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Feeding a warming world

Securing food and economic stability in a changing climate

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Allianz Research

Content

Executive Summary

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- **In the 80 years since World Food Day was first established, the transformation of agriculture, fueled by fertilizers and international trade, has helped reduce global hunger – albeit unevenly across regions.** Since 1961, the global calorie supply has increased by around +35%, contributing to a reduction in undernourishment worldwide. While global hunger declined by almost -4% between 2000 and 2023, South-Eastern Asia lowered the prevalence of hunger from 20% to 6% during the same period, with Latin America and parts of South Asia recording comparable improvements. Yet, Sub-Saharan Africa continues to face acute food insecurity, with nearly one-quarter of its population undernourished.

- **But advancements in agriculture have come with high environmental and systemic costs.** The transport of agricultural products generates roughly 3 gigatons of CO_2 equivalent annually, accounting for nearly one-fifth of total emissions from the food system. Food freight represents less than one-fifth of overall transport activity but produces over one-quarter of transport-related emissions, with fruit and vegetable shipments especially intensive. Fertilizer inefficiency is another major challenge: on average, only 40% of applied nitrogen is absorbed by crops. The remainder leaks into ecosystems, degrading water quality and creating hypoxic "dead zones". In the US alone, damages from freshwater eutrophication are estimated at USD2.2bn annually.

- **Agriculture faces a double materiality risk: it drives climate change and environmental degradation while being among the sectors most vulnerable to them.** Over the past three decades, natural disasters have caused an estimated USD3.8trn in agricultural losses – equivalent to 5% of global agricultural GDP per year – with droughts accounting for two-thirds of the damage. The 2022 European megadrought alone affected 143,000 km^2 of land, reducing vegetation productivity on 66,500 km^2 of cropland (+13% above the long-term average). In Europe, cereal yields fell by roughly -10%, while agricultural and environmental losses reached EUR50bn that year. In the US, drought remains the dominant driver of agricultural losses, with record indemnities during 2012, 2020 and 2022. Other hazards – such as floods, excess moisture and freeze events – have also increased, revealing a growing volatility of climate risks. Most losses are concentrated in corn and soybean production, exposing structural vulnerabilities in the US food system and highlighting the urgency of diversification and adaptation. Weather-related insurance payouts in 2023 were seven times higher than in 2000, underscoring the mounting financial burden on farmers and the federal insurance system.

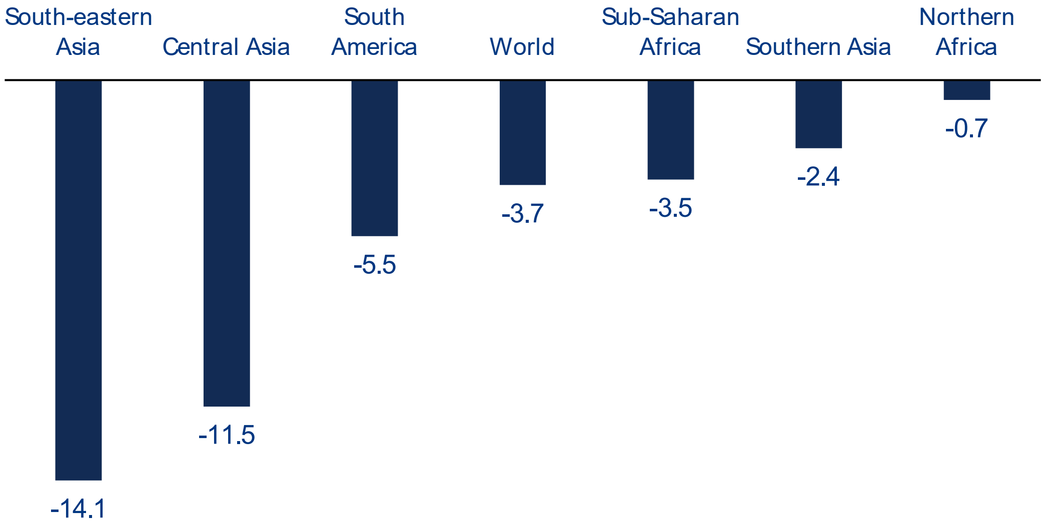
- **Looking ahead, our analysis suggests that by 2050, maize yields could decline by -9%, wheat by -7% and soybeans by -4%, triggering inflationary ripple effects, most notably in the Asia-Pacific region (+27%) and Europe (+6%).** By 2050, fluctuations in crop yields could fuel global food inflation, pushing consumer prices about 13% above the baseline. The Asia-Pacific region is projected to experience the steepest rise (+27%), led by countries such as Indonesia (+146%), Malaysia (+113%), India (+31%) and China (+21%). Beyond agricultural risks, this poses a macroeconomic threat as climate-driven food inflation may trigger broader economic, social and financial instability. Furthermore, falling yields and increasing agricultural commodity prices could squeeze margins of agrifood companies: we estimate that every 1pp increase in price leads to about a -1.67pp decline profitability for both upstream and downstream companies.

- **To secure food and economic stability, agriculture needs to build resilience in a changing climate.** The global food system must strengthen adaptation along four key pillars: farmer practices, technological innovation, government support and financial safety nets. Insurance is among the most effective tools to strengthen financial resilience. Parametric insurance products, which link payouts to objective measures such as rainfall or yields, provide speed and affordability while reducing administrative costs. Policy action is helping scale these instruments: the EU now subsidizes up to 70% of premiums, a move expected to help double the global index insurance market in the next decade, from USD18bn today to USD34.4bn by 2033. However, access remains highly constrained for smallholder farmers, particularly in developing countries. For these farmers, microinsurance offers a more practical solution: The potential market is vast, covering nearly 3bn people, yet actual coverage reaches only 11.5% globally and just 8.2% in Africa.

Agriculture at the crossroads of nourishment and nature

Over the past two decades, the world has made remarkable progress in the fight against hunger. Thanks to advances in agricultural productivity, international cooperation and targeted food security programs, the share of undernourished people has declined significantly in most regions (Figure 1). The trend is especially striking in South-Eastern Asia, where the prevalence of undernourishment fell from 20.2% of the population in 2000 to just 6.1% in 2023, a reduction of 14.1pps. Latin America and parts of South Asia also saw similar positive dynamics as governments combined agricultural expansion with nutrition programs and social safety nets. Nevertheless, global progress has been uneven. Sub-Saharan Africa remains the region most severely affected by food insecurity. Despite a modest decline of 3.5pps since 2000, the prevalence of undernourishment still stood at 23.2% in 2023. Put differently, nearly one in four people in the region does not have reliable access to sufficient calories. Persistent structural challenges, ranging from fragile agricultural systems and limited infrastructure to rapid population growth and recurring climate shocks, continue to undermine food security efforts. Compounding these regional disparities are recent setbacks linked to conflict, economic disruption and climate change. Wars in places such as Gaza, Sudan and Yemen, as well as extreme weather events, have caused localized spikes in hunger even against the backdrop of long-term global improvement.

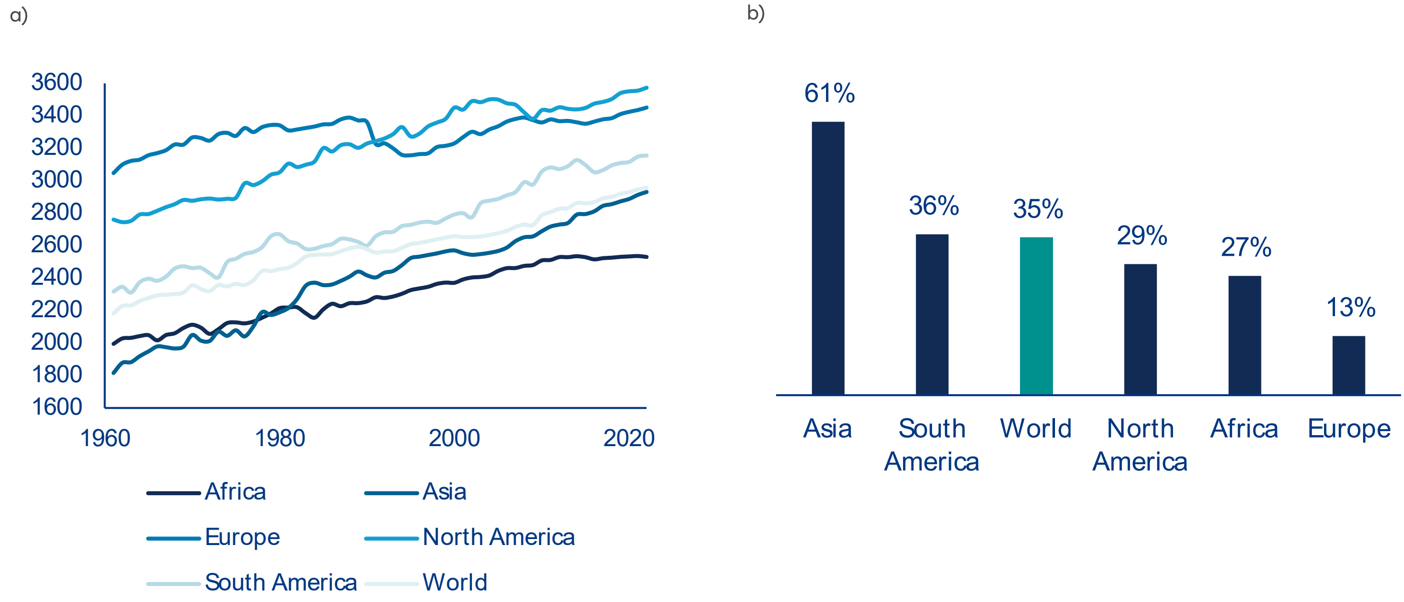
Figure 1: Change in undernourishment from 2000 to 2023 in pps



Sources: Our World in Data, Allianz Research

This global improvement in nutrition outcomes is closely linked to the steady increase in the availability of calories per person across all regions (Figure 2). Since the 1960s, average daily caloric supply has risen sharply, reflecting both the Green Revolution and broader modernization of food systems (Figure 2a). In Asia, the transformation has been particularly remarkable: Between 1961 and 2022, daily calorie availability grew by +61%, lifting hundreds of millions of people out of chronic hunger and undernourishment (Figure 2b). Latin America also achieved substantial gains, with an increase of +36%, while the global average rose by +35% over the same period. At the same time, regional disparities remain evident. In Africa, average calorie supply per person rose by +27%, a slower pace compared to Asia or South America, leaving the continent more vulnerable to food insecurity. In contrast, Europe, which already had relatively high caloric availability in the 1960s, recorded only a +13% increase. Yet, these improvements in food security worldwide are accompanied by a growing paradox: While more food is produced and available than ever before, vast amounts are wasted at every stage of the system, from harvest and storage losses to retail inefficiencies and household waste. This raises critical questions about how gains in availability translate into actual nutrition outcomes, and underscores the urgency of tackling food waste alongside increasing supply (see Box 1).

Figure 2: Daily supply of calories per person: a) development of the daily supply of calories across regions for the period 1971 – 2022 (kcal); b) growth of daily calorie consumption between 1961 and 2022



Sources: Our World in Data, Allianz Research

These gains are linked to improvements in crop yields and nutrition programs, but also to the steady growth of international agricultural trade. The growth of trade since 1990 has been extraordinary (Figure 3 and Figure 4). Agricultural merchandise trade increased sixfold worldwide between 1990 and 2023, with Asia expanding by a factor of ten and South America by seven (Figure 3b). Trade in crops and livestock grew even more dramatically: South America alone expanded exports 44 times over the same period, consolidating its role as a global supplier of soybeans, maize, beef and other commodities (Figure 4). North America grew around sixfold, while Europe's increase was more modest at threefold, reflecting a more mature trade base. These shifts have been central to reducing hunger by linking surplus-producing regions with those where domestic production lagged behind population growth.

At the same time, this food trade system has contributed to climate change. Transporting food over long distances, measured as "food miles", produces around 3.0 gigatons of CO_2 equivalent ($GtCO_2e$) annually, about 19% of total food system emissions. Food miles represent only 18% of freight activity, but account for 27% of freight-related emissions, underlining the carbon intensity of international shipping and aviation. Fruits and vegetables alone are responsible for 36% of food miles emissions, nearly twice the emissions generated in their production[1].

These same networks are also highly vulnerable to climate hazards. The 2010–2011 drought in China, which hit key wheat-growing regions, forced the country to purchase large quantities on global markets. This surge in demand contributed to a doubling of global wheat prices. In Egypt, the world's largest wheat importer, bread prices tripled, placing enormous pressure on households and intensifying unrest during an already fragile political moment[2]. The sequence – drought, trade disruption, soaring prices and social instability – demonstrates how tightly food security is bound to climate risks. The past decades show that while trade has been indispensable in reducing hunger, food security remains vulnerable when it depends on long-distance supply chains that both generate emissions and are exposed to the climate shocks those emissions worsen. Managing this tension will define the resilience of global food systems in the years ahead.

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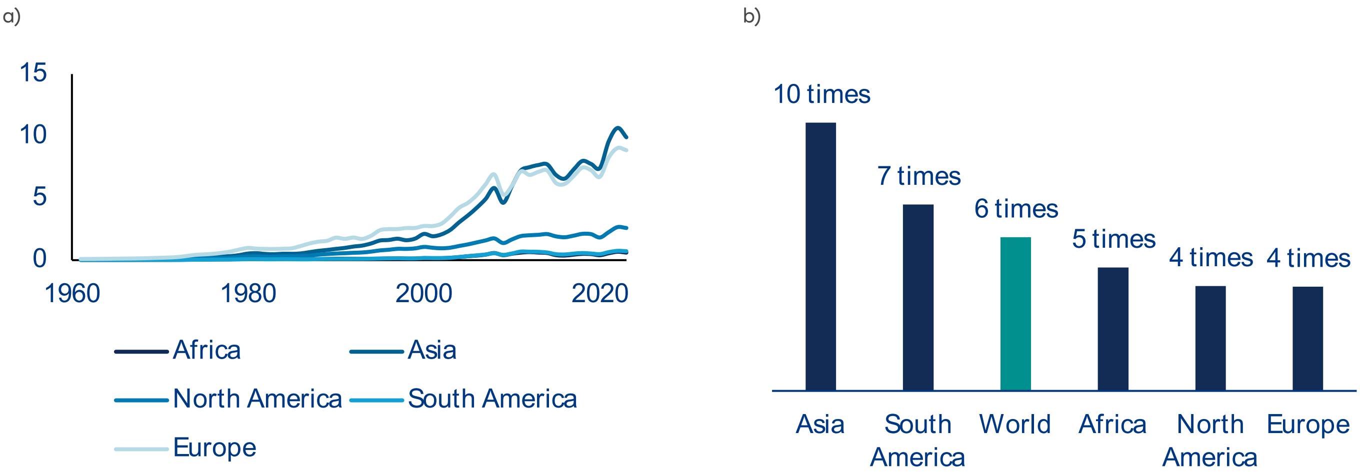
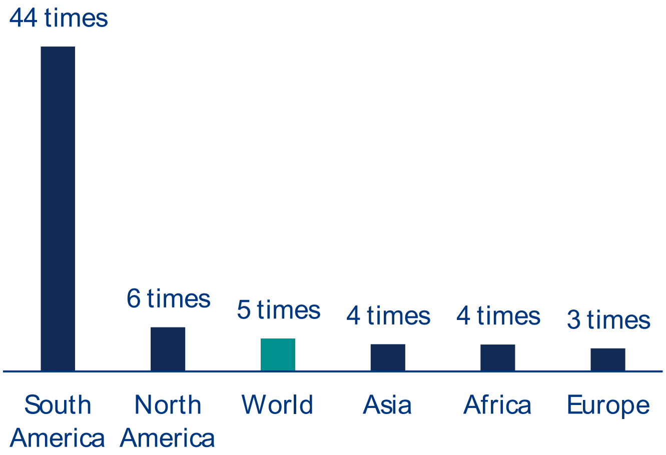
[1] Global food-miles account for nearly 20% of total food-systems emissions | Nature Food
[2] Chinese drought, bread and the Arab Spring - ScienceDirect

