LLOYD'S

Emerging Risk Report – 2015
Innovation Series

SOCIETY & SECURITY

Food System Shock

The insurance impacts of acute disruption to global food supply

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Contents

Executive summary

The ability of the global food system to achieve food security is under significant pressure.

Global demand for food is on the rise, driven by unprecedented growth in the world's population and widespread shifts in consumption patterns as countries develop. The Food and Agriculture Organization (FAO) projects that global agricultural production will need to more than double by 2050 to close the gap between food supply and demand.[1] As this chronic pressure increases, the food system is becoming increasingly vulnerable to acute shocks.

There is a pressing need to reduce the uncertainty surrounding the impacts of an extreme shock to the food supply.

Sudden disruptions to the supply chain could reduce the global food supply and trigger a spike in food prices, leading to substantial knock-on effects for businesses and societies. The food system's existing vulnerability to systemic shocks is being exacerbated by factors such as climate change, water stress, ongoing globalisation, and heightening political instability.

Lloyd's commissioned the development of a scenario of extreme shock to global food production in order to explore the implications for insurance and risk.

Experts in the field of food security and the economics of sustainable development were asked to develop a scenario describing a plausible, relatively severe production shock affecting multiple agricultural commodities and regions, and to describe the cascade of events that could result.

The systemic production shock to the world's staple food crops described in the scenario generates widespread economic, political and social impacts.

There are uncertainties in the scenario, arising from the difficulty of obtaining key data, the applicability of historical data to modern food trade networks, and the uncertainty surrounding future impacts of climate change. However, the scenario provides a robust tool to allow these uncertainties to be explored, and to begin to think about the possible implications of a global food shock for the insurance industry.

A shock to the global food supply could trigger significant claims across multiple classes of insurance, including (but not limited to) terrorism and political violence, political risk, business interruption, marine and aviation, agriculture, environmental liability, and product liability and recall. These losses could be compounded by the potential for a food system shock to last for many years; and the ability of insurers to pay claims quickly is expected to be an important factor in post-shock recovery. More broadly, the insurance industry may also be affected by impacts on investment income and the global regulatory and business environment.

The insurance industry is in a position to make an important contribution to improving the resilience and sustainability of the global food system.

As businesses become increasingly aware of the threat posed by food system disruption, they may invest more heavily in comprehensive risk transfer structures, and a severe shock could motivate individuals and businesses to address gaps in their risk management. As such, global food supply shock could also represent a substantial opportunity for insurers, who will have a key role in assisting clients to understand their risk exposure and to tailor appropriate risk transfer solutions.

Scenarios are an important method of exploring emerging risks; they are not predictions or forecasts.

The following scenario is simply one of a multitude of events that could occur. When the scenario considers actions or events by individual governments or individuals within specific countries, it is not stating that Lloyd's is predicting that the events will occur. Many of the comments are based on events that have occurred in the past – either in the countries mentioned or extrapolated from other regions. However, individual countries are only named specifically to give realism to the event and allow appropriately detailed calculations to be made – events could occur in different countries or not at all, and to illustrate this some alternative scenarios are provided. Lloyd's firmly believes that the insurance industry will be stronger by considering a variety of scenarios around mega-risks, and the only way to do this consistently is to give sufficient detail. This has long been the approach within the Lloyd's Realistic Disaster Scenario process. Lloyd's has chosen to share this work openly because it believes that a debate within the insurance industry, and beyond, will strengthen the global community.

Introduction

Modern society depends on interconnected food systems that are global in reach and designed to harness a multiplicity of complex supply chains. These systems have delivered significant benefits, but they also face major threats to their sustainability.

Following our report on the issue of global food security (*Feast or Famine*, Lloyd's, 2013), Lloyd's commissioned the development of a scenario for plausible shock events in order to explore the implications for insurance and risk. Experts in the fields of food security and the economics of sustainable development were asked to develop a plausible scenario of a global production shock to some of the world's staple food crops, and to describe the cascade of impacts that could result. The scenario was developed in conjunction with members of the UK/US Task Force on Resilience of the Global Food Supply Chain to Extreme Events, which is supported by the UK Foreign and Commonwealth Office. The scenario was peer-reviewed by a diverse group of leading academics before being presented to insurance industry practitioners for assessment at two workshops. This report presents one plausible scenario and the findings of the workshops. It aims to reveal some of the complex risk factors that exist in the modern food system, and to present initial findings on the role that insurance could play in managing those risks.

Part 1: Food system shock

Agriculture is the single largest employer in the world, providing livelihoods and jobs for 40% of the world's population.[2] It is a fundamental component of the global food system. This system encompasses the numerous processes and infrastructure involved in feeding the world's population, from growing, processing and transporting food products, to disposing of consumers' waste.

The primary goal of food systems is to achieve food security, which exists when all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life.[3] In principle, there is sufficient global aggregate food production for nearly everyone to be well fed, but there remain marked differences in levels of nourishment across the globe. Despite international focus, around one in nine of the world's population is chronically hungry[4] – and although the number of people going hungry is falling, the ability of the global food supply to keep up with demand is under increasing pressure. Global demand for food is on the rise, driven by unprecedented growth in the world's population, which is expected to surpass 9 billion by 2050, and widespread shifts in consumption patterns as countries develop. To meet the increased demand for food driven by these factors, the FAO projects that we must more than double global agricultural production by 2050.[1]

Most discussions of global food security have focused on the long-term pressures facing the global food system and the difficulty of matching supply to an ever-increasing demand. However, this chronic pressure on food supply heightens the system's vulnerability to acute supply shocks. Sudden disruptions to the food supply chain could reduce global food supply and trigger a spike in food prices, leading to substantial knock-on effects for businesses and societies. Crop production shocks could pose a systemic threat to food security if they were to impact any of the world's major 'breadbaskets',[5] regions which produce a surplus of staple food crops considered vital for global society as a whole. Closing the gap between global food supply and demand should remain a priority for the world food system, but there is a pressing need to reduce the uncertainty surrounding the impacts of an extreme shock to the food supply.

