private investment in adaptation for agriculture. Because both incremental and transformative adaptation measures are capital-intensive for farmers with tight margins, well-designed insurance mechanisms that reward adaptation initiatives in their premium prices could help incentivise these investments. Ministries of Finance, through their responsibility for financial services policy, should work with supervisory authorities and the insurance industry to develop a standardised framework for recognising and pricing on-farm adaptation measures in crop insurance policies.

1. Introduction

The agri-food system in the European Union faces mounting climate- and nature-related risks that are increasingly translating into fiscal and macroeconomic consequences. This report examines how shifting from ex-post to ex-ante financing to address these risks can reduce the burden on post-disaster public expenditure and strengthen the agri-food system's resilience against these growing shocks, and the role of Ministries of Finance in this process. It also explores how the risk management mechanism of crop insurance can provide some protective capacity for the agri-food and financial systems.

Context: rising risk

The crop sector across the EU is increasingly facing significant disruption arising from climate change and nature degradation, alongside a range of other drivers including changing geopolitical and transition risks. This report focuses on the climate- and nature-related drivers of risk to the EU's agri-food sector. We examine the crop sector given its particular exposure to both these types of shock and in order to look at just one form of insurance.

The macroeconomic implications of these impacts across the food system are becoming increasingly material and are likely to rise in frequency and severity. They span food price stability, supply chain disruptions and food security, and broader financial system impacts. Thus, the agri-food system faces risks from a changing climate and nature degradation and will require a proactive and coordinated policy response to build a resilient food system.

Terminology used in the report

Agri-food system: the food system value-chain, including upstream and downstream processes

Crop sector: arable farming, i.e. the cultivation of plants for food, fibre, fuel or other commercial purposes

Climate shock: sudden, unexpected changes in temperature or precipitation and their consequent impacts

Nature-related shock: sudden, unexpected impacts from disruption or degradation of natural ecosystems

For example, in 2024, floods swept across Valencia, Spain, a critical region for the supply of fruit and vegetables, causing €1.37 billion worth of damage to the regional agriculture sector (Associació Valenciana D'Agricultors, 2024), but also creating cascading economic disruptions and affecting supply chains across the EU (González-Torres Fernández and Parker, 2025). In 2021/2022, a widespread drought across the European part of the Mediterranean caused a 9% drop below the previous five-year EU average for cereal crop production (Garrido-Perez et al., 2024). These examples illustrate the escalating risk landscape for crop farmers in the EU.

A greater role for adaptation and insurance

Adaptation to increasingly unpredictable environmental conditions is urgently needed to ensure ongoing viability for the EU crop sector and wider agri-food system, to guarantee stable livelihoods for farmers and food security across Europe. It is also necessary to dampen the potential macroeconomic effects and avoid the undue fiscal pressure created when post-disaster expenditure entails governments acting as 'insurers of last resort'. We argue that in the face of increasing climate- and nature-related shocks, governments should support ex-ante risk management and adaptation of the crop sector to manage increasing costs from future disaster relief.

Crop insurance is one tool that can support the agri-food system's response to climate- and nature-related risks. Insurance is an ex-post compensation and risk management mechanism designed to provide income protection for insured economic losses experienced by farmers (Santeramo et al.,

2023). While this has not traditionally been the case, crop insurance policies can be designed with climate adaptation principles in mind to support the resilience and adaptive capacity of farmers through incentivising and rewarding on-farm risk mitigation and providing financial security in the face of unpredictable shocks.

However, as climate change drives more frequent and severe extreme weather events, and nature degradation accelerates disruptions to the hydrological cycle, soil health and pestilence, crop insurance is becoming progressively less affordable and less available. Currently, crop insurance uptake in the EU covers between 20 and 30% of climate-related losses, with the majority of farmers uninsured or underinsured for these events (fi-compass, 2025[1]). This is a sizeable gap, especially considering that crop insurance premia are heavily subsidised by a range of Member States through EU Common Agricultural Policy (CAP) funding or state aid. However, while these subsidies aim to target the insurance affordability issue, they only address the symptom of high premia prices and underinsurance, rather than the causes of these high and increasing premia: climate change and nature degradation. Further, these blunt subsidies artificially dampen the risk signal on premia from escalating climate and nature risks, which disincentivises farmers to reduce their risk and further disincentivises insurers to reward on-farm risk reduction through lower premium prices. These dynamics warrant closer attention from fiscal and economic policymakers at both the Member State and EU levels.

A role for Ministries of Finance

In the context of the upcoming changes to the CAP post-2027, shaping crop insurance to deliver on public policy goals should be considered in the suite of policy tools at the disposal of Member State governments and the EU. For Ministries of Finance, reducing unbudgeted fiscal pressure and dampening broader macroeconomic implications from shocks to the food system is squarely within their remit.

In the following sections, we explore why Ministries of Finance should therefore take proactive action to reshape the risk landscape and reduce the potential macroeconomic effects of climate- and nature-related shocks on the crop sector and the public balance sheet. We analyse how crop insurance is a promising yet underutilised risk management mechanism to shift fiscal risk off public balance sheets. Finally, we explore three key levers available to Ministries of Finance: increasing public investment in adaptation measures; enabling greater uptake of crop insurance, including through public-private (re)insurance schemes; and mobilising private sector investment in agri-food adaptation.

[1] fi-compass is an advisory service platform jointly provided by the European Commission and European Investment Bank. Its 2025 report quantified the crop insurance protection gap in the EU.

2. Impacts on the crop sector from climate change and nature degradation

Crop yields are heavily exposed to both extreme weather impacts and long term-environmental changes to soils, water supply, pollination and the climate system. The intensity and characteristics of impacts from climate change and nature degradation vary across the EU's Member States. Certain crop commodities and regions are hit especially hard. Eighty per cent of total crop losses in the EU are driven by four primary types of climate hazard or peril:[2] drought, excess rainfall, frost and hail. The depth of losses from these perils determines how the financial burden is shared between farmers, insurers and governments.

Increasingly unpredictable conditions and their impact on farming

Crop yields are highly dependent on predictable, favourable weather conditions and therefore the crop sector is extremely vulnerable to perturbations caused by climate change.

The scale and pace of climate change and nature degradation are accelerating, delivering non-linear, unpredictable, irreversible ecological tipping points that materialise through both 'chronic' and 'acute' forms of environmental change.

- Chronic trends that can affect crop yields are pervasive, long-term changes to the environment driven by unsustainable economic activity. For example, higher average mean temperatures[3] can affect growth patterns of crops, reduce yields and create a more amenable environment for a range of pests and pathogens; a loss of pollinators can reduce crop yields; soil degradation can affect available soil nutrients and composition for crops; and rising sea levels can affect the salination of soils. (Almeida et al., 2025; Panagos et al., 2024; Jägermeyr et al., 2021; Marsden et al., 2024). In Germany, for example, weather-related risks have been shown to account for over 40% of wheat yield variability (Michels et al., 2024).

- Acute shocks like floods, hail, drought or bouts of disease may present over a shorter temporal period but can have an equally, if not more, devastating effect on crop production and farm yields as chronic forms of change (Marsden et al., 2024). Each of these perils is driven by interconnected drivers of climate change and nature degradation. Collectively, drought, heavy rain, hail and frost events were estimated to have driven 80% of agricultural losses in the EU over a recent 10-year 'Olympic average' (fi-compass, 2025).[4] Droughts and heatwaves are the most common of the perils in the EU, with average annual crop losses up to 2024 from drought affecting over 3% of total EU crop yields and representing over half of all climate-related losses

[2] We mainly use the term 'peril' in this report as this is the term used by the insurance industry.

[3] The temperature–yield relationship is shown to be largely negative and, for many crops, subject to tipping point thresholds, above which yield decreases sharply. However, these effects are heterogeneous. We can anticipate a general northward shift of growing regions with global warming, and there is some evidence that certain countries within the EU will experience small increases in crop yields due to warmer winters and less cold damage – for example, some research shows that wheat and barley crops in Eastern Europe experienced an average increased yield of 0.33 tons per hectare due to a 1-degree temperature increase over winter based on data from 1961–2019(Lopes, 2022). Some scientists also argue that certain crop species may experience a counterbalancing of warming and drought effects through the CO_2 fertilisation effect (which promotes plant growth), but this remains contested in the scientific literature and the compounding effects are poorly understood (Ainsworth and Long, 2020).

[4] In agricultural risk analysis, an "Olympic average" typically means taking a series of recent years, discarding the highest and lowest values, and averaging the rest.

(ibid.). Less frequent events such as hail, frosts, pestilence and disease, and cold spells can also cause significant economic damage to crops (Manescu et al., 2025).

Chronic trends and acute shocks can interact and compound (Marsden et al., 2024, Almeida et al., 2025), leaving the crop sector more exposed and more vulnerable to more extreme hazards, and changing the risk landscape for farmers, policymakers and financiers. For example, since the 1960s, average soil moisture has decreased significantly across the EU due to climate change and pressure on groundwater (chronic), increasing the vulnerability to and losses from drought events (acute) (fi-compass, 2025).

The variations in the impacts of climate change and nature degradation across the EU have a disproportionate effect on certain crop commodities and sharpen regional disparities. Overall, net yield losses from climate-related perils currently equate to an estimated 6.4% of EU crop production annually, with the potential to rise to over 10% in the worst-affected years (fi-compass, 2025). Without stronger climate adaptation, average crop losses could increase by up to 66% by 2050 under a business-as-usual emissions scenario (ibid.).

Four primary climate perils

There are four primary climate perils that affect the crop sector across the EU, which are also expected to maintain primacy in 2050 climate change scenarios (fi-compass, 2025):

- Drought, with its significant impacts on plant physiology, is the biggest driver of crop losses in the EU (measured in Annual Average Losses/AAL – see Box 2.1). Global agricultural productivity is already seeing significantly diminished crop yields due to the damaging effects of drought (Bijalwan et al., 2025). The largest agricultural producers in the EU (Spain, Italy, France, Romania and Germany) already have AALs from drought amounting to over €1 billion. By 2050, under a moderate emissions scenario, AALs in the EU from drought are expected to increase by 46%, with the most severe losses expected in Greece, Italy and Spain (fi-compass, 2025).

- Excess rainfall is the second biggest driver of crop AALs in the EU. Heavy rain can cause direct damage to crops, e.g. through waterlogged soil inhibiting root growth, and indirect damage through promoting environments that support nature-related risks like pests and disease, highlighting the compounding risks of the climate–nature nexus (Almeida et al., 2025; Mooney et al., 2026). Current AALs from excess rainfall are highest in France, Italy, Poland, Romania and Spain, where AALs due to this peril are expected to increase by nearly 40% by 2050 under a moderate emissions scenario (fi-compass, 2025).

