



Supply chains and food security

Assessing the impact of disruptive forces

Farrelly & Mitchell analyse how disruptive forces have affected the global food market and what it means for future food security





Preface and acknowledgements

Farrelly & Mitchell presents our perspective on food supply disruption through our report, *Supply chains and food security: Assessing the impact of disruptive forces*. In producing this report, we have dug deep into our own regional and international expertise, and also drawn from the wealth of published information on this subject in government and business archives.

The 2020 global coronavirus pandemic serves once again to remind us of the external threats to our agri-food supply chains. It is relatively novel that the present disruptive threat comes from a dangerous virus, rather than phenomena we are more familiar with, such as financial crises or conflicts. Such pandemics, predicted to arise more often, and the ever-increasing difficulties posed by global warming show that evolving and improving our food supply chains is essential. Not only do these disruptors demand a capable response but there should also be a proactive approach to improvement as complacent belief in the supply chain status quo leaves us unnecessarily vulnerable to known and unknown threats to our food security.

Our analysts have taken an in-depth look at the disruptors that blindsided us in the past and the present, and perhaps looming larger than all, the challenge to food supply posed by climate change, along with our recommendations in tackling these, building a more robust system.

We would like to thank the contributors for their expert input and hope you find it provides useful insights. As always, we welcome your feedback. If you find this report valuable, please consider sharing it with your colleagues and peers



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The report at a glance



COVID-19 has again highlighted the threat to food security

Food security is reliant on international trade, but globalisation has its pitfalls. International trade is also undermined by protectionist policies that negatively impact domestic and international food security.

\$1.1 trillion worth of agricultural produce is traded worldwide each year, and every nation is dependent on trade to an extent to meet its food requirements.

Globalisation has great advantages in access to year-round, efficiently produced foods that allow for comparative advantage, where countries produce most suited to them. The system leads to cheaper and more available food, however also can have a detrimental effect on the environment.

The interconnectedness of markets leaves it open to systemic risk as disruptions in production in one location can lead to worldwide impacts on the market for that product, and lack of resilience in our supply chains. An example is the halting of seasonal migrant labour required for harvest in EU countries due to COVID.

Past events such as the 2011 earthquake in Japan damaged an estimated 38,000 agricultural entities, at a cost of roughly \$82 billion. Contamination continues to impact on local food and agribusinesses in Japan.

265 million people are at risk of going hungry in 2020 due to Covid-19. Many meat processing plants were forced to shut, food wastage rose and protectionism grew.

Complacency around food security hindered effective response to Covid-19 and the world needs to be work harder to constantly maintain a resilient food supply system.

Climate change is likely to be the biggest disruptors and threats to food security in the coming years as higher temperatures, more frequent extreme weather events, drought, increased concentrations of CO₂ in the air and sea level rise being felt.

Countries already extremely food insecure will be among those most vulnerable to disruptions in supply chains. Countries with low self-sufficiency may be exposed to market shocks but benefit from having diversified supply chains.

Saudi Arabia has focused food security initiatives on diversifying their supply chains and investing in farmland abroad. Sub-Saharan Africa will need to invest to unlock its agri-potential while Switzerland's strategic reserve scheme offers a model for sensible and sustainable food security planning.



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Executive Summary

Food security is of utmost importance in a growing global economy. This report discusses the relationships between international markets and food security, and the interconnectedness of modern food supply. While food security is undoubtedly reliant on international trade, globalisation does have its pitfalls. International trade can also be undermined by protectionist policies that ultimately disimprove domestic and international food security. We examine past disruptions to international markets in terms of impact on food, agriculture and overall food security, as well as considering future disruptors, namely climate change. It is important to recognise that although supply chains function well in a normal climate, they are not immune to disruptive events. Countries and businesses alike can prepare for these events by reinforcing their food and agriculture systems to limit the impact of the likes of COVID-19 on food security.

Some countries are more vulnerable to interference than others, and this report looks at some of these nations, retrospectively and prospectively, with a view to understanding how food security can be achieved on a worldwide scale.

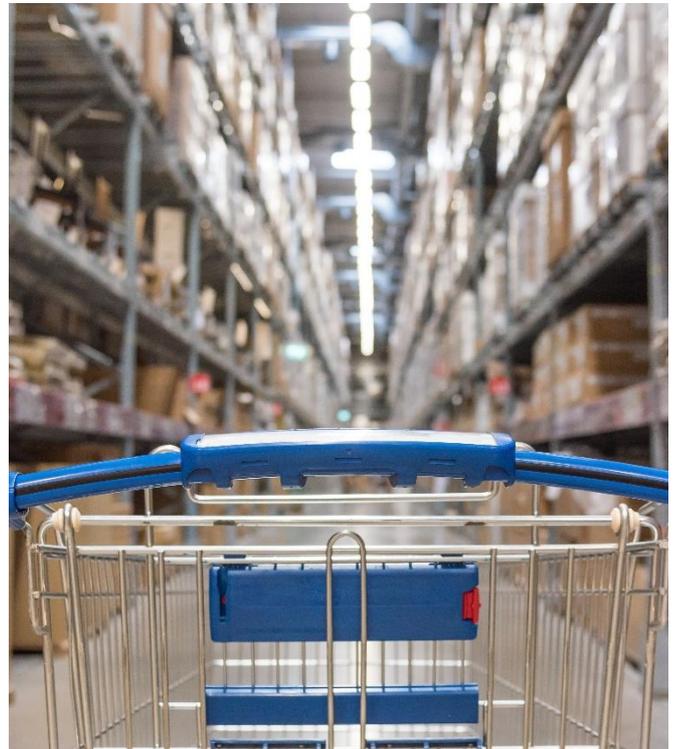




Modern Food Supply

Modern food markets are connected globally for labour, input and product flows in a system which has both its advantages and disadvantages, as highlighted in times of disruption such as the recent COVID-19 pandemic. Over \$1.1 trillion worth of agricultural produce is traded worldwide each year, indicating the complexity and scale of the international market.

Every country in the world is dependent on trade, to a certain extent, to meet its food requirements. Economic strength plays a role in trade, as wealthier economies can afford to import produce that is resource intensive in an effort to conserve their domestic resource banks. Water is one such resource. One kilogram of beef uses 10-11 tonnes of water and a single green bean uses roughly 1 gallon. It is very important, therefore, to consider whether agriculture is rainfed or irrigated. Irrigation in some locations, although essential for productivity, is leading to depletions in groundwater tables, threatening food security in the countries facing shortages.



