Climate Change And Food Security

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The Al-Attiyah Foundation

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INTRODUCTION

CLIMATE CHANGE AND FOOD SECURITY

Climate change is leading to overall warmer climates, as well as to less predictable weather, more extreme events, and shifts in precipitation. At a national and global level, farmers and governments must plan to produce more food with lower environmental impact in a more challenging climate.

How does climate change affect food security? What impacts are being seen today and predicted in future? What adaptation options are available to mitigate climate-related food insecurity, and how are they being deployed?

Sustainability Report

This research paper is part of a 12-month series published by The Al-Attiyah Foundation every year. Each in-depth research paper focuses on a prevalent sustainable development topic that is of interest to The Foundation's members and partners. The 12 technical papers are distributed to members, partners, and universities, as well as made available online to all Foundation members.

EXECUTIVE SUMMARY

- Climate change will have major, and overall negative, impacts on agriculture and food security.
- This is one of the most serious areas of damage arising from climate change, and applies to urban as well as rural populations, and to middle- and high-income countries as well as low-income ones, though in different ways.
- Although adequate food is available worldwide, it is unevenly distributed in quantity and nutrition. Meeting future food needs is possible but will be challenged by climate change impacts.
- Agricultural yields will be affected by higher temperatures, shifting precipitation causing drought in certain areas, and higher levels of extreme weather, parasites and diseases.
- Tropical and subtropical areas are likely to suffer worse, while high-latitude areas such as Canada and Russia will probably gain in agricultural yields.
- Agriculture is also a major contributor to climate change, producing 20% of greenhouse gases (GHGs), as well as having unsustainable impacts on water, biodiversity and the nitrogen cycle, all of which have to be tackled.
- Food insecurity is not just a problem of malnutrition and under-development; it threatens further environmental degradation, conflict and mass migration.
- Assuring food security in the face of climate change requires a holistic approach, combining:
    - o Higher production (mostly through intensification rather than expansion of cultivated lands)
    - o Climate-resilient agriculture to adapt to climate change, with a harmonisation of traditional measures, advanced technology, and infrastructure investment, and with particular attention to water
    - o Market mechanisms with support of international organisations to limit food shocks
    - o Managing food insecurity collaboratively, including by reducing food trade barriers.

THE EFFECTS OF CLIMATE CHANGE ON AGRICULTURE AND FOOD SECURITY

Food security can be defined as the access to a sufficient quantity of affordable and nutritious food. This applies at all levels from an individual or family, to a country, through to the global level. While at a personal level, this may be largely a function of income, information and physical availability, at a national and international level it also encompasses considerations of macroeconomics, trade and geopolitics.

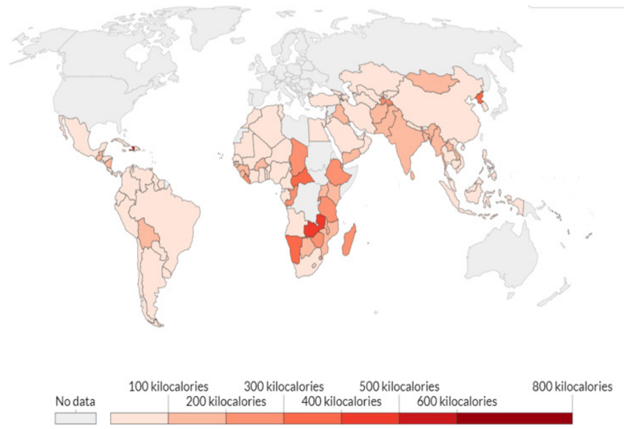
Climate change can affect food security in several ways[i]. Most obviously, it reduces yields – the amount of crop or livestock produced on a given area, and the amount of land suitable for cultivation. But also significantly, it damages the economy generally and makes it harder for lower-income people to afford sufficient food. This applies to urban as well as rural populations. And it has impacts on politics and conflict that themselves can be driven by, and exacerbate, food insecurity. Finally, agriculture itself, as a major contributor to greenhouse gas emissions, will be under pressure to change.