As the pressure on our global food supply rises, so too does its vulnerability to sudden acute disruptions. Although there is a large amount of uncertainty about exactly how climate change might impact world food production over the coming decades, there is general consensus that the overall effect will be negative.[6] Increases in the intensity and frequency of extreme weather events such as floods, droughts and wildfires, coupled with a rise in conditions amenable to the spread and persistence of agricultural pests and diseases, are expected to have a destabilising effect on world food production. This is further exacerbated by the growing issue of water scarcity, which is accelerating at such a pace that two-thirds of the world's population could live under water stress conditions by 2025.[7]

The continued globalisation of modern food networks is introducing an unprecedented level of complexity to the global food system, bringing both significant benefits and systemic risks. Disruptions at any one point in the system would be likely to reverberate throughout the food supply chain. Volatile food prices and increasing political instability are likely to magnify the impacts of food production shocks, causing a cascade of economic, social and political impacts across the globe. The insurance industry has a key role to play in encouraging businesses to think about their exposure to risks throughout the food supply chain, and providing risk transfer products that could enhance global resilience to systemic food system shocks.

Part 2: Global crop production shock scenario

The following scenario is set in the near future and covers a year. It begins with a set of events that create a major shock to global agricultural commodity production, followed by a series of plausible, relatively extreme responses to those shocks within an annual cycle. Additional alternative responses are listed as examples.

The scenario describes the potential consequences of a plausible, relatively drastic production shock affecting several agricultural commodities and regions. The magnitude of the shock for each commodity is based on de-trended FAO data from 1961 to 2013. Three de-trending methods were applied to global aggregated data and country data to address shifts in crop area, crop yield, technology and other significant factors through this time period. The midpoints of the range of percentage reduction in production for specific years caused by specific historical events were then selected as the basis for the components of this scenario. Plausible impacts of these shocks are described.

The scenarios were prepared by a research team led by Aled Jones and Molly Jahn with significant contribution from Tobias Lunt. Assistance was provided by David LeZaks, William Mulhern and Carol Barford. Expert consultation and review were provided by Stephen Baenziger, Catherine Cameron, Corey Cherr, Nancy DeVore, Kenneth Donaldson, Joshua Elliott, Charles Godfray, Maryam Golnaraghi, Jonathan Hellin, Marc Levy, Tom Lumpkin, Niall Moten, Michael Obersteiner, Sherman Robinson, David Robson, Mark Rosegrant, J. Shukla, Jerry Skees, Keith Wiebe, Don Wuebbles, the International Food Policy Research Institute's Global Futures and Strategic Foresight Program for IMPACT model runs, members of the UK/US Task Force on Resilience of the Global Food Supply Chain to Extreme Events supported by the UK Foreign and Commonwealth Office, and the Knowledge Systems for Sustainability Collaborative's Multiple Breadbasket Failure Initiative.

Lloyd's would also like to acknowledge the role of the Global Resource Observatory project based at Anglia Ruskin University. Initial results from its global models and database have proved invaluable in assessing the potential political and economic impacts that could arise from the physical food shock scenarios that we are presenting.

Summary

A strong warm-phase of the El Niño Southern Oscillation (ENSO) develops in the central equatorial Pacific Ocean. Flooding develops in the Mississippi and Missouri rivers, reducing production of maize in the US by 27%, soybean by 19% and wheat by 7%. Severe drought reminiscent of 2002 hits India, while parts of Nepal, Bangladesh, northeastern India and Pakistan are hit by torrential rainfall, flooding and landslides. Severe drought affects eastern and southeastern Australia and Southeast Asia. In India, wheat production is reduced by 11% and rice by 18%. In Bangladesh and Indonesia, rice is reduced by 6%, and rice production falls in Vietnam by 20%, and by 10% in Thailand and the Philippines. In Pakistan, wheat production is reduced by 10% due to flooding. Australian wheat is reduced by 50% by drought. Asian soybean rust expands throughout Argentina and Brazil, causing an epidemic. In Argentina, soybean production is reduced by 15%, with a 5% drop in Brazil. The Ug99 wheat stem rust pathogen is windblown throughout the Caucasus and further north; Turkey, Kazakhstan and Ukraine suffer 15% production losses in wheat, while Pakistan and India lose an additional 5% on top of existing flood and drought damage. Russian wheat production declines by 10%.

Wheat, maize and soybean prices increase to quadruple the levels seen around 2000. Rice prices increase 500% as India starts to try to buy from smaller exporters following restrictions imposed by Thailand. Public agricultural commodity stocks increase 100% in share value, agricultural chemical stocks rise 500% and agriculture engineering supply chain stocks rise 150%. Food riots break out in urban areas across the Middle East, North Africa and Latin America. The euro weakens and the main European stock markets lose 10% of their value; US stock markets follow and lose 5% of their value.

Maize: 10% production shock
Soybean: 11% production shock
Wheat: 7% production shock
Rice: 7% production shock