Macro and Societal Drivers of a Global Food Market

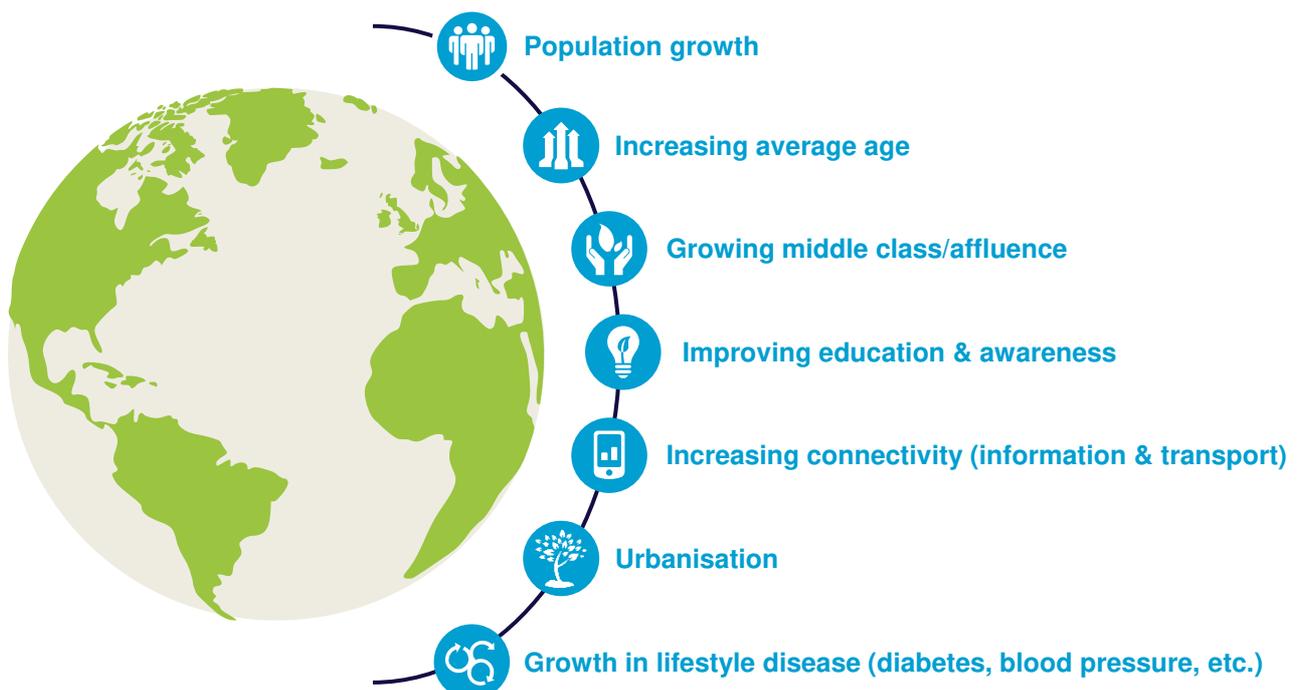
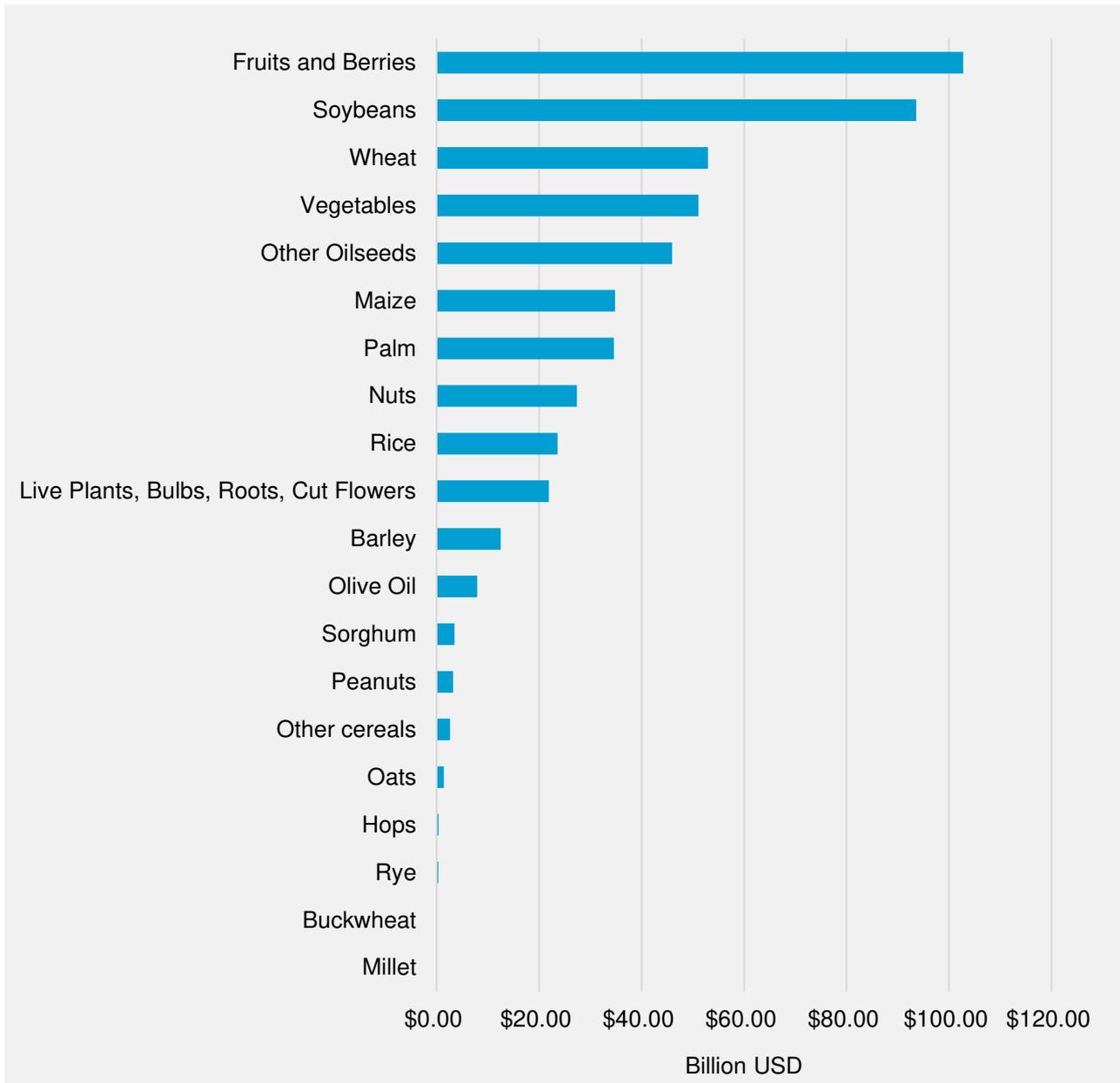




Figure 1.1: Global Horticulture, Oilseed and Cereal Trade by Value 2015



Source: resourcetrade.earth (<https://resourcetrade.earth/stories/food-security-trade-and-its-impacts#section-86>)

Benefits of a Globalised Food Market

Access to foods that can be produced more efficiently elsewhere

Access to seasonal foods that have demand year-round, such as fruits and vegetables

International trade allows for 'comparative advantage', a theory central to international economics that means countries produce those products they are most suited to produce

Countries with a significant agricultural economy are able to export and benefit from their advantage

- Comparative advantage therefore leads to efficiencies and price reductions
- In other words, trade leads to cheaper and more available food to all who participate



Globalisation also has a number of downfalls, many linked to environmental issues

For years, widespread land use conversion has occurred to the detriment of natural wildlife habitats and rainforests

Deforestation in the Amazon for crop production is widely publicised, with deforestation also occurring in regions such as Africa, leading to desertification

- Consequential losses include loss of carbon sinks, reduced rainfall production and negative impact on the lives of indigenous people

Land conversions from forests to agricultural land releases up to 5Gt of CO₂ equivalent per year, or equal to 10% of anthropogenic emissions

Emissions associated with the transport of food across the globe

Greenhouse gas emissions that increase the rate of climate change directly threaten food security, as more and more areas of land will become unproductive and unsuitable for cultivation. The economic costs of the 5 largest negative externalities involved in the global food system is over \$6 trillion per year, or 7% of global GDP. This figure includes the cost of malnourishment, obesity, food loss and waste, insufficient food safety and losses relating to land use. This figure omits the costs of biodiversity loss, health costs due to agricultural chemical use, and contributions to antimicrobial resistance.

The interconnectedness of the markets gives way to systemic risk in that disruptions in production or trade in one location can lead to worldwide impacts on the market for that product, leading to a lack of resilience in our supply chains. Examples of these disruptions include Brexit, or protectionist policies adopted by the US. The consequence of these protectionist policies is an upward shift in market prices for produce, which can negatively affect food security, especially in more vulnerable countries.

While issues undoubtedly arise with the global food market, the answer is far more complicated than resorting to self-sufficiency. Not only do countries rely on the trade of food, but also on the inputs required to produce that food, including everything from chemicals and seeds, to machinery and labour. Self-sufficiency in food production in such a situation further exposes countries to risk on reliance in trading inputs, as the benefits of global trade in food goods is lost.