FOOD INSECURITY, TRENDS AND OUTLOOK

Food insecurity has diminished over time but remains a serious problem. The Millennium Development Goal 1.C was to halve the proportion of people suffering from undernourishment in developing countries between 1990 and 2015. From 23.3% in 1990, this proportion reached 12.9% in 2015, so the target was narrowly missed, but major progress was made, nevertheless. Despite great improvement in some African countries such as Angola, Cameroon and Mali, most of this advance occurred in Asia. Serious calorie deficits persist in many African countries, in South Asia and to a lesser extent in parts of West Asia and Central and South America (Figure 1).

It is important to note that calorie supply is only one part of nutrition; at a minimum, food also has to provide a balanced diet including fats, proteins and carbohydrates, with vitamins and other micronutrients. Less crucially but still importantly, it also has to meet cultural needs and expectations, for instance growing desires for meat and dairy, and for foodstuffs consumed primarily for pleasure rather than nutrition, such as coffee and wine.

Figure 1 Per-capita calorie deficit by country[ii]



Even middle- and high-income countries may have concerns over inequality of availability to good nutrition, and to spikes in food prices which drive inflation, or the unavailability of important foodstuffs. This vulnerability can be assessed by measures such as cereal import dependence (Figure 2). Some countries are major exporters, shown at the top with negative import dependence. Others have very high import dependence ranging up to 100%, mostly small island or city states (e.g. Barbados, Fiji, Hong Kong) or arid countries (Jordan, UAE). Djibouti and Yemen are examples of low-income countries with very high import dependence. Of course, some of these countries are producers of other crops or have fisheries.

Figure 2 Cereal import dependency by country, 2016-18[iii]