Figure 3: Total agriculture merchandise trade : a) Trade development between 1961 – 2023 (USD trn); b) Trade growth in 2023 compared to 1990



Sources: FAOSTAT, Allianz Research

Figure 4: Change in crops and livestock trade in 2023 compared to 1990



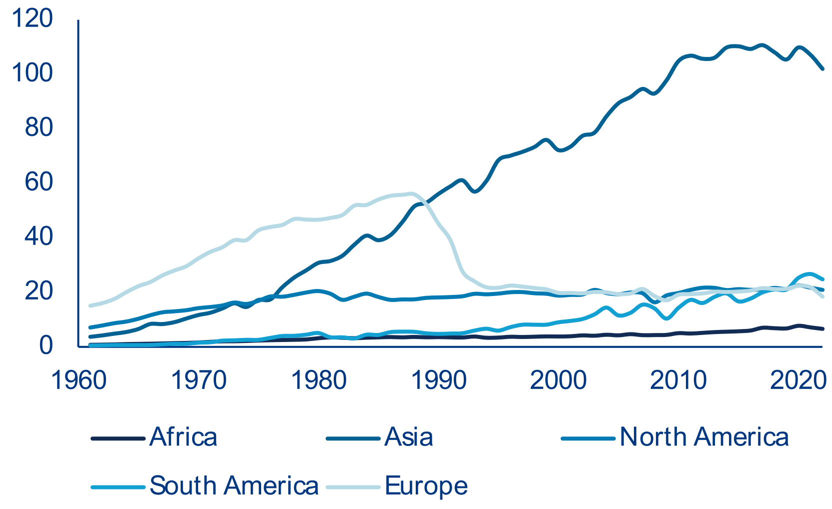
Sources: FAOSTAT, Allianz Research

Since the 1960s, the use of fertilizers has expanded at an unprecedented scale, reshaping agricultural production worldwide (Figure 5). Asia stands out, with fertilizer consumption rising more than hundredfold over the second half of the twentieth century, driving the Green Revolution and transforming food security across the region. South America followed from the 1980s onward as export-oriented farming systems began to rely heavily on synthetic inputs. In North America and Europe, fertilizer use reached high levels earlier, then plateaued or even declined as efficiency improvements and environmental concerns grew.

Modern fertilizers were pivotal to yield gains, but their widespread, often inefficient use has imposed large and measurable environmental and health costs. Globally, less than half of applied nitrogen is recovered in crops, meaning a substantial share is lost to air and water as reactive nitrogen; recent syntheses place mean recovery around 40%, underscoring systemic inefficiency and leakage across food systems[3]. These leakages degrade soils, impair waters and harm human health. Long-term field surveys in China show that intensive nitrogen inputs acidified major cropland soils between the 1980s and 2000s, a process that depletes base cations, mobilizes metals and can lower biological activity, ultimately reducing soil quality and resilience ("making land poor")[4]. Losses to water drive eutrophication in lakes and estuaries are linked to the proliferation of coastal "dead zones": the global extent of hypoxic coastal waters has expanded exponentially since the 1960s, fueled in part by fertilizer runoff. In the US alone, eutrophication of freshwaters has been valued at roughly USD2.2bn per year in economic damages (property and recreation losses, among others)[5]. Nitrogen applied today also accumulates as a "legacy" in soils and aquifers, causing decades-long time lags before water quality improves even after surface applications are reduced, complicating policy evaluation and public expectations.

Human health burdens arise via multiple pathways. Ammonia (NH_3) from fertilizer and manure forms secondary fine particulates ($PM_{2.5}$) that drive morbidity and mortality; Europe's comprehensive European Nitrogen Assessment (ENA) estimates the annual damage cost of reactive nitrogen at EUR70bn – EUR320bn[6]. Beyond the established risk of infant methemoglobinemia, systematic reviews and cohort studies report associations with colorectal cancer, thyroid disease, preterm birth and certain congenital anomalies, though results vary by outcome and setting, and uncertainty remains in exposure–response at low doses.

Figure 5: Use of fertilizers during the period 1961 – 2022 (mn ton)



Sources: Our World in Data, Allianz Research

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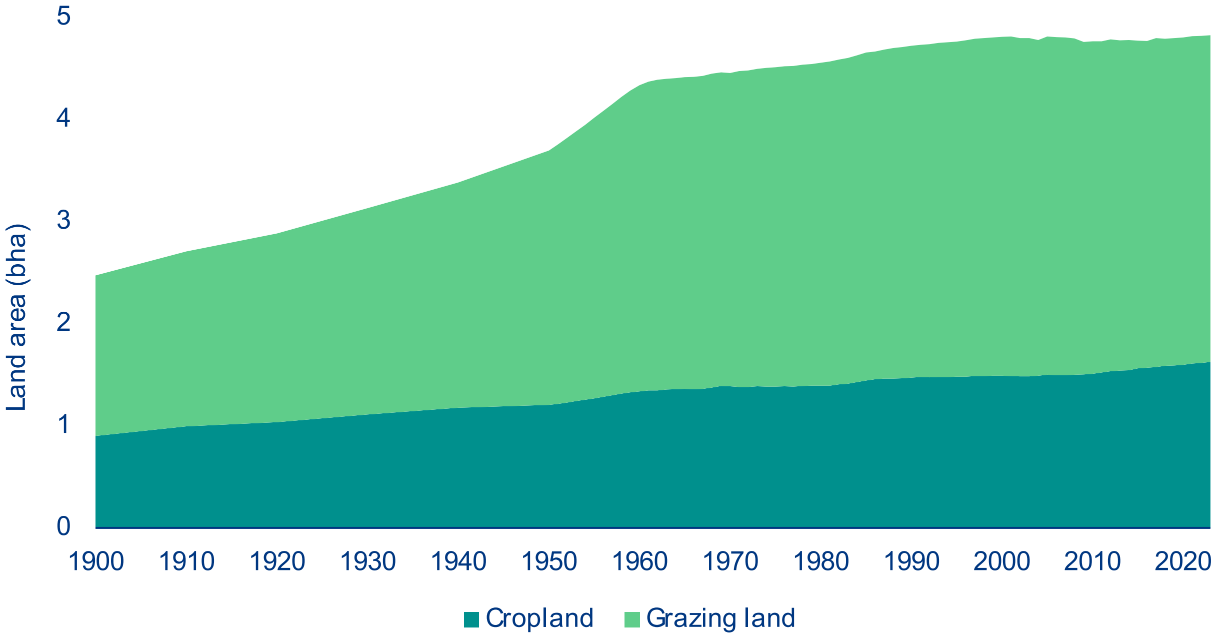
[3] Managing nitrogen for sustainable development | Nature
[4] Science Express Logo Report
[5] Eutrophication of U.S. freshwaters: analysis of potential economic damages - PubMed
[6] Costs and benefits of nitrogen in the environment (Chapter 22) - The European Nitrogen Assessment

Agricultural expansion has been the most important driver of land-use change over the past century (Figure 6). Since 1900, both cropland and grazing land have expanded markedly, with the mid-twentieth century showing the steepest growth as global demand for food and livestock products accelerated. While cropland has continued a gradual increase since the 1990s, grazing land has remained the dominant component, underscoring the weight of meat and dairy production in shaping landscapes (Figure 6a). This long-run expansion is directly tied to the rising trajectory of deforestation (Figure 6b). Annual tree-cover loss fluctuates with regional fire and harvest cycles, but the aggregate trend remains high, with Brazil, Canada, Russia and the US consistently among the largest contributors. Brazil stands out in particular, not only for the scale of its forest loss but also for the commodity dynamics behind it. Figure 6c traces the development of Brazilian deforestation linked to soybeans farming. From 2015, soy production climbed from around 100mn tons to nearly 120 mn tons, yet soy-related deforestation declined by more than half over the same period. This decoupling reflects the Amazon Soy Moratorium[7], a supply-chain agreement that curtailed direct conversion of Amazonian forest for soy, reducing the share of new plantings on recently deforested land to roughly -1% by 2014, even as output surged[8]. However, the success of this initiative has not come without trade-offs: pressure has spilled into other sensitive ecosystems, especially the Cerrado savanna, where high biodiversity and endemism are threatened by continuing conversion. Recent modeling suggests that extending moratorium-style rules to the Cerrado could prevent the loss of more than 3.6mn hectares of native vegetation by 2050, though without comprehensive measures leakage could erase as much as half of the gains[9].

The carbon implications of agriculture deforestation are profound. Land-use change has emitted an estimated 4.7 ± 2.6 gigatons of CO_2 each year in the past decade, roughly a tenth of global annual emissions[10]. Valued at an updated social cost of carbon of about USD185 per ton of CO2[11], this translates into welfare losses on the order of USD900bn annually. Beyond carbon, the ecological toll is staggering.

Figure 6: Use of fertilizers during the period 1961 – 2022 (mn ton)

a)



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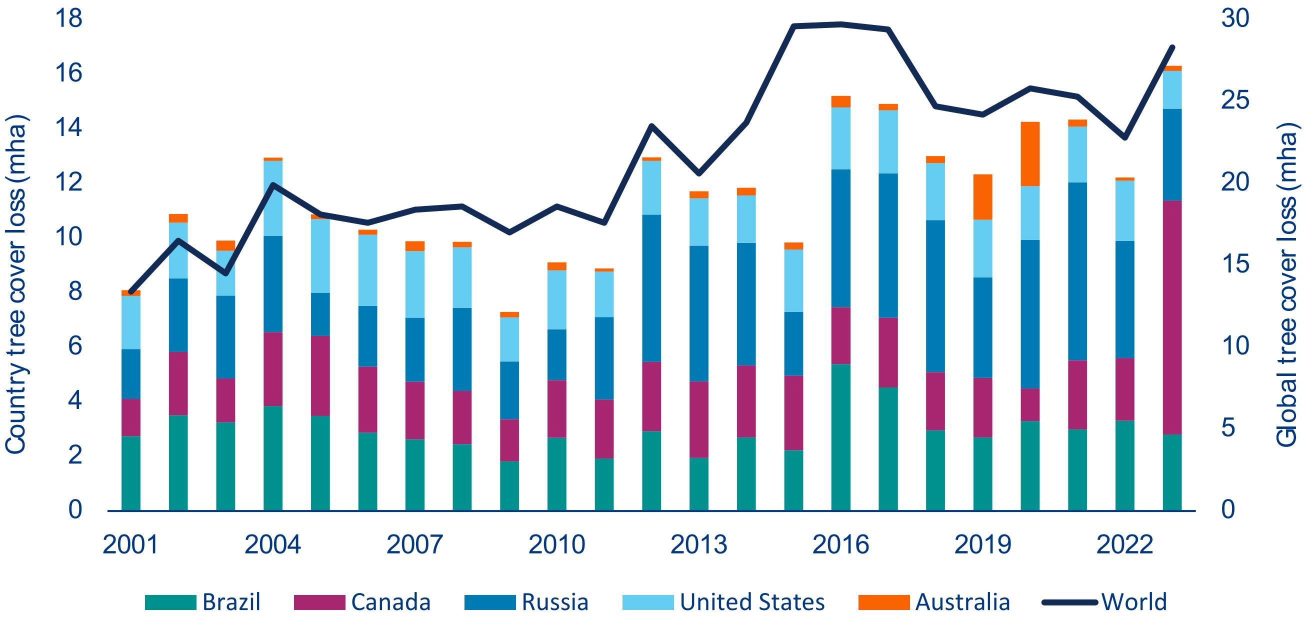
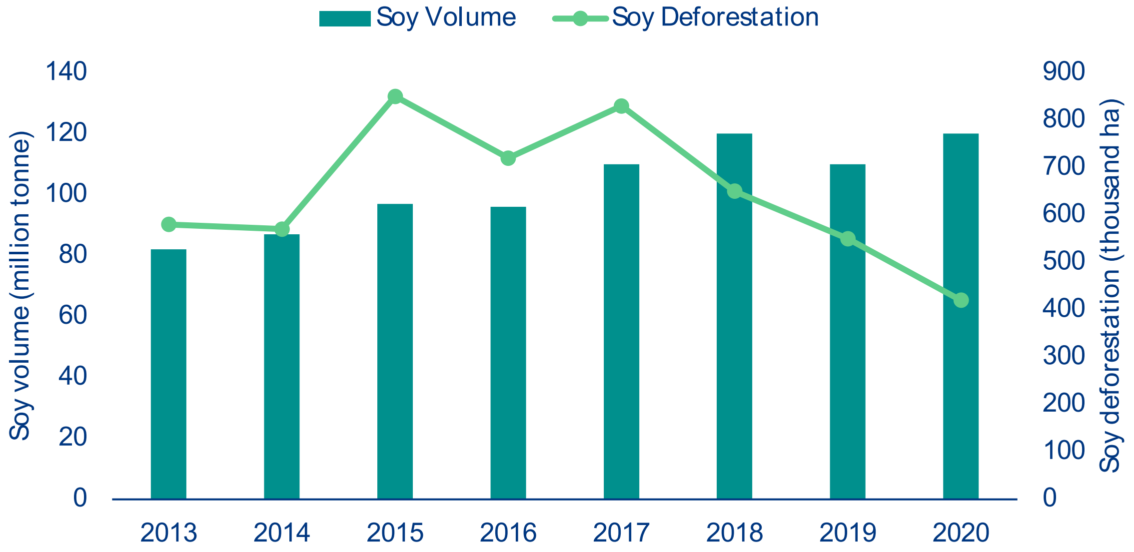
[7] Brazil's Amazon soy moratorium | WWF Forest Solutions
[8] The rotten apples of Brazil's agribusiness | Science
[9] The origin, supply chain, and deforestation risk of Brazil's beef exports | PNAS
[10] ESSD - Global Carbon Budget 2022
[11] Comprehensive evidence implies a higher social cost of CO2 | Nature

b)



c)



Sources: Our World in Data, Trase, Allianz Research

Modern agriculture embodies a profound contradiction: it is indispensable for feeding a growing world, yet it simultaneously undermines the ecological systems on which it depends. As shown in Figure 7, this tension emerges across several critical dimensions. Agriculture is responsible for about 26% of global greenhouse gas emissions (Figure 7a), a share that, though smaller than non-food sectors, remains exceptionally difficult to decarbonize because it is rooted in biological processes such as soil emissions and livestock digestion. The sector's spatial footprint is equally striking. Half of the planet's habitable land is now devoted to agriculture (Figure 7b), reflecting decades of cropland expansion and grazing pressure. This has come at the expense of forests and natural habitats, fueling biodiversity loss and deforestation, particularly in tropical regions, such as Brazil. Agriculture is also the largest user of freshwater resources (Figure 7c), accounting for 70% of global withdrawals, a dependence that exposes food systems to growing risks from drought, groundwater depletion and climate variability. Finally, nutrient runoff from fertilizers and manure makes agriculture the dominant driver of eutrophication (Figure 7d), responsible for nearly 80% of the problem worldwide. The result is widespread water pollution, algal blooms and coastal dead zones, with cascading consequences for ecosystems and human health.