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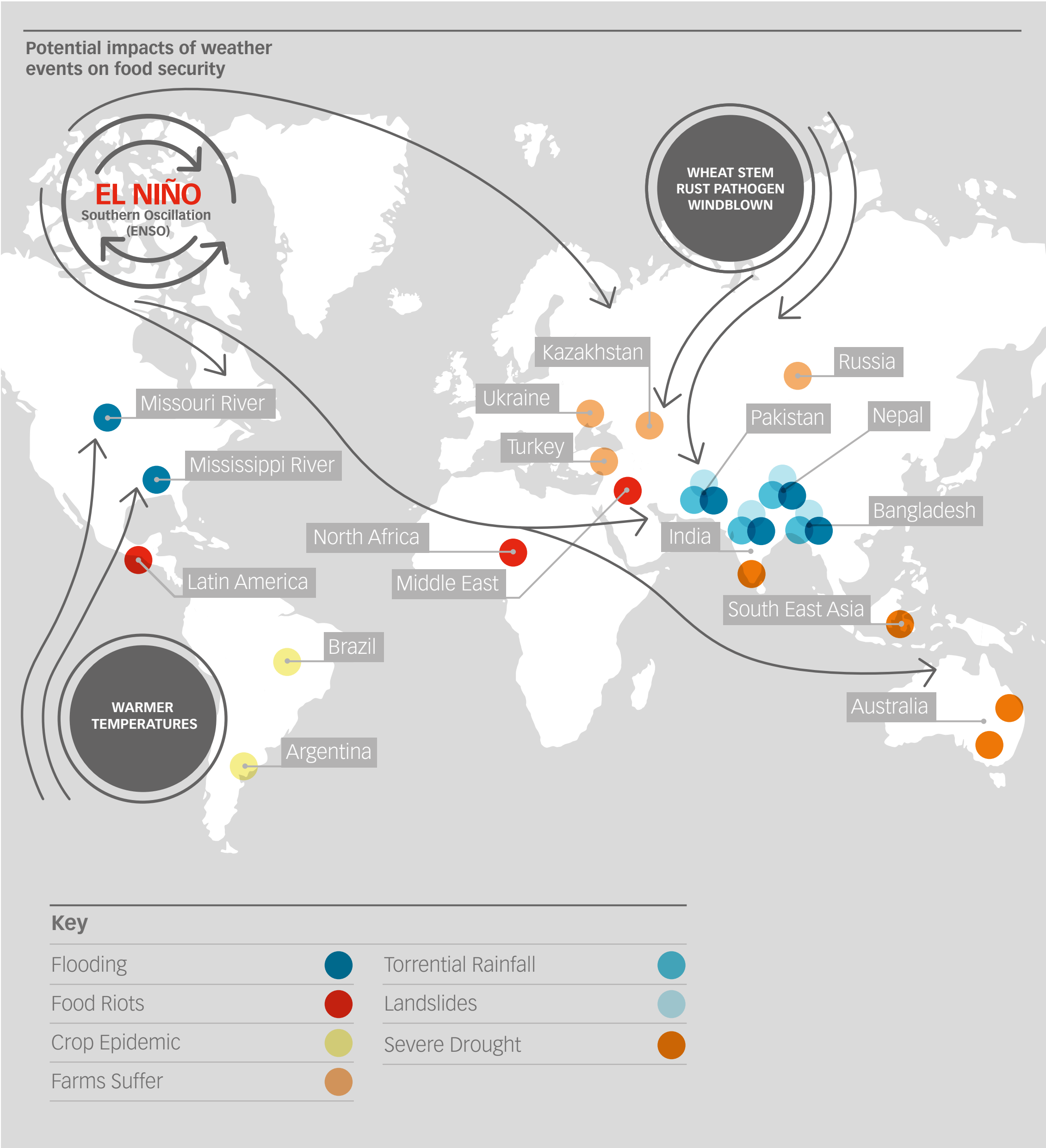

Overall global economic impact:

-5%	-10%	-7%	-10%	-11%	+500%
US stocks lose 5% of value	EU stocks lose 10% of value	Global rice production falls by 7%	Global maize production falls by 10%	Global soybean production falls by 11%	Rice prices increase by 500%

The scenario

The year opens with a strong US dollar and ongoing tension in Ukraine, while the Islamic State continues to cause unrest across the Middle East and North African countries including Tunisia and Libya. Boko Haram has expanded more actively into Chad and Cameroon. Oil prices have been fluctuating between $58 and $64 per barrel. The European Central Bank has implemented its programme of quantitative easing and the US and UK continue to keep interest rates low but do not increase their quantitative easing programmes. Greece remains part of the Eurozone and the UK has not held a referendum on its EU membership to date. India continues to strengthen its geopolitical and military ties with the US. Food stocks remain at a relatively low level (below approximately 80 days of consumption) following recent droughts in California and extreme weather events in Brazil and Asia; therefore grain prices remain high (double the levels seen around 2000).[a]

January and February see record snowfall in Canada and the US Midwest, coupled with abnormally warm sea surface temperatures in the central equatorial Pacific. Atmospheric scientists have already designated the anomaly as a strong warm-phase ENSO and warn that global precipitation patterns are likely to deviate from normal during the coming growing season. As snow melts in boreal spring, agricultural soils in the US grain belt reach saturation. Consistent low magnitude rainfall events in April elevate concerns about flooding in the Mississippi and Missouri river systems. In May, an anomalous and strong zonal flow from the western Pacific to the eastern US is established, which funnels abnormally intense cyclonic activity in the mid-latitude North Pacific across the continental US and into the grain belt.[b] These cyclones induce a series of strong precipitation events in late May and June, primarily affecting Iowa, Missouri, Illinois, Nebraska, South Dakota and Kansas, and neighbouring states to a lesser degree, preventing farmers from planting.[c] The Mississippi and Missouri river systems overflow and approximately 17,500 square miles of farmland are severely flooded, slightly surpassing the 1993 flood event but not exceeding the 27,000 square miles of flooding observed in 1927.[13] New crops are washed away, erosion and sedimentation dramatically disturb agricultural soils, and equipment and infrastructure are destroyed. Spring wheat planting is delayed and winter wheat plantings are affected by oversaturated soils and erosion. Barge capacity is reduced to near zero for two months, overwhelming rail networks already insufficient to cope with booming demand from the energy sector in the Dakotas, Oklahoma and Alberta. In the US, maize production drops by 27%, soybean output drops by 19%, and wheat by 7% due to flooding.