- Frost is the third biggest driver of crop AALs in the EU. It poses a particular threat to high value crops like vines, fruit and vegetables, which are highly exposed to this peril at especially vulnerable stages in the plant life cycle. As plants are increasingly experiencing milder winters and therefore earlier biological springs, vines and fruit bud and blossom earlier, thus increasing their vulnerability to frost in later winter months. By 2050, frost stress will be most prevalent in Central, Eastern and Northern Europe, with Italy, Romania, Germany and France predicted to see the largest increases in frost-driven AALs (fi-compass, 2025).

- Hail is the fourth largest driver of crop AALs in the EU. It can cause severe damage to high-value crops like vines, and the current highest AAL losses in the EU from hail are seen in Italy and France. Under a moderate emissions scenario, the frequency of hail events is expected to increase by 15-20% for certain areas of the Mediterranean and central Europe, including Germany, Austria, Croatia, Serbia and Romania (fi-compass, 2025).

Box 2.1. Measuring risks and losses in the crop sector

The United Nations Office for Disaster Risk Reduction (UNDRR) and Intergovernmental Panel on Climate Change (IPCC) (UNDRR, 2017; Reisinger et al., 2020) measure risk as: **Hazard x Vulnerability x Exposure**, where, in the case of the crop sector:

- **Hazard [or peril]** is the physical event that may cause disruption to crop yields.
- **Vulnerability** is the propensity of exposed elements, such as planted crops, to suffer adverse effects when impacted by hazard events or perils.
- **Exposure** describes the situation of crops in a hazard-prone area.

Risk is measured by insurers through two key metrics, both derived from the same modelled loss distribution: Annual Average Losses (AALs), and Probable Maximum Losses (PMLs) (fi-compass, 2025). AALs capture the mean annual loss across all simulated years in modelling by insurance companies, whereas PMLs identify the maximum loss expected to be exceeded at a specific return period.

- **Attritional losses** are caused by high-frequency (10% to 20% annual probability of occurring), low-intensity events. These events tend to be uninsured or do not pass the payout threshold.
- **Severe losses** are caused by medium-frequency (2% to 10% annual probability of occurring), medium-intensity events. These are usually insurable losses and fit within the expectations of insurer payouts.
- **Catastrophic losses** are caused by low-frequency (2% or lower annual probability of occurring), high-intensity events, commonly referred to as 'fat tail' or 'tail' risks. These losses are significant and often exceed insurance coverage, sometimes requiring government to step in with additional, unplanned, disaster recovery financing. They are increase due to the impacts of climate change and nature degradation (ibid.).

Different risk layers require different approaches and have varying significances for fiscal risk. 'Risk layering' will be key to consider in future agricultural policy design, whereby generally the farmer would 'own' the attritional risk, then, if insured, would pass on the risk for severe losses to the insurer. That risk would then, at the catastrophic loss scale, get passed on to the reinsurer, governments or sometimes supranational bodies (ibid.).

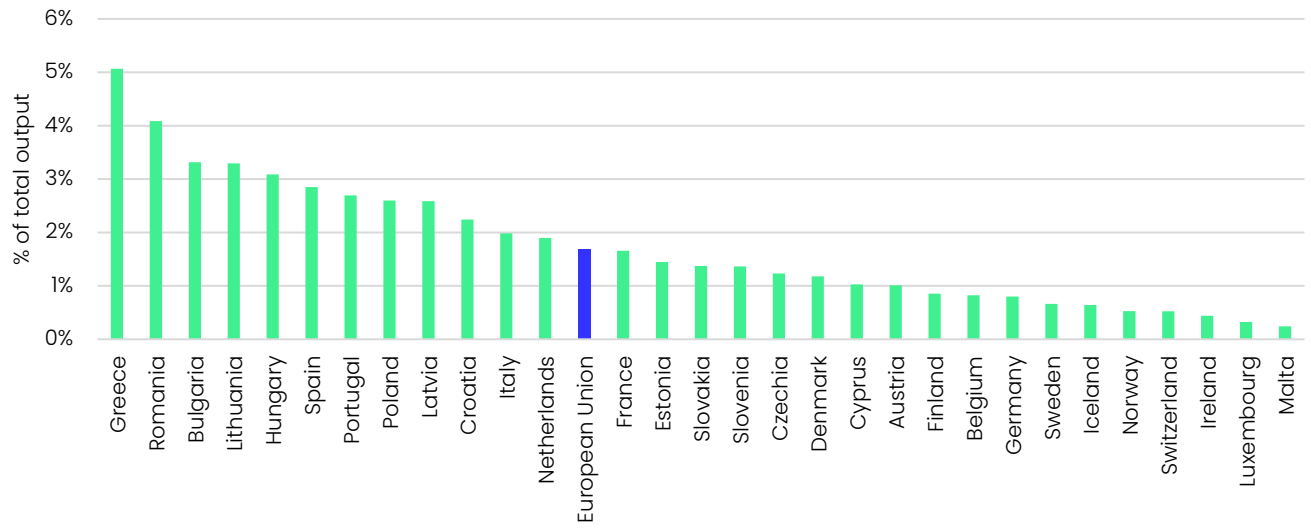
3. The role of the agri-food system in the EU economy

The agri-food sector is a central economic pillar of the European Union, with important cultural, economic and social significance to Member States. However, increasing variability in crop yields due to climate change and nature-related risks is undermining this strength and eroding financial reserves for farms with economic implications that extend well beyond the agri-food sector. The impacts affect food prices for consumers, trade balances, import vulnerability for trade partners, supply chains and the stability of the insurance and financial sectors.

The importance of arable farming to the EU and the risk posed by environmental change

Of the 640 million tonnes of crops produced in the EU (excluding Cyprus) in 2023, 48% was exported and another 350 million tonnes was imported (FAOSTAT, 2026a; 2026b), indicating the global importance of the EU's crop sector. In 2024, the sector generated a gross value added (GVA) of €228.6 billion, contributing 1.2% to the EU's gross domestic product (GDP) (Eurostat, 2025; 2026). The contribution of this sector varies significantly by Member State, depending on their dominant crops, as shown in Figure 3.1. The policy response to climate and nature shocks will therefore depend on the relative contribution of specific crop commodities to the EU's economy and food supply.

Figure 3.1. Crop output in EU Member States as a percentage of total national output, 2025



Sources: Eurostat, GDP and main components (output, expenditure and income), 2026; Eurostat, Economic accounts for agriculture - values at current prices, 2026; authors' calculations.

The EU agricultural sector is losing over €28 billion annually due to extreme weather (fi-compass, 2025). These losses erode financial reserves for farms, while also contributing to food price inflation and other macroeconomic stressors. Seventy to eighty per cent of crop sector climate-related losses are uninsured (ibid.), leaving the industry highly exposed to escalating climate- and nature-related risks. These losses remain uninsured in part due to limited availability of insurance products or inappropriateness of those that are on offer, high premium prices, other, non-financial barriers, to

insurance (i.e. a dearth of information and high administration costs), and the prevalence of high-frequency, low-intensity climate events that result in costs that fall below insurance payout thresholds for farmers (these are referred to as attritional losses; see Box 2.1) (Grislain-Letrémy et al., 2024; fi-compass, 2025).

The economic implications of increasing crop yield variability due to climate- and nature-related risks extend well beyond the agri-food sector. This section examines the transmission mechanisms through which crop yield disruptions affect the broader EU macroeconomy, thus making it central to the mandates of Ministries of Finance.

Food price inflation and macroeconomic stability

Disruptions to crops that result in diminished yields can precipitate food shortages that drive consumer price inflation (Algieri, 2025). The macroeconomic impact proves particularly severe when shocks affect commodities that have extensive price pass-through effects, including grains (used in livestock feed and processed food products), oilseeds (used for cooking oils and biodiesel), and other staples with high value-added processing chains.

Furthermore, food prices are volatile and asymmetrically 'sticky'. This means that, in response to higher production costs, food prices increase rapidly and stay elevated above the pre-shock level even when the input cost pressures ease (Rezitis and Tsionas, 2019). The risk of household expectations contributing to persistent inflation has been found to be highest following inflationary shocks to food prices (Anesti et al., 2025). Household expectations contribute to inflation because when households expect prices to rise, they change their behaviour in ways that cause prices to do exactly that. These behaviour changes include demanding higher wages to protect their purchasing power, which leads to higher production costs for firms that ultimately get passed on to consumer prices and consumers bring forward their purchase of goods if they expect prices to rise in future. Changes to food prices also have a significant impact on consumers' expectations of inflation, meaning sudden increases in food prices have a larger and more persistent impact on inflation expectations than a similar shock not driven by food price increases, such as an increase in energy prices (Bonciani et al., 2024).

Increases in food prices also have an outsized effect on lower-income households compared with higher-income households. The gap between the effective inflation rates experienced by those in the lowest and highest income quintiles, calculated using Eurostat Household Budget Survey data, was at its largest since 2006 during the recent 2022-23 inflation crisis, increasing from 0.1 percentage points in September 2021 to 1.9% in September 2022 (Charalampakis et al., 2022). Lower-income households spend the highest share of their budget on food (23.8% of disposable income compared with 9.5% by the highest income quintile in 2020; Eurostat, 2024). Therefore, when prices rise, they are unable to make reductions to their spending if they are already purchasing the lowest quantity and quality of food to meet their dietary needs, meaning these shocks will disproportionately impact lower-income households. Ministries of Finance and Economy may therefore deploy fiscal resources to provide consumer subsidies, price controls or strategic food reserves to protect vulnerable households and maintain social stability. This will become an increasing pressure on Member States' balance sheets as climate- and nature-related risks escalate.

Furthermore, central banks may be compelled to respond when food price shocks fuel broader inflationary pressures, potentially requiring the tightening of monetary policy (Bonciani et al., 2024). These policy interventions, while necessary to protect consumers and manage economic stability, will impose fiscal costs and may create broader economic distortions.

Exposure of trade and imports to disrupted crop yields

Crop yield disruptions can also affect trade balances. In the future this could reduce the EU's substantial export surplus, a key source of income for the bloc. Lower crop yields reduce export volumes both directly through restricted production, and indirectly as a result of policy interventions, as countries frequently impose export restrictions to prioritise domestic food security (Falkendal et al., 2021). For major agricultural exporting countries, reduced export revenues worsen trade balances,

potentially leading to downward pressure on the exchange rate which can increase the price of imports, thus increasing domestic inflation.

For example, the October 2024 floods in Valencia, Spain that followed torrential rain on 29 October, caused substantial damage to the agricultural sector, affecting around half of productive agricultural land in the region. Daily data on port activity showed a sharp drop in exports from the Port of Valencia following the torrential rainfall, with exports declining 30% year-on-year in the first week afterwards and 47% in the second week. The Bank of Spain estimated that the floods could result in a 0.2% reduction in Spain's economic growth rate for the last quarter of 2024 (Banco de Espana, 2024).