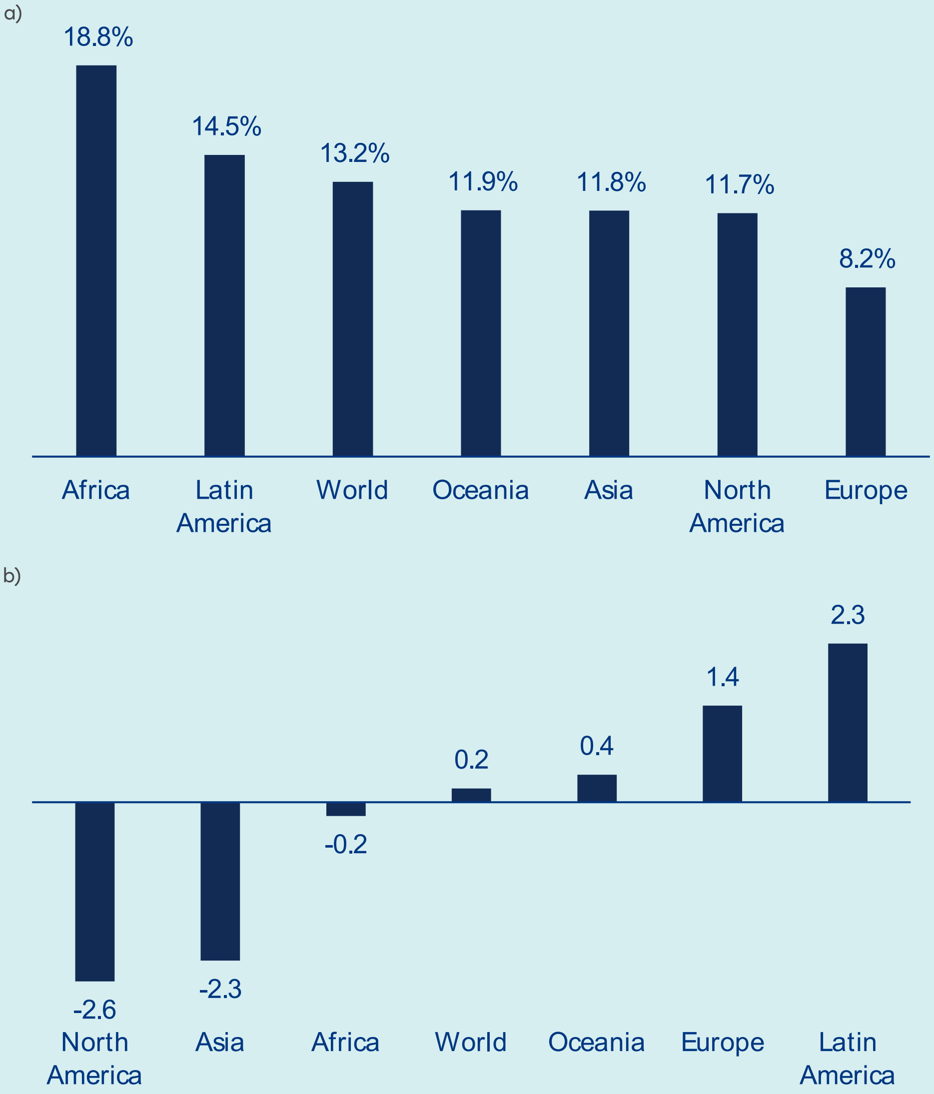
Figure 7: Climate and environmental impact of the agriculture sector: a) Greenhouse gas emissions; b) Land-use; c) Freshwater withdrawals; d) Eutrophication

Sources: Our World in Data, Allianz Research

Box 1: Rising availability, rising waste

Ensuring societies' access to food has come with significant environmental costs, not least the persistent and growing problem of food waste. According to the UNEP Food Waste Index Report (2024), an estimated 1,052mn tons of food were wasted in 2022, equivalent to 19% of food available at the consumption stage, that is, at the level of retail, food services and households. This marks an increase of 2pps compared with 2019, when the share stood at 17%. The implications are far-reaching: food wasted at the consumption stage alone is responsible for around 8–10% of global greenhouse gas emissions, making it a major yet often overlooked driver of climate change. But food losses do not occur only at the point of consumption. When looking at the earlier stages of the supply chain (production, storage, transport and processing) an additional 11.8% of food is lost globally (Figure 8a). These supply-related losses are highly uneven across regions. Africa, for example, records the highest share of food waste during supply, largely due to weaker infrastructure and limited cold-chain capacity. By contrast, in more industrialized regions, losses are lower at the production stage (11.7% in North America and 8.2% in Europe). Encouragingly, some progress is being made. Between 2016 and 2021, Africa reduced its supply-related food waste slightly by 0.2pp, while globally, supply-chain waste rose by 0.2 points. The most pronounced increases were seen in Latin America (+2.3pp: 14.5% in 2021 compared to 12.2% in 2016) and Europe (+1.4pp: 8.2% in 2021 compared to 6.8% in 2016) (Figure 8b).

Figure 8: Regional patterns of food waste: a) Food waste by region in 2021 (% of total food produced); b) The evolution of food waste by region between 2016 and 2021 (pp)

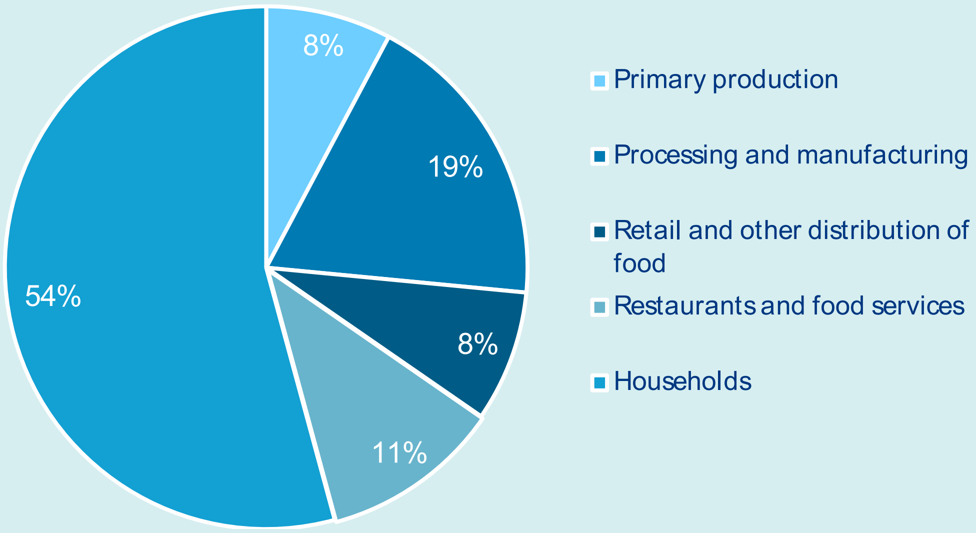


Sources: FAO, Allianz Research

A closer look at regional patterns provides further nuance on where and how food is wasted along the value chain. In the EU, households are by far the largest source of waste, accounting for more than half of the total (54%), followed by processing and manufacturing (19%) and retail and food services (together 19%) (Figure 9a). This underscores the critical role of consumer behavior, alongside inefficiencies in the broader food system. Yet the picture is not uniform across Europe: per capita food waste varies widely, with Cyprus and Denmark recording the highest levels (294 kg and 254 kg per person, respectively), more than two times higher than the EU average of 132 kg per person. By contrast, countries such as Slovenia, Croatia and Hungary report per capita waste below 90 kg (Figure 9b). In Sub-Saharan Africa, by contrast, food waste is concentrated much earlier in the supply chain. Around 90% of losses occur at the stages of production and post-harvest handling, with consumption-related waste playing only a marginal role of 2% on average in 2018 (Figure 9c). This reflects systemic challenges such as inadequate infrastructure, limited storage capacity and weak logistics, which prevent food from reaching markets in the first place. The contrast between Europe and Africa illustrates the dual challenge of tackling waste: In high-income regions, solutions must focus on consumer awareness, portion sizes and retail practices, whereas in low-income settings, investments in storage, transport and market access are more pressing, which can substantially improve food availability and bolster food security in regions with a long history of vulnerability.

Figure 9: Food waste in the value chain: a) Food waste in the EU by sector (2022); b) Total food waste in the EU by country (top 5 and least 5 countries in kg per inhabitant, 2022); c) Food waste in Sub-Saharan Africa by sector (2018)

a)



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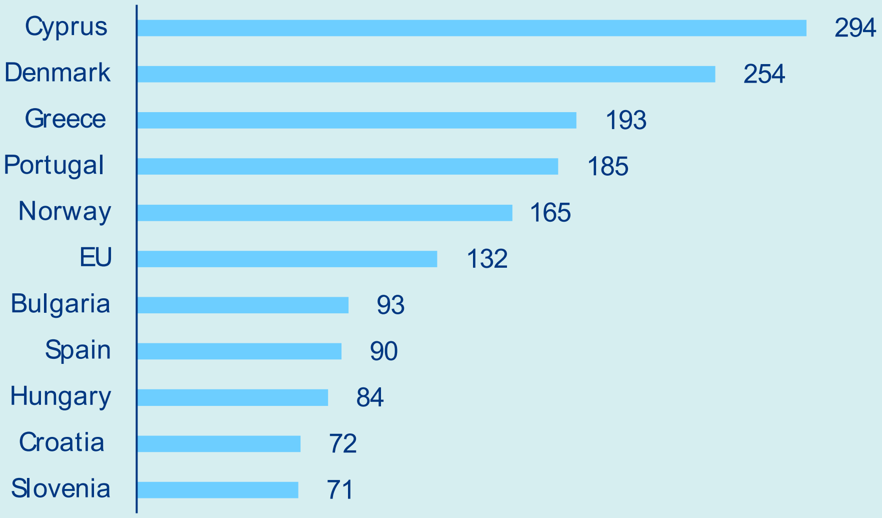

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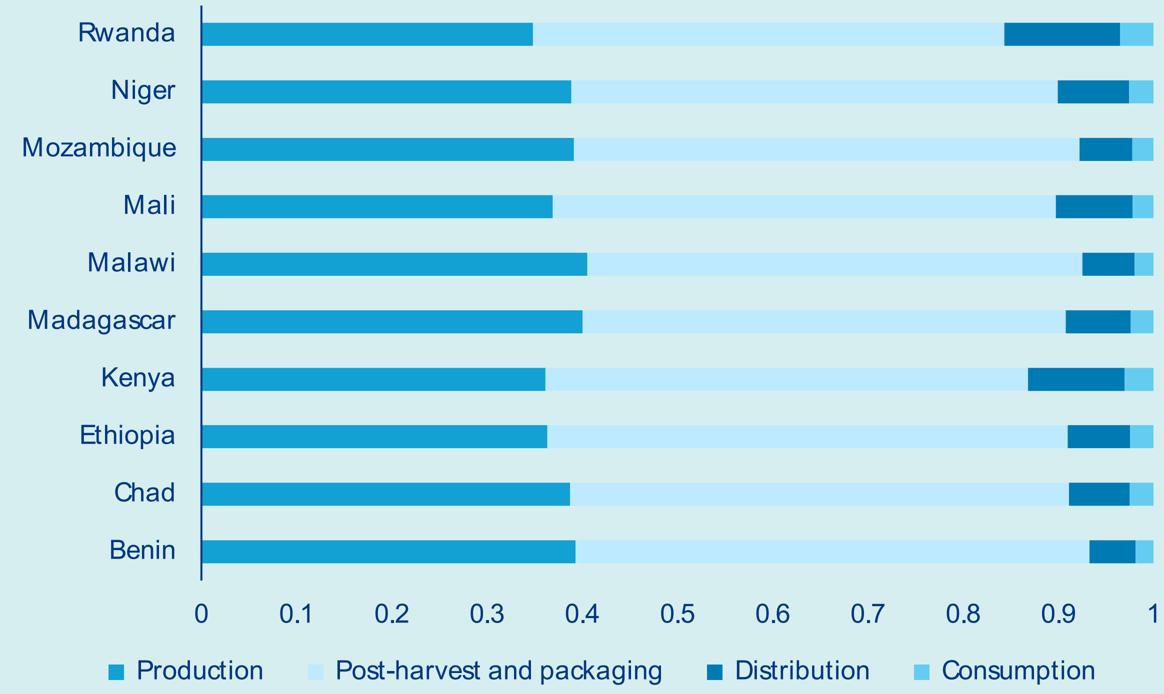
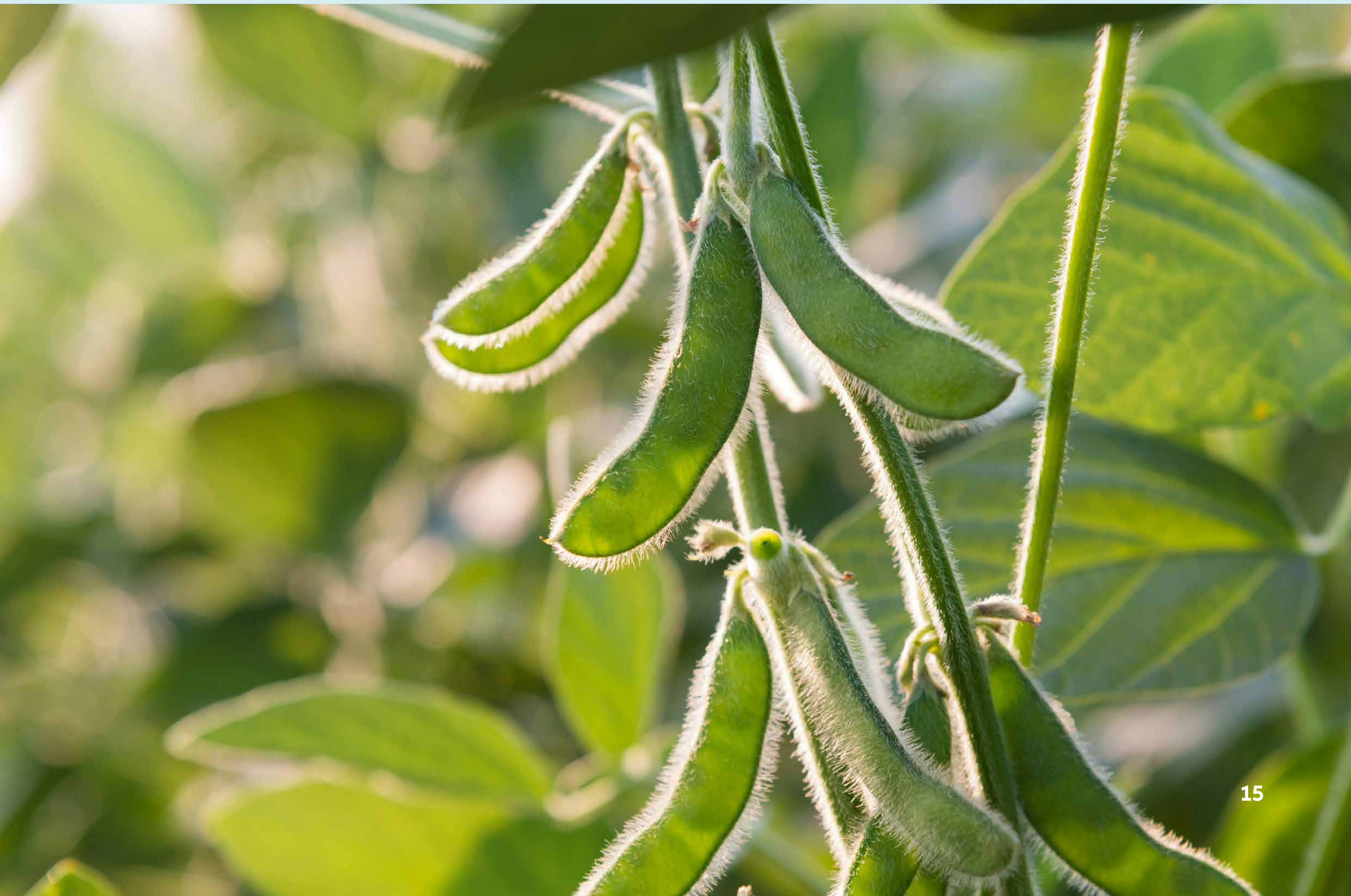