In India, agricultural productivity (and the economy as a whole) is dependent upon favourable rainfall associated with the South Asian monsoon. The warm Central Pacific–ENSO event results in an eastward displacement of the Walker circulation in the western tropical Pacific, generating subsidence patterns in the Pacific and Indian oceans that prevent normal monsoon freshening and precipitation.[d] Over the course of the boreal summer, the main growing season for single and double-cropped rice, monsoon precipitation over all of India is reduced by 20%, with central and peninsular regions experiencing deficits approaching 70% as of mid-July. Although wheat is grown primarily in non-monsoon months, wheat production is known to be affected by deficient monsoon rainfall in July[17] as well as elevated temperatures.[18] Consequently, wheat production is reduced. Because of Himalayan topography and orographic induction, extreme drought in much of India is coupled with an intense concentration of rainfall events in Bangladesh, parts of Nepal and eastern Pakistan, resulting in submerged cropland and significant economic losses and human health impacts in these countries.[e] Further, Australian drought has been known to coincide with Indian drought in ENSO warm-phases since 1888,[f] which comes to pass again in this scenario. Eastern and southeastern states of Australia experience well below average levels of precipitation, which overlap the majority of the nation's wheat-producing areas. The effects of the drought ripple from the agricultural sector through to urban areas and the broader Australian economy.[g]

In India, wheat production is reduced by 11% and rice by 18% because of the drought. In Bangladesh, flooding and erosion reduce rice by 6%; in Pakistan, wheat is reduced by 10%. In Australia, wheat is reduced by 50%.[h]

[a] In 2000, wheat was traded at approximately $2.50 per bushel; at the end of 2015 it was trading at $5.00 per bushel.

[b] This ENSO-induced 'duct' effect was observed in the 1993 floods in the US Midwest[8], which inundated over 16,000 square miles of farmland and caused as much as $20bn in losses.[9–11]

[c] Extreme precipitation events in the Mississippi River Valley have been increasing since the 1930s.[12]

[d] These effects have been historically observed during warm-phase ENSO events.[14] The most severe drought of the 21st century impacted Australia and the US in 2002 when a strong Cental Pacific–ENSO coincided with a 21% decrease in summer monsoon rainfall.[15] The worst drought of the past 100 years was in 1918, affecting more than 68% of the land area of India.[16]

Concurrent with erratic monsoon behaviour in South Asia, drought develops in Southeast Asian countries, which are known to be affected meteorologically by El Niño.[22,23] ENSO is correlated with precipitation declines in the Philippines,[22,24] Indonesia,[25] Thailand[23] and Vietnam,[26] and rainfall deficits from approximately June to January, interrupting the rainy season, disrupt production of both first and second crop rice.

Rice production falls by 20% in Vietnam, 10% in Thailand and the Philippines and 6% in Indonesia.

The South American winter (May–September) is abnormally warm, with much of the Argentinian Pampas and parts further north failing to freeze, allowing distributed inoculum sources of Asian soybean rust (ASR) to persist in non-crop weedy host species,[i] thus expanding the survival range of the disease. ASR is a highly mobile fungal pathogen originating in East and Southeast Asia, which spread to South America in 2001 and the US in 2004.[29] There are no completely resistant cultivars available to growers; ASR has been found in as many as 90% of soybean fields in Brazil was responsible for 4.7 Million Metric Tonnes in crop losses in 2006[30] (9% of production) and approximately $1bn in losses in 2003.[31] After the US, Brazil and Argentina are the two next largest producers of soybean in the world, grown primarily for animal feed, which has expanded rapidly in planted area since 1990.[32] As the South American spring turns into early summer, wet conditions in the Pampas resulting from ENSO push further into Argentina and north into Brazil, providing ideal environmental conditions for the spread and development of the disease. A particularly virulent strain of ASR[j] takes advantage of the warm winter, wet growing conditions, eddying continental winds and favourable South American geographical features to spread rapidly and establish itself across tightly interconnected soybean plantations[29] in Argentina and Brazil early in the growing season, causing a severe outbreak in Brazil and an unprecedented epidemic in Argentina.[k] Brazilian farmers have experience in aggressively treating their crops with fungicide early to combat rust, but Argentina is less prepared.

In Argentina, soybean production is reduced by 15% by ASR, with a 5% deficit in Brazil.

[e] *Although Bangladesh and Pakistan are in close proximity to India, the unique Himalayan topography and dynamics of the monsoon have combined in the past to create drought conditions in the major agricultural states of India while simultaneously inducing floods and landslides in neighbouring Pakistan and Bangladesh.*[19,20]

[f] *This co-occurrence phenomenon was noted by Todd, Russell and Ellery in The Australasian in December of 1888.*

[g] *The drought in 2002, the most severe in 20 years, caused income losses up to 20% and reduced national GDP by 1.6%, despite the relatively small size of the agricultural sector.*[21]

[h] *Wheat production in Australia is volatile. In 2006, 2002 and 1994, drought conditions reduced wheat production by 50%.*

[i] *Disease usually develops too late to cause an Argentinian epidemic because of winter cold in the higher latitudes,*[27] *but these distributed inoculum sources are considered a risk for future outbreaks under favourable environmental conditions.*[28]

[j] *ASR is genetically quite diverse, with varying pathogenicity profiles, and evolves quickly, posing a serious threat to soybean growers. ASR strains in South America were found to have already evolved to be distinct from Asian isolates.*[33]

[k] *Some 8–10% of soybean production in these regions is commonly lost to plant disease. ASR is well established in non-soybean-producing areas, which presents a major concern as a source for highly mobile airborne ASR urediniospores that can progress from initial infections to 90% disease in as little as three weeks.*[27]

Meanwhile, another significant plant pathogen expands its influence further to the east. Stem rust of wheat (Puccinia gramininis f. sp. tritici) has been a scourge of agricultural civilisations for millennia,[34] and was well controlled for the first time in human history by new varieties of wheat developed in the 'green revolution' of the 1950s and 1960s.[35,36] However, a new strain of the pathogen was discovered in Uganda in 1999 (Ug99) that overcame known host resistance and has continued to evolve and migrate rapidly, reaching Iran in 2007.[37] Rust spores are highly mobile and can be windblown by prevailing currents, travelling hundreds of miles within a period of months.[37] Ug99 is now composed of an aggressive set of races that has mobilised the scientific and donor communities to develop alternative sources of host resistance in order to defend against the expansion of this pathogen into breadbasket areas of global wheat production. However, 90% of world wheat fields are still susceptible to Ug99 isolates,[38] and the deployment of new resistance genes such as Sr31 and Sr33 is difficult and may be unable to defend against the evolving threat.[39] This season, fungal spores of a hypervirulent Ug99 race are further windblown beyond prior expansion in the previous year, and the fungus is discovered throughout the Caucasus and further north in major wheat-producing areas of Russia. Disease takes hold across west and northwest Asia and rapidly expands across the wheat breadbasket, dramatically reducing yields and overcoming deployed resistance genes. While much of the Indian wheat fields are resistant to Ug99 to some degree, the resistance is dependent on a small subset of resistance genes[39] which are overcome by this new race of the pathogen. Smallholders in many affected regions have little alternative to economic activity and social unrest becomes problematic.