Where disruptions are spread across several Member States or hit certain key production regions, total food supply may decline across multiple markets, potentially exacerbating domestic food price inflation. The magnitude of these effects will vary across Member States according to their food import dependence. Where they are significant, they can exacerbate the impact on domestic food prices (Bukeviciute et al., 2009). There is also a risk to food prices and security of supply from weather events and nature degradation impacts that occur in non-EU countries. This is particularly relevant for the EU's top trading partners: Brazil, the UK and the USA (European Commission, 2026d). Further, these effects will be especially compounded if they occur at the same time as supply disruptions in the EU, as EU markets would be unable to respond to shortfalls through imports, leaving policymakers with limited levers to stabilise supply and protect consumers from price volatility.

Disruptions to wider supply chains

There are also implications for the financial viability of firms across the economy that rely on the food sector as part of their supply chains.

Supply chain effects propagate both upstream and downstream from the agri-food sector. Upstream, disruptions can reduce demand for agricultural inputs, affecting farm machinery manufacturers and fertiliser producers, which experience declining revenues when agricultural production contracts. Downstream effects are potentially more extensive, as certain crop commodities serve as key inputs across numerous sectors (Jensen and Hourdin, 2025).

Consequently, reductions in crop yields can generate wider economic implications through production bottlenecks and supply chain delays in dependent sectors, rising input costs that compress profit margins, and negative employment effects as production costs increase.

Employment in the agricultural and dependent sectors can be impacted as a result of disruptions to labour productivity during extreme weather events. These events can impact the physical and mental health of on-farm workers, lowering their productivity and overall sectoral output. With climate change, impacts from extreme heat will have the largest productivity impacts on sectors with outdoor workers. Average temperature changes experienced in Europe between the periods 1965-1994 and 2016-2019 have already resulted in an almost 1% decline in labour supply (measured in working hours) in high-exposure sectors, including agriculture (van Daalen et al., 2022).

The agri-food sector is particularly vulnerable to shocks due to its exposure to global supply chains. These supply chains tend to be optimised for efficiency rather than resilience, meaning they often do not have much spare capacity or a large choice of alternative routes and are highly exposed to disruptions. Systemic shocks to crop yields can therefore have both domestic and international macroeconomic consequences (Mikaelsson, 2026).

Implications for the insurance and financial sectors

Global food systems have direct and indirect impacts on insurance markets and rural lending coverage, and vice versa. Insurance works as a form of invisible infrastructure that governs uncertainty through the redistribution of risk: supporting the de-risking of investments for lenders, reducing unbudgeted fiscal pressure arising from potential government response, and increasing access to credit for borrowers through lowered default risk (Gabriel and Baker, 1980; Jarzabkowski et al., 2023; Greenslade, 2025). Insurance has long played a critical role in reinforcing economic stability through its

ability to absorb parts of systemic risk that could otherwise become widespread and cascade across global supply and trade systems (Mikaelsson, 2026).

Well-functioning crop insurance markets enable farmers to access affordable coverage against natural hazards or perils, thereby protecting farm livelihoods as well as facilitating credit access and providing a buffer against risk for the lending market. When insurance markets are not functioning well, however, insurance can become unaffordable or unavailable in certain regions, often for specific types of peril (e.g. excess rainfall or drought).

Environmental stressors, both chronic and acute, are increasing total crop losses and delivering more frequent attritional, severe and catastrophic losses (see Box 2.1). This landscape of escalating risk results in higher insurance premium prices to reflect the risk that insurers are taking on. In turn, the population base for the crop insurance pool tends to get smaller as fewer farmers choose to purchase insurance coverage, concentrating the risks even further. Insurance also suffers from adverse selection, with farmers who are more at risk or who have recently experienced losses more likely to purchase higher coverage, making the overall pool more risky for insurers (Bielza et al., 2009). With the increasing frequency of severe Probable Maximum Losses (PMLs) arising from these highly uncertain climate- and nature-related risks (see Box 2.1), some of these perils are increasingly becoming understood within the insurance sector as being uninsurable, which has serious implications for insurers (Manescu et al., 2025). Where insurance sector modelling identifies particular perils as 'too risky' to underwrite, an 'insurance protection gap' emerges, defined as the gap between economic losses and insured losses (Jarzabkowski et al., 2023). This is more likely to happen when there are prohibitively high premia or an unavailability of insurance coverage.

The protection gap creates a secondary barrier to credit, as lenders become unwilling to absorb the liability of uninsured crop failure on their own balance sheets. Without insurance or credit to serve as a financial buffer, farmers are left acutely vulnerable to extreme weather events (Blackmore et al., 2025). Farms' financial reserves will decline via lower profits and restrictions to rural lending, which can also reduce farmers' ability to maintain employment. The financial instability of the sector may also mean farmers choose to leave and seek employment in a different sector, potentially causing future employment shortages in agriculture that will further exacerbate rising food prices. This is a concern that disproportionately falls on small-scale farmers, which constitute the majority of farms in the EU (93% of agricultural holdings in the EU in 2020 were family farms), although the 7.5% of large farms manage 68.2% of agricultural land (Eurostat, 2022).

4. Implications of underinsurance in the crop sector

Crop insurance can act as a safety net for farmers after an extreme weather event, providing some protective capacity for the agri-food system against the systemic risks presented by the escalating impacts of climate change and nature degradation. In the EU, the crop insurance protection gap is 70–80% for all climate-related losses, meaning most crop farmers are uninsured. Although the proportion of coverage varies significantly among Member States, this is becoming an increasingly relevant threat for governments' fiscal sustainability as the need for post-disaster financial support for farms grows.

The insurance protection gap

In the EU, just 20–30% of crops are insured against climate-related losses (fi-compass, 2025). Crop insurance performs an important function for farmers and the wider agri-food system by providing a financial buffer after an extreme weather event (Santeramo et al., 2023). Given this insurance protection gap, the projected increase in total average annual losses (AALs) of crops from €17.4 billion in 2025 to €24.8 billion under a moderate emissions scenario and €28.9 billion under a business-as-usual (i.e. high) emissions scenario in 2050 reflects a substantial burden on uninsured and underinsured farmers (ibid.). This represents a market failure that requires coordinated policy attention from governments.

Several structural features of existing crop insurance markets in the EU are of note:

- For one, the majority of crop insurance across the EU is 'single peril' rather than 'multi-peril', meaning that even where a crop insurance policy is in place, the farm may still be underinsured against other perils that are not named in the policy (Mateos-Ronco, 2025; Michels et al., 2024; fi-compass, 2025).

- Secondly, the crop insurance protection gap is further exacerbated by increasing reinsurance prices for crop insurers, which reduce the ability of primary insurers to transfer risk. Reinsurance provides insurance to primary insurers, enabling insurers to underwrite large exposures and forming a key part of the risk sharing hierarchy (Prudential Regulation Authority, 2026; Möhr et al., 2025). However, the principle of risk diversification, upon which the reinsurance sector depends, is being eroded by an increasingly concentrated risk landscape (e.g. all of southern Europe experiencing a drought in one growing season). Climate- and nature-related shocks are constraining reinsurance capacity, squeezing primary insurers further (The Insurer, 2025; Mikaelsson, 2026). This has been described as the 'reinsurance protection gap' (Möhr et al., 2025).

- Thirdly, insurance models focus only on direct impacts arising from these events. As a result, indirect and cascading effects such as broader supply chain or labour market disruptions are excluded from their scope, even though these may further impact farmers' resilience (Mikaelsson, 2026).

- Finally, insurance is an ex-post solution and cannot address the overall risk that farms face. Nonetheless, it can provide a useful financial buffer for farmers after a climate- or nature-related shock, enhancing sectoral resilience. Without crop insurance farmers might not have sufficient financial buffers to rebuild after a such a shock, and in the medium term this may drive food shortages and price rises for specific commodities. However, crop insurance as a mechanism cannot address the climate or nature-related hazard itself, nor can it resolve any

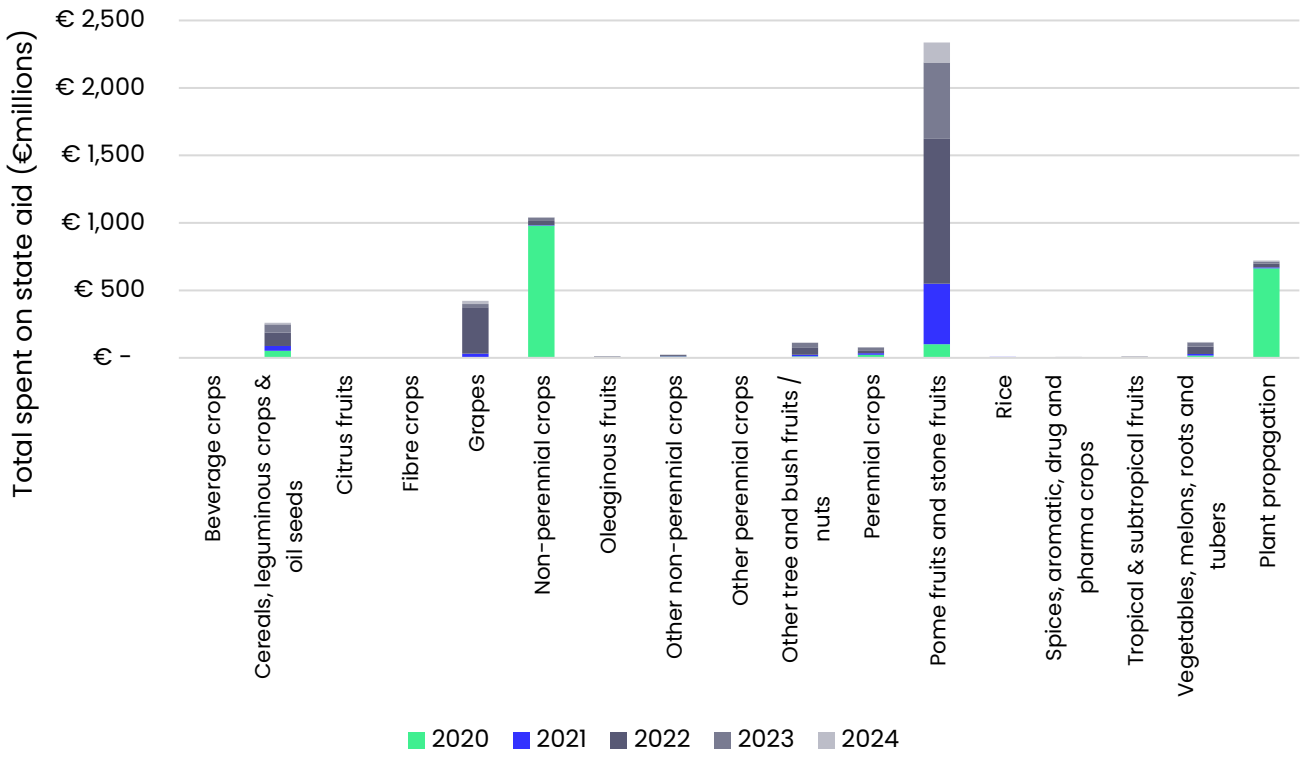
immediate issues arising from crop yield failures or subsequent food price shocks. Crop insurance must be considered part of a broader suite of adaptation policy tools.