Figure 1.2: Major Producers of Fertilisers 2016

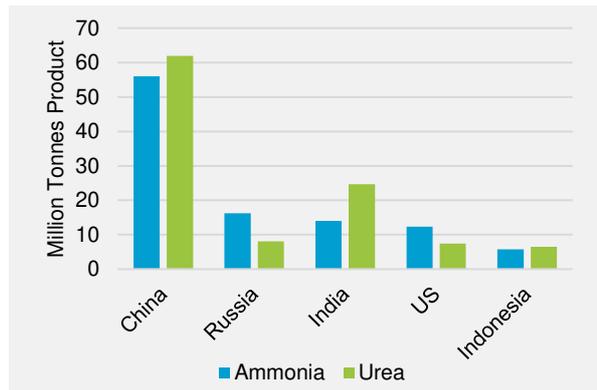
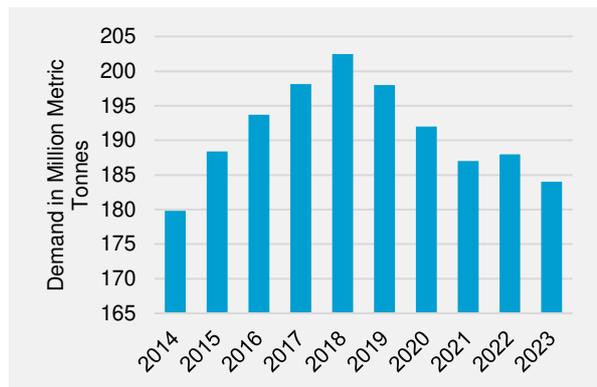


Figure 1.3: Urea Fertiliser Demand



Source: ICIS and IFA Global Fertiliser Trade Map
Source: statista.com

Figures 1.2 and 1.3 show how international markets facilitate comparative advantages and allow for more efficient agricultural operations. For example, China alone in 2016 produced almost one third of the global demand for urea fertiliser, which is widely used in agriculture around the world.





Migrant labour is another essential aspect of the interconnectedness of the international food market. Many farm enterprises around the world rely on an influx of foreign labour to meet the demand for workers, especially during harvest. These workers are equally reliant on their travel work to provide for themselves and their families, meaning that the transfer of labour between countries is vital for food security in both the exporting and importing countries. Migrant workers need the better wages to feed their families, and without the seasonal labour, farmers would be unable to harvest their crops.

Figure 1.4: European Migrant Labour Requirement Estimates

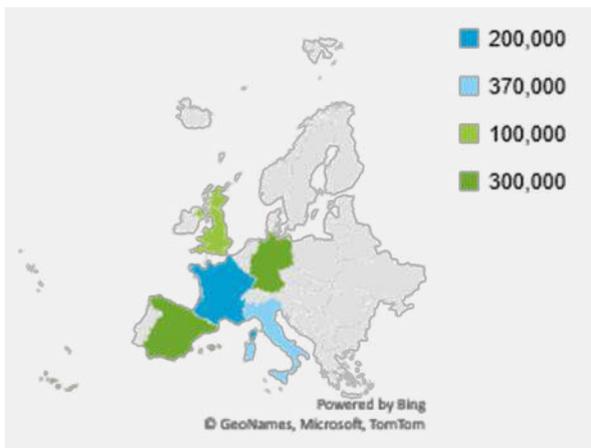
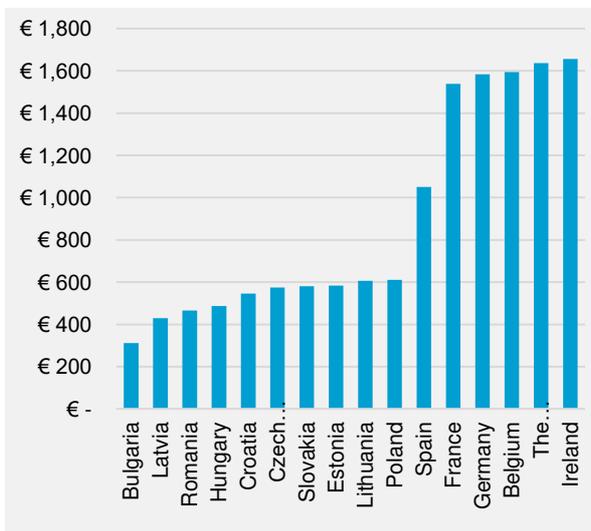


Figure 1.5: Minimum Wages



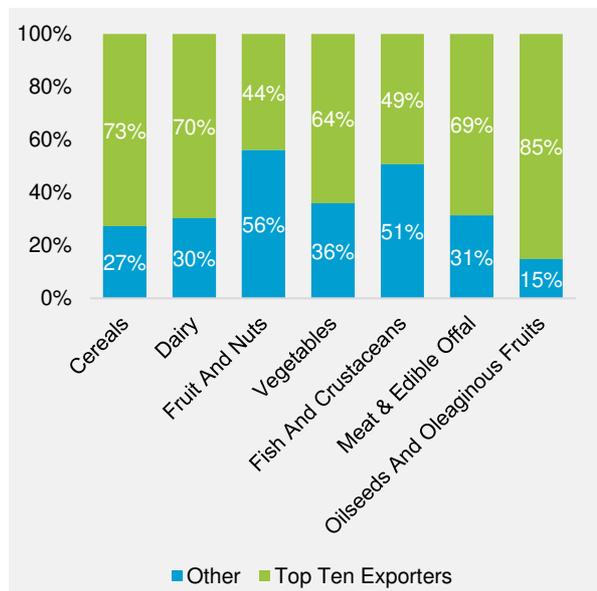
Source: Financial Times.
Source: lawsociety.ie

Monthly wages are generally less than €600 in Eastern Europe and above €1500 in the North West of the EU. Even after eliminating price differences, the highest minimum wage in the EU is still 3 times higher than the lowest. Figure 1.4 gives an indication of the volume of seasonal labour required for agriculture in the region.

Disruptive Forces

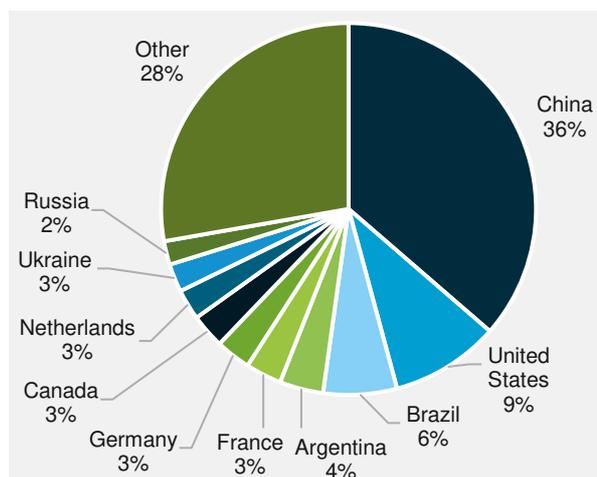
On average, over 70% of trade in food and agriculture products originates in just 10 countries, with oilseeds, cereals, meat and dairy among the most concentrated food groups. As these comparative advantages are maximised, the potential for black swan events to cause major disruption increases. The use of these comparative advantages also improves food security, however, through reducing production costs, increasing supply and making food more available to the masses

Figure 2.1: Global Trade by Origin & Key Food Commodity Group- Top Ten Countries Vs Others



Source: UNCTAD

Figure 2.2: Food and Agriculture Related Trade by Origin- 2017 % Breakdown



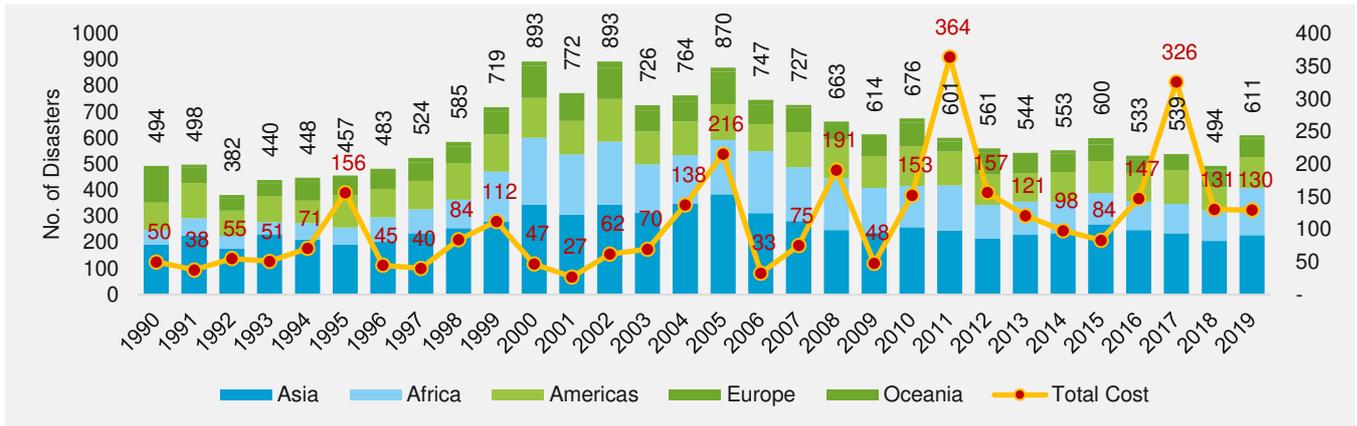
Source: UNCTAD



While aggregate numbers are down on peak years during the 1999-2006 period, data gathered by the Centre for Research on the Epidemiology of Disasters (CRED) shows a general upward trend in the occurrence of disasters over the last 30 years. The cost of the damage caused has also increased significantly. The average annual cost of damage was \$70 billion from 1990-1999. This augmented to \$90 billion over the next decade and spiralled to \$171 billion per annum in the period from 2010-2019.

While the estimated monetary costs do not capture the full costs of these events, they do suggest an amplification of the impact of the disasters. Over the period from 1990-2019, technological disasters (from industrial, transport or other technological disasters) account for 39% of disasters, with various types of natural disasters accounting for the bulk (61%) of disasters over the period.

Figure 2.3: Number of Disasters by Continent & Total Cost of Damages 1990-2019



Source: CRED

Great East Japan Earthquake 2011

Natural disasters have huge capacity to jeopardise food security, both locally and internationally. One such example is the Great East Japan earthquake which occurred in March 2011. It was one of the most powerful ever recorded and triggered powerful tsunami waves that reached heights of up to 40m, travelling 10km inland at speeds of more than 700km per hour.

The devastation resulted in:

- More than 15,000 deaths and the displacement of 500,000 people

- The collapse or half-collapse of more than 400,000 buildings and partial damage to 700,000 others
- Extensive structural damage to roads, railways and a dam collapse
- The worst nuclear disaster since the 1986 Chernobyl disaster following meltdowns in Fukushima
- A total economic cost of \$360 billion, the costliest natural disaster on record





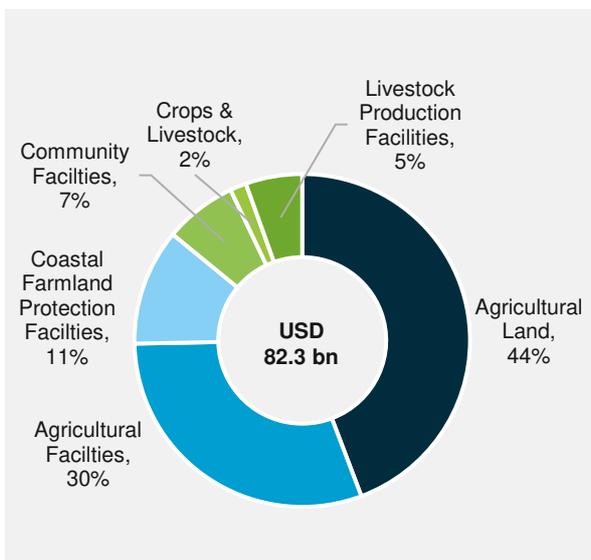
Impact on Food and Agriculture Industry

Among the world's major economies, Japan has one of the lowest food production self-sufficiency rates, around 40%. Food and agriculture were among the worst hit sectors with huge destruction of soil, landscape, natural flora and fauna and entire coastal ecosystems. The worst hit areas were among the most food secure, where self-sufficiency rates were significantly above the national average. The disaster damaged an estimated 38,000 agricultural entities, at a cost of roughly \$82 billion. In addition, large areas of farmland were contaminated, and many livestock, crops and other products destroyed or devalued due to radiation. More than 50% of Japan's agricultural entities claimed that they had been adversely affected by the triple disaster. In the worst affected regions, this rose to 90%. Also in these regions, the value of sales dropped to between 28% and 59% of 2010 levels. Sales recovery was slow in the subsequent years, mainly due to consumer concerns around food safety and the contamination of products sourced from these locations.

Further upstream in the value chain, the food industry was also profoundly impacted by events in the agriculture sector, as 70% of the raw materials consumed by the food processing sector are sourced locally. The industry was also affected by:

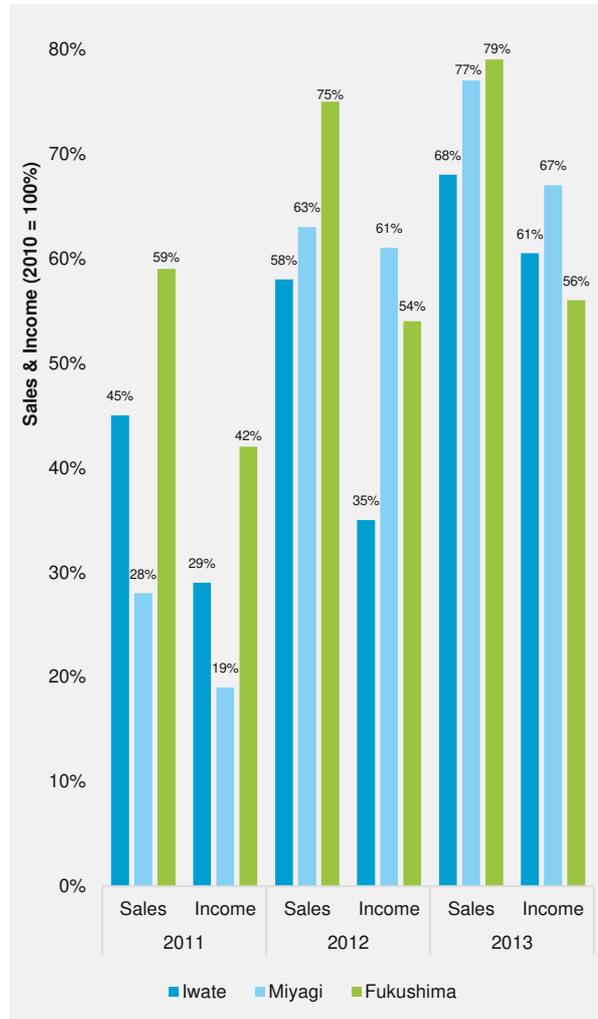
- Production drops and damaged plants
- Business suspensions
- Distribution ruptures and packaging material production shortages
- Rolling blackouts and gasoline shortages

Figure 2.4: Estimated 2011 Earthquake Damage to Agriculture in Japan



Source: MAFF Japan

Figure 2.5: Agri Sales and Income in Tsunami-Damaged Areas



Source: Japan Finance Corporation

Surveys revealed that more than 70% of food industry businesses were affected across Japan. Within individual subsectors, the impacts and their magnitude varied. The most common impacts were reductions in sales volume (customer demand and number of customers) and increases in the price of ingredients and materials. By 2014, the number of business still reporting adverse effects dropped to just 22%, demonstrating the adaptability and resilience of the food industry. One of the major longer-term impacts was the reputational damage (in both the local market and internationally) to the Japanese food industry that resulted from perceived or genuine food safety concerns centred around contamination. This was a significant issue in the major agricultural areas of north eastern Japan, with many Japanese consumers refusing to buy products produced in these regions. Consequently, the demand and sales prices for many traditional farm products from these regions decreased.



The collective disasters also impacted upon international trade, with around 40 countries, including major trading partners, imposing restrictions on agri-food imports from Japan. In the periods March to December 2011 and January to March 2012, the value of agri-food exports plunged by 11% and 13% respectively, on the same periods the previous years. In contrast, Japanese agri-food imports increased by 16% in 2011. In subsequent years, agricultural exports recovered, while import volumes declined.

Overall, the Japanese agriculture and food sectors have showed themselves to be relatively resilient over the period. Agriculture continued to produce at similar levels of production. Downstream players adjusted to consumer fears by sourcing food and raw materials internationally where necessary, while the authorities attempted to quell consumer and buyer fears around food safety through the introduction of increased and more stringent testing. Despite the scale of the disaster, its impact on Japan has been mitigated by a combination of Japan's excellent preparedness and well-established national system of disaster management. In addition, previous disaster experience, good organisation and the enormous efforts of various stakeholders (government, other organizations, volunteers, etc.) have allowed a rapid recovery and successful reconstruction of a large extent of devastated regions and sectors.

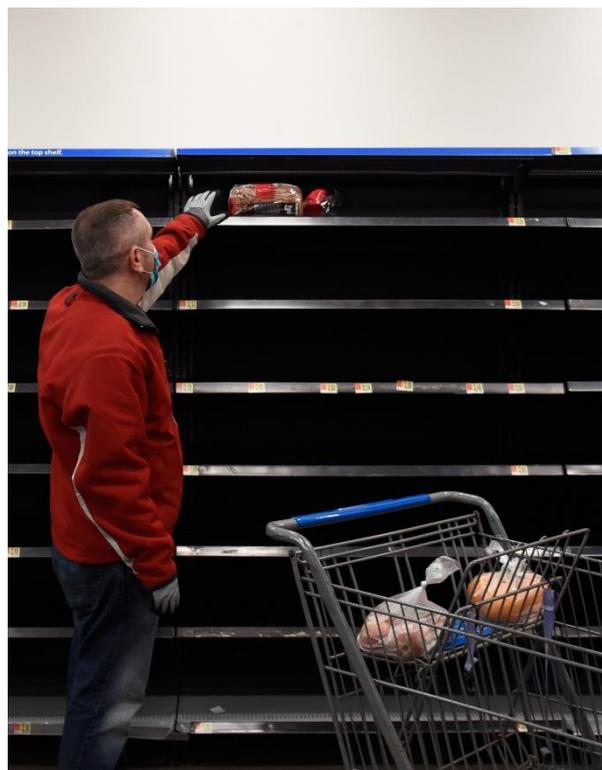
How the COVID-19 Pandemic Threatened Food Security

A minimum of 265 million people are at risk of going hungry in 2020, according to an estimate made by the WFP in April, almost double the figure for 2019. Pandemics have long been recognised as a severe risk to international business, with the coronavirus outbreak presenting unique challenges to international agriculture. These included:

- Harvests going to waste as seasonal labourers were banned from travelling, couldn't travel to farms or were afraid to travel in case of catching the virus
- Panic buying and stockpiling by consumers, which put supply chains under further pressure
- Meat processing plants shutdown due to outbreaks
- Farmers forced to dump milk as demand plummeted due to restaurant and café closures

- Transport restrictions making it difficult for farmers to obtain seeds and fertilisers for planting new crops, as well as making access to markets even more limited
- Economies shutting down and job losses making it more difficult for people to afford food. An estimated 195 million jobs were lost during the outbreak
- Russia announcing a wheat quota for exports from April until June, blocking trade that countries rely on to feed their populations
- Vietnam announcing a temporary ban on rice exports
- Protectionist policies threatened the supply of rice and wheat
- Forecasted shrinking of the global economy by 3% in 2020
- Developing, oil-exporting countries such as Nigeria being hit by the simultaneous oil price plunge and coronavirus outbreak, decimating government budgets and making food imports even more costly
- Lockdown restrictions potentially impacting on harvests in the coming months as farmers struggled to plant crops for the next agricultural season

The pandemic may provide leaders with the impetus to invest in more productive, climate resilient, sustainable and healthy home-grown food and agriculture systems, shortening supply chains so that our food miles are greatly reduced.





Lebanon Explosion

The Beirut explosion in August 2020 serves as a reminder of the capacity for manmade catastrophe to cause serious disruption, especially to already-weak supply chains. The explosion at a warehouse holding 2,700 tonnes of ammonium nitrate in the port area of Beirut, Lebanon, devastated the area, and is considered to be one of the most powerful non-nuclear explosions in history. The blast was felt as far as 240km away in Cyprus, registering as a magnitude 3.3 earthquake.

The devastation resulted in:

- More than 220 deaths, injuring at least 7,000 people, and leaving 300,000 homeless
- An estimated \$15 billion in economic costs
- The destruction of the country's only major grain silo, with a 120,000 tonne capacity



Impact on Agriculture and Food Security

Lebanon, prior to the explosion, was already in a highly vulnerable position, following decades of sectarian government, systemic dysfunction, conflict and financial mismanagement. On top of that, the country was under strain from having the highest concentration of refugees in the world, thanks to regional conflict and disturbance. Finally, Covid-19 had dramatically worsened the economic crisis and profoundly disrupted the food supply chain for a country extremely dependent on imports.

That vulnerability was heightened when the Lebanese government defaulted on around \$30 billion of Eurobonds in March and has since been trying to get a bailout from the International Monetary Fund. Foreign exchange has dried up, causing a collapse in the Lebanese pound and shortages of food and fuel. Overall inflation in June stood at 90%, and for food alone it was almost 250%, according to the government's statistics agency, limiting the ability of the country's poor and middle-class citizens to afford the price of basic goods.

Dire economic conditions are also impacting on Lebanon's agricultural sector, as reduced purchasing power has made it difficult for farmers to access inputs, usually bought on credit. The crash has left farmers facing difficulties in paying creditors, who are then unlikely to approve loans for the next harvest cycle. There are fears that the next agricultural season, due to begin in September, may not start. Existing structural flaws such as inadequate cold-chain infrastructure and poor connections to retailers also reduce the resilience of domestic food supply chains in Lebanon.

There is a real threat of hunger caused by the confluence of events as food prices are likely to be beyond the reach of many. In a study released in late July, Save the Children warned that over 900,000 people, including more than 550,000 children, did not have enough money to buy basic goods like food. Food costs have risen dramatically in recent months and there are significant risks for hunger as people rebuild. Prior to the explosion, 50% of the population surveyed said that they were worried about not having enough to eat.

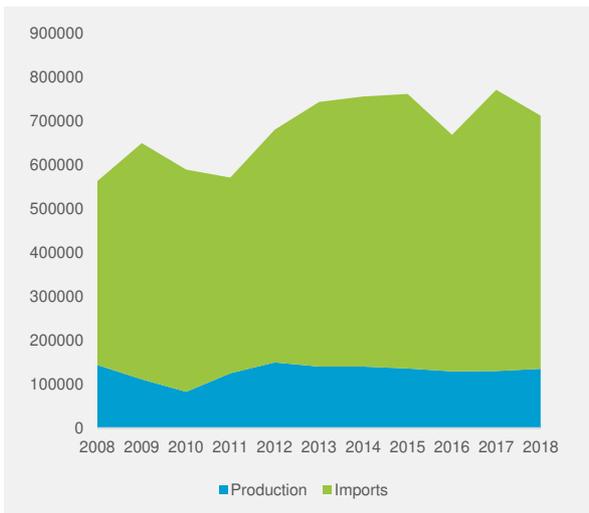
The destruction of the country's only major grain silo has highlighted poor supply chain planning on behalf of the government, as they recently rejected plans for a second facility in Tripoli, citing financial constraints. Only a relatively small amount of grain was stored in the silos at the time of the blast, but none of that estimated 15,000 tonnes — its capacity is 120,000 tonnes — could be salvaged. A further 24,000 tonnes of corn in silos and 7,000 tonnes of soy on an incoming ship were also destroyed in the blast.

The disabling of the country's biggest port, where Beirut receives much of its imported food including most of its wheat, is also a grave concern in terms of food security. The facility takes in an estimated 85% of the country's imported grain. Lebanon also imports nearly 85 per cent of its food, much of it through the port, now destroyed. The redistribution of imports to other ports, including to Tripoli in the North of the country, will likely exacerbate already rising food prices. Grain storage facilities do not exist in Tripoli, but cargoes were being considered for warehouses 2km away. The ports of Saida, Selaata and Jiyeh are also equipped to handle grain.



A major consumer of flatbread, Lebanon's domestic demand for wheat ranges from 35,000 to 40,000 tonnes per month. Domestic production only covers 10% of that demand, making the country highly dependent on wheat imports — around 1.2 million tonnes per year — 80 per cent of which came from Russia and Ukraine, who were both withdrawing export.

Figure 1.1: Wheat Production and Imports, Lebanon 2008-2018



Source: FAOSTAT

Despite the overreliance on wheat imports, the state's food security plans did not include keeping a government-held reserve, a common practice in most countries heavily dependent on imports, for use in the event of emergencies. The Beirut port silo main function is not meant to be for strategic grain reserves. Its main function is operational serving as temporary storage for imported grain until the grain is transported to the mills. The ministry had been planning to create a strategic reserve of around 40,000 tonnes but had not managed to do so yet.

At the time of the explosion, officials estimated that Lebanese flour mills and other grain end users had roughly one month's worth of inventory before they would need additional supplies. The World Food Programme has announced the shipping of 50,000 tonnes of wheat flour to Beirut, enough to supply the country for three months. The shipments were aimed at going to bakeries and millers to ensure no food shortage. Additionally, a host of nations have pledged nearly \$300 million in humanitarian assistance for food security, housing, healthcare and education in the country.

The country's importers syndicate have expressed fears of critical supply chain problems unless international aid is given. Meanwhile the country's private millers, around eight in total, will have to navigate new logistics fast for the supply chain to run smoothly, even after some of them suffered damage from the blast. This means trucking wheat to nearby warehouses at a time when most of the traffic meant for Beirut, not just wheat, will also be diverted to Tripoli.

In 2016, the country's imports were 10 times the country's exports by volume, according to the Ministry of Economy and Trade. As a result, the temporary loss of Beirut's port will have a relatively small impact on global trade but significant consequences for Lebanon's domestic supply chains. Because of Lebanon's financial setup, it was cheaper to import food than to produce it locally, although the country has ample water, sun, rich soil and farming talent. Once referred to as the breadbasket of the Eastern Mediterranean, now more than half of Lebanese food is imported.

Although the incoming aid will undoubtedly benefit short-term food security in the country, Lebanon urgently requires deep structural reforms to ensure nationwide food security beyond this crisis. These reforms must include developing domestic production, and the building of sufficient strategic reserves.





Previous Events that Jeopardised Supply Chain Flows

Brexit:

- Increase in prices of imported goods through customs and tariffs
- Logistics disruptions
- Non-compliance with EU standards
- Losses in agri-sector from WTO trade rules
- Agribusinesses exiting the UK

2008 Financial Crisis:

- Decreased purchasing power of consumers
- Weakened currency leading to higher food prices
- Inflation of food prices

2007/08 World Food Crisis:

- Shortage of supply and large increases in the price of staple food items such as rice, maize and wheat caused many countries to look to strategic reserves to mitigate against market shocks
- Crops being diverted for use as biofuels instead of food led to further food insecurity in poverty-stricken nations
- Riots occurred in over 70 countries

Natural Disasters:

- Loss of transport links between cities
- Loss of distribution centre facilities
- Shortage of fuel
- Labour shortages
- Poor crop yields

Future Disruption

Although the risk that pandemics and epidemics bring to business and international trade has long been recognised, it has become underestimated in recent years, leading to an unpreparedness for a viral outbreak such as that experienced with COVID-19. It is possible, therefore, that businesses and countries will consider restructuring supply chains or putting contingency measures in place, so that the trade risk of such an event in the future is limited, minimising its effect on food prices and food security.

Climate Change

Climate change and its environmental impacts are likely to be the biggest disruptors and threats to food security in the coming years. In any given location, decades-long climate patterns dictate what can be grown and to what extent. Farmers are now struggling to keep up and adapt to the rates at which weather patterns are changing, as temperatures rise, and precipitation becomes increasingly unpredictable. Higher temperatures, more frequent extreme weather events, drought, increased concentrations of CO₂ in the air and sea level rise will put the quality and quantity of our food supplies in doubt.

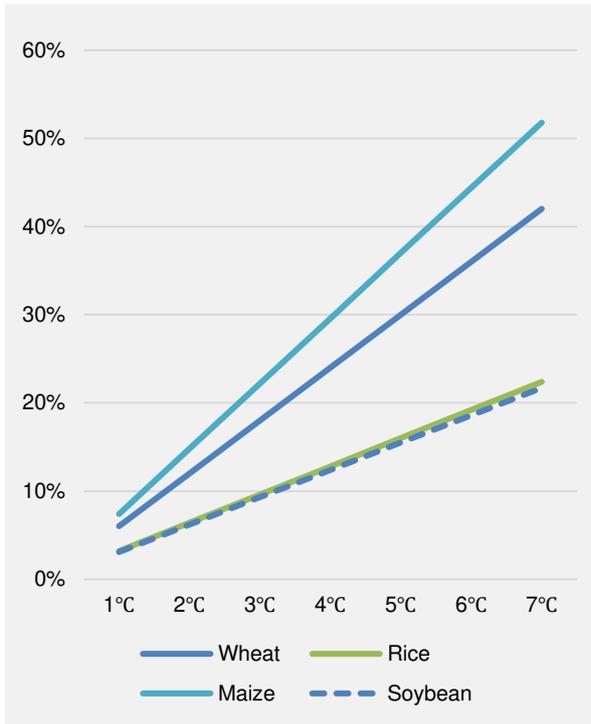
With the same rate of fossil fuel emissions as present, global temperatures could increase by between 4 and 7 degrees Celsius by the end of the century, to temperatures that would devastate agriculture. A report published in 2017 in the Proceedings of the National Academy of Sciences said that each degree increase in temperatures would reduce global yields of:

- Wheat by 6%
- Rice by 3.2%
- Maize by 7.4%
- Soybean by 3.1%





Figure 3.1: Impact of Temperature Increases on Crop Yields (% Reduction)



Source: Farrelly and Mitchell

Approximately two thirds of global caloric intake are provided by these 4 staple crops alone and lower yields would equate to higher prices, meaning more people struggling to feed themselves and their families.

80% of the crops grown globally are produced by rainfed agriculture, making shifting rainfall patterns due to climate change a serious issue. In some areas, minor decreases in precipitation cause vast crop losses, where in others, excess rainfall is causing over-saturation of the soil, which kills crops and means that farmers are unable to access fields to operate machinery for planting, harvesting and maintaining crops. The consequences of droughts were shown in Syria, where a major climate-change related drought and consequential agricultural shortages were initial factors in the unrest of the country that later descended into civil war, claiming half a million lives, displacing 7 million people and creating almost 5 million refugees.

Evidence suggests that heightened levels of CO₂ in our atmosphere may be making food less nutritious, threatening to exacerbate the already overwhelming problem of malnutrition around the world. The idea is that higher concentrations of CO₂ speed up photosynthesis, causing plants to create more carbohydrates at the expense of other nutrients vital to human health.

- When grown under the CO₂ levels expected by 2050, reductions of protein, iron and zinc in common produce in some parts of the world could be in the range of 3-17%
- Countries in the Middle East and North Africa, South and South-East Asia, and some in Sub-Saharan Africa are likely to be the worst affected
- In India, up to 50 million people could become zinc deficient and a further 38 million, protein deficient

As food is a globally traded commodity, climate events in one region can raise prices and cause shortages right across the globe, especially those that occur in breadbaskets such as Argentina or Ukraine. The more frequent climate-related disruptions will make it more difficult to access food, through distribution and production issues, as well as raising the cost and reducing the quality of produce.

Vulnerable Supply Chains

Highly consolidated supply chains and supply chains whose produce emerge mostly from one area of the world are likely to be among those most vulnerable to disruption. One example of a highly consolidated industry is the US Meat Industry.

The number of meat processing plants in the US has decreased by around 70% since the late 1960's, with a reduced number of large plants now controlling vast proportions of the animals slaughtered in the country. Three companies now control two thirds of the meat processed in the US. Tyson Foods chairman warned that the "supply chain is breaking" during the coronavirus outbreak when in April 2020, 12 plant closures caused a 25% dip in pork production and 10% in beef production, while leaving farmers with no choice but to depopulate their farms. A single plant closure can result in a loss of 10 million servings of beef in just one day. This is in stark contrast to the EU, where far less disruption occurred during the outbreak. The top 15 companies there account for less than one third of all production. When a fire closed down a single Tyson plant in 2019, margins for beef carcasses doubled, while prices for live cattle fell, in a market shock that was deemed historically significant. These examples show the dangers and vulnerabilities of consolidation- meat prices rise to unaffordable levels for more people while at the same time, farmers are forced to cull animals.



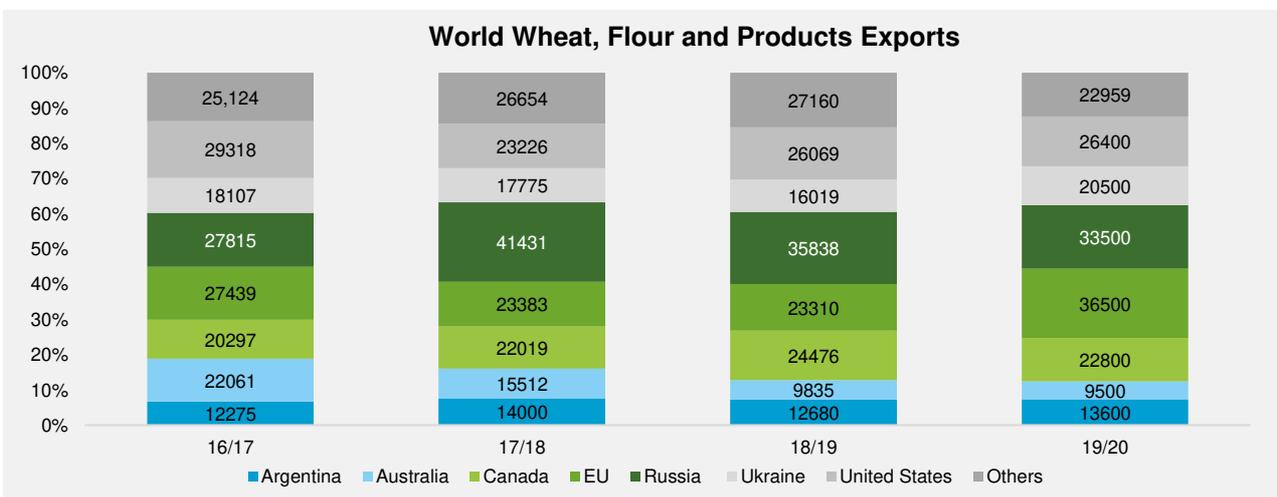
Bread baskets are regions of the world where large amounts of grain are produced, largely for the purpose of utilising comparative advantages to earn foreign currency. Climate change is one factor that could lead to food security issues arising from production being impacted in these highly productive locations. Currently, climatic variations cause 30% of yield fluctuations in agricultural crops worldwide.

Under normal conditions, these losses or surpluses can be mitigated by the use of trade and reserves, however, with the increasing frequency of extreme weather events and pace of climate change, these mitigating techniques may not be enough.

A study published by Nature Climate Change showed that “there has been a significant increase in the probability of multiple global breadbasket failures for, particularly, wheat, maize, and soybeans”. The study also explained how there can be negative or positive correlation between climate events. Rainfall in India and Argentina are negatively correlated, for example, meaning that crops negatively affected by rainfall in India can be compensated for by importing from Argentina. There is a positive correlation between maximum temperatures in Australia and Europe, however, and this is where the largest risks arise. The effect of drought on crops in Australia may impact the volume they can export to the EU, where at the same time, countries in the EU may be suffering a similar heat-related event during the wheat growing season. The occurrence of these climate disasters will lead to global market price spikes in these commodities, many of which are vital for the food security of billions of people on the planet.



Figure 4.1 shows the concentrated nature of the global supply of wheat and related commodities. Seven regions consistently account for well over 80% of all wheat related exports, leaving the global market at risk of disruption



Source: USDA

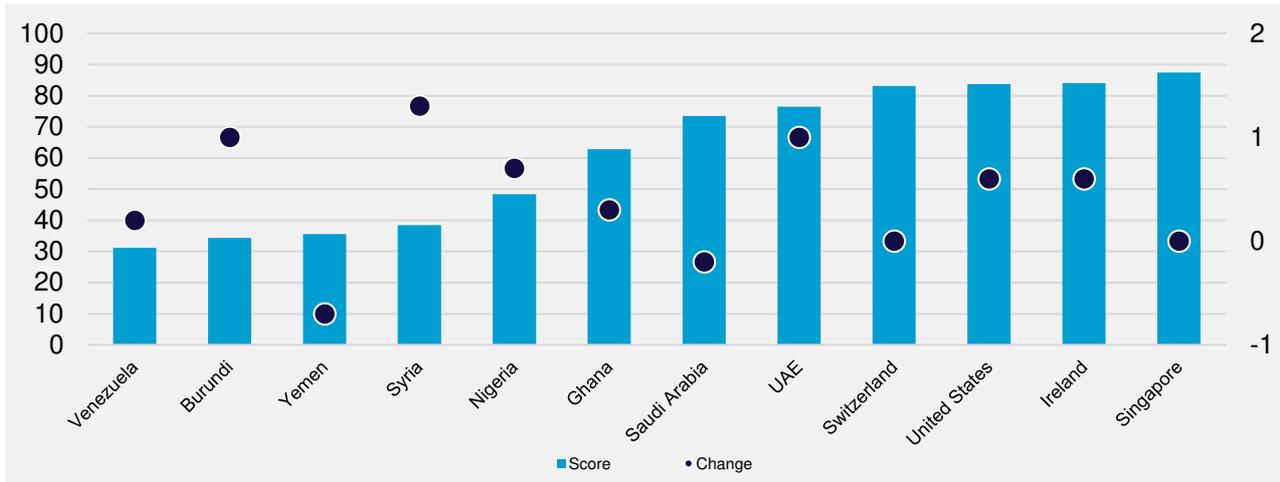


Vulnerable Regions and Food Security Policy

Countries that are already extremely food insecure are likely to be among those most vulnerable to disruptions in supply chains.

Countries with low self-sufficiency may also be exposed to market shocks, however they may benefit from having diversified supply chains in such scenarios

Figure 5.1: GFSI Scores



Source: GFSI





Saudi Arabia

Saudi Arabia, like many Arab nations, is a country with low self-sufficiency in food production, importing around 90% its of food supplies. For this reason, an attempt was made during the 1980's to achieve self-sufficiency in some areas of production, like wheat, for example, where farmers were subsidised on water and fertilisers and discounts provided on farm machinery. The government then sold the grain at artificially lowered prices, despite inefficiencies in producing and exporting crops that could not be sustainably supported. The programme was largely unsuccessful and resulted in heavily depleted groundwater resources and contaminated supplies. Since then, the country has focused their food security initiatives towards diversifying their supply chains and investing in farmland abroad.

In 2008, King Abdullah launched the initiative of Saudi agricultural investment abroad, asking Saudis to travel abroad to purchase agricultural land to boost domestic food security. This was in the wake of the global food crisis in 2007 & 2008 when food prices dramatically increased, and prices of grains and rice doubled in the space of a number of months. Ethiopia is one such country investors have focused their attentions. There are now over 200 investors injecting over \$200 million into agriculture and energy in the country. The produce of these operations is then exported to Saudi Arabia, which can have a negative impact on the food security of the host country. Smallholder farmers are forced to abandon their lands and livelihoods, depriving entire communities of their land and creating environmental and resource problems that can threaten the food security of the country into the future. These land acquisitions often result in localised increases in food prices and expose poor rural communities to hunger, violence, and the threat of a lifetime in poverty. Ultimately the food security of other nations is compromised when large scale land acquisitions take place.

Threats to Saudi Arabia's oil revenue also extend into food security risks, as 90% of export earnings originate in the petroleum sector. It is for this reason that the state is diversifying its economy, as sustainable and renewable energy sources become more prevalent. A sharp, sustained dip in oil prices could threaten food security in the country, however, the diversified supply chains the country has developed with 123 other nations around the world should see to protecting supply during any future disruptions.

Sub-Saharan Africa

Sub-Saharan Africa differs greatly from Saudi Arabia and other Gulf states in that it is extremely resource rich, but capital poor. Given these resource advantages, it is alarming that African countries import over \$80 billion worth of food and agriculture products every year. While food exports remain vital for African economies, imports continue to grow and exceed the value of exports. Although conditions for agriculture are optimal right across the continent, productivity remains at extremely low levels for a number of reasons. Political unrest, corruption, lack of investment, land grabs, population growth and limited access to credit and technologies have all impacted upon food production and security in a majority of African states. This is why African countries continue to import food, as smallholder farmers often farm on a subsistent basis with not enough food to sell to or feed others outside of their families.

The region is extremely vulnerable to supply chain disruption as even with their wealth of resources, imports are vital for food security and the capacity does not exist in government budgets to continue importing in times of market price spikes. Disruption may also mean that farmers crops are negatively affected, or that already difficult-to-access markets becomes even more inaccessible, leading to a decrease in foreign exchange earnings, threatening food security even further.

Figure 5.2: Agriculture Products Africa (billions USD)

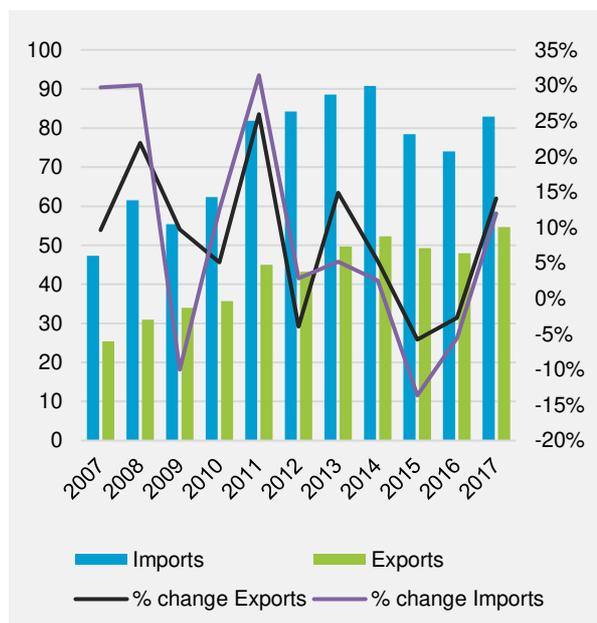




Figure 5.2 displays that African agricultural imports have been double exports in the recent past, however there is an encouraging trend in that exports are growing at a faster rate than imports since 2012.

Considering the wealth of natural resources available across the continent, African governments should strive to increase the productivity of their agricultural sectors to ensure the security of their populations and reduce risk during market disruptions. This must be done through increased political will to invest in and support smallholder farmers, training and education, research and development and endeavouring to make credit and loans more affordable to farmers. Increasing self-sufficiency is the key to African food security.

Swiss Model for Food Security

Resource-poor Switzerland is one of the most food-secure countries in the world, with abundant food supplies, low retail prices in terms of purchasing power parity and few poverty traps. As the country has 40-50% dependence on imports, a vast and efficient strategic reserve scheme is maintained, that insures against market disruptions, such as those caused by the COVID-19 pandemic. At the start of the outbreak, Switzerland had between three- and six-months' worth of stockpiles of essential foods, one of the largest in the world. As of 2019, the country had 63,000 tonnes of sugar, 160,000 tonnes of white flour for bread, 33,700 tonnes of cooking oil, and around 400,000 tonnes of specialist feed for its dairy industry. Sustaining the availability of the goods in reserve is primarily the responsibility of the private sector. Over 250 Swiss company heads coordinate with the government to report on their industries and bolster supply chains. No central stockpile exists, instead the goods are kept in businesses' warehouses across the country. The advantages of this are that reserves can be released into the supply chain immediately and the cost to the state is low. The stockpiles require thorough and regular analysis as stockpiles are only useful if the right products are retained in the right numbers. The government has also had success in running regular public information campaigns in recent decades, advising citizens on the most efficient ways to supply food for their households. This investment came to fruition during the coronavirus outbreak, as consumer confidence in the government was so high, that people did not feel the need to panic buy and stockpile, avoiding additional, needless pressure being placed on the country's value chains.

Recommendations

Where resources are readily available and plentiful, governments should first focus on maximising domestic production. This can be done through investments in farmer education and training, research and development projects, and allowing farmers the access to credit that they require to adopt new technologies and efficient inputs. Greater self-sufficiency minimises risk during times of global crisis as the supply chain is shortened and domestic market is able to support itself.

A shortened supply chain also reduces the impact of food production on the environment, an action that helps to mitigate against future disruption-causing climate change. Where improving self-sufficiency is not feasible, diversifying the sources of food imports is vital, so that if disruption occurs in one location, a substitute supplier can be used to facilitate the continuity of supply. Singapore is an example of a country that has made the most of this useful policy tool. Finally, as seen in the case of Switzerland, strategic reserves can play an important role in protecting against price spikes and market shortages during disruptions. It is advisable to coordinate with the private sector to store reserves around the country, making them available for quick release into the market, limiting the cost of such a system on the government.

Protectionist policies should be avoided, as free trade encourages more efficient allocation of resources and stimulates wealth creation and economic growth within a nation's borders, leading to improved food security. Protectionism also means that consumer choices become limited and prices often increase for what they can buy. These consequences have been witnessed in the wake of Brexit, with WTO tariffs on food threatening to average 22% in the case of a no-deal Brexit, raising prices and limiting choice for British consumers. Producers in developing countries would have even less access to markets for their produce. By keeping the value of its currency low, countries embracing a protectionist system force their citizens to pay higher prices for the traded commodities that are needed to survive.





Trade wars could also have serious negative implications for food security around the globe, as trade has played a vital role in reducing undernourishment, improving nutrition and dietary diversity, and improving economic fortunes in developing countries. The facilitation and encouragement of trade in Ghana is an example of what can be achieved, with the country increasing the spectrum of imported produce by over 58% since the turn of the century.

Food businesses are central to food security issues. Through investing in the fortification of their supply chains, they can ensure the quality of supply, even during serious disruptor events. Methods of achieving the desired outcome include shortening of value chains, investing in blockchain and other technologies which enhance traceability, retaining strategic reserves in partnership with state entities, and restructuring distribution methods to improve efficiencies.



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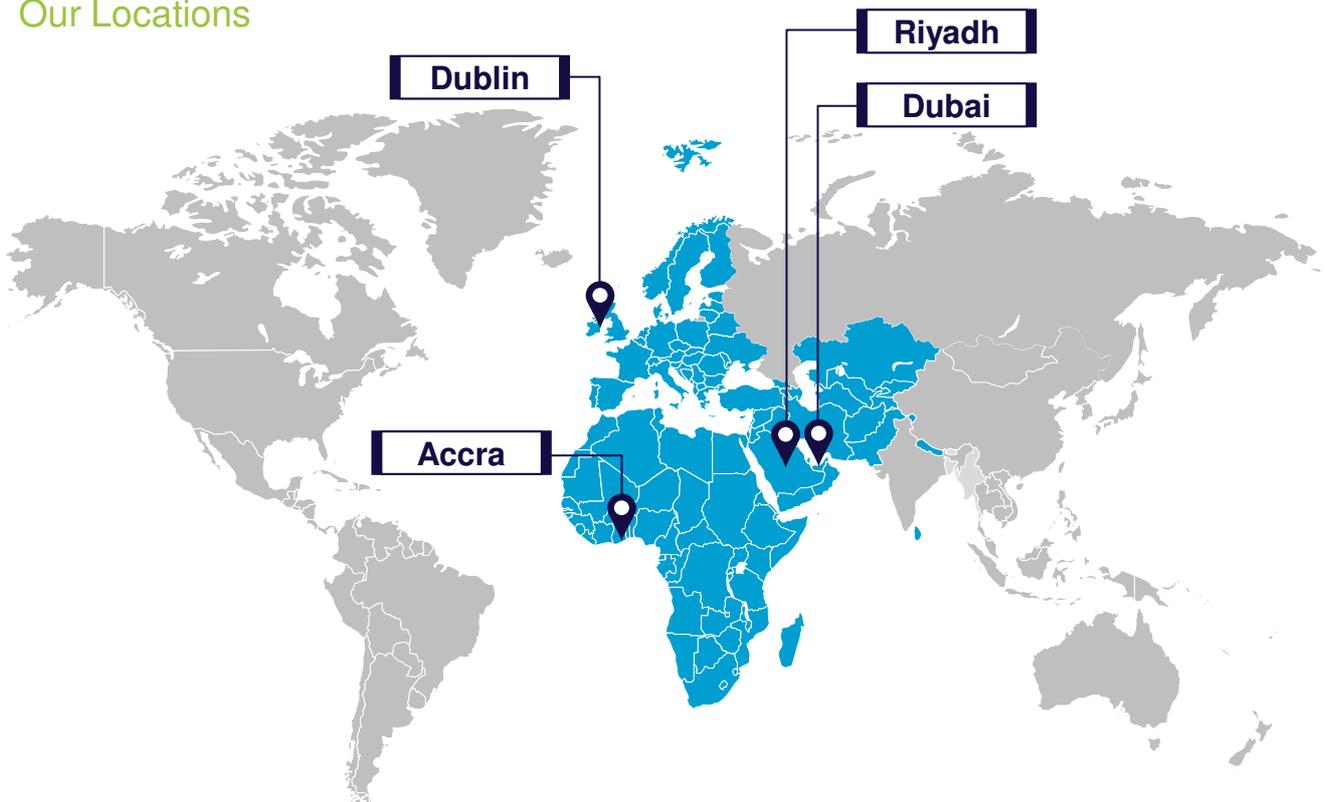
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Our Locations





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