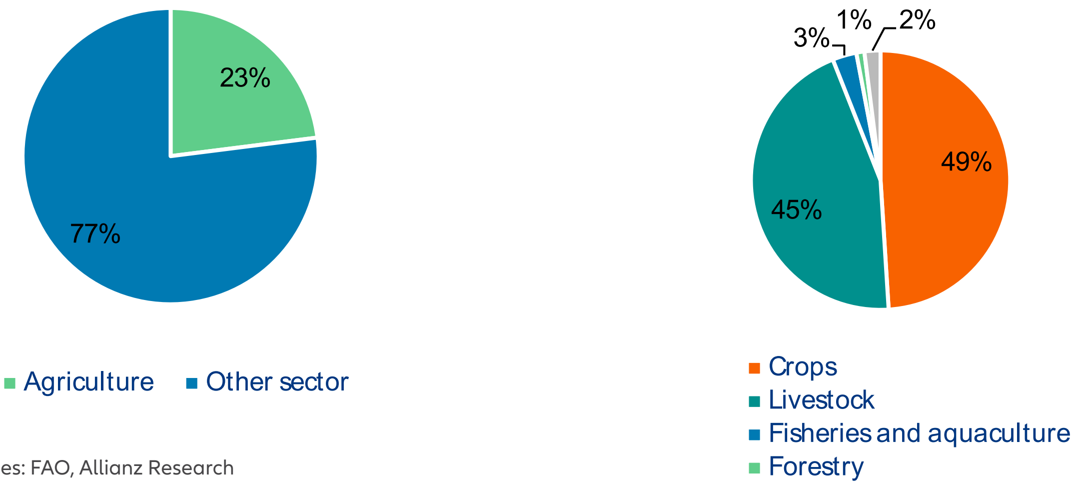
Sources: Eurostat, Aragie et al. (2018), Allianz Research



The climate threat to agriculture

In the past three decades, natural disasters have wiped out an estimated USD3.8trn in crop and livestock output. This translates into an average setback of USD123bn each year, roughly 5% of global agricultural GDP[12]. To put the scale into perspective, the cumulative agricultural losses over this period are comparable to the entire GDP of Brazil in 2022, making the sector at the heart of the climate challenge. It is both the major source of greenhouse gas emissions and land-use and also the sector most exposed to the consequences of climate change. To capture these impacts, Post-Disaster Needs Assessments (PDNAs) are often used to evaluate the aftermath of disasters across productive sectors such as agriculture, industry, trade and tourism. Between 2007 and 2022, 88 PDNAs were conducted in 60 countries. As shown in Figure 10a, agriculture accounted for an average of 23% of total disaster-related losses across all sectors, making the sector in the frontline of the climate crisis. The scale of losses varies depending on the type and intensity of the hazard, its geographic location, local ecosystems and even its timing within the agricultural calendar. Droughts, for instance, place a particularly heavy burden on the sector, with more than 65% of associated losses occurring in agriculture. By comparison, floods, storms, cyclones and volcanic activity each account for roughly 20% of agricultural damages. PDNAs also shed light on losses within the sector itself: crops and livestock dominate, each representing about half of total recorded losses (Figure 10b). Meanwhile, fisheries, aquaculture and forestry appear less prominently, largely because they receive limited attention in these assessments.

Figure 10: Share of sectoral weather extremes related losses (2007 – 2022 average): a) all sectors; b) agriculture sub-sector



a)

a)

Sources: FAO, Allianz Research

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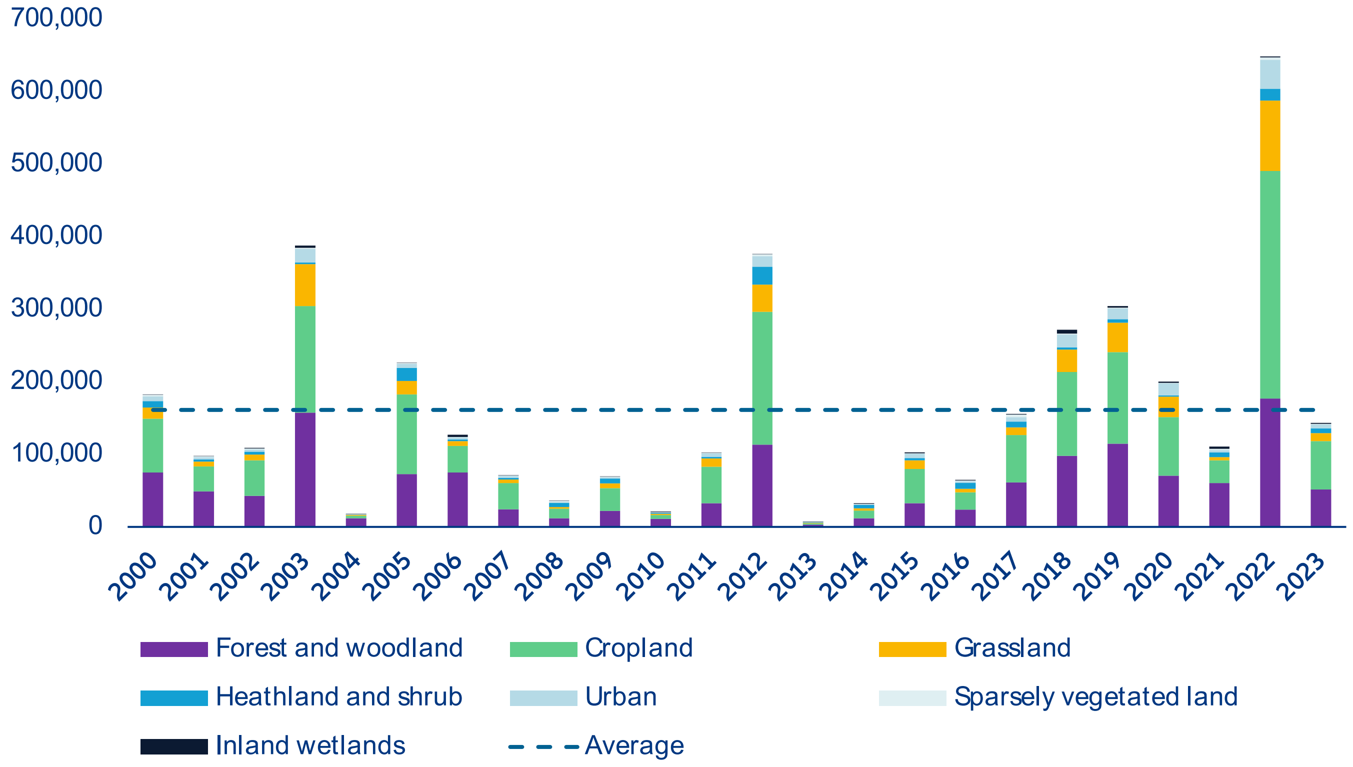
[12] The Impact of Disasters on Agriculture and Food Security

In recent years, drought has become one of the most damaging climate-related hazards in Europe, undermining ecosystems, reducing their ability to provide essential services and degrading soils critical for agriculture. The extreme drought of 2022 left particularly deep scars: an estimated 143,000 km² of land was affected, slightly above the 2000–2020 average of 141,000 km², with croplands were hit the hardest (Figure 11). Roughly 66,500 km² of farmland showed lower vegetation productivity, exceeding the long-term average of 59,000 km² (+12.7%). According to the European Environment Agency, cereal production fell by around -10% in 2022 and 2023, while the economic cost of agricultural and environmental losses reached EUR50bn in 2022 alone[13]. Such severe drought episodes disrupt food production, strain the sustainable management of natural resources and hinder progress towards EU objectives on biodiversity protection and soil health. In 2022 forests also suffered (Figure 11), with more than 52,000 km² impacted, an area larger than Slovakia. Since forests and woodlands are vital carbon sinks, their reduced growth during drought years directly undermines Europe's ambition to reach climate neutrality by 2050. Biodiversity-rich grasslands and heathlands, which also store significant amounts of carbon below ground, saw impacts over an area of 18,000 km², close to the size of Slovenia.

The data in Figure 11 also reveal a critical trajectory. Between 2000 and 2023, eight years recorded above-average drought impacts, five of them within the last decade (Figure 11, dashed line shows the average). With droughts expected to intensify further by mid-century, the risk of large-scale damage to land and ecosystems is set to rise, posing particular threats to the agriculture sector, especially in EU countries heavily reliant on farming. This underscores the growing vulnerability of Europe's food system to climate extremes, with cascading implications for food security, rural economies and environmental resilience.

Figure 11: Area of drought impact on vegetation productivity in the EU-27



Sources: EEA, Allianz Research

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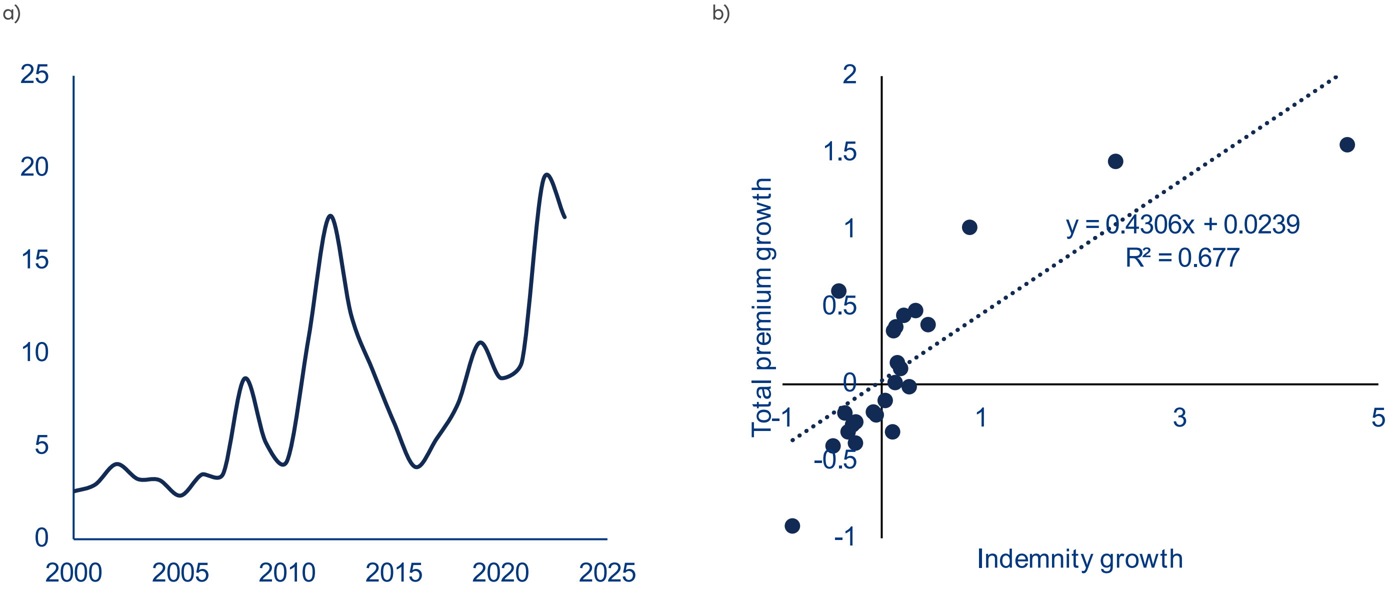
[13] Droughts | Climate Preparedness 2025

In 2023, weather-related agricultural insurance indemnities in the US were seven times higher than in 2000, reflecting a confluence of environmental, economic and policy drivers (Figure 12a). The most prominent factor is the growing intensity and frequency of extreme weather. Droughts, floods and heat events now occur more often and with greater severity, leading to both larger and more frequent losses for farmers, representing 80% of the indemnities between 2001 and 2022[14]. Yet climate alone does not explain the surge. Policy expansion has broadened eligibility, with new insurance products covering whole-farm revenue protection, specialty crops and even controlled-environment agriculture. This expansion has brought many more farmers into the system, increasing total claims. Rising input costs add another layer: as fertilizers, seeds, and energy grow more expensive, financial risk intensifies, pushing farmers to seek insurance coverage to protect against volatility. The structure of subsidies further fuels participation, with more than 60% of premiums subsidized and insurer guarantees lowering entry barriers. Finally, farmer behaviour and incentives play a crucial role: heavily subsidized insurance reduces the urgency to adapt to risks or shift practices, leading to more claims, especially in high-risk regions. Together, these drivers explain why indemnities have escalated so sharply over the past two decades.

The surge in indemnities has implications for insurance premiums. As Figure 12b shows, there is a strong positive relationship between indemnity growth and total premium growth. This means that as losses climb, the cost of insurance protection also rises, with farmers facing higher premiums over time. However, this effect is significantly cushioned by the heavy role of subsidies in the US crop insurance program. On average, more than 60% of premiums are subsidized by the federal government, which has allowed participation to expand even as indemnities grow[15]. In practice, this creates a paradox: while rising claims should normally lead to a steep increase in premium costs, subsidies dilute the price signal and keep insurance affordable for producers. The consequence is twofold: greater financial protection for farmers, but also reduced incentives to adapt to climate risks or adopt risk-reducing practices, since the public sector absorbs much of the cost of escalating losses.

Figure 12: Weather related indemnities in the US: a) evolution of total amount of losses for the period 2000 – 2023, b) dependency between indemnity growth and premium growth


a)

b)

Sources: RMA, Allianz Research

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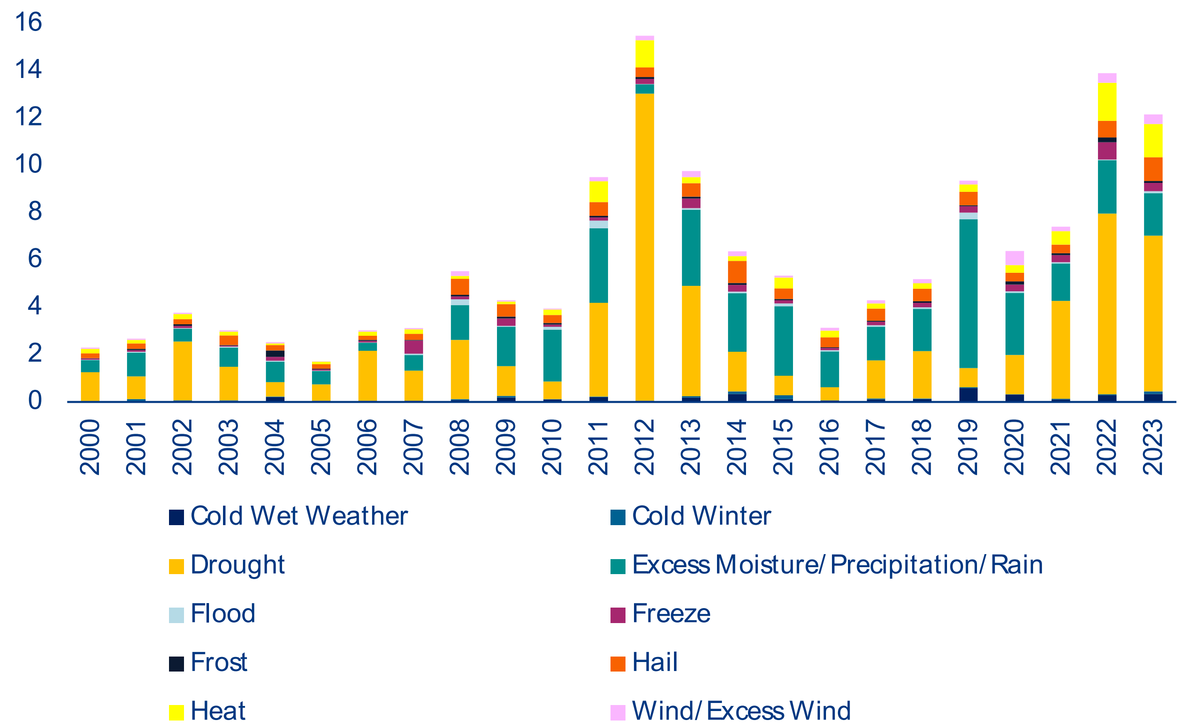
[14] Why Crop Insurance Claims Are Rising