Turkey, Kazakhstan and Ukraine suffer 10% production losses in wheat, while Pakistan and India lose an additional 5% on top of existing flood and drought damage to 15% and 16% net losses respectively. Russian wheat production drops by 10%.

The combined effects of these shocks result in global crop production declines of 10% for maize, 11% for soybean, 7% for wheat and 7% for rice.

These magnitudes are within the boundaries of historical production shocks for these crops, but the concurrent and global nature of these losses has not occurred in modern history. Infrastructural damages and overburden lead to significant expenditure and business interruptions, magnifying the effects.

As the scale of production loss from the US becomes clear, wheat and maize prices start to rise. As extreme weather impacts India, export restrictions are immediately put in place. Thailand responds with a rice export ban. Russia imposes restrictions on freight transport internally, slowing down its export capability. China does not release any of its grain stocks, and the US does not alter its biofuel mandate. Global exports are down 25% across wheat and maize. By June, wheat and maize prices reach a level that is triple those seen in 2000.

In late September, as the scale of production losses of soybean in Argentina and wheat in Australia become clear, wheat, maize and soybean prices increase to quadruple the levels seen around 2000 so that wheat is again trading above $10.00 per bushel. Rice prices increase 500% as India starts to try to buy from smaller exporters following the restrictions imposed by Thailand.

As soybean prices increase, farmers start to cull animals early, particularly in the US. This leads to several livestock companies issuing profits warnings. In eastern Europe the livestock industry is particularly hard hit and a number of companies either declare insolvency or are taken over by larger multinationals. In China and Saudi Arabia, the governments begin to subsidise soybean production to protect their own livestock farmers and growing popular demand for meat.

As was seen in 2008, public agricultural commodity stocks increase 100% in share value, agricultural chemical stocks rise 500% and agricultural engineering supply chain stocks rise 150%. There is no immediate change in other public or private equity stocks and no discernible impact on government bonds as the impact of quantitative easing and low interest rates means little change is possible.

The World Food Programme (WFP) anticipates severe food security problems and seeks to mobilise emergency relief, hoping to be able to distribute sufficient food aid. However, donors choose not to provide additional aid in the short term. WFP purchases food on the open market, but its limited budget does not allow it to purchase sufficient food to meet demand. India and China start to become more forceful in seeking contracts for food imports to be fulfilled. Countries on the WFP's watch list for food insecurity become unable to import food. WFP issues a warning of impending famine in Bangladesh, suggesting that one million deaths are possible.

The increase in grain prices causes difficulties for some countries and food riots break out in urban areas across the Middle East, North Africa and Latin America. A number of net food importing sub-Saharan countries, including Sudan and Zimbabwe, confiscate grains held in warehouses to use as emergency food aid. On the back of the deployment of the military in Kenya to manage food distribution, several terrorist attacks take place across the country, resulting in travel bans, and simultaneous bomb blasts occur on buses and in museums in Nairobi. A coup breaks out in South Sudan.

In Nigeria, food shortages are seen as a further move by the government to control food supply into the north of the country and Boko Haram launches a major offensive. The capital city experiences running battles while the main ports are captured by rebels. Looting is widespread. Violence spreads further into Cameroon. Oil prices increase globally but stabilise below previous peaks. African troops are deployed into Nigeria but fail to stop the country from falling into civil war. All foreign workers are evacuated from mainland Nigeria. Terrorists target key strategic assets including onshore oil rigs and shallow offshore rigs. As the scale of the unrest unfolds, banks in Nigeria find it difficult to refinance, particularly those heavily exposed to oil finance, and by the end of the year the first bank failures are seen.

Yemen, Egypt and Tunisia experience further food protests which lead to changes in government. In Egypt, the Muslim Brotherhood seizes power with the support of the army, and the Old Guard seizes power in Tunisia. In Yemen, no clear faction is in control and internal markets cease to function effectively. Mali becomes a failed state in the absence of a second unilateral intervention by France.

Tensions between Pakistan and India rise as the Pakistani media and nationalist politicians blame India for exacerbating the crisis and forcing further food price inflation on Pakistan. A bomb explosion at an Indian Premier League (IPL) cricket match is claimed by the Lashkar-e-Taiba terrorist group in retaliation for India's aggression against the Pakistani people. All IPL matches are suspended pending the completion of a security review.

Russia continues to intervene in Ukraine and expresses concern that other eastern European countries may become unstable following food riots. Internal transport within Russia is heavily restricted as troops and military equipment are moved around, resulting in food exports from Kazakhstan failing to reach seaports. Pro-Russian protests occur in Lithuania. The euro weakens and the main European stock markets lose 10% of their value amid the possibility of military action, increasing pressure on southern European borders owing to immigration from North Africa, an unstable eastern Europe and further sanctions against Russia. US stock markets follow and lose 5% of their value. Spreads on corporate bonds increase. Government bonds and treasuries are not significantly impacted given historic low rates on government bonds and a new programme of quantitative easing in Europe.

In summary, quadrupled commodity prices and commodity stock fluctuations, coupled with civil unrest, result in significant negative humanitarian consequences and major financial losses worldwide.