In the absence of public policy changes, the crop insurance protection gap in the EU is expected to increase, as private insurers continue to adjust their risk-based pricing, raise premia prices and may even withdraw from the greatest risks in exposed areas. Given the increasing climate- and nature-related risks facing the EU agri-food system, upfront public and private investment is also required to reduce this overall risk (European Scientific Advisory Board on Climate Change, 2026).

Fiscal consequences for Member States

Where governments step in to protect farm viability, this will present an increasing threat to fiscal sustainability as climate- and nature-related risks intensify. To date, this public financial support has been disproportionately concentrated in specific crop subsectors, including high-value pome fruits (apples, pears etc.), stone fruits and viticulture, non-perennial crops and plant propagation (European Commission, 2026c) – as illustrated in Figure 4.1.

Figure 4.1. Total spent on state aid to support different crops following a climate change-induced natural disaster at the national level in the EU (2020–2024)



Sources: European Commission, State Aid Transparency Public Search, 2026; authors' calculations.

When governments intervene after a disaster, this is referred to as the government acting as an 'insurer of last resort'. Acting in this way generates unbudgeted fiscal exposures in the form of contingent liabilities. A contingent liability is a potential fiscal obligation that may materialise dependent on the outcome of future uncertain events (Polackova, 1999) (see Box 4.1 for examples). Some of these contingent liabilities are explicit, in that governments acknowledge that they will have to pay out in response to an event before it happens. However, most remain implicit: governments typically refrain from formally announcing ex-ante commitments to compensate for agricultural losses from natural catastrophes, recognising that such explicit guarantees would create moral hazard by diminishing incentives for private risk mitigation and adaptation investments (Bağcı and Küçükbayrak, 2026). However, the implicit nature of these obligations does not eliminate their fiscal significance. Political-economy dynamics create pressures that make post-disaster government intervention highly likely even in the absence of legal mandates. The agri-food sector's political influence, linked to its

geographical distribution across electoral constituencies, cultural significance in national identity, strategic importance for food security, and lobbying capacity, generates strong incentives for elected officials to provide emergency relief following catastrophic events (Collantes, 2020).

This political-economy logic transforms nominally discretionary responses into *de facto* entitlements. However, the implicit nature of these commitments obscures their fiscal implications and impedes effective budgetary planning, while also neglecting to address the underlying vulnerabilities of the system. Unlike explicit contingent liabilities such as deposit insurance or public debt guarantees, implicit agricultural disaster relief lacks designated reserves, actuarial assessment or transparent accounting in government balance sheets. This opacity generates several fiscal risks, including:

- Underestimation of medium-term fiscal pressures
- Procyclical expenditure patterns (as agricultural disasters often coincide with broader economic stress during extreme weather events)
- Political pressure for progressively more generous relief packages as extreme weather normalises.

These implicit contingent liabilities are expected to escalate substantially as the risks from climate change and nature degradation intensify and private crop insurance becomes increasingly unaffordable or unavailable, thereby shifting risk from onto public balance sheets. We argue that increasing crop insurance uptake can reduce the overall pressure on governments' balance sheets, especially when disasters require cross-sectoral financial support, with the potential for other sectors to take higher priority in the public disaster relief package. For example, in 2012 a report found that "a 1% increase in insurance coverage could reduce the global cost of climate-related disasters to taxpayers or governments by 22%" (Edwards, 2012). This is particularly valuable in the context of increasingly tight fiscal space across the EU.

Subsidies also dampen the risk signal on premia pricing that reflect escalating climate- and nature-related risks. This can act against incentives for farmers to reduce their risk and insurers to reward on-farm risk reduction through lower premium prices. See Box 5.3 for how insurers price premia.

Despite substantial public expenditure on disaster relief, compensation frequently proves insufficient to cover farmers' total losses, leaving agricultural producers bearing the often-significant residual risk while simultaneously creating potential fiscal exposure for governments (fi-compass, 2025). This outcome represents a suboptimal equilibrium wherein neither private insurance markets nor public intervention adequately manages agricultural climate risk, suggesting the need for fundamental reform of agricultural risk management frameworks.

Box 4.1. Examples of EU Governments acting as an insurer of last resort

At the EU level, Member States are supported to act as insurers of last resort through the Common Agricultural Policy, which includes an agricultural reserve of at least €450 million per year to help farmers cope with market disruptions or exceptional events**,** representing approximately 0.6% of the total CAP budget for the 2021–2027 period. This reserve can be deployed to support markets facing serious disturbances, including those triggered by extreme weather events affecting supply (see Box 5.2 (European Commission, 2024a). In October 2024, €119.7 million was allocated to assist farmers in Bulgaria, Germany, Estonia, Italy and Romania affected by extreme weather events. In March 2025, €98.6 million was allocated to support farmers in Spain, Croatia, Cyprus, Latvia and Hungary facing losses from climatic events since spring 2024 (European Commission, 2025a).

As a Member State-level example, Ireland's government, in response to extreme rainfall experienced in 2023 that severely impacted agricultural production, established a compensation scheme offering farmers €1,000 per hectare of ruined crops (for up to 20 hectares), with €7 million allocated to the scheme to partially recoup losses incurred by heavy rainfall and maintain farm viability (Maguire, 2023). This was an unbudgeted fiscal expenditure.

Similarly, France faced catastrophic flooding in 2023, when six months'-worth of rain fell in 30 days, prompting an €80 million emergency fund for Brittany, Normandy and Hauts-de-France to cover crop and investment losses (Hortidaily, 2023). France also responded to severe drought conditions in 2022-2023 by providing €500 million in aid to cover lost crops and feed costs (Reuters, 2023).

These examples demonstrate how EU governments, supported by EU-level policy, intervene as insurers of last resort, taking on contingent liabilities by providing emergency financial support to stabilise farm operations following extreme weather events.

Climate change and nature degradation amplify the severity and frequency of these 'exceptional events'. To reduce the need for government stepping in ex-post as an insurer of last resort, creating undue fiscal pressure from unbudgeted and unplanned expenditure, governments should support ex-ante risk mitigation and adaptation approaches for the crop sector.

5. Levers available to Ministries of Finance to build financial resilience in the crop sector

The translation of climate change and nature degradation impacts on the agri-food system into macroeconomic consequences means that food system resilience can no longer be considered exclusively the remit of environmental and agricultural policymakers. Ministries of Finance have a key role to play in increasing overall spending on adaptation in the crop sector, promoting increased uptake of crop insurance, and shaping insurance underwriting practices to incentivise adaptation in crop insurance policies.

Public investment in adaptation in the crop sector can help build resilience for farmers against future climate- and nature-related shocks. However, crop yield variability is a core characteristic of crop farming, and some level of risk will always remain due to the limitations of adaptation measures and the increasing severity and frequency of hazards (Reisinger et al., 2020). Therefore, Ministries of Finance should take a proactive approach to increasing crop insurance uptake to spread this risk across economic actors, and support the insurance market in developing innovative tools that promote risk management. Below we describe three 'levers' they can use.

Lever 1: Increase public spending on adaptation to reduce overall risk to the agri-food system

A significant increase in public investment in adaptation for the crop sector in the EU would increase food system resilience by reducing farm and supply chain vulnerability to hazards and therefore reduce both threats to on-farm business continuity and to macroeconomic risks. This would also reduce the size and number of insurance claims, thus reducing the overall burden on the crop insurance system after a disaster. Public financing of adaptation programmes is therefore key to building physical and financial resilience in the EU agri-food system (European Scientific Advisory Board on Climate Change, 2026).

These programmes include hard technical measures (structural and technological solutions), or nature-based solutions (see Box 5.1). Improving drainage, using modified drought-resilient crop species, and improving current irrigation systems to make them more effective are all measures that can reduce the vulnerability to these perils (EEA, 2019; Publications Office of the European Union, 2026). Using the risk equation outlined in Box 2.1, adaptation can be conceived as a tool to reduce the vulnerability of an asset to the hazard, but it cannot address the hazard itself (only action to halt greenhouse gas emissions and reduce pressure on the environment can mitigate climate change and nature degradation).

Currently, gains from these technical solutions remain limited by local environmental conditions and climate trajectories. For example, improving irrigation systems has been shown to reduce maize losses caused by drought in Southern Europe from 80% to 11% under a 2°C warming scenario but only insofar as water remains available (Feyen et al., 2020; IPCC, 2023). Further, beyond the 3°C warming threshold, 'hard limits' emerge where the natural adaptive capacity is exhausted. This renders adaptation measures such as altering sowing dates or planting new cultivars insufficient to mitigate projected losses (Ruiz-Ramos et al., 2018; Feyen et al., 2020; IPCC, 2023).

Box 5.1. Adaptation in the crop sector

Adaptation in the crop sector can be defined as the adjustment of agronomic practices, genetic resources and management systems to minimise the negative impacts of vulnerability caused by climate events, climate change and nature degradation (such as heat stress, drought or pestilence) to support food security and yield stability over time. These measures can be incremental or transformative, leveraging hard technical measures (e.g. precision farming, hail/frost protection, and upgraded infrastructure and efficient irrigation systems) or nature-based solutions (e.g. planting cover crops, exercising crop rotation, and no-tillage practices) and can be implemented at the farm, regional, national or international scale.