[15] Risk Management - Crop Insurance at a Glance | Economic Research Service

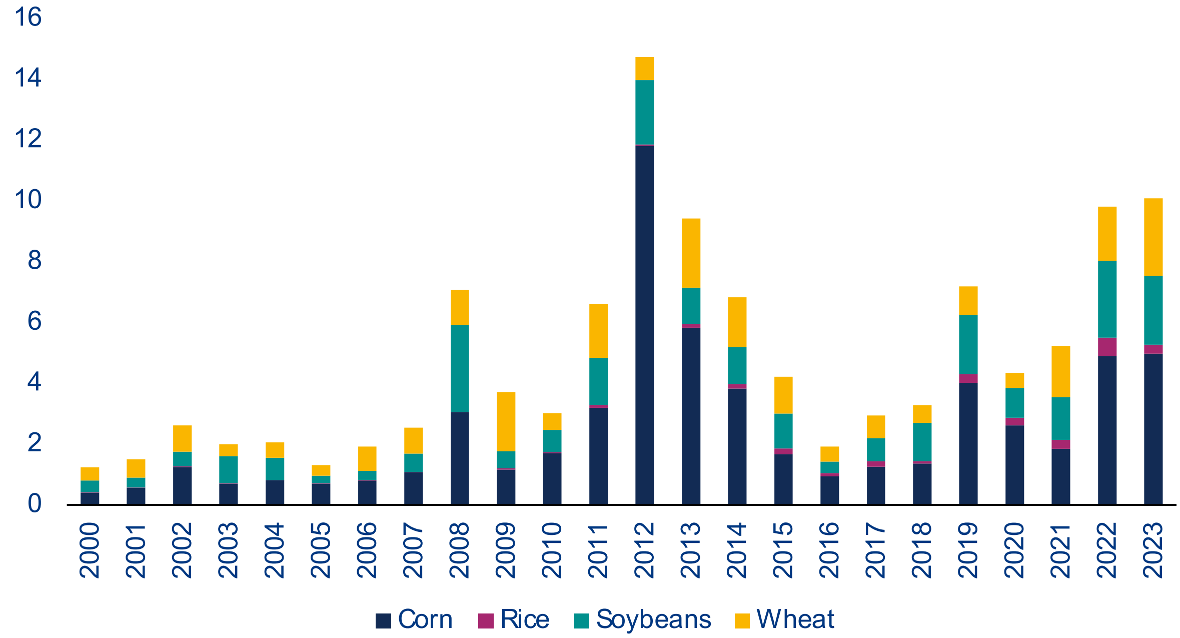
The breakdown of indemnities provides important insights into the structural drivers of rising agricultural risk in the US. Figure 13a shows that drought has been the dominant peril over the past two decades, with exceptionally high losses during 2012, 2020 and 2022. While drought remains the leading factor, other weather events such as excess moisture, floods and freeze events have also triggered substantial payouts in certain years, highlighting the growing diversity and volatility of climate-related hazards. Figure 13b illustrates how these perils affect specific crops. Corn and soybeans consistently account for the bulk of indemnities in the US, reflecting both their large share of planted acreage and their high exposure to climatic extremes, mainly in the Midwest. Wheat seems to contribute also during drought years, while rice plays a smaller role. The concentration of indemnities in a few crops and perils reveals systemic vulnerabilities: US agriculture is increasingly reliant on a limited set of staple crops while facing rising exposure to weather shocks. This structural imbalance amplifies the financial burden on the federal crop insurance system and underscores the need for adaptation strategies that diversify production, strengthen resilience and reduce long-term dependency on indemnity payments.

Figure 13: Decomposition of weather-related indemnities in the US (bn USD): a) Indemnities by peril; b) Indemnities by crop

a)



b)



Sources: RMA, Allianz Research

According to the Food and Agriculture Organization (FAO), disaster-related agricultural losses weigh most heavily on poorer economies, where resilience is weakest and adaptive capacity limited. Over the past three decades, low- and lower-middle-income countries have suffered damages equivalent to 10% – 15% of their agricultural GDP, underscoring the disproportionate vulnerability of regions where farming provides both income and subsistence. Small Island Developing States (SIDS) have also been severely affected, with disasters erasing nearly 7% of their agricultural output, a stark reminder of their exposure to climatic and natural shocks (see Box 2 for a case study).

The case of Pakistan in 2022 exemplifies the vulnerability of the agriculture sector in developing countries. The 2022 monsoon floods were among the most devastating climate-induced disasters in the nation's history, inundating a third of the country and leaving lasting scars on the food and agriculture system. According to the government's Post-Disaster Needs Assessment (PDNA), agriculture, livestock and fisheries were among the hardest-hit sectors, suffering nearly USD3.7bn in direct damages and an additional USD9.2bn in losses, together representing around 3.5% of Pakistan's GDP. The scale of destruction was immense: more than 4.4mn acres of farmland were submerged, wiping out standing crops of cotton, rice, sugarcane and vegetables that are central to both household food security and export earnings. Livestock losses were equally severe, with nearly 800,000 animals killed, depriving millions of households of milk, meat, draft power and an essential source of savings and income.

The indirect effects of the floods compounded these direct production shocks. Irrigation systems, grain storage facilities and rural infrastructure such as feeder roads and market connections were heavily damaged, preventing farmers from accessing inputs and preparing land for the next planting season. The geographic concentration of damages was also notable: Sindh and Balochistan provinces accounted for over 90% of the agricultural toll, exacerbating pre-existing vulnerabilities in regions already facing water stress and poverty. The cascading impacts of the floods included reduced availability of staple foods, a surge in market prices and heightened risks of malnutrition in already food-insecure communities. In this way, a single disaster not only devastated one season but also cast a long shadow over the country's future food security.

Bangladesh's experience in August 2024 mirrors many of these dynamics, although on a different scale. Unusually heavy rainfall and surging river levels triggered catastrophic flooding across 11 eastern districts, displacing hundreds of thousands and inflicting severe economic damage. The World Bank's GRADE assessment estimated total direct damages at USD1,676bn, of which USD468mn (28%) were in agriculture. More than 321,000 hectares of cropland were inundated, with the districts of Lakshmipur, Cumilla and Noakhali hardest hit. These areas are among the country's most productive rice-growing zones, and the floods struck at a critical point in the Aman rice season, leading to widespread crop failure. For millions of rural households, the loss of rice translated directly into food insecurity and income loss.

The floods also devastated Bangladesh's livestock and poultry sectors, killing nearly 47,000 animals and more than 8.4mn poultry. This was a blow to household economies as poultry farming provides vital income, particularly for women. Fisheries and aquaculture infrastructure were similarly damaged, with ponds and hatcheries washed away, further eroding protein sources and livelihoods. As in Pakistan, these losses were magnified by their timing: with fields submerged and inputs destroyed, farmers were unable to prepare for the next planting cycle, raising the risk of sustained production shortfalls. Local food markets responded quickly, with price spikes that disproportionately hurt poorer households.

Box 2: The future of West Africa's cocoa industry

The 2023/24 cocoa season experienced unprecedented disruption due to extreme El Niño conditions, fueled by climate change and warmer global temperature, resulting in significant production shortfalls across West Africa. Cote d'Ivoire and Ghana, accounting for 65% of global supply, saw output decline by -17% and -27% respectively. Such a drop, preceded by three years of lower-than-average harvesting, caused global prices of cocoa to surge above +250% during 2024/25, up to USD10,000 per metric ton, nearly doubling the 1977 record. After peaking again in early 2025, the price has declined to below USD5,000 but that is still double 2022 levels.

The price surge sent shockwaves through the chocolate industry. Buyers (mainly international firms) implemented defensive strategies by postponing order calls, partially offsetting local revenues, and raising chocolate prices between +15-30% globally. In Ghana and Cote d'Ivoire, government authorities were the main beneficiaries of such price hikes via higher FX earnings and export tax revenues increasing windfall earnings from USD600mn to USD1bn, strengthening sovereign positions, particularly Ghana which benefited during debt-restructuring efforts.

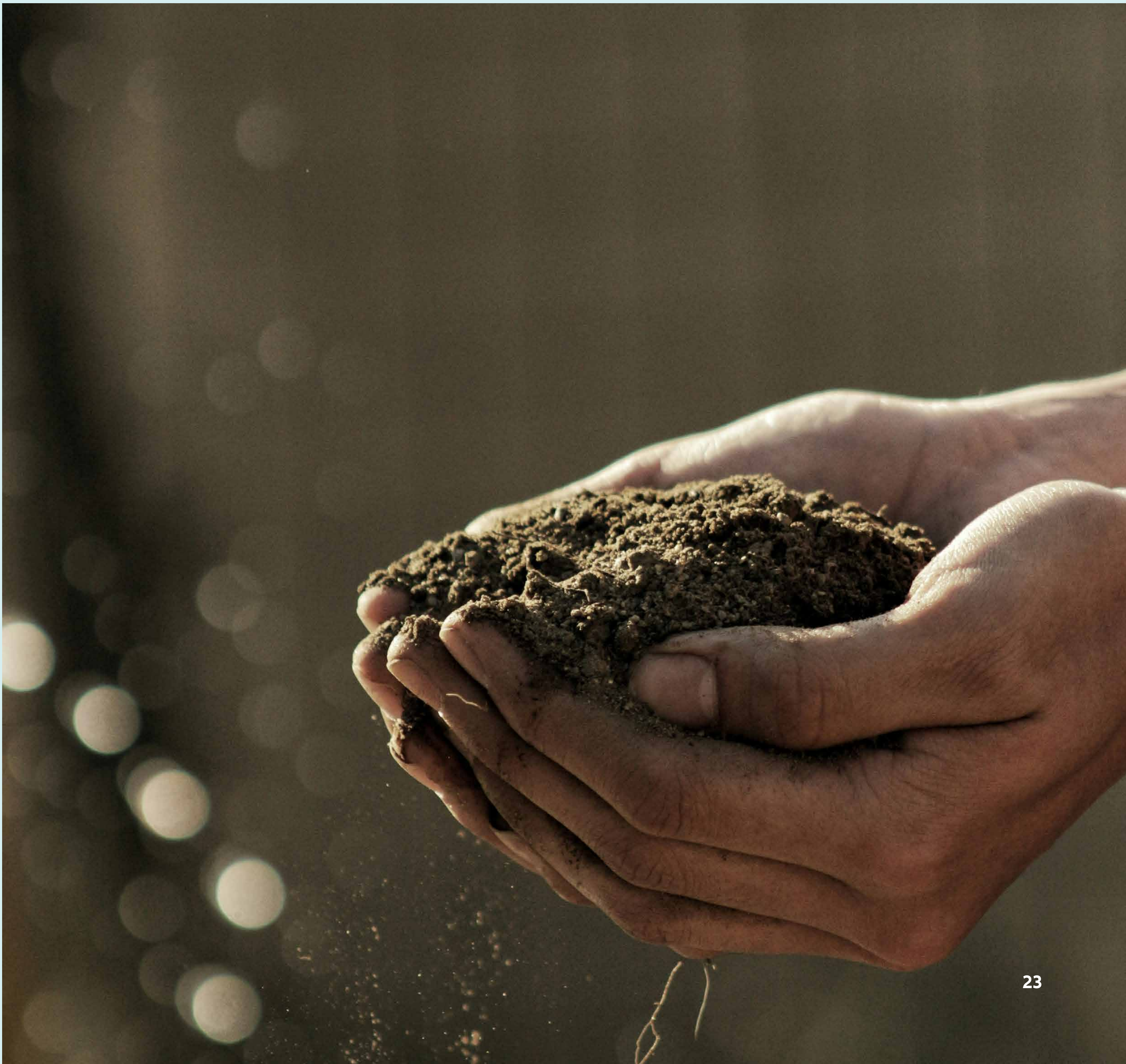
Despite record global prices, smallholder cocoa farmers experienced limited financial gains due to regulated pricing mechanisms in Cote d'Ivoire and Ghana. In Cote d'Ivoire, the Coffee-Cocoa Council (CCC) initially set prices at USD1.65/kg, later raising it to USD2.47/kg mid-season in response to the price spike. In Ghana, the Ghana Cocoa Board, maintained pricing but did offer bonuses to adjust incomes. Ahead of the 2025/26 harvesting seasons, CCC has announced an increase of the price to USD4.12/kg. This represents a daily income between USD2 to USD4 depending on the farm size, above the international poverty line. However, considering that Ivorian households average between six to eight people in cocoa-growing regions, this translates to per capita income below USD1 per day.

Looking forward, farmland productivity trends present a concerning long-term outlook for the sector. Cote d'Ivoire's yields improved from approximately 400kg/ha in the 80's to 600kg/ha in the mid-2000's, but have declined since, falling below 510kg/ha in 2022 for the first time since 1985. On the other hand, Ghana has achieved steady yield improvements, surpassing 500kg/ha in 2024 through more centralized management approaches that facilitate coordinated fertilizer application and pest control programs. However, both countries underperformed compared to Peru's 800kg/ha benchmark. The South American producer, a small but growing exporter of cocoa beans, has specialized in higher premium cocoa types, allowing for higher price premiums, which has allowed for greater investment into the land. West Africa's productivity constraints stem from aging tree stock (typically 25+ years old), progressive soil degradation and insufficient application of modern agronomic practices.

These yield challenges carry substantial socioeconomic impact given agriculture's centrality to employment in the region. Agriculture accounts for about 50% of total employment in Cote d'Ivoire and 30-35% in Ghana, while cocoa farming accounts for above 10% of total employment in both countries. Declining productivity not only threatens farmer livelihoods but accelerates rural-to-urban migration, intensifying pressure on already strained urban areas.

As during the 2023/24 harvesting season, extreme El Niño conditions are increasingly common pattern, drier-than-normal conditions are projected to occur more frequently across West Africa. Between 20-40% of annual cocoa production is at risk in drier harvesting seasons, potentially rising to 50% by 2050 particularly in cocoa-intensive regions in the south-central areas of both countries such as Bono East and Ashanti in Ghana, and Lacs and Sassandra-Marahoue in Cote d'Ivoire. As existing farmland becomes less productive, farmers increasingly clear forested areas for new plantations, creating a troubling feedback loop between deforestation and climate vulnerability.

Revitalizing West Africa's cocoa productivity represents both an urgent necessity and a significant investment challenge. Rehabilitating the region's 6+ mn hectares of cocoa farmland would require approximately USD6bn, roughly 4% of Ghana and Côte d'Ivoire's combined GDP, an especially daunting figure given Ghana's constrained fiscal position. However, innovative risk-management solutions are emerging to bridge this investment gap. Index-based weather insurance has evolved significantly through satellite technology and mobile payment infrastructure, without traditional barriers to insurance access. Supply-chain interruption coverage offers processors protection against both physical shortages and price volatility, creating a more stable environment for local value addition activities like grinding and packaging. Blended finance approaches combining public subsidies, private insurance and development funding can facilitate the necessary long-term investments while distributing risk appropriately across stakeholders. These risk transfer mechanisms can transform challenges into opportunities, protecting investments, promoting sustainable intensification and supporting the region's transition toward climate-resilient cocoa production, with higher farmer incomes and enhanced local value capture.