Alternative responses

Response 1

Europe has an increasingly militarised border with Russia as political tensions continue. In addition, following the Greek exit from the euro in late 2015, inflation within the country rapidly increases and food imports becoming increasingly difficult as international exporters are reluctant to sell to Greece. Following food riots in Athens, Greece re-elects Syriza and holds a popular referendum which sees Greece leave the EU and vote for closer ties with Russia.

Response 2

Following recent political and civil unrest in Argentina, the Justicialist Party takes a more interventionist approach to food and at the start of the year nationalises Bunge Ltd, triggering calls in the US for anti-Argentina sanctions. Argentina increases export tariffs to protect internal food supplies. However, farmers divert production towards the internal black market and support a strike at the ports, leading to a cessation of all exports. After a decade of increasing political turmoil, the effective shutdown of Argentina causes S&P to downgrade Argentinian debt (government and corporate) to junk status. This results in a sharp rise in inflation. Some of the strikes turn violent. The military is deployed into cities and ports.

In mid-December, a fertiliser bomb destroys the headquarters of a major hedge fund in New York. Credit for the attack is claimed by a small group of Argentinian farmers, who blame the hedge fund for causing a loss of stability in their country by aggressively going after Argentinian debt over the last decade. The headquarters are located on Wall Street and the building is entirely levelled.

This event further erodes confidence in the US stock market, which drops 10% (with European stock markets dropping 20% from the start of the year) and causes US Treasuries go from 3% to 5% and corporate bonds for high yield increase to 8%. Gold increases 20%. These do not recover by the end of the year as the US contemplates a response in Latin America and Europe contemplates its response to events in Ukraine.

Response 3

Food riots occur across the Middle East at the end of the summer. Saudi Arabia announces a cut in oil production, which causes oil prices to jump to $100–110 per barrel within a month. This allows oil-exporting countries in the Middle East to raise the capital needed to secure food imports and subsidise food distribution within their countries, so that they avoid a repeat of the civil protests seen during the Arab Spring. However, these countries agree to pay high prices to guarantee rapid access to grains, causing several contract defaults with other countries including India. Russia refuses to honour contracts with one of the largest commodity traders and instead sells directly to Saudi Arabia. Non-oil-exporting countries across the Middle East and North Africa see an increase in terrorism, civil unrest and internal migration into urban centres. Rolling energy blackouts are seen across several of these countries and riots are common.

Response 4

Russia invades eastern Ukraine. It declares in the UN that Ukraine has been slow to respond to the global food crisis and it must intervene to stabilise that part of the country to deliver immediate food aid locally and internationally. Pro-Russian riots break out in Lithuania, leading to deployment of the military in the east of the country. Russia is seen to build up its military presence near the Lithuanian border. NATO responds by sending troops into Ukraine; however, by the end of the year they have not engaged with Russian troops. Countries that are now recipients of food from Russia vocally support Russian action at the UN General Assembly. However, the political tensions and sanctions that this leads to effectively cut off the Black Sea from global exports, causing significant disruption to supply chains.

Part 3: Key conclusions of insurance practitioner workshops

There is little doubt that a systemic production shock to the world's most important food crops as described in this scenario would generate a cascade of economic, political and social impacts. What is striking about the scenario is that the probability of occurrence is estimated as significantly higher than the benchmark return period of 1:200 years applied for assessing insurers' ability to pay claims against extreme events.

There are uncertainties in the scenario, arising in part from the difficulty of obtaining accurate data on some key metrics such as global food stocks. Furthermore, the ongoing globalisation of food trade networks is exposing the world food system to impacts that have not been seen in the past, and it is unclear how food system shocks cascade through a modern, interconnected economy. The historical information used as a guide for events within the scenario can provide only a partial example of what the reality might be for a present-day food shock. Finally, there is uncertainty surrounding the future impacts of climate change, particularly how it might affect the frequency and severity of weather extremes.

The scenario presented in this report provided a robust tool to allow these uncertainties to be explored, and to achieve an initial set of conclusions on the potential impacts. We present the findings according to insurance classes of business in order to provide a framework familiar to both risk managers and insurers, so that the implications can be considered in terms that translate what might appear to be an abstract concept into real impacts on societies and businesses around the world.

Terrorism & political violence

Civil unrest and political conflicts can arise from factors linked to food insecurity. The shock to staple crop production in this scenario, the resulting spike in global food prices and the widespread political fall-out that follows could bring major losses to the political risk insurance market. The nature and scale of these impacts will vary across countries around the world, and in turn political risk insurers would be differently affected according to where their exposures lie.

Cover for damage to property caused by strikes, riots and civil commotion may be provided as part of a property insurance policy. Although it is rarely the only trigger of civil unrest, there is an established link between food price spikes and the rise of anti-government demonstrations and riots. This link is particularly strong in countries with existing social and political instability. Although insurance penetration is generally lower in these regions, severe losses from property damage claims could arise for insurers with concentrations of exposure in these areas. Portfolios with geographically-concentrated exposures in vulnerable regions may also be at risk of an accumulation of losses as acts of civil unrest spread contagion-like cross neighbouring regions. This phenomenon was a defining characteristic of the 2010–2011 Arab Spring, which was itself driven in part by food shortages and price spikes.[40] The Arab Spring also illustrated the capacity of civil uprisings to evolve into civil war, a risk that will only be covered if businesses are protected by full political violence insurance.

High levels of social disruption resulting from a food crisis may bring a heightened risk of terrorist attacks, which can be insured against with a programme that sits alongside a standard property damage policy. Acts of terrorism will often target key assets or 'iconic targets', and as such can trigger substantial claims. In the shock scenario, a number of acts are committed in the wake of the severe spike in world food prices that may be considered acts of terrorism, but whether insurers are liable for claims for the damage they cause would depend on the definition of terrorism in the individual insurance policy. This definition can vary widely between policies and can be ambiguous, making it difficult for insurers to determine which claims they are liable for – a judgement made harder by the potential for governments to treat episodes of civil unrest as terrorism.