Incremental vs. transformative adaptation

- **Incremental adaptation:** gradual adjustments intended to maintain the existing system's function and structure while reducing the vulnerability of crops to climate variability (e.g. improved irrigation, modifying crop calendars). These are mainly considered in medium-term adaptation strategies (up to 2050) and are unlikely to be wholly sufficient in either a moderate or business-as-usual emissions scenario.
- **Transformative adaptation:** fundamental, systemic changes that alter the basic attributes of the agri-food system (e.g. shifting livelihoods, migrating production, or large-scale land-use changes). Plans for long-term climate change adaptation strategies (i.e. over the period 2050–2100) often **include a mix of incremental and transformational approaches as climate impacts intensify (EEA, 2024).**

Geographical scales and governance for adaptation in the crop sector

Scale	Focus	Key actors	Examples
Farm level	Technical and incremental	Individual farmers, private insurers	Precision farming, adapted crops, cover crops, no/minimum tillage, efficient irrigation
Community/ catchment level	Production patterns, soil health, water efficiency	Farmers' associations, producer organisations, cooperatives, mutual funds, local authorities	Collective crop insurance schemes, mutual aid funds, shared irrigation infrastructure, agri-environment group schemes, peer-to-peer knowledge networks
Regional/ national	Mix of technical and organisational adaptation. Focuses on shared risk management, collective resource governance, and knowledge diffusion across farms	Regional authorities, national governments	Infrastructure (large-scale irrigation), flood prevention (under the EU Floods Directive), and financial safety nets (Mutual/Calamity funds)
EU	Mix of incremental and transformative strategies	European Commission, EU Member States	EU Adaptation Strategy, European Climate Law, monitoring Member State progress (under the CAP)

There are significant gaps in knowledge about the systemic efficacy of these adaptation measures. While quantitative effectiveness data for irrigation may exist, this is largely missing for other adaptation measures, and the performance of combined adaptation measures is rarely assessed (Ewert et al., 2015; Müller et al., 2020; IPCC, 2023). Most studies remain species- or hazard-specific, leaving a blind spot concerning the systemic risks of compounding hazards, such as simultaneous heatwaves and pest outbreaks. Finally, soil management practices like crop residue retention are frequently implemented as nature-based solutions for carbon sequestration, without evaluating their specific resilience-building or risk reduction capacity (Hamidov et al., 2018; IPCC, 2023). This knowledge gap makes it difficult to evaluate the risk reduction and subsequent potential cost savings of each adaptation measure, limiting the insurer's capacity to model their premium prices sensitively to farm-level adaptation. Furthermore, poorly designed adaptation strategies, notably due to this lack of data, can in turn lead to maladaptation by creating inefficient or unfair resource use and lock-ins (Schipper, 2020).

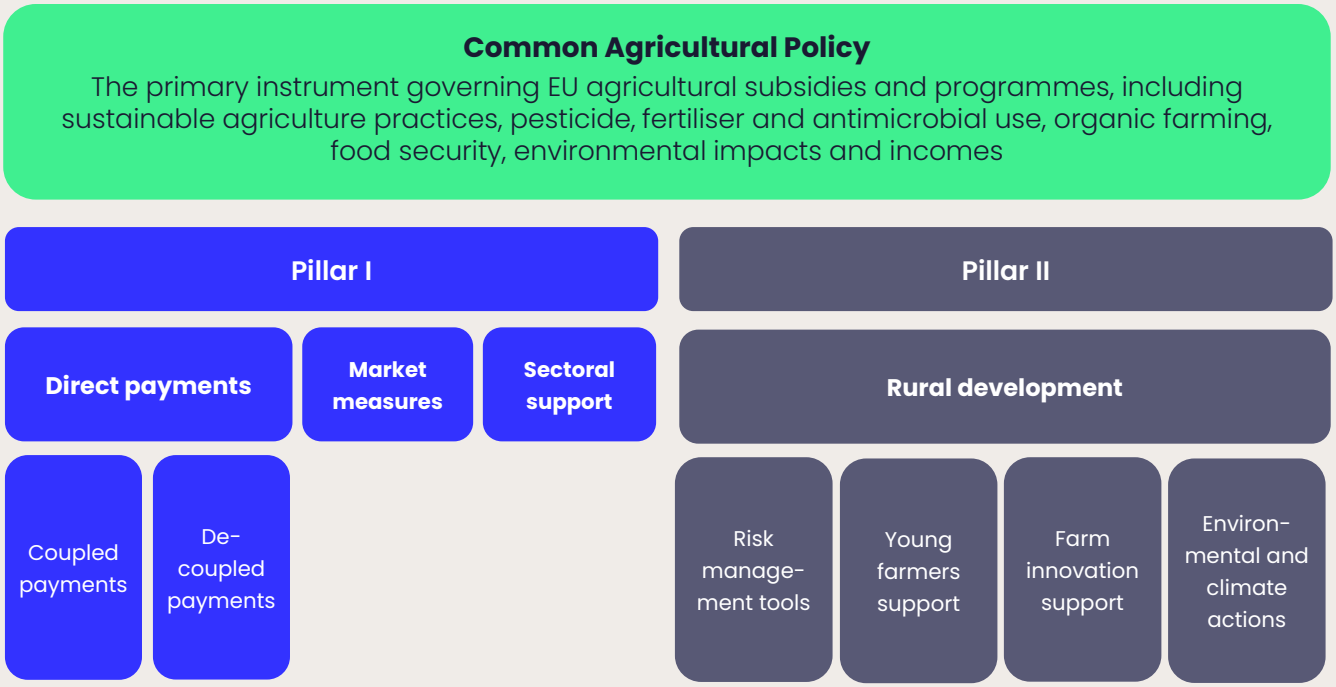
The Common Agricultural Policy's contributions to adaptation

Pillar II of the Common Agricultural Policy and national co-financing programmes are the EU's major contributors to adaptation funding in the agricultural sector (see Box 5.2). The current adaptation funding baseline for agriculture in the EU-27 is estimated at €9.3–9.8 billion annually, including significant investments in climate-resilient rural development through CAP Pillar II programmes (under the EAFRD – see box), national funding for agricultural innovation and extension services, and some private on-farm investments incentivised by subsidies or insurance (Neumann and Botia, 2025).

Box 5.2. The Common Agricultural Policy (CAP)

The CAP plays an important role in addressing financial risks for farmers through formalised risk management tools, and represents 32% of the EU's Multiannual Financial Framework (MFF) for 2021-27, with a total allocation of €386.6 billion. Forty per cent of total CAP expenditure is dedicated to climate action over this period, although the CAP delivery model allows a high degree of flexibility in how Member States use this funding (European Scientific Advisory Board on Climate Change, 2026). This flexibility looks set to increase further with the design of the 2028-2034 CAP (European Commission, n.d.).

The CAP is structured under two primary pillars:



Sources: fi-compass, 2025; European Commission, 2026a.

Pillar I, the European Agricultural Guarantee Fund (EAGF), focuses primarily on providing direct income support to farmers and managing market interventions, with a total budget of €291.1 billion. Roughly €270 billion is allocated to income support schemes, where payments are determined by farm size in hectares and are strictly conditional upon compliance with EU standards regarding the environment and plant health. The remainder of the EAGF budget, approximately €20 billion, is dedicated to market measures designed to combat price instability and provide emergency support during crises, such as extreme weather events, through tools like the agricultural reserve with an annual allocation of at least €450 million (European Commission, 2026b). A new Unity Safety Net has been put forward in the 2028-2034 MFF proposal that would help EU farmers in case of disruption to agricultural markets, totalling up to €900 million per year (European Commission, 2025c).

Pillar II, Rural Development, plays a key role in driving adaptation of the agrifood sector to climate- and nature-related risks to diminish the emergency support crisis costs carried by the agricultural

reserve. It aims to strengthen and support rural areas through a budget of €95.5 billion for the 2021-2027 period and is funded through the European Agricultural Fund for Rural Development (EAFRD). The EAFRD operates through co-financing, where EU funds are complemented by Member State national budgets to support CAP Strategic Plans. The EAFRD provides investment support to rural enterprises through financial instruments such as loans, guarantees, equity and other risk-bearing mechanisms.

Despite this EU-level public funding, the gap between the current level of financing for adaptation and what is needed remains significant in the EU agrifood sector and it is critical that financing is scaled up. A recent study commissioned by the European Commission estimated total food sector adaptation investment needs at €11.5 billion annually (or €200 billion in net present value [NPV] terms by 2050), with the crop sector dominating these requirements at 80% of the total. Within this sector, a specific cluster for 'climate-smart agriculture' investment (including drought-resistant crop varieties, irrigation upgrades, soil management and improved water use efficiency) is estimated to require nearly €7.8 billion annually (or €135 billion in NPV terms). This cluster alone represents 68% of all food sector investment needs by 2050 (Monteleone et al., 2026).

The best attempts at projecting the impact of inaction show high consequent costs, in the order of €28–30 billion per year by 2100 (Neumann and Botia, 2025). However, these costs are likely to be an underestimate due to methodological constraints, where they are extrapolations of a few national studies. In the study's high-emissions scenario, investment needs are expected to rise from an initial €11.2–17.4 billion per year in the mid-term to over €20.9 billion annually by 2100, leaving a gap of €11 billion per year (ibid.).[5]

Even where CAP funds are aimed at adaptation measures, there is significant variance between Member States. On average, 28% of the utilised agricultural area (UAA) in the EU received financial support to improve climate adaptation capacity in 2023. However, the proportion of UAA covered differs significantly between Member States (Directorate-General for Agriculture and Rural Development, 2023; European Commission, 2024b). High-performing regions and countries such as Wallonia (Belgium), Finland, France and the Netherlands have secured more than 75% of their agricultural area under adaptation commitments. In contrast, Central-Eastern and Southern European Member States, including Romania, Bulgaria, Malta, Cyprus and Spain, recorded shares close to or below 1% in 2023 year, despite facing disproportionately high climate impact exposure in the form of drought, heat stress and desertification (Directorate-General for Agriculture and Rural Development, 2023). This paradox, wherein the countries with the lowest adaptation coverage are among those most vulnerable to climate change impacts on agriculture, suggests that current CAP implementation has been highly country-dependent and has not succeeded in aligning adaptation investment with climate risk exposure.

Given the large future needs and growing risks faced by the crop sector, attracting private finance alongside public investment for adaptation will be necessary to close the adaptation financing gap. Coordinated public investment can support this goal, notably by supporting a better adaptation investment landscape for private finance. It would also reduce the risk and potential scale of intervention from governments stepping in as insurers of last resort and the wider macroeconomic risks of disruptions to crop yields.

[5] The cost of adaptation represents the estimated annual investment needed to implement adaptation measures in agriculture. This is likely underestimated as it: 1) relies on data from just three EU Member States who have quantified their specific agricultural adaptation needs; 2) reflects uncertainties in how much adaptation is pursued (incremental vs. transformational) and the unit costs of measures (and importantly, all three national studies on which these figures are based focused on 'incremental' adaptation and did not include radical transformative measures); 3) uses numbers that are extrapolations based solely on anticipatory costs where studies were made, excluding reaction costs, maladaptation costs, socioeconomic impacts and 'other/unclear' costs.