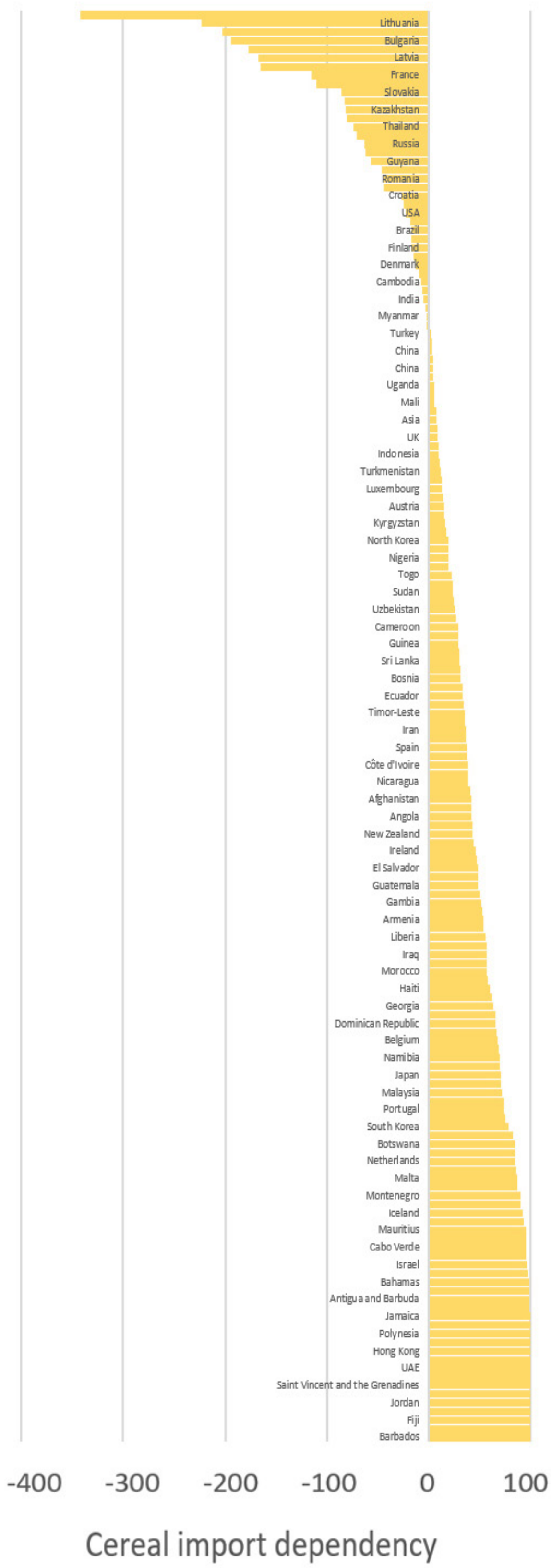
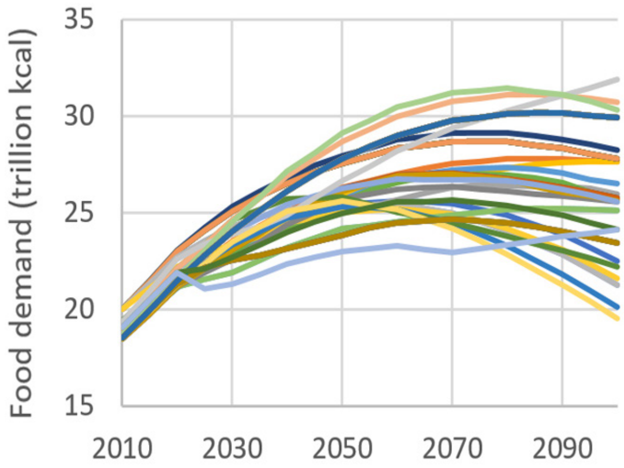
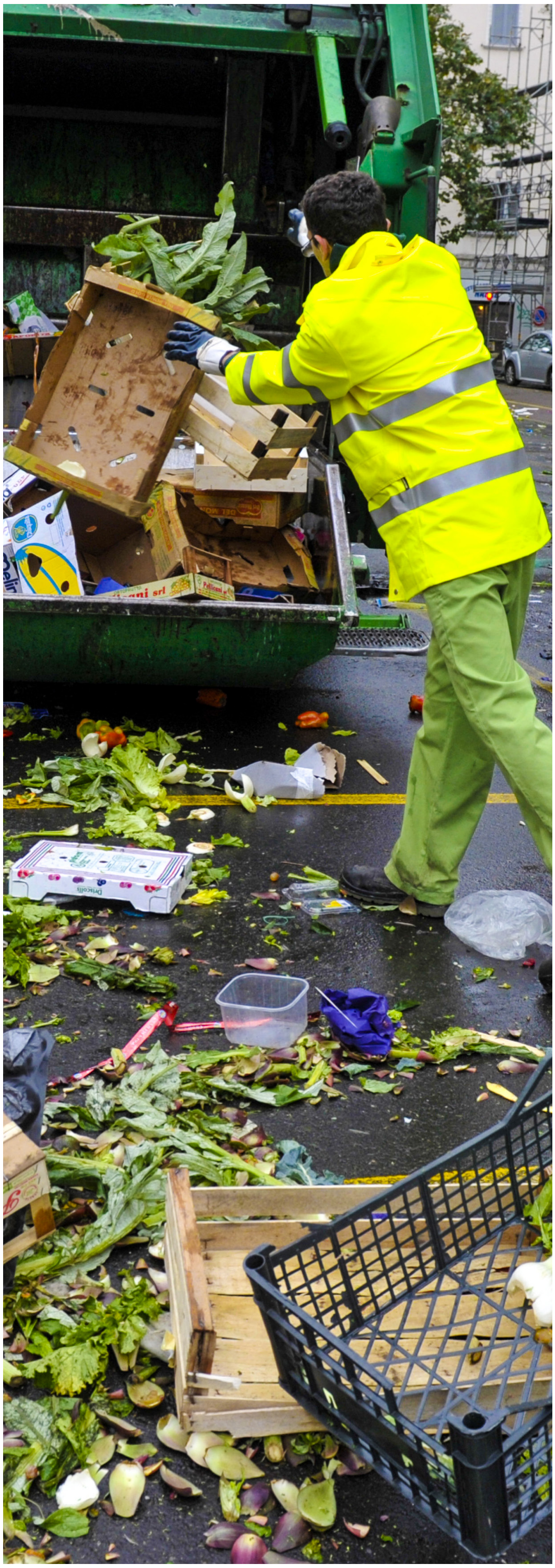