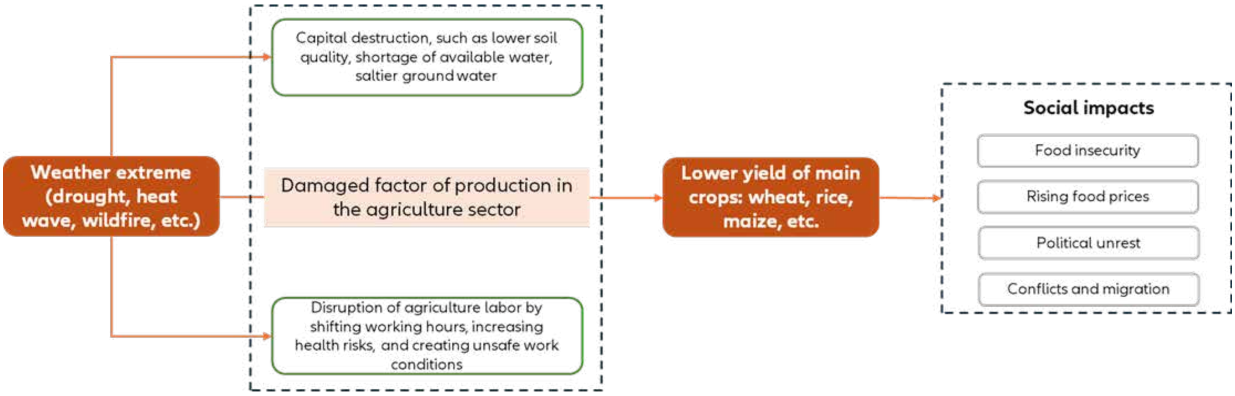


The economic impact of droughts on agriculture

Climate change poses a mounting challenge to global agriculture, with far-reaching consequences for food security, price stability and societal resilience. Shifting precipitation patterns are disrupting agro-ecological systems, bringing floods to some regions and prolonged droughts and water stress to others. These climatic extremes increasingly undermine both the physical and economic foundations of agriculture. Among all economic sectors, agriculture is particularly vulnerable to climate change (Figure 10a above). This heightened sensitivity stems from two critical factors: i) the direct exposure of agricultural capital, such as soil quality, crop systems and water infrastructure, to climate-driven degradation, and ii) the sector's strong dependence on labor whose productivity is impaired by extreme weather conditions, such as heatwaves. The exposure of the sector to climatic stressors is already translating into yield losses in key staple crops, including wheat, rice, maize and soybeans (Hultgren et al., 2025)[16]. These losses strain local food systems and could potentially disrupt global supply chains, amplifying food insecurity globally.

A striking example of this cascading risk occurred during the 2010 – 2011 drought in China, affecting most of its wheat-producing regions (Sternberg 2012)[17]. As extreme drought conditions threatened domestic wheat production, China responded by purchasing large quantities of wheat from global markets. This move contributed to a doubling of global wheat prices, with profound consequences for importing nations. In Egypt, the world's largest wheat importer, bread prices tripled, exacerbating economic stress and fuelling public unrest during an already volatile political moment. This sequence of events, from drought to food price shocks to civil unrest, highlights the complex and often underappreciated links between climate hazards, agricultural markets and political stability at both local and global levels. Figure 14 shows a simplified representation on how climate shocks affect food supply and social stability.

Figure 14: Decomposition of weather-related indemnities in the US (bn USD): a) Indemnities by peril; b) Indemnities by crop



Sources: Allianz Research

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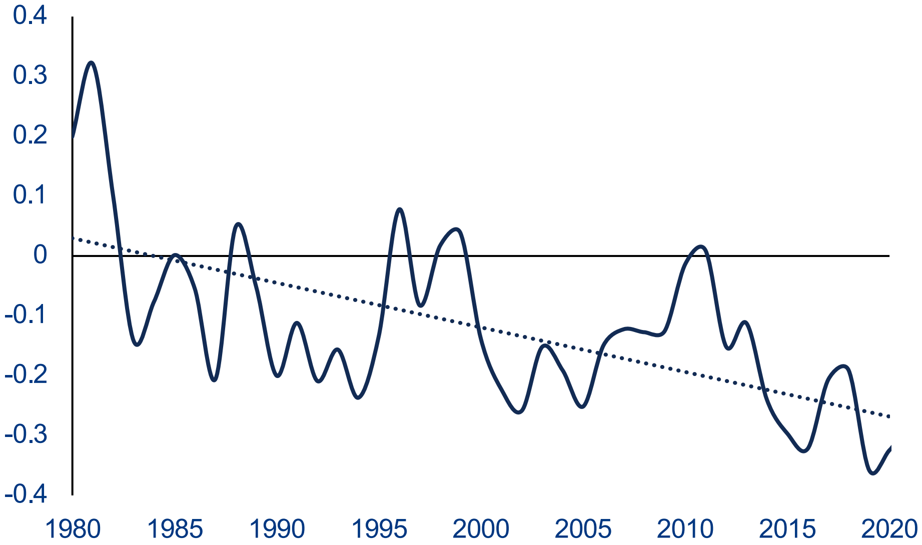
[16] Impacts of climate change on global agriculture accounting for adaptation | Nature
[17] Chinese drought, bread and the Arab Spring - ScienceDirect

Drought stands among the most severe threats to agricultural productivity. By depleting water resources and degrading water quality, drought undermines the foundation of farming, ranching and grazing systems. The consequences ripple through the agricultural economy, driving both immediate crop losses and longer-term financial strain. Figure 15a shows the global trend in average SPEI (Standardized Precipitation and Evapotranspiration Index[18], we consider the 12 month SPEI) from 1980 to 2023. While short-term variability is present, the overall trajectory points clearly downward, indicating an increase in global drought conditions over time. In the 1980s, the average SPEI stood at 0.014, suggesting relatively balanced conditions. By contrast, for the period 2014 – 2023, the average dropped to -0.29, reflecting a significant shift toward more widespread and persistent water deficits. This decline underscores the intensifying impact of climate change on global water availability and agricultural drought risk. This intensification of drought conditions is evident across much of the world: in 112 out of 194 countries, 2023 SPEI values fell below their respective historical averages (1980–2010). However, the pace and severity of this shift are unevenly distributed, leaving certain nations disproportionately exposed to the impacts of deepening water stress (Figure 15b). Notably, some European countries (France and Switzerland) rank among the ten most affected globally, highlighting that even historically temperate regions are not immune to the growing risks of climate-driven drought.

Figure 15: Global development of drought conditions: a) global trend in average SPEI from 1980 to 2023; b) SPEI anomaly in 2023, calculated as the deviation from the 1980–2010 average

a)



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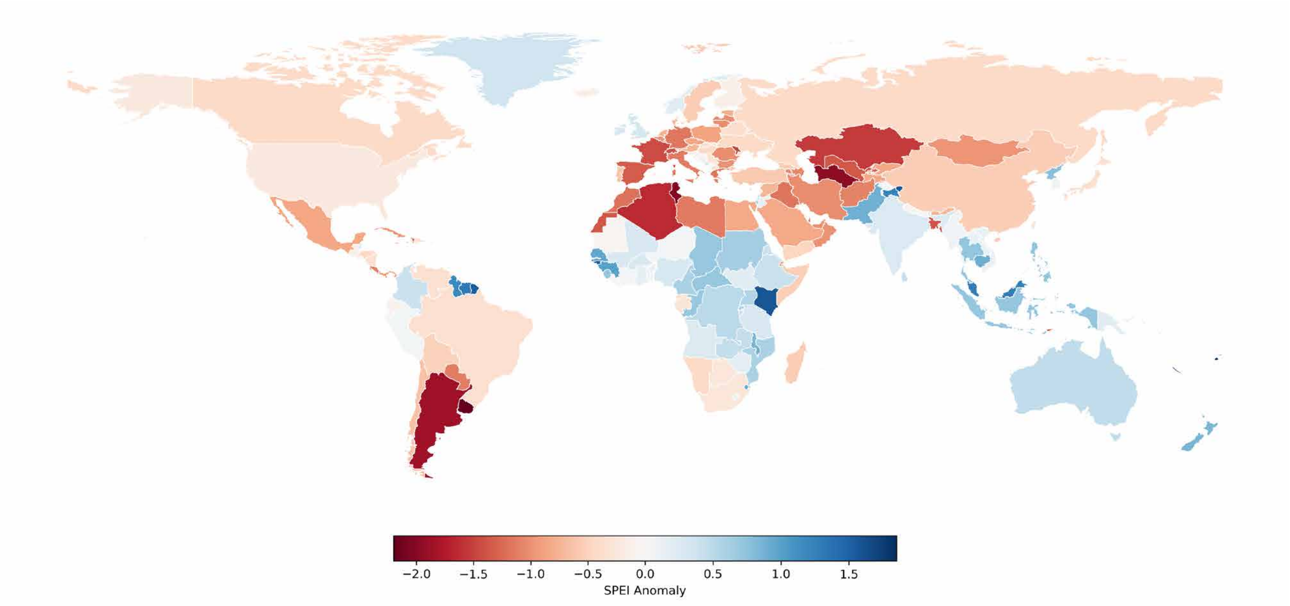
[18] SPEI is a widely used indicator of drought conditions. It compares how much water is available (from precipitation) to how much is lost (through evaporation). Values close to 0 indicate normal conditions, while negative values signal drought (e.g., –1 is moderate drought, –2 is severe drought). Positive values (e.g., +2) reflect unusually wet conditions.

b)



Sources: Global Drought Monitor, Allianz Research

Climate change is already putting pressure on the world's major crops (wheat, maize, rice and soybeans) and yields are expected to decline further as droughts intensify. To assess the impact, we use high-resolution global crop yield data from 1980 to 2016[19], analysing how droughts, measured by the 12-month SPEI, affect yields at the subnational level[20]. Our results are statistically robust and show a clear negative effect of drought on the four considered crops[21]. Looking ahead, we use projections of drought conditions under the SSP5-8.5 scenario[22], a pathway marked by high emissions and limited climate action, likely resulting in around +3°C of global warming. Based on this scenario, we estimate how future drought trends will affect crop yields by 2050. Figure 16 shows the global distribution of drought impacts on crop yields, highlighting how climate change, via more frequent and intense droughts, will reshape agricultural productivity. The maps illustrate the projected deviation in yields for wheat, maize, rice and soybeans under the high-emissions SSP5-8.5 scenario, relative to a baseline where drought intensity (as captured by the 12-month SPEI) remains consistent with the historical average. The findings reveal a broad and significant decline in agricultural yields due to drought. Maize, wheat and soybean are especially vulnerable, with projected yield reductions reaching up to -9.2%, -7.1% and -4.1%, respectively. These losses are concentrated in major producing regions, including Australia, Pakistan and Kazakhstan for wheat, and across large parts of South America for soybeans.

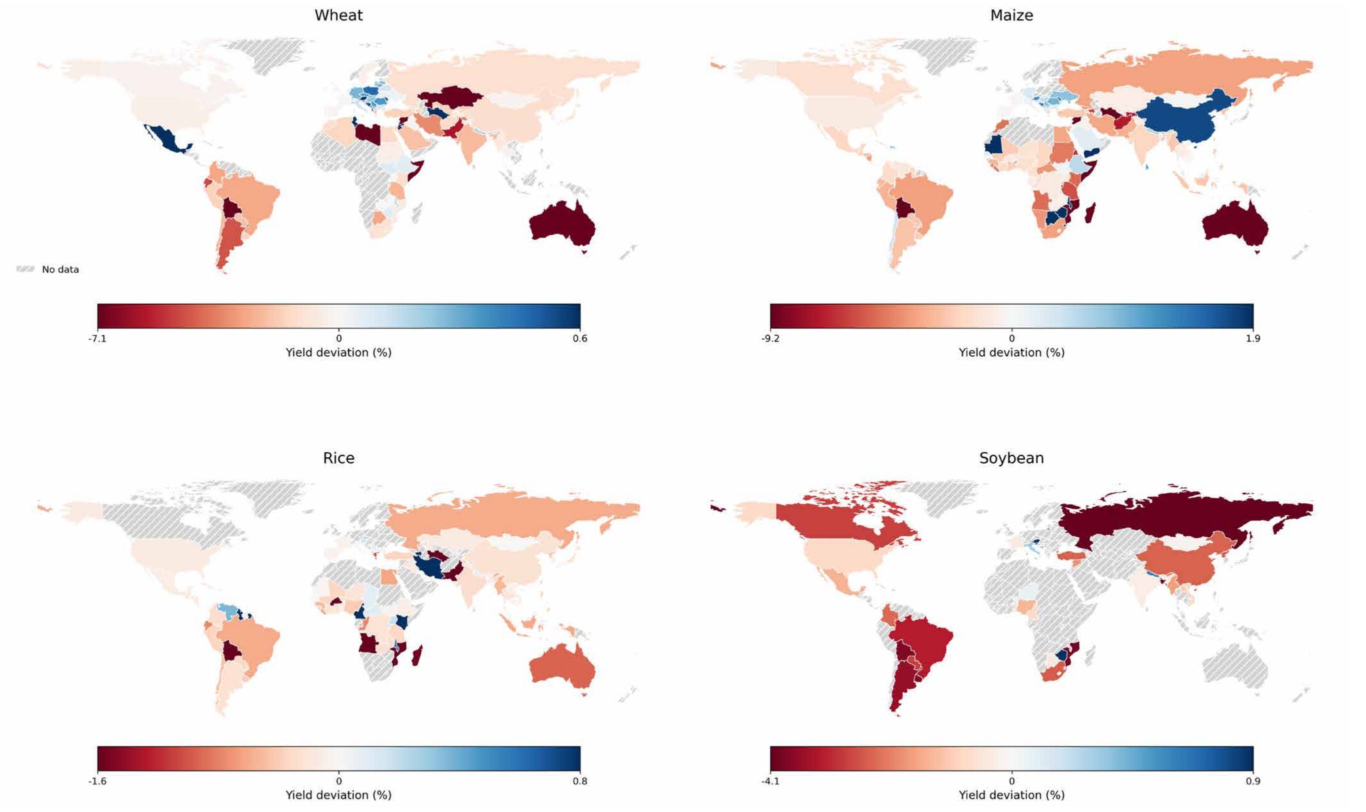
[19] The global dataset of historical yields for major crops 1981–2016 | Scientific Data

[20] GADM, ADM1 resolution

[21] We use a three-ways fixed effect panel model with OLS regression with a region clustered robust covariance

[22] SEDAC - Global Future Drought Layers, Version 1

Figure 16: Crop yield deviation from baseline in 2050 under the SSP585 scenario



Sources: Allianz Research

The combination of widespread crop yield losses and their concentration in key producing regions is likely to exert considerable pressure on global food prices. To assess this risk, we examine the relationship between crop yields and domestic crop price inflation using country-level crop producer price indices from 1992 to 2016. Our analysis reveals strong and statistically significant effects[23]: a decline of one ton per hectare in crop yield is associated, on average, with an +11.7% increase in wheat prices, a +6.5% rise in maize prices, a +6.7% increase in rice prices and an +18.5% surge in soybean prices. Looking ahead, when applying the projected crop yields under the SSP585 scenario[24], drought is expected to put chronic upward pressure on food prices over the next two decades. The cumulative impacts shown in Figure 17 confirm these dynamics: soybeans are projected to face the strongest additional price pressures, with cumulative inflation reaching about +6.4% by 2050. Maize and wheat also exhibit notable increases of +4.5% and +3.1%, respectively, while rice remains relatively less affected at +0.8%. This heterogeneity reflects both differences in crop sensitivity to drought and their geographic concentration in highly exposed regions.