Lever 2: Increase uptake of crop insurance for increased protection and encourage risk spreading across multiple economic actors

Crop yield variability is a longstanding issue in agricultural economics and climate adaptation can only partially reduce the risk. So, regardless of adaptation's effectiveness, there will remain some risks that must be managed carefully to avoid risking the fiscal sustainability of EU Member States. This is where shifting the risk onto other balance sheets can be an effective policy goal. The logic of insurance spreads risk across diverse portfolios and geographical areas, reducing concentrated exposure to shocks (Jarzabkowski et al., 2023). To mitigate the burden of unbudgeted ex-post disaster aid at the EU level, the Commission has committed to shifting use of the CAP towards a proactive, ex-ante model that leverages private and mutual insurance and reduces reliance on direct government intervention (fi-compass, 2025). Such investments allow risk to be shifted off public balance sheets and towards a structured public–private risk-pooling market.

This evolution of the CAP makes funding more sustainable, effectively promoting farmers to manage risk independently through market-based instruments (fi-compass, 2025). Under the current CAP framework (2023–2027), the EU has organised its farm-level risk management toolkit around three main levers within Pillar II (Rural Development):

- Premium subsidies for up to 70% of crop insurance premia for farmers facing losses exceeding 20% of their average annual yield (€156 to €216 million annually)
- Mutual Funds and Income Stabilisation Tools to treat income shocks suffered by farmers due to production or market pressures
- Exceptional public funds for disaster compensation to provide farmers with swift financial support after natural catastrophes (ibid.).

National insurance markets and approaches to using the CAP funds vary significantly between Member States. While 14 Member States currently opt to promote private crop insurance via CAP-funded premium subsidies (these include France, Italy, Poland, Germany, the Netherlands and Romania), others maintain distinct public–private partnership (PPP) models, subsidised through national budgets (like Spain's Agroseguro and Austria's ÖHV, which have crop insurance PPP models with high penetration) (ibid.).

Despite the EU's efforts to increase crop insurance uptake, two key challenges remain (European Commission, 2025b). Firstly, the poor design of crop insurance subsidies can create moral hazards, whereby farmers do not face incentives to alter their high-risk farming practices (such as input-intensive crops on unsuitable marginal land). This can artificially sustain a production model that is increasingly vulnerable, effectively 'subsidising the risk' rather than reducing it (Dalhaus et al., 2023). Careful thought should therefore be put into defining associated conditions with this funding, especially given the changing risk landscape and constrained fiscal space. While some subsidy conditionalities already exist and have significantly influenced private insurance policy conditions, no data is yet available to evaluate the efficiency of this measure to encourage insurance uptake and general risk reduction (fi-compass, 2025). Further work should be undertaken to understand how these conditionalities could go further in reducing overall risk in the EU's crop sector.

The second challenge is the ongoing market viability of private insurance. There is a risk that as climate- and nature-degradation-driven losses increase, private crop insurers may exit the market or hike premia beyond a level that even subsidies can render viable, leading to further reduced uptake and coverage precisely where it is most needed. Coupled with the adverse selection dynamics discussed earlier, actuarial viability may be undermined by a pool skewed towards high-risk farmers. Therefore, consideration should be given to expanding existing subsidies, while also investing in risk mitigation measures and designing insurance models that encourage adaptation.

Lever 3: Shape insurance underwriting practices to incentivise adaptation and further reduce potential macroeconomic risks

A central imperative for the EU is to move beyond a reactive, grant-based model to proactively shaping crop insurance markets to incentivise adaptation in their underwriting practices and de-risk private investment in adaptation in EU agriculture (European Commission, 2025b). Theoretically, in a perfectly efficient insurance market with timely data and accurate risk modelling, price signals can incentivise farmers to adopt risk mitigation measures that reduce vulnerability to climate and nature-related perils, in return for a lower insurance policy premium (Beck et al., 2019).

In practice, the insurance sector has not played a significant role in promoting adaptation in the EU's agri-food system. Like most forms of insurance, crop underwriting largely happens on a 12-month cycle with annual repricing of risks, so its reactive, short-term nature creates a natural barrier to incentivising and supporting long-term adaptation for its policyholders (Mikaelsson, 2026). As a compounding factor, evidence suggests that farmers insurance purchasing decisions are driven primarily by economics over risk exposure: uptake only increases when total earnings (including subsidies and compensation) outweigh the total costs (i.e. of the premia) (Sun et al., 2024)

Despite it being a historically slow-moving and risk-averse market, many scholars have argued that insurance can be redesigned as a key tool in the adaptation toolkit (Stein et al., 2025; Jarzabkowski et al., 2019; Surminski and Oramas-Dorta, 2014). The insurance sector's direct exposure to local climate- and nature-related risks makes it a key contributor not only to local farm-level adaptation but also in de-risking private finance for adaptation, protecting farmers' income and supporting farm resilience to extreme events.

As a result, crop insurance as a mechanism may be well positioned to embed anticipatory risk management into underwriting and pricing. Because both incremental and transformative adaptation measures are capital-intensive for farmers with tight margins, well-designed insurance mechanisms that reward adaptation initiatives in their premium prices could help incentivise these investments. There is also an important role for banks to play here in co-designing insurance and credit packages that support investment into crop sector adaptation. For example, 'sustainability-linked insurance' models that propose paired loans for adaptation measures with long-term insurance contracts have emerged in the property insurance market, primarily in Asia (Chan, 2025).

Box 5.3. How insurers price premia – general method

Crop insurance pricing is complex, and methodologies vary across the industry.

Insurance premium calculations are built around the **pure premium principle**. This represents the expected indemnity, that is the weighted average (usually by probability of occurrence) of all possible indemnity payments before additional loadings are added. Pure premia are usually estimated from historical data and can be calculated by multiplying the average loss ratio (over a reference period) by the total sum insured (expressed in Euros) (World Bank Group, 2014).

The **average loss ratio** (expressed as a percentage) is calculated by dividing the **historical indemnity claim payments** by the **total insured value**, averaged over a reference period. For example, if claims averaged 8% of insured value over 10 years, the **average loss ratio** is 8%. The sum insured is the maximum amount the insurer agrees to pay out in the event of a total loss. This represents the financial value being protected by the policy, also called liability (with Liability = Expected Yield x Coverage x Commodity Price) (World Bank Group, 2014).

The pure premium may then be adjusted by various factors to accurately reflect the risk and uncertainty taken by the insurer. For instance, this pricing is **adjusted for spatial risk correlation**, because agricultural losses tend to cluster geographically. This is due to the location-specific nature of hazards s**uch as drought, intense rainfall and flooding that** impact crops. The spatial correlation between farm-level losses reduces the effectiveness of risk pooling, meaning insurers cannot fully diversify away from systemic weather risk within their portfolios (Feng et al., 2026).

Finally, **loads** are added to this pure premium, including operating costs, uncertainty in loss estimates, reinsurance and profit margin (World Bank Group, 2014).

This pricing logic applies to both traditional **indemnity-based insurance** and **index-based insurance**; however, costs and pricing risks are spread differently across the two models. The former pays indemnity based on verified individual farm losses, thus insuring a more precise but administratively costly process, hence increasing the extra loading costs. The latter provides compensation on an objective observable trigger such as rainfall or satellite vegetation index. It is a cheaper alternative to run but introduces the risk that the index diverges from a farmer's actual loss experience.

Long-term climate change poses a fundamental challenge to this entire pricing architecture: because the methodology is retrospective by design, it prices future risks based on past risks (Greenslade, 2025; Stein et al., 2025). As climate change increases the uncertainty of loss distributions, historical loss ratios become increasingly unreliable predictors of future claims.

Rather than basing the expected loss rate solely on historical indemnity payments, insurers could apply a quantified risk reduction factor to farms that can demonstrate the implementation of certified adaptation practices such as cover cropping, improved drainage or drought-resistant varieties. This would allow them to adjust premia in real time to reflect changing farm vulnerability and exposure to the hazard. For this mechanism to incentivise adaptation, the risk reduction factor would need to be credible, transparent and standardised. The current lack of data and collectively recognised studies represents a major obstacle to this.

Implemented adaptation measures could, theoretically, feed back into premium pricing through their effect on the expected loss ratio. As adaptation increases resilience to yield losses, realised indemnity payments would decrease over successive policy years. As the historical reference period rolls forward, the pure premium rate is adjusted accordingly (World Bank Group, 2014). Over time, and as risks increase, the benefits of adaptation measures may be reflected through historical indemnity payment data. However, this feedback operates with a lag, meaning the premium signal follows adaptation investment rather than anticipating it. Critically, research has shown that farmers need to receive premium reductions *before* undertaking risk reduction measures (Mato-Amboage et al., 2022). So, without clear premium incentives, the upfront costs of adaptation measures will remain unaffordable for many crop farmers in the EU. Ministries of Finance, through their responsibility for financial services policy, could work with supervisory authorities and the insurance industry to develop a standardised framework for recognising and pricing on-farm adaptation measures in crop insurance policies.

6. Conclusion

Shocks to the EU's agri-food system from climate change and nature degradation can cascade into systemic risks for the macroeconomy. Alongside climate adaptation, crop insurance is a promising yet underutilised tool that can be used to shift fiscal risk off governments' balance sheets. This report has outlined three key levers for Ministries of Finance to use in their role in dampening the potential macroeconomic effects of agri-food shocks, maintaining rural sustainability and avoiding undue fiscal pressure from post-disaster expenditure.

There are significant costs to inaction as the crop sector across the EU faces increasing risks from climate change and nature degradation. These losses have macroeconomic implications, spanning food price volatility, supply chain disruptions and broader financial system impacts. Moreover, the examples presented in this report are illustrative of a trend that is only set to intensify. With crop insurance uptake in the EU remaining between 20 and 30%, most crops in the EU are uninsured for climate-related losses, leaving farmers and supply chains exposed to a high level of risk. Ministries of Finance have a role to play in dampening the potential macroeconomic effects of agri-food shocks, maintaining rural economic sustainability and avoiding undue fiscal pressure from post-disaster expenditure. This requires a strategic shift from the status quo in how risk is distributed and how finance flows throughout the agri-food system.

We have explored three levers available to Ministries of Finance to address these issues: increasing public investment in adaptation measures; enabling greater uptake of crop insurance, including through public–private (re)insurance schemes; and shaping insurance underwriting practices to incentivise crop sector adaptation. While crop insurance alone cannot address the issues arising from, nor drivers of, climate change and nature degradation, wider investment in adaptation can support overall risk reduction for the crop sector.

Viewed through this lens, integrating crop insurance and adaptation into fiscal planning is necessary for the long-term stability of the EU agri-food system and the sustainability of its public finances. This is especially pertinent in the context of a changing agricultural policy landscape at the EU level.

A follow-up report will tackle roles and responsibilities, exploring how much risk management should sit with national Member State budgets and how much should sit at the EU level. It will also cover in more detail the specific policy approaches available to Ministries of Finance to build financial resilience in the crop sector.