Political risk

Instability in a country's food supply can result in government interventions in the food system. Governments may carry out direct physical confiscation of stocks, and the cost of a loss of stock to businesses further down the food supply chain may need to be met by political risk insurers. Governments may also make less direct interventions to protect or manage a country's food supply, such as by introducing quotas, taxes, licences and trade restrictions. In the shock scenario there is systemic disruption to the world food trade as nations seek to protect their own food supply by imposing export restrictions and embargoes. Trade restrictions can result in significant losses for food processing companies, as existing contract obligations cannot be met, and stock may be abandoned in ports. Political risk insurers offering trade credit insurance could also incur claims for non-payment or delivery. As food prices continue to rise, there will likely also be a heightened risk of wilful contract defaults if countries are able to sell crops at a higher price or receive crops more quickly than their existing contracts allow.

Political risk insurance can also provide cover against inconvertibility of foreign currency, and claims would be incurred under the scenario arising from the collapse of banks in Nigeria. Insurers could also be impacted by systemic failures elsewhere, triggered by volatility in global stock markets and ongoing political upheaval.

Civil unrest and political instability can generate much wider destabilisation, and a multitude of further political consequences may arise in response to a systemic shock to the global food supply. These include state fracture and the development of regional blocs, which could hold serious implications for the operation of the insurance industry, as well as widespread behavioural trends such as mass migration. Such large-scale change could have serious implications for the global risk landscape.

Business interruption

Property insurance could be expected to be an area of significant exposure for insurers under the shock scenario, owing to the widespread impact of extreme weather events, compounded by the resulting disruption caused to businesses' operations. Business interruption (BI) insurance covers losses arising from unavoidable interruptions to the ordinary operations of a business, usually linked to property damage.

Agricultural businesses could be expected to suffer direct BI impacts as crop production stalls during the time taken for flood- and drought-damaged cropland to recover. The extreme weather events that cause the initial shock to food crops also hinder key transport networks, which may result in further BI claims from operators. The rerouting of transport to those still able to operate may overwhelm the remaining networks, resulting in infrastructural damages and overburden which could lead to property damage and BI claims if these systems break down. BI can generate very uncertain exposure and is often sub-limited as a result. If appropriate sub-limits are not in place, insurers in the shock scenario could be vulnerable to escalating recovery costs, particularly if recovery operations are delayed by civil and political turbulence.

It is highly likely that food processing and distributing businesses further down the supply chain would be affected by a disruption to staple crop production, as their ongoing operations are dependent on its continued supply. These businesses would be unlikely to be able to protect themselves against such knock-on effects under a standard BI policy. Contingent business interruption (CBI) is an optional extension of coverage that provides cover against losses arising as a result of disruption to 'dependent property' not owned by the policyholder but relied upon for its business operations.[41] CBI is an increasingly important offering from property insurers, as a number of factors have left supply chains in the world food system more vulnerable than ever. The rise of outsourcing to reduce costs is increasing the length and complexity of supply chains, with networks often spanning multiple countries, and the drive to minimise costs has led to an increasing reliance on a 'just-in-time' production approach, which reduces the buffer capacity of each link in the supply chain. The high degree of concentration in the supply chain has also led to large processing and retail firms occupying a dominant role; if one of these conglomerates were to fail, the ripple effect on the global food system could be catastrophic, and could generate cascade effects throughout global supply chains. An event of this kind could therefore generate significant loss accumulation for insurers, creating a complex exposure management challenge. Understanding the dependencies and linkages in supply chains will be a key requirement for CBI policy coverage.

A shock of the scale described in the scenario would present a severe test of many businesses' resilience to supply chain disruption. A large shock would be likely to trigger a spike in demand for BI and CBI, which would represent a growth opportunity for insurers. As experienced risk managers, insurers could also offer an advisory service to businesses on effective supply chain management and business continuity planning.

Marine and aviation

Impacts of the global food shock scenario on marine and aviation food transport networks are likely to be felt in two stages: first, the immediate impacts of supply chain disruption on food transporters; and second, the impacts of widespread trade restrictions introduced by governments in response to reduced food supply and rising food prices. Insurers may be liable for large claims arising in these classes.

Non-food marine and aviation networks could also expect to be affected by heightened political tensions that arise in the aftermath of the food price spike, which could lead to governments imposing restrictions on key shipping lanes and airspace as a result of safety concerns. Governments might also introduce trade restrictions beyond the food industry. More focused disruptions to key transport infrastructure, such as the seizure of ports by rebel groups, would likely have a smaller but still notable impact on marine insurers, particularly if the seized ports exist along key trade routes. Marine hull and cargo losses might arise for any assets stranded or involuntarily abandoned in seized or unsafe ports.

Agriculture

The most immediate impact of the crop production shock scenario is widespread physical loss of crops, due to various extreme weather events and the subsequent spread of disease. It is unlikely that losses would be limited to a single harvest, as the weather extremes not only damage existing crops but also disrupt planting, while producers may experience long-term reductions in yield as a result of damage to agricultural land and possible persistence of fungal pathogens.

Operating costs would be likely to spike after a shock as more resources are needed to recover pre-shock levels of production. For agricultural producers affected by plant disease, for example, the cost of pesticides (which would be likely to rise as demand increases) could have a serious impact on their bottom-line. The early cull of livestock made necessary by shortages in animal feed may have implications for agricultural insurance products covering livestock. Livestock insurance products typically cover mortality due to accident, disease or illness, and an early cull could generate complex claims situations.

The global market for agricultural insurance is growing at an average of 20% per year, and has quadrupled in size since 2005.[42] While the majority of this growth has come from North America, the substantial rise of insurance penetration in the world's most rapidly developing countries (such as China, India and Brazil) has been a key driver of growth in recent years. These regions represent a significant growth opportunity for insurers, many of which regard expanding global reach as a strategic priority. Insurers will need to develop good understanding of the hazards and vulnerabilities affecting the agriculture sector in these regions.