Figure 3 Global food demand to 2100, 1.5°c-compatible scenarios[iv]



Over the twenty-first century, food demand is likely to grow substantially because of improved nutrition, rising incomes, growing populations and a preference in developing countries for more meat and dairy (Figure 3).

Current food supply of 2800-3000 kcal per day per person is more than adequate (the average adult man requires 2500-2700 kcal and adult woman 2200 kcal), but it is unevenly distributed and often lacking in other nutritional requirements. For future food requirements, there is a wide range of scenarios. Even considering only those compatible with the Paris Agreement's aspiration to limit warming to no more than 1.5°c, total world food demand, currently about 22 trillion kilocalories (kcal) per year, could end the century between 19.5 and 31.9 trillion kcal (about 2600-3300 kcal/day per person). In many of these scenarios, world food demand peaks between 2060-80 because of falling population and a stabilisation in per-capita consumption by reducing food waste and improving nutritional practices. Nevertheless, 44 out of the 49 scenarios shown in Figure 3 above have total food demand in 2100 above that of today.



EXPOSURE OF FOOD SUPPLY TO CLIMATE CHANGE

These patterns of malnutrition and vulnerability to food insecurity are likely to be substantially worsened by climate change.

Of all the main economic sectors, agriculture (including aquaculture and fishing) is probably the most exposed to climate change. Indeed, climatic impacts are already being seen, and will intensify over time. These range from the global and regional to local, including lower yields, poorer nutritional quality, greater variation in harvests, and shifts in optimal crops and growing areas. While impacts are negative on the whole, they will be positive for some countries and crops. Some of the impacts can be mitigated by approaches such as different agricultural practices, improved infrastructure and new crop and livestock varieties.

Agriculture is also a major contributor to climate change, through emissions of carbon dioxide, methane, nitrous oxide and black carbon. Therefore, the agricultural sector will increasingly be required to be a net carbon sink, with carbon sequestration becoming an important part of agriculture alongside food production. In many scenarios, agriculture will also be required to produce large quantities of biofuels. At the same time, there is a growing concern for other environmental impacts of modern agriculture, including diminished biodiversity, soil erosion, over-use of groundwater, excessive application of fertiliser and pesticides, disturbance of the nitrogen cycle, disturbance of traditional farming and small-holdings, and animal cruelty.

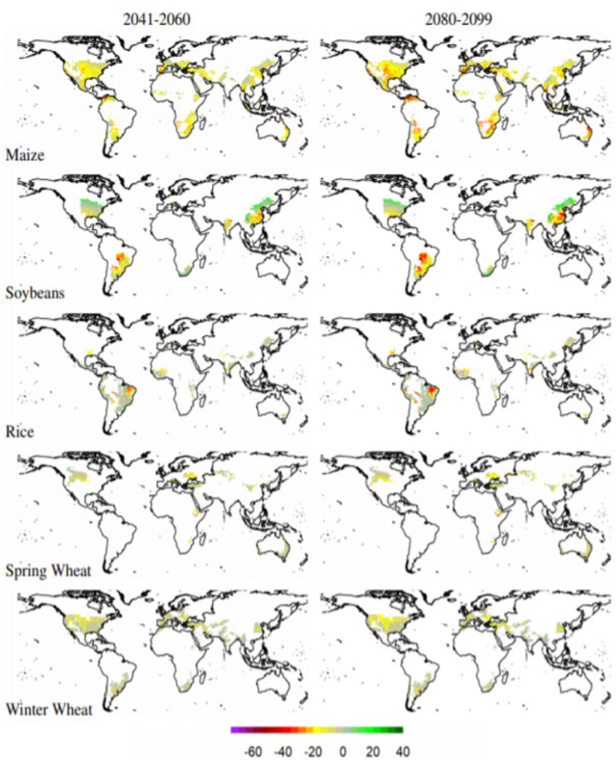
The impact of climate change on food production operates through several channels. The main ones are:

- Rising temperatures, which permits expansion of cold-sensitive crops into higher latitudes and altitudes, and lengthens growing seasons, but exposes crops to greater risk of heat damage. Crop production is expected to drop 5-15% for every 1°c increase in global temperature[v];
- CO_2 fertilisation, resulting in rising primary productivity because of the higher availability of the key constituent for plant growth. However, CO_2 fertilisation may not persist over time, its effect can be limited by shortages of water and essential nutrients, and it results in lower levels of protein, vitamins and minerals in crops;
- Greater precipitation overall, which can be positive for agriculture, but droughts in some areas (such as the Mediterranean and US south-west), greater variation in rainfall, and melting of glaciers reducing the predictability of river flows. About 10% of the crops from major food-producing regions are already grown with non-renewable groundwater, including in the US Great Plains, California's Central Valley, India and Pakistan, north-eastern China, Iran and Iraq[vi];
- Higher rates of evaporation and transpiration, raising plants' exposure to water shortages;
- Reduced labour productivity in hot countries because of high outdoor temperatures and humidity;
- Greater incidence of extreme weather, such as droughts, forest fires, floods, hail and hurricanes, damaging crops and interrupting transport of food (for example, by lowering river levels);
- Higher variability of weather, meaning greater variance between good and bad years for crop yields;

- Rising sea-levels inundating coastal areas and raising the salinity of groundwater;
- Spread of diseases and parasites, which were previously controlled by low winter temperatures;
- Damage to coral reefs and other shell-building organisms from rising temperatures (bleaching) and ocean acidification, reducing fish habitats;

The effects of climate change on yields for five main crops, without effective adaptation, are shown in Figure 4. Note that this is for the RCP 4.5 scenario, which yields 2-3°c of warming by 2100. In general, impacts on yields are negative, sometimes heavily so (losses of 40% or more in some areas). Maize is badly affected across most of its cultivation range; spring wheat suffers less. Yields of the main crops in Brazil are particularly hit. On the other hand, soybeans could benefit from some northward expansion of their range in North America and China.

Figure 4 Median impact of climate change on crop yields, RCP 4.5 scenario[vii]



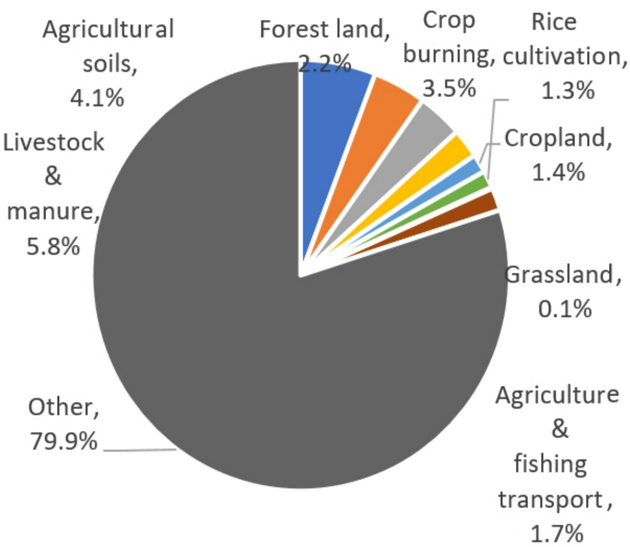
It should be noted, of course, that all these scenarios come with substantial degrees of uncertainty, that the emissions trajectory can also vary widely, and that the degree of achievable adaptation is unclear.

Climate impacts on agriculture are already being seen. Food prices rose sharply in 2021, up 34% in the year to June, partly due to extreme weather. This includes frost that hit Brazil's coffee crop; heat, drought and wildfires affecting Canadian grain and shellfish; flooding in Henan province of China; and floods in Germany and Belgium[viii].

CLIMATE IMPACT OF AGRICULTURE

Agriculture is itself a major contributor to climate change. The entire food system, including fertilisers, transport and processing, accounts for 21-37% of annual GHG emissions, of which agriculture itself is about 20% (Figure 5), usually calculated at a 100-year global warming potential (GWP). Agriculture generates about half of anthropogenic methane (CH_4), three-quarters of anthropogenic nitrous oxide (N_2O), and 10% of anthropogenic CO_2, mostly from land clearance[x]. Methane is emitted from rice paddies and livestock, particularly cattle, and as a by-product of biomass burning. N_2O mainly derives from the breakdown of nitrogenous fertilisers.

Figure 5 Breakdown of GHG emissions from agriculture, fishing and land-use versus other sources[xi]



To reach countries' commitments under the Paris Agreement (2015), and various net-zero carbon emissions by 2050-60 ambitions declared by the EU, UK, US, China and others, agricultural emissions will have to be reduced along with those from the rest of the economy. In some cases, such as increased use of low-carbon fuels and electricity, renewable energy and improved efficiency, this will be an extension of decarbonisation measures used broadly. But in others, particularly land-use and methane and N_2O emissions, specific agricultural policies will be required. These may impose further constraints on raising agricultural yields.

IMPACT ON GEOPOLITICS AND TRADE RELATIONS

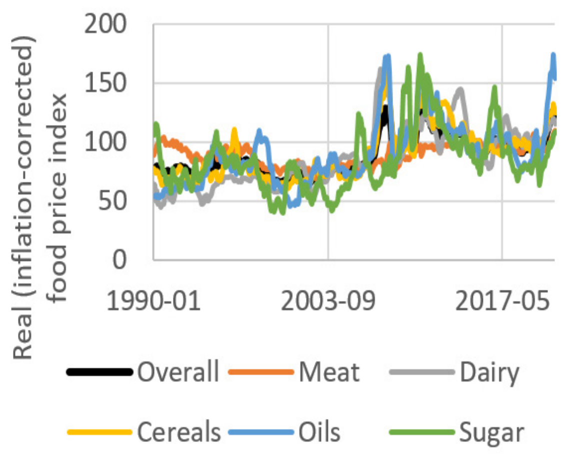
Climate change impacts on agriculture is likely to result in the following:

- Some important agricultural areas will suffer diminished yields, notably Australia, Brazil and the south-eastern USA and possibly central eastern China.
- A number of already significant agricultural areas will be able to raise output, mostly those in northerly latitudes with uncultivated land, particularly Canada and Russia and possibly north-eastern China;
- Some already food-insecure areas, mostly semi-arid tropical countries, will see diminished yields which will worsen their situation;
- Some very populous areas, notably South Asia, face an uncertain situation, with potential disruption of the monsoon and Himalayan rivers.

These developments will have important economic, political and social ramifications. Food insecurity may further damage the economy of affected low-income countries, and, in combination with other negative events such as drought or conflict, place them at risk of famines. In turn, this can affect state stability and migration. Water shortages threaten local as well as international conflicts in various places, notably the Tigris-Euphrates basin, the headwaters of the Indus (India/ Pakistan), the Amu Darya and Syr Darya in Central Asia, and the Ethiopian Grand Renaissance Dam on the Blue Nile, which has attracted great concern from Egypt.

Food prices were quite stable in the 1990-2006 period but have been volatile since then, and significantly above the 1990s average (Figure 6). Recently, a number of extreme weather events combined with post-Covid recovery and economic stimulus, and logistical disruptions, have again driven the overall index to highs close to those seen in 2008 and 2011.

Figure 6 Food real price index 1990-2021 (2014-16 average = 100)[xii]



Food price volatility is difficult for farmers and consumers to deal with. High food prices are good for agricultural producers but bad for consumers, particularly low-income people for whom food is a large part of their budget. For countries which subsidise some staple foods, high prices are also problematic.

The negative effects of climate change, alongside rising world food demand, can be expected to lead to higher and more volatile food prices. This may offset reductions in food production costs achieved since the 1960s by better or more intensive farming practices and improved infrastructure and logistics. In turn, higher food prices often feed into political discontent and protest.

Food shortages or sharp price rises are often met by price controls and export bans. These are politically understandable and likely to be used again. During the Covid-19 crisis, several countries, including Cambodia, Myanmar and Vietnam, banned rice exports. Russia has also restricted various food exports, partly to control domestic inflation and partly in retaliation for Western sanctions.

IMPACT ON GEOPOLITICS AND TRADE RELATIONS

However, such bans are damaging and counterproductive[xiii]. During the major food price spike in 2007-8, it was estimated that trade restrictions accounted for 45% of the price rise in rice and 30% of that in wheat. They prevent domestic farmers from seeing the full value of their product, and hence deter investment in future output. They harm the reputation of the food supplier on international markets. For instance, after it restricted rice exports in response to the 2011 price spike, Thailand lost its 30-year position as the world's leading exporter to India and has not regained it since. Other countries tend to retaliate by imposing restrictions of their own, and this can lead to cascading shortages even of food and goods that are overall in adequate supply. And food 'trade wars' fit into a wider recent pattern of less free trade, lowering economic efficiency and raising tensions between countries.

POLICIES TO ENSURE FOOD SECURITY IN THE FACE OF CLIMATE CHANGE

To ensure food security, there are essentially five groups of approaches.

1. Mitigate climate change, including the climate change effects of agriculture itself
2. Increase the supply of food (quantity and quality)
3. Make food production less vulnerable to climate effects
4. Protect against the negative impacts of food price or supply shocks and disasters
5. Manage the wider negative consequences of food insecurity

Increasing food supply can be done by the broad continuation of the methods used since the 1960s to feed a rapidly growing world population. This includes extensive (development of new lands) and intensive (raising crop yields per hectare) methods.

However, some of these methods are reaching the limits of efficacy. Fertiliser is already often over-applied, to the point of diminishing returns and also damaging water quality and creating oceanic 'dead zones' and algal blooms. Further land clearance will harm biodiversity, interrupt important watersheds, and release more stored carbon. Numerous key fish stocks have already been over-exploited, some to the point of virtual extinction.

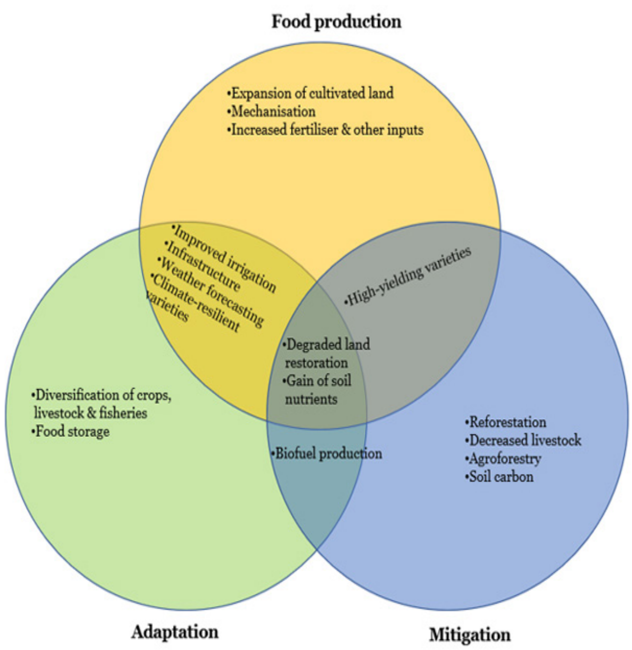
Instead, higher yields without accompanying over-cultivation can be achieved by a variety of modern farming techniques.

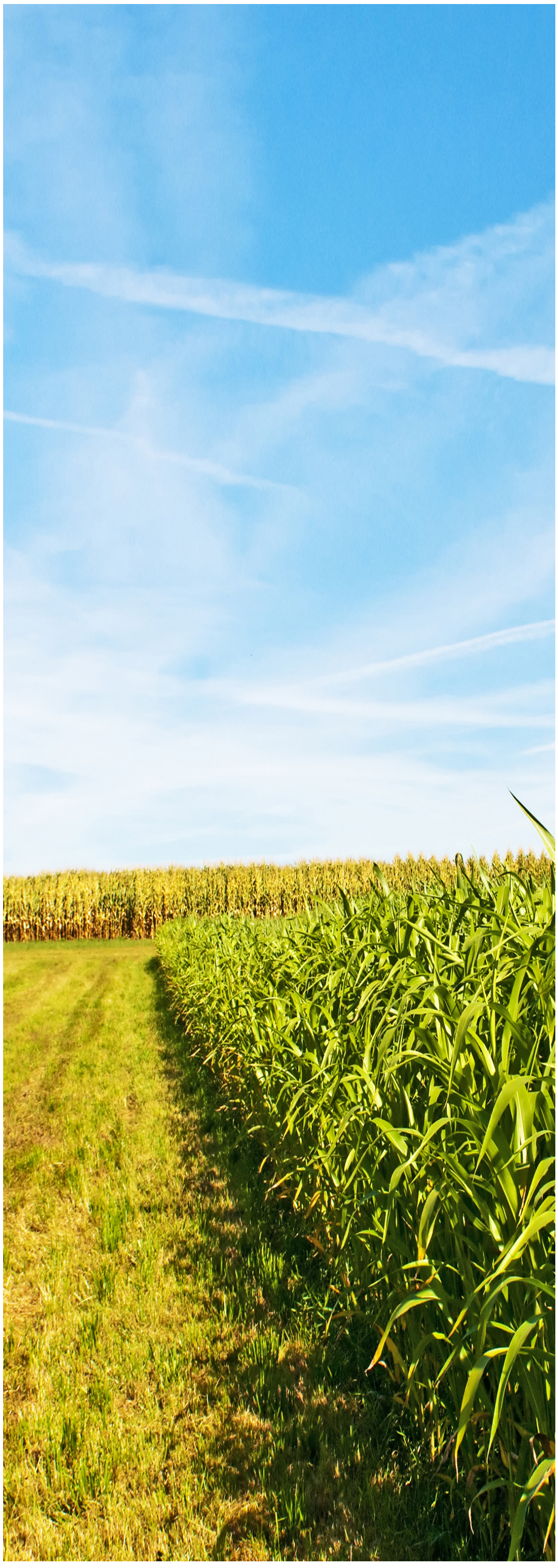
Some food-importing countries have invested in overseas agriculture, with an explicit or implicit concept that produce would be brought back to the home country. By 2016, China had invested $26 billion in 100 countries in agriculture, based on its food security strategy unveiled in the 2006-10 five-year plan[xiv]. Saudi Arabia's Agricultural Development Fund has made about $1 billion of loans, including in Ukraine and Sudan, and supports Saudi investments abroad as long as at least 50% of the crops are exported to the Kingdom[xv]. Sudan was a particularly popular destination for investment, with the Kuwait, Qatar, UAE and others also acquiring land there.

Reducing food waste is also important, via better processing methods, re-use of by-products (as food, fertiliser, construction materials or bio-energy), and better infrastructure, including roads, ports, silos and refrigeration facilities, to get produce to market before it spoils.

Reducing vulnerability of agriculture to climate change is probably the key area of focus. Climate