References

Ainsworth E A, Long S P (2020) 30 Years of Free-Air Carbon Dioxide Enrichment (FACE): What Have We Learned About Future Crop Productivity and Its Potential for Adaptation? *Global Change Biology,* 27(1), pp. 27–49. https://doi.org/10.1111/gcb.15375

Algieri B, Kornher L, Von Braun J (2025) The Changing Drivers of Inflation – the Case of Food: Macroeconomics, Speculation, Climate Change and War. *Structural Change and Economic Dynamics,* 75, pp. 782–800. https://doi.org/10.1016/j.strueco.2025.10.006

Almeida E, Goumet L, Greenslade W, Waaifoort M (2025) *Understanding the Climate–Nature Nexus and Its Implications for the Economy and Financial System*. London: Centre for Economic Transition Expertise, London School of Economics and Political Science. https://cetex.org/publications/understanding-the-climate-nature-nexus-and-its-implications-for-the-economy-and-financial-system/

Anesti N, Esady V, Naylor M (2025) Food Prices Matter Most: Sensitive Household Inflation Expectations. *SSRN Electronic Journal [Preprint*]. https://doi.org/10.2139/ssrn.5303596

Associació Valenciana D'Agricultors (2024) AVA-ASAJA eleva a 1.379 millones las pérdidas en la agricultura de la C. Valenciana por la DANA. www.avaasaja.org. https://www.avaasaja.org/index.php/prensa/notas-de-prensa/item/10547-ava-asaja-eleva-a-1-379-millones-las-perdidas-en-la-agricultura-de-la-c-valenciana-por-la-dana

Bağcı A, Küçükbayrak M (2026) Moral Hazard in Crop and Livestock Insurance*. Borsa Istanbul Review*, p. 100791. https://doi.org/10.1016/j.bir.2026.100791

Banco De Espana (2024) *Assessment of the Impact of the Dana on the Financial System and the Economy: A Central Bank Perspective*, 20 November. https://www.bde.es/f/webbe/GAP/Secciones/SalaPrensa/IntervencionesPublicas/Gobernador/Arc/Fic/IIPP-2024-11-20-escriva-en-tr.pdf

Beck M W, Quast O, Pfliegner K (2019) *Ecosystem-based Adaptation and Insurance: Success, Challenges and Opportunities*. InsuResilience Global Partnership.

Bielza M, Costanza C, Pinilla F, Stroblmair J, Catenaro R, Dittmann C (2009) *Risk Management and Agricultural Insurance Schemes in Europe*. https://www.researchgate.net/publication/253132310_Risk_Management_and_Agricultural_Insurance_Schemes_in_Europe

Bijalwan P, Sharma M, Yadav A, Dhanda P, Kaushik P, Mishra D et al. (2025) A Systematic Review of Plant Responses to Drought Stress. *Applied Fruit Science*, 67(5), p. 386. https://doi.org/10.1007/s10341-025-01632-z

Blackmore E, Guarín A, Nicolini G (2025) *Making Crop Insurance Work for Small-Scale Farmers: A Review of Recent Evidence.* https://www.iied.org/sites/default/files/pdfs/2025-04/22605iied.pdf

Bonciani D, Masolo R M, Sarpietro S (2024) *How Food Prices Shape Inflation Expectations and the Monetary Policy Response.* Staff Working Paper 1,094. London: Bank of England.

Bukeviciute L, Dierx A, Ilzkovitz F (2009) *The functioning of the food supply chain and its effect on food prices in the European Union*. European Commission, Directorate-General for Economic and Financial Affairs. https://ec.europa.eu/economy_finance/publications/pages/publication15234_en.pdf

Chan W (2025) Sustainability-Linked Insurance – The Next Breakthrough in Sustainable Finance? CWR, May. https://cwrrr.org/opinions/sustainability-linked-insurance-the-next-breakthrough-in-sustainable-finance/

Charalambakis E, Fagandini B, Henkel L, Osbat C (2022) The impact of the recent rise in inflation on low-income households. *ECB Economic Bulletin* (7). https://www.ecb.europa.eu/press/economic-bulletin/focus/2022/html/ecb.ebbox202207_04~a89ec1a6fe.en.html

Collantes F (2020) *The political economy of the Common Agricultural Policy: coordinated capitalism or bureaucratic monster?* London: Routledge. https://doi.org/10.4324/9781003015246

Dalhaus T, Wu J, Möhring N (2023) Rapidly growing subsidization of crop insurance in Europe ignores potential environmental effects. *Nature Plants*, 9(12), pp. 1938–1939. https://doi.org/10.1038/s41477-023-01569-9

Directorate-General for Agriculture and Rural Development (2023) *Agri-food data portal / PMEF Data Visualizer*. https://agridata.ec.europa.eu/extensions/DataPortal/pmef-indicators.html

European Scientific Advisory Board on Climate Change (2026) *Climate Adaptation and Mitigation in the Agri-Food System – Recommendations for Coherent EU Policies*. Copenhagen: European Scientific Advisory Board on Climate Change. https://climate-advisory-board.europa.eu/reports-and-publications/climate-adaptation-and-mitigation-in-the-agri-food-system-recommendations-for-coherent-eu-policies

Edwards C (2012) *Lloyd's Global Underinsurance Report.* London: The Society of Lloyd's. https://www.lloyds.com/news-and-insights/risk-reports/library/global-underinsurance-report

European Commission (2024a) *Report from the Commission to the European Parliament and the Council – The use of crisis measures adopted pursuant to Articles 219 to 222 of the CMO Regulation*. Brussels: European Commission. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2024:12:FIN

European Commission (2024b) *Result Indicator - Agriculture and Rural Development*. Brussels: European Commission. https://agriculture.ec.europa.eu/system/files/2023-09/pmef-result-indicators_en.pdf

European Commission (2025a) *Commission Implementing Regulation (EU) 2025/441 of 6 March 2025 providing for emergency financial support for the agricultural sectors affected by adverse climatic events and natural disasters in Spain, Croatia, Cyprus, Latvia and Hungary*. Brussels: European Commission. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:L_202500441

European Commission (2025b) *Vision for Agriculture and Food – Shaping the future of farming and the agri-food sector for future generations in Europe.* Brussels: European Commission. https://agriculture.ec.europa.eu/overview-vision-agriculture-food/vision-agriculture-and-food_en

European Commission (2025c) *The 28 CAP Strategic Plans Underway – Summary of Implementation in 2023-2024 – Facts and Figures*. Brussels: European Commission. https://agriculture.ec.europa.eu/cap-my-country/cap-strategic-plans_en

European Commission (2026a) *CAP at a glance – Agriculture and rural development*. Brussels: European Commission. https://agriculture.ec.europa.eu/common-agricultural-policy/cap-overview/cap-glance_en

European Commission (2026b) *Market measures explained – Agriculture and rural development.* Brussels: European Commission. https://agriculture.ec.europa.eu/common-agricultural-policy/market-measures/market-measures-explained_en

European Commission (2026c) *State Aid Transparency Public Search*. Brusssels: Eureopean Commission. https://webgate.ec.europa.eu/competition/transparency/public?lang=en

European Commission (2026d) *Monitoring EU Agri-Food Trade Developments in 2025*. Brussels: European Commission. https://agriculture.ec.europa.eu/document/download/94f6ec51-bae0-4807-bb48-828f38a46717_en?filename=monitoring-agri-food-trade_feb2026_en.pdf

European Commission (n.d) *The CAP post-2027 in the next EU budget.* Brussels: European Commision. https://agriculture.ec.europa.eu/common-agricultural-policy/cap-post-2027-next-eu-budget_en

European Environment Agency [EEA] (2019) *Climate Change Adaptation in the Agriculture Sector in Europe*. Luxembourg: Publications Office. https://doi.org/10.2800/537176

EEA (2024) *European Climate Risk Assessment*. Luxembourg: European Environment Agency. https://doi.org/10.2800/8671471

Eurostat (2022) *Farms and farmland in the European Union – statistics.* Luxemborg: Eurostat. https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Farms_and_farmland_in_the_European_Union_-_statistics

Eurostat (2024) *Disposable income of households (with expenditure greater than zero) spent on essential goods and services by income quantiles – experimental statistics*. Luxemborg: Eurostat. https://doi.org/10.2908/ICW_AFF_01

Eurostat (2025) *Performance of the agricultural sector*. Luxemborg: Eurostat. https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Performance_of_the_agricultural_sector

Eurostat (2026) *Key figures on food chain – agriculture's value added*, 23 February. Luxemborg: Eurostat. https://ec.europa.eu/eurostat/web/products-eurostat-news/w/ddn-20260223-1

Ewert F, Rötter R P, Bindi M, Webber H, Trnka M, Kersebaum K C et al. (2015) Crop modelling for integrated assessment of risk to food production from climate change. *Environmental Modelling & Software*, 72, pp. 287–303. https://doi.org/10.1016/j.envsoft.2014.12.003

Falkendal T, Otto C, Schewe J, Jägermeyr J, Konar M, Kummu M et al. (2021) Grain Export Restrictions During COVID-19 Risk Food Insecurity in Many Low- and Middle-Income Countries. *Nature Food*, 2(1), pp. 11–14. https://doi.org/10.1038/s43016-020-00211-7

Food and Ariculture Organisation of the United Nations [FAO] (2026a) *Food Balances (2010-)*. Quebec City: FAO. https://www.fao.org/faostat/en/#data/FBS

Food and Ariculture Organisation of the United Nations [FAO] (2026b) *FAOSTAT*. Quebec City: FAO. https://www.fao.org/faostat/en/#data/QCL/visualize

Feng S, Zscheischler J, Hao Z, Jägermeyr J, Müller C, Bevacqua E (2026) The influence of spatial correlations in crop production on global crop failures in model simulations. *Agricultural and Forest Meteorology,* 379, p. 111021. https://doi.org/10.1016/j.agrformet.2026.111021

Feyen L, Ciscar Martinez J C, Gosling S, Ibarreta Ruiz D, Soria Ramirez A, Dosio A et al. (eds.) (2020) *Climate change impacts and adaptation in Europe*. Luxembourg: Office of the European Union. https://doi.org/10.2760/171121

fi-compass (2025) *Insurance and Risk Management Tools for Agriculture in the EU*. https://www.fi-compass.eu/library/market-analysis/insurance-and-risk-management-tools-agriculture-eu

Gabriel S C, Baker C B (1980) Concepts of Business and Financial Risk. *American Journal of Agricultural Economics*, 62(3), pp. 560–564. https://doi.org/10.2307/1240215

Garrido-Perez J M, Vicente-Serrano S M, Barriopedro D, García-Herrera R, Trigo R, Beguería S (2024) Examining the outstanding Euro-Mediterranean drought of 2021–2022 and its historical context. *Journal of Hydrology*, 630, p. 130653. https://doi.org/10.1016/j.jhydrol.2024.130653

González-Torres Fernández G, Parker M (2025) The economic impact of floods. *ECB Economic Bulletin*, Issue 1/2025.