Despite this impressive growth, the global agricultural insurance market does remain underdeveloped in emerging markets, where agricultural insurance penetration was estimated at only 0.2% in 2011.[43]

Low-income regions already suffer disproportionately from food insecurity – in Africa one in four people suffers from chronic hunger[44] – and they are also expected to be the worst affected by systemic shocks to the global food system.[45] The absence of agricultural insurance has major implications for post-shock recovery in these areas. The development of new, innovative insurance products to protect those most vulnerable to crop production shocks would not only provide the immediate financial security necessary to aid recovery from a loss, but could also catalyse investment in farms, as banks in disaster-prone regions have traditionally been wary of lending to uninsured producers due, at least in part, to the risk of widespread loan defaults in the wake of a production shock. This would be expected to increase the resilience of agricultural production in the most vulnerable parts of the world.

Environmental liability

Increasing agricultural intensity has driven many authorities to adopt a stricter stance on environmental liability. Under the production shock scenario, crop producers affected by wheat stem rust and ASR aggressively apply pesticides to eliminate the fungal pathogens from their stock. More widely, producers might increase their use of fertilisers on undamaged crops as they try to compensate for those lost through damage and disease. These actions could result in abnormally high levels of chemicals entering the water supply from farmland run-off, particularly in flood-hit regions of the US. This could trigger litigation, even in the absence of conclusive evidence for negative health impacts. However, establishing liability can be difficult. Where intensification is widespread, it may not be possible to pinpoint a single crop producer as responsible for an environmental pollution event.

Product liability and recall

Product liability insurance exists to protect or compensate consumers against negative health effects resulting from consumption of a product. This class of insurance is particularly important in the food industry, where the link between defective products and bodily harm is so direct. Food safety has also been under the spotlight in recent years in the wake of a number of high-profile food contamination cases such as the UK horsemeat scandal, and as consumers become increasingly aware of the correlations between food and health.

Extreme weather events, like those that trigger this crop shock scenario, can increase the risk of contamination of food products. Furthermore, a systemic production shock to staple crops which widens the gap between global food supply and demand could place pressure on agricultural producers to release substandard quality products.

Although both fungal pathogens which spread in this scenario are not known to be harmful to humans, the long-term effects of a high prevalence of spores in the food supply is not known, and could expose insurers to long-tail liability claims. There may also be unknown long-term health effects of the fungicides used to try to eradicate these pathogens, particularly if they are applied more aggressively than existing guidelines recommend. The impacts of a shock to crops available for animal feed could also have implications for product liability insurers, as malnutrition is known to contribute to suppressed immunity in cattle, which could have serious implications for the outbreak of disease and the entry of harmful toxins into the food supply. Companies that supply seeds to food crop producers could be highly vulnerable to law suits if their products are found to be contaminated with rust spores – particularly in the highly litigious US – and the costs of these would need to be met by insurers. Similarly, seed companies could be liable if they sell products that are supposed to be resistant to the pathogens but subsequently become infected.

The devastating impacts of fungal pathogens in the scenario could promote increased investment in the development of genetically modified (GM) soybean and wheat strains resistant to infection. If successful, the development of resistant crops could bring enormous benefits to the global food industry and could minimise future losses to agricultural insurers. Nevertheless, the risk of long-tail liabilities must be kept in mind. Once developed, there would likely be immense international pressure for researchers to bring the disease-resistant crops to market as quickly as possible, which could have implications for how thoroughly the strains are tested for efficacy and safety.

The complex nature of modern food supply chains could expose a large number of companies to legal claims after a food contamination event, regardless of the ultimate source of contamination. Insurers should work with clients to understand the complexity of supply chains in order to ensure that all parties understand their potential risk exposure. In advanced economies, food safety and quality are safeguarded by complex regulatory frameworks. While these should afford additional protection, they also increase the likelihood and complexity of litigation following a shock event such as that described in the scenario.

The entry of defective and harmful products into the food chain may necessitate a product recall. The strain placed on US food transport networks in this scenario could hinder the speed of recalls, and the already difficult task of locating specific products along complex global supply chains could be made harder by rising political instability elsewhere in the system. These 'positive feedback' effects could serve to add complexity and cost to a product recall.

Product liability and product recall policies can also cover agroterrorism, providing indemnity against malicious contamination of the food supply, which has the potential to cause catastrophic impacts to a country. A systemic shock to global food supply and the social disruption that follows could enhance the threat of agroterrorism further: in countries where food shortages and price spikes are most acutely felt, key components of the food system may be targeted.

Wider impacts and key conclusions

A global production shock of the kind set out in this scenario would be expected to generate major economic and political impacts that could affect clients across a very wide spectrum of insurance classes. This analysis has presented the initial findings for some of the key risk exposures. Insurers could be faced with complex claims, particularly relating to clash of cover and proximate cause, and their ability to pay claims quickly will be an important factor for post-shock recovery.

The effects of the food price shock would likely have significant impacts on the insurance industry beyond the need to pay a large number of highly complicated claims. The destabilising effect of a spike in the price of staple crops on global stock markets would be expected to have major consequences for companies' investment income. Unlike many of the extreme loss events faced by the industry where insurers' balance sheets generally recover in the year following the event, there is potential for the events in this scenario to generate losses that span many years – prolonged El Niño phases can last up to two years,[46] while substantial political upheaval can take decades to resolve. Heightened political tensions might lead to greater restrictions on international business, which could limit the opportunities of insurers overseas. However, the growing threat of food insecurity does bring opportunities for insurers. As businesses become increasingly aware of the threat posed by food system disruption, they might invest more heavily in comprehensive risk transfer structures, and a severe shock could motivate individuals and businesses to address gaps in their risk management. Insurers can be expected to have a key role in assisting clients to understand their risk exposure and to tailor appropriate risk transfer solutions.

The global food system is under chronic pressure to meet an ever-rising demand, and its vulnerability to acute disruptions is compounded by factors such as climate change, water stress, ongoing globalisation and heightening political instability. The insurance industry is in a position to make an important contribution to improving the resilience and sustainability of the global food system. Further research should seek to quantify the impacts of a systemic shock to the food system to insurers' portfolios, so that estimations of loss can begin to be made.

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