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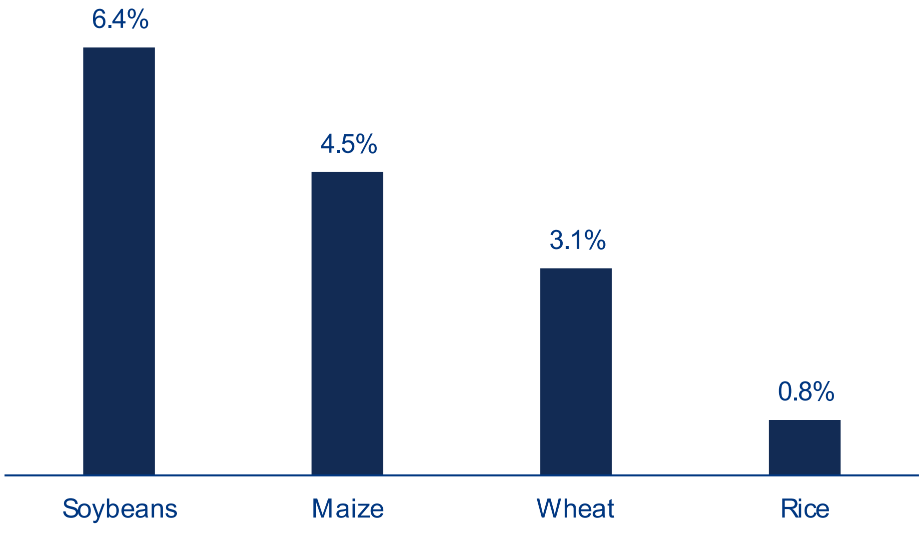
[23] We use a three-ways fixed effect panel model with OLS regression with a robust covariance, and stationary price growth

[24] A combination of Shared Socio-economic Pathways (SSP) and Representative Concentration Pathways (RCP): Intergovernmental Panel on Climate Change SSP-RCP scenarios | Ministry for the Environment

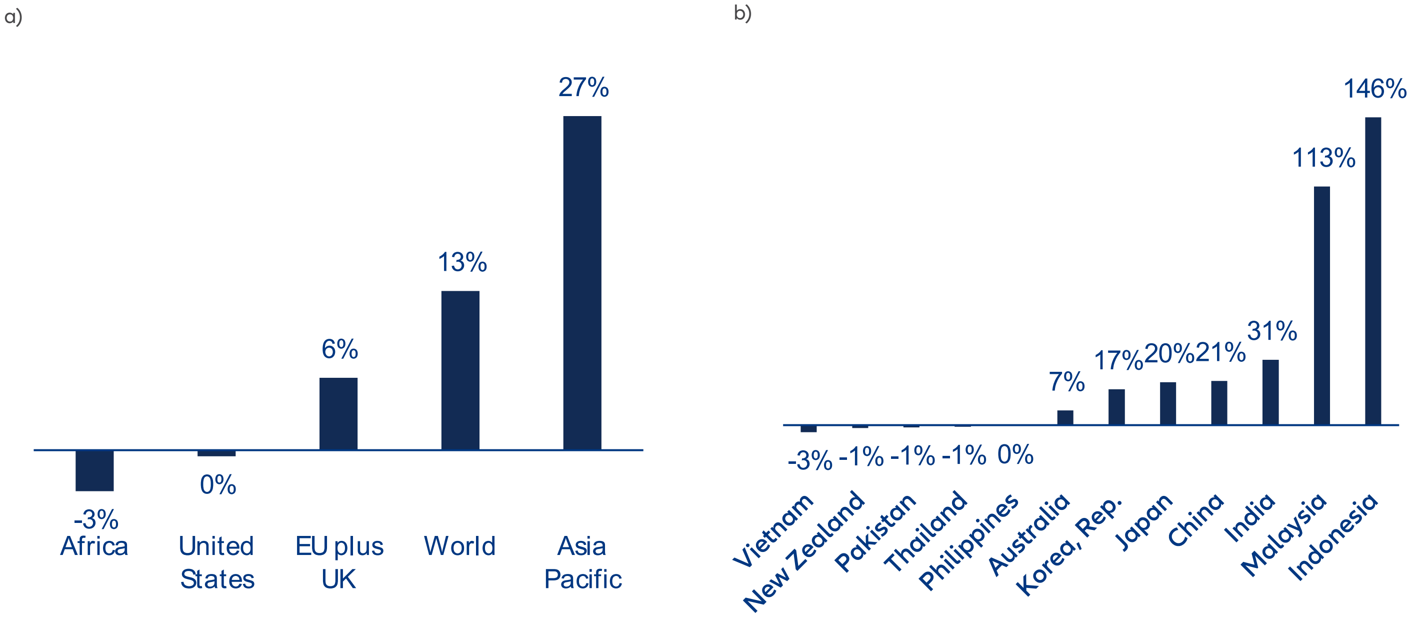
Figure 17: Cumulative crop price inflation in SSP585 relative to baseline (2025 – 2050)



Sources: Allianz Research

The rise in food prices under future drought conditions would ripple through core inflation, exerting significant pressure on consumer price indices (CPI) worldwide. Our analysis suggests that, by 2050, global CPI could be around 13% higher under SSP585 compared to a baseline climate, assuming future droughts follow historical patterns (Figure 18a). Yet, these effects are far from evenly distributed. Asia-Pacific is projected to face the largest impact, with cumulative CPI increases of about +27%, reflecting both the region's high exposure to drought and its importance in global food supply chains. Within the region, impacts vary sharply across countries (Figure 18b). While some economies such as Vietnam, New Zealand, Pakistan, and Thailand are projected to see limited or even slightly negative effects on inflation, others face steep inflationary pressures. Indonesia and Malaysia emerge as the most affected, with cumulative CPI increases of +146% and +113%, respectively, for the period 2025–2050. India (+31%) and China (+21%) also record significant inflationary pressure, reflecting their large agricultural bases and growing demand pressures. Europe and the UK see a more moderate increase of around +6%, while Africa and the US record little to no additional inflationary pressure relative to the baseline. This does not imply that Africa or the US are safe from drought impacts. Rather, it indicates that in these regions, future drought patterns may not diverge dramatically from what they have historically experienced. In contrast, Asia-Pacific stands out as particularly vulnerable, suggesting that climate-driven shocks to food prices could become a major economic and social challenge there, with ripple effects on global markets and food security.

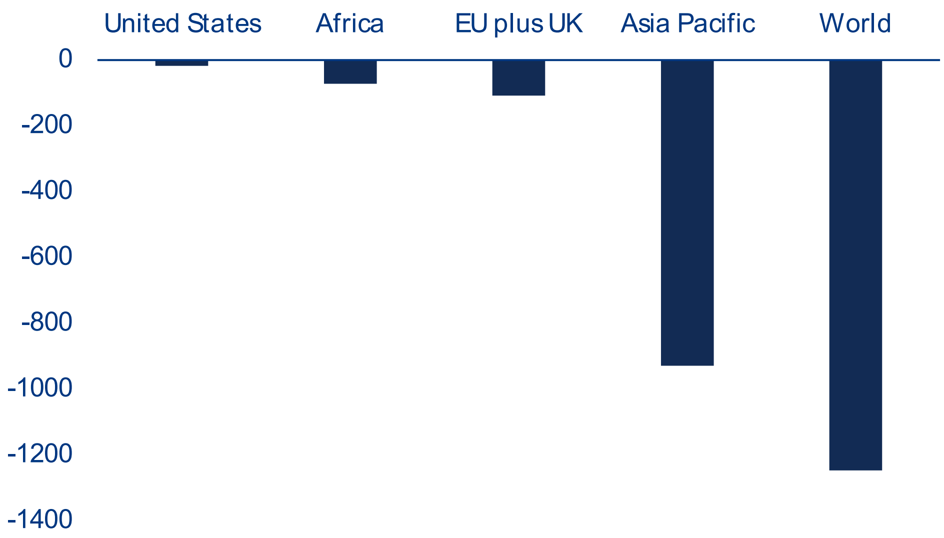
Figure 18: Cumulative consumer price index increase in SSP585 relative to baseline: a) CPI increase by region (2025–2050); b) CPI increase within the most affected region (Asia-Pacific, 2025–2050)



Sources: Oxford Economics, Allianz Research

Building on the projected rise in consumer prices under future drought conditions, we applied a demand shock to assess how higher food inflation translates into broader economic outcomes (Figure 19). The results show substantial cumulative GDP losses under the SSP585 scenario between 2025 and 2050, with the burden falling unevenly across regions. At the global level, GDP is projected to decline by around USD1.3trn relative to a baseline climate pathway. Asia-Pacific stands out as the hardest hit, with cumulative GDP losses of around USD1trn, reflecting both its exposure to climate-induced food price shocks and the central role of food expenditure in household budgets. Losses in Europe and the UK (USD100bn) and Africa (USD71bn) are more moderate in absolute terms but remain significant given their economic structures. By contrast, the US records only marginal GDP impacts, consistent with its relatively muted inflationary response to drought. These results highlight how climate-driven food price inflation can spill over into growth, eroding demand and slowing economic activity. The uneven distribution of losses raises concerns over widening regional disparities, reinforcing the urgency of adaptation and resilience measures. However, it is important to note that these estimates remain conservative. They do not capture all commodities that are highly sensitive to drought, such as cocoa in Africa or coffee in Asia and Latin America, which would likely magnify the impact. Nor do they account for other weather extremes, such as hail and floods, or the potential knock-on effects of trade disruptions, both of which could further amplify economic losses.

Figure 19: Cumulative GDP losses in SSP585 relative to baseline by region (USD bn, 2025–2050)



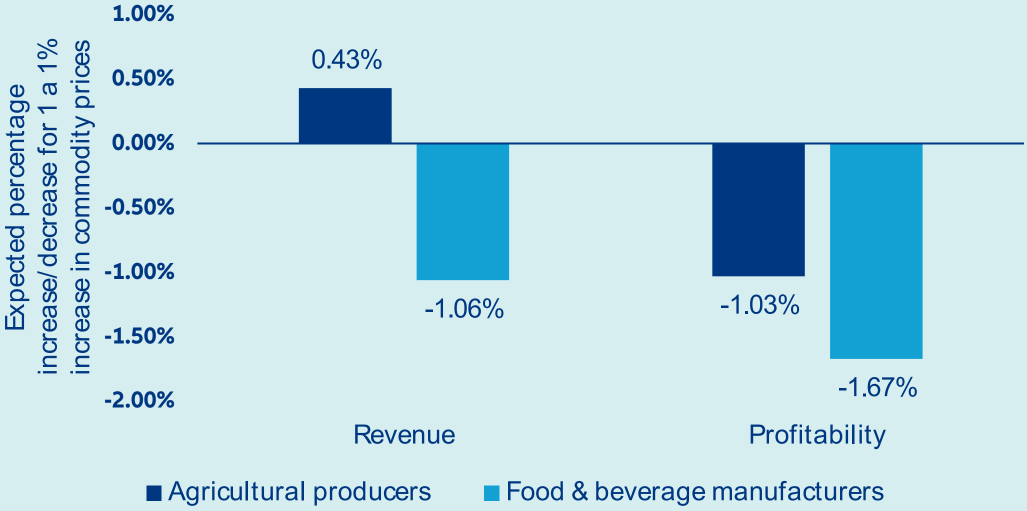
Sources: Oxford Economics, Allianz Research

Box 3: How lower crop yields could pressure the agrifood sector's profitability

From weather shocks to yield declines and corporate value chains. Physical shocks to crop yields translate swiftly into financial stress for agrifood corporates. When drought, floods or heat reduce output, inventories shrink and global commodity prices surge. A notable historical example is the 2007-08 food price crisis: severe drought in Australia's Murray-Darling Basin, heatwaves in California and flooding in India led to supply shortfalls and dramatic price spikes in wheat and rice. Some food companies were forced to absorb skyrocketing input costs. During that period, Mexico's Grupo Bimbo, for example, publicly froze product prices despite a +20% jump in production costs, absorbing margin losses to maintain market share and keep food affordable for customers. More recently, extreme rainfall and overcast conditions in France in 2024 cut wheat harvests by -22% relative to the five-year average, forcing processors to scramble for supply at elevated cost. These yield-driven price shocks have opposite effects across the value chain. In theory, growers and primary processors benefit from higher sales values, but input and production volatility amplify risks. Downstream, food and beverage manufacturers face surging raw-material costs and uncertain supply.

An increase in agricultural commodity prices leads to a profitability squeeze for both upstream and downstream firms. Our estimate suggests that a 1pp increase in agricultural commodity prices is associated with about a -1.67pp decline in downstream food and beverage manufacturers' profitability, and a 1.03pp cent drop in their revenues (see Figure 20). Meanwhile, upstream agricultural producers record an approximate 0.43pp boost in revenues, but still a similar -1.67pp fall in profitability. This contrast arises because manufacturers suffer from limited pricing power, and farmers face rising input and infrastructure costs. Thus, while crop price rises offer a temporary top-line boost, earnings for upstream firms remain fragile. Food manufacturers' limited pricing power leads to their vulnerability: retailers resist cost inflation, and consumers shift to lower-cost alternatives.

Figure 20: Sensitivity analysis of revenue and profitability of upstream and downstream agricultural companies (2012 – 2025)



Sources: Refinitiv & AllianzTrade

Agrifood corporates must reframe climate risk as a structural financial risk. Downstream firms should diversify sourcing across multiple geographies to reduce exposure to regional yield shocks, coupled with hedging strategies or long-term offtake agreements, and build flexibility into product design (i.e. reducing reliance on climate-vulnerable inputs). Strengthening brand equity and pricing flexibility helps to defend margins in times of input inflation. On the agricultural side, resilience depends on investing in "climate-smart" farming: drought- and heat-tolerant seed varieties, precision irrigation, soil health practices and digital yield monitoring. Upstream firms should seek vertical integration with processors or secure long-term supply contracts to stabilize cash flows. Joint risk-sharing models – such as revenue-sharing contracts or insurance-backed procurement – can align incentives. Financial innovation (e.g. weather derivatives, parametric insurance) can also help buffer revenue volatility. Adapting effectively will separate resilient players from those exposed to margin erosion or revenue shocks. In an era of increasing climate stress, the ability to absorb yield-driven price volatility will become a core determinant of long-term competitiveness in agrifood.

Adaptation of the agriculture sector

As a main pillar for economic and social stability, with its double materiality, the agriculture sector is under pressure to mitigate its climate impacts and to adapt to growing climate risks. Sustainable food production must therefore evolve both in methods and in supply-chain design. Key options include agroecological practices, diversified cropping systems, precision agriculture and controlled-environment farming (e.g. vertical farming, greenhouse systems)[25]. By reducing reliance on monocultures and applying targeted inputs (water, fertilizers, pesticides), these practices can lower greenhouse gas (GHG) emissions per unit of output while enhancing resilience[26]. In parallel, demand-side measures are essential. Diet shifts toward less resource-intensive foods, improved supply-chain logistics and consumer behavior changes reduce the pressure on agricultural production. Food loss and waste along the supply chain also represent a major emissions source. Eliminating waste will cut direct emissions from production and disposal, and also reduces the need for marginal expansion of agricultural land and inputs[27]. Beyond mitigation, carbon sequestration in soils, agroforestry, cover cropping and regenerative approaches can help turn farms into carbon sinks, further constraining net emissions. However, despite the central importance of mitigation, this report will focus on adaptation solutions, strengthening resilience, buffering climate shocks and developing governance, finance and technology pathways that allow agriculture to thrive in a warming world.

Agricultural adaptation to climate change is a multidimensional process that involves interventions at different levels of society and governance (Figure 21). Farmers stand at the frontline of adaptation as they are directly exposed to shifting rainfall patterns, heat stress and extreme weather events. At the farm level, adaptation strategies often include diversifying crops to spread climate risks, selecting optimal sowing dates that align with changing seasonal cycles and applying innovative breeding techniques to develop more resilient varieties. Improvements in soil and water management, such as mulching, conservation tillage or enhanced irrigation scheduling, are also critical to maintain productivity under increasingly variable conditions. At the technological level, advances in science and innovation provide new opportunities for resilience. Drought-tolerant and heat-resistant seeds allow farmers to maintain yields in harsher environments, while early warning systems for droughts, floods or pest outbreaks improve preparedness. Similarly, technology-driven water management systems help optimize resource use and reduce vulnerability to water scarcity. Finance plays an equally important role in enabling adaptation. Access to and understanding of insurance products, such as parametric insurance or microinsurance, can help farmers manage risks associated with climate shocks, while credit facilities and financial safety nets provide the liquidity needed to invest in resilient practices[28]. Finally, governments set the broader framework within which adaptation takes place. Through land-use planning, infrastructure development and the design of resilient agricultural programs, governments can reduce systemic vulnerabilities and create enabling environments for farmers and markets. Public policy is especially crucial in ensuring that adaptation strategies are scaled up equitably and integrated into long-term rural development.

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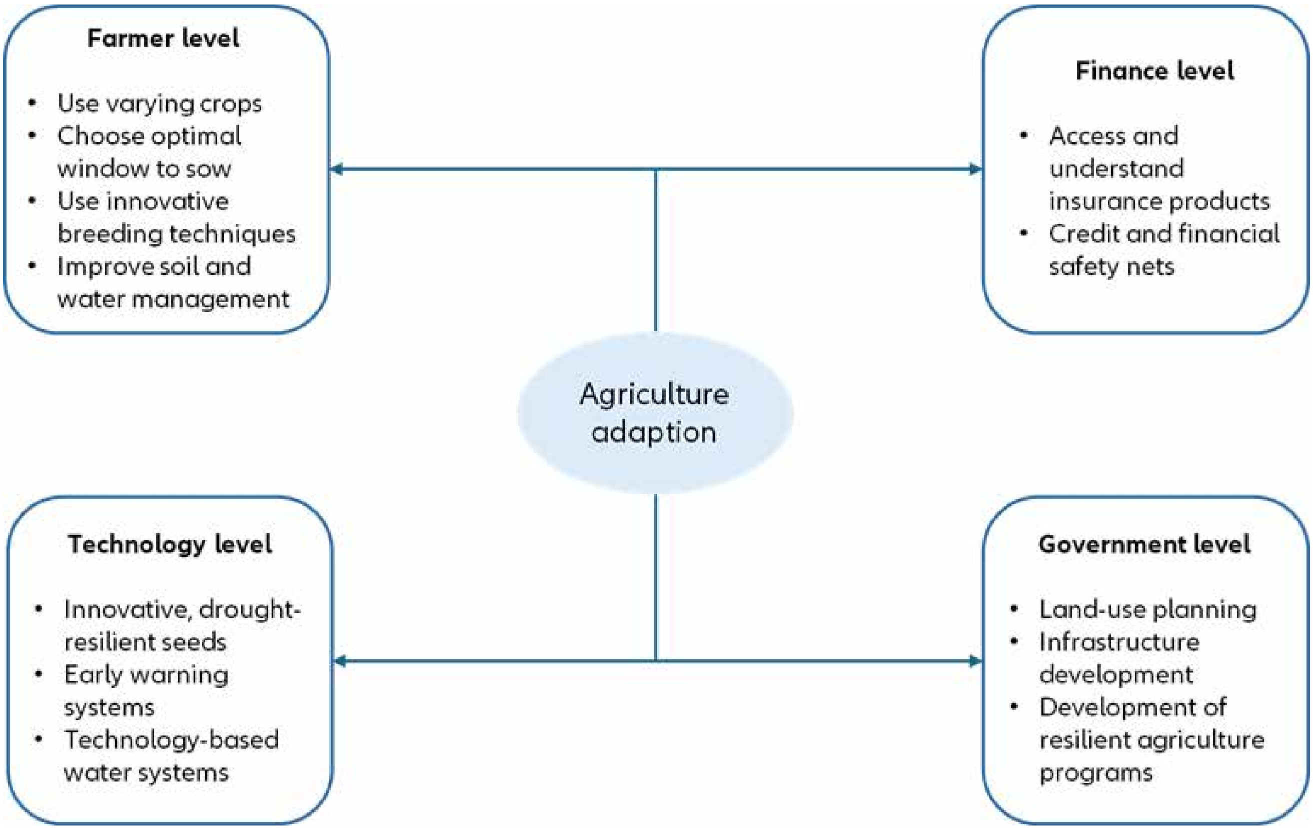
[25] A sustainable food future - PMC
[26] Perspectives on sustainable food production system: Characteristics and green technologies - ScienceDirect
[27] Food Waste and its Links to Greenhouse Gases and Climate Change | USDA
[28] Decile-based index drought insurance to help improve income stability for wheat producers in Australia - ScienceDirect

Figure 21: The adaptation landscape of the agriculture sector



Sources: Allianz Research

Agricultural insurance is a critical instrument for cushioning the financial impact of extreme weather and limiting the debt burden. By providing compensation for weather-related losses, it strengthens farm-level risk management and enhances the overall resilience of the sector. As climate change drives more frequent and severe extremes, insurance becomes not only a safety net but also an essential component of broader adaptation strategies, supporting farmers in sustaining production and income under growing uncertainty.

Agricultural insurance can broadly be divided into two main categories: indemnity-based insurance and index-based insurance[29]. Indemnity insurance, the dominant model in Europe, compensates farmers based on estimated losses determined through field inspections or accounting data. It can cover single perils, such as hail, or multiple risks under comprehensive multi-peril policies. Despite its widespread use, the system faces notable drawbacks. Accurately separating weather-related damage from management-related factors introduces uncertainty, known as basis risk, and requires extensive networks of trained loss adjusters. This makes indemnity products costly to operate and particularly difficult to scale when systemic events occur. In the case of a continent-wide drought, for instance, carrying out timely inspections across thousands of farms would be practically impossible.

Index insurance offers an alternative, relying on objective, data-driven indicators rather than physical loss assessments. Payouts are triggered by a pre-defined index, such as cumulative rainfall or regional yield averages. Three common index types are used. Area-yield indices measure average yields at a regional level, such as county averages. Vegetation-health indices rely on satellite data to capture plant health and stress across regions. These can reflect multiple weather risks as well as other factors, such as nutrient

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[25] Weather insurance in European crop and horticulture production - ScienceDirect

deficiencies. Weather indices are more specific, targeting conditions like cumulative rainfall during sensitive crop growth stages to insure against drought. This design reduces asymmetric information, ensures transparency and allows for faster and lower-cost payouts. Yet, index insurance also faces the challenge of basis risk: payouts may not perfectly reflect the actual on-farm losses.

The availability of insurance products alone does not guarantee that farmers are adequately protected. For insurance to play its role, farmers must be able to afford it, understand how it works and have confidence in the product. This remains a challenge, particularly for index-based insurance, which many small and medium-sized farmers still find difficult to fully grasp. One effective way to stimulate uptake has been the use of premium subsidies. In Europe, the Common Agricultural Policy (CAP) introduced in 2018 made it possible to subsidize up to 70% of insurance premiums, though the exact level of support varies across member states. Austria covers up to 55% of premiums, France and Italy provide support of up to 70%, while Spain offers around 40%. Germany does not provide subsidies at the federal level, but some states, such as Bavaria, Baden-Württemberg, and Rhineland-Palatinate, subsidize up to 50%, alongside a national value added tax deduction. The CAP framework continues to evolve[30]. Under the 2023–2027 programming period, Regulation (EU) 2021/2115 establishes the legal foundation for premium subsidies and explicitly extends eligibility to index-based insurance. This policy shift enables member states to support innovative instruments such as weather index and decile insurance. By making these products more affordable, the EU creates an opportunity to expand the use of modern risk-transfer tools that strengthen farmers' resilience and provide an important pillar of climate adaptation in the agricultural sector.

Looking ahead, the parametric insurance market is projected to expand rapidly, reflecting both rising demand for climate risk protection and greater confidence in data-driven products[31]. Parametric insurance is a type of insurance that provides a pre-agreed payout when a specific measurable event or parameter, such as rainfall, wind speed, or temperature, exceeds or falls below a defined threshold (it include index-based insurance). Global market size is expected to grow from around USD18bn in 2023 to USD34.4bn by 2033, representing an average annual growth rate of +6.6% (Figure 22). This trajectory underscores the increasing recognition of parametric solutions as a mainstream instrument in the broader insurance and risk-transfer landscape. Several factors are driving this momentum. First, the accelerating frequency and intensity of climate-related disasters is pushing governments, development banks and private insurers to invest more heavily in scalable products that can deliver rapid payouts. Second, technological advances, including satellite remote sensing, high-resolution weather forecasting and digital distribution platforms, are reducing costs and improving the accuracy of indices, thereby making these products more attractive for both providers and clients. Finally, policy frameworks, such as the EU's recognition of index-based insurance under the Common Agricultural Policy, are legitimizing and subsidizing their use, fostering wider uptake. Nevertheless, realizing this growth potential will depend on addressing persistent challenges, such as basis risk, limited financial literacy and affordability for smallholders.

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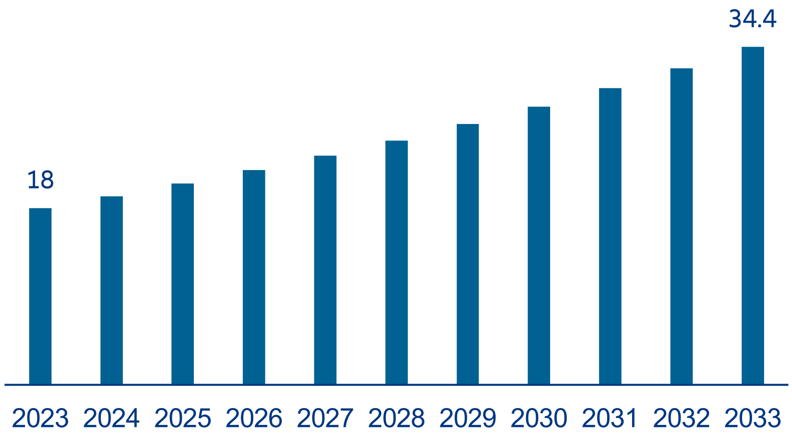
[30] Regulation - 2021/2115 - EN - EUR-Lex

[31] Parametric Insurance System Market Size, Share & Growth 2033

Figure 22: Development pathway of the parametric insurance market globally (USD bn)



Sources: Allied Market Research, Allianz Research

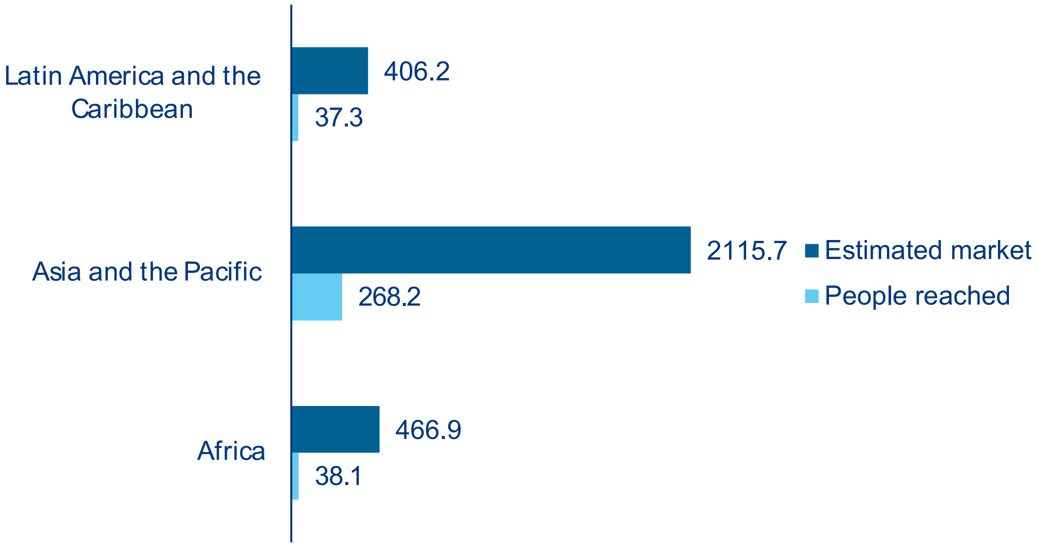
Traditional indemnity-based or parametric insurance products remain largely out of reach for the majority of smallholder farmers in developing countries. While parametric insurance has clear advantages, such as rapid payouts and reduced administrative costs, its schemes are often technically complex, requiring a level of financial literacy and institutional support that many rural communities in developing countries lack. Moreover, the up-front premiums, even when modest, can represent a significant financial burden for small farmers operating at or near subsistence levels. This combination of limited capital, structural barriers and insufficient policy support continues to restrict the accessibility of formal insurance markets for the most vulnerable agricultural producers in developing regions.

One pathway to overcome these barriers is through microinsurance. Unlike conventional products, microinsurance is specifically designed to extend protection to low-income households. It offers coverage against clearly defined risks in exchange for small and affordable premium payments that are proportionate to both the likelihood of occurrence and the potential cost of the peril. In the context of agriculture, this means that small farmers can secure a financial safety net against weather-related shocks, such as droughts, floods or pest outbreaks, without needing to navigate highly complex insurance contracts.

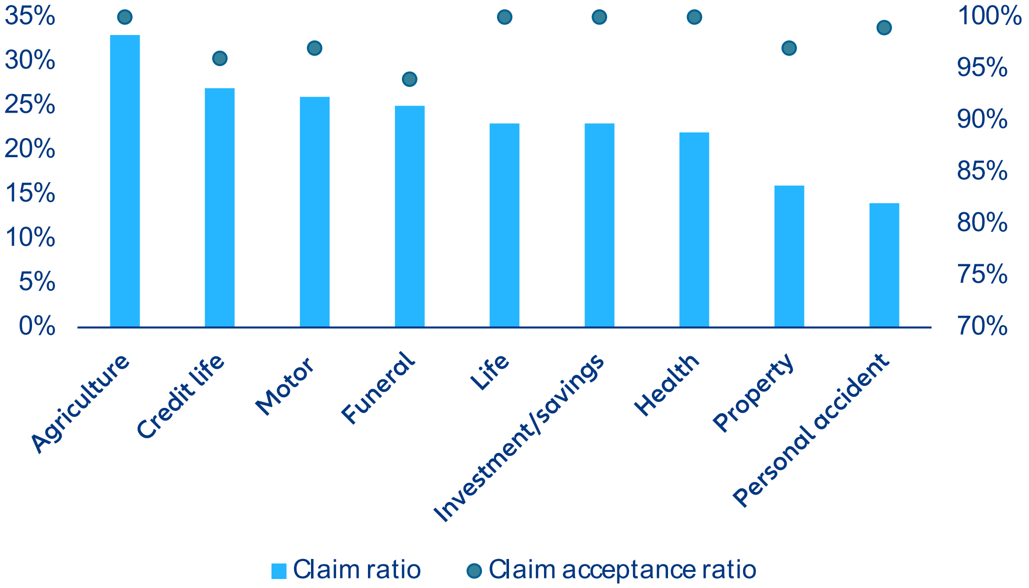
The potential scale of microinsurance is enormous. Globally, an estimated 3bn people represent the potential market for microinsurance (across sectors, including agriculture), with about 2bn located in the Asia-Pacific region (Figure 23a). Yet coverage remains strikingly low: only 11.5% of this potential market is currently served, with regional disparities: 12.7% coverage in Asia-Pacific compared to just 8.2% in Africa. Encouragingly, agriculture-related microinsurance has shown strong performance: it records the highest claim ratio at 33%, combined with a claim acceptance rate of 100% (Figure 23b). These figures point to the effectiveness and trustworthiness of agricultural microinsurance products, reinforcing their value as a tool to strengthen the resilience of smallholder farmers against climate-related risks.

Figure 23: Microinsurance market: a) market size and number of people covered by microinsurance (mn); b) Claim ratio and claim acceptance ratio by product line

a)



b)



Sources: Microinsurance Network, Allianz Research

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