Greenslade W (2025) *A Square Mile in a Round Hole?* London: UCL Institute for Innovation and Public Purpose. https://www.ucl.ac.uk/bartlett/sites/bartlett/files/2025-05/A%20Square%20Mile%20in%20a%20Round%20Hole%3F%20The%20London%20insurance%20ecosystem%20in%20an%20era%20of%20climate%20uncertainty_0.pdf

Grislain-Letrémy C, Villeneuve B, Yeterian M (2024) *Don't bet the Farm on Crop Insurance Subsidies: A Marginal Treatment Effect Analysis of French Farms*. Paris: Banque De France. https://www.banque-france.fr/en/publications-and-statistics/publications/dont-bet-farm-crop-insurance-subsidies-marginal-treatment-effect-analysis-french-farms

Hamidov A, Helming K, Bellocchi G, Bojar W, Dalgaard T, Ghaley B B et al. (2018) Impacts of climate change adaptation options on soil functions: A review of European case-studies. *Land Degradation & Development*, 29(8), pp. 2378–2389. https://doi.org/10.1002/ldr.3006

Hortidaily (2023) Floods damage crops in northern France. *Hortidaily*. https://www.hortidaily.com/article/9577612/floods-damage-crops-in-northern-france/

Intergovernmental Panel on Climate Change [IPCC] (2023) *Climate Change 2022 – Impacts, Adaptation and Vulnerability: Working Group II Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge: Cambridge University Press. https://doi.org/10.1017/9781009325844

Jägermeyr J, Müller C, Ruane A C, Elliott J, Balkovic J, Castillo O et al. (2021) Climate impacts on global agriculture emerge earlier in new generation of climate and crop models. *Nature Food*, 2(11), pp. 873–885. https://doi.org/10.1038/s43016-021-00400-y

Jarzabkowski P, Chalkias K, Clarke D, Iyahen E, Stadtmueller D, Zwick A (2019) *Insurance for climate adaptation: Opportunities and limitations*. Rotterdam and Washington, DC: Global Commission on Adaptation. https://gca.org/wp-content/uploads/2019/07/Insurance-for-climate-adaptation_Opportunities-and-Limitations.pdf

Jarzabkowski P, Chalkias K, Cacciatori E, Bednarek R (2023) *Protection Gap Entities: Saving insurance from itself?* In: Jarzabkowski P et al., Disaster Insurance Reimagined. Oxford: Oxford University Press, pp. 1–30. https://doi.org/10.1093/oso/9780192865168.003.0001

Jensen L and Hourdin C (2025) *climate change impacts on food security in the European Union.* Strasbourg: European Parliament. https://www.europarl.europa.eu/RegData/etudes/BRIE/2025/775874/EPRS_BRI(2025)775874_EN.pdf

Lopes M (2022) Will temperature and rainfall changes prevent yield progress in Europe? *Food and Energy Security,* 11, e372. https://doi.org/10.1002/fes3.372

Maguire, M (2023) Farmers welcome compensation for unharvested crops after 'major losses' due to extreme weather. *The Journal*. https://www.thejournal.ie/farmers-welcome-compensation-for-unharvested-crops-after-major-losses-due-to-extreme-weather-6219474-Nov2023/

Manescu A C, Barna F M, Regep H D, Manescu C M, Cerba C (2025) The Impact of Extreme Weather Events on Agricultural Insurance in Europe. *Agriculture*, 15(9), p. 995. https://doi.org/10.3390/agriculture15090995

Marsden L, Ryan-Collins J, Abrams J, Lenton T (2024) *Ecosystem tipping points: Understanding the risks to the economy and the financial system.* London: UCL Institute for Innovation and Public Purpose. https://www.ucl.ac.uk/bartlett/public-purpose/2024/apr/ecosystem-tipping-points

Mateos-Ronco A (2025) *Sustainability of Agricultural Insurance Systems: Challenges from a European Approach*. In: Bataller-Grau J, Kawiński M, Marano P (eds.) Sustainability and the Insurance Market. Cham: Springer Nature Switzerland, pp. 217–246. https://doi.org/10.1007/978-3-031-72186-1_9

Mato-Amboage, Touza J, Salino M (2022) Understanding Farmers' Preferences Towards Insurance Schemes that Promote Biosecurity Best Management Practices. *International Journal of Disaster Risk Science,* 13, pp. 705–715. https://doi.org/10.1007/s13753-022-00435-0

Michels M, Wever H, Mußhoff O (2024) Cultivating Support: An Ex-Ante Typological Analysis of Farmers' Responses to Multi-Peril Crop Insurance Subsidies. *Journal of Agricultural and Applied Economics*, 56(2), pp. 260–277. https://doi.org/10.1017/aae.2024.8

Mikaelsson M A (2026) *Insurance and Reinsurance Under Climate Stress: Managing Systemic Risk in Global Supply Chains*. SEI working paper. Stockholm Environment Institute. tea

Möhr C, Yong, J, Zweimueller M (2025). *Mind the climate-related protection gap – reinsurance pricing and underwriting considerations* (FSI Insights on policy implementation, No. 65). Bank for International Settlements. https://www.iais.org/uploads/2025/03/FSI-Insights-65-Mind-the-climate-related-protection-gap-reinsurance-pricing-and-underwriting-considerations.pdf

Monteleone L, Roberti G, Fossati F, Davis W, Forster D, Miras Lopez C et al. (2026) *Assessment of EU and Member States adaptation investment needs*. Luxembourg: Publications Office of the European Union. https://data.europa.eu/doi/10.2834/2895769

Mooney A, Plimmer G, Speed M (2026) UK farmers warn of rotting crops after exceptionally wet start to year. *Financial Times*, 11 February. https://www.ft.com/content/0066036b-a428-40d7-9c57-1793b5faa4b6

Müller B, Hoffmann F, Heckelei T, Müller C, Hertel T W, Polhill J G et al. (2020) Modelling food security: Bridging the gap between the micro and the macro scale. *Global Environmental Change*, 63, p. 102085. https://doi.org/10.1016/j.gloenvcha.2020.102085

Neumann T, Botia L M (2025) *Knowledge Development and Application Concerning Costs of Adaptation Compared to Costs of Inaction*. Ramboll Management Consulting.

Panagos P, Borrelli P, Jones , Robinson D A (2024) A 1 billion euro mission: A Soil Deal for Europe. *European Journal of Soil Science*, 75(1), p. e13466. https://doi.org/10.1111/ejss.13466

Polackova H (1999) Contingent Government Liabilities. A Hidden Fiscal Risk. *Finance and Development,* 36(1). https://www.imf.org/external/pubs/ft/fandd/1999/03/polackov.htm

Publications Office of the European Union and Directorate-General for Research and Innovation (European Commission) (2026) *CORDIS Results Pack on Nature-Based Solutions in Agriculture - Strengthening Biodiversity Benefits in Sustainable Farming.* Publications Office of the European Union. https://data.europa.eu/doi/10.2830/3316656

Prudential Regulation Authority (2026) *Mind the gap: a UK microprudential perspective on general insurance protection gaps.* https://www.bankofengland.co.uk/bank-insights/2026/mind-the-gap-uk-microprudential-perspective-general-insurance-protection-gaps

Reisinger A, Howden M, Vera C, Garschagen M, Hurlbert M, Kreibiehl S, Mach K J et al. (2020) *The concept of risk in the IPCC Sixth Assessment Report: A summary of cross-working group discussions*. Intergovernmental Panel on Climate Change.

Reuters (2023) France launches 500 mln euro support scheme for agri-food sector. 3 March. https://www.reuters.com/world/europe/france-launches-500-mln-euro-support-scheme-agri-food-sector-2023-03-03/

Rezitis A N, Tsionas M (2019) Modeling Asymmetric Price Transmission in the European Food Market. *Economic Modelling*, 76, pp. 216–230. https://doi.org/10.1016/j.econmod.2018.08.004

Ruiz-Ramos M, Ferrise R, Rodríguez A, Lorite I J, Bindi M, Carer T R et al. (2018) Adaptation response surfaces for managing wheat under perturbed climate and CO2 in a Mediterranean environment. *Agricultural Systems*, 159, pp. 260–274. https://doi.org/10.1016/j.agsy.2017.01.009

Santeramo F G, Russo I, Lamonaca E (2023) Italian subsidised crop insurance: What the role of policy changes. *Q Open*, 3(3), p. qoac031. https://doi.org/10.1093/qopen/qoac031

Schipper E L F (2020) Maladaptation: When Adaptation to Climate Change Goes Very Wrong. *One Earth*, 3(4), pp. 409–414. https://doi.org/10.1016/j.oneear.2020.09.014

Stein K, Greenslade W, Day E (2025) To insure or not to insure, that is the question: why property insurance matters for urban climate resilience, and why some urban areas are becoming "uninsurable" just when we need insurance protection most. *University of Toronto Press, Journal of City Climate Policy and Economy*, 4, 1, pp 186 – 201. https://doi.org/10.3138/jccpe-2024-0050

Sun J, Ran T, Wang J (2024) Do farmers always choose agricultural insurance against climate change risks? *Econ Anal Policy* 81:617-628. https://www.sciencedirect.com/science/article/abs/pii/S0313592623003387

Surminski S, Oramas-Dorta D (2014) Flood insurance schemes and climate adaptation in developing countries. *International Journal of Disaster Risk Reduction*, 7, pp. 154–164. https://doi.org/10.1016/j.ijdrr.2013.10.005

The Insurer (2025) Axis Re's Leahey: The Effect of Commodity Price Fluctuations on Agriculture Insurance. *theinsurer.com*, 11 September. https://www.theinsurer.com/ti/viewpoint/axis-res-leahey-the-effect-of-commodity-price-fluctuations-on-agriculture-2025-09-11/

United Nations Office for Disaster Risk Reduction [UNDRR] (2017) The Sendai Framework Terminology on Disaster Risk Reduction. "Disaster risk". Accessed 4 May 2026. https://www.undrr.org/terminology/disaster-risk.

Van Daalen K, Romanello M, Rocklöv J et al. (2022) The 2022 Europe report of the Lancet Countdown on health and climate change: towards a climate resilient future. *The Lancet Public Health*, 7, e942–e965.

World Bank Group (2014) *Agricultural basics.* International Finance Corporation 2014. https://documents1.worldbank.org/curated/en/823851490774684515/pdf/113697-WP-Manual-02-Actuaral-Basics-PUBLIC.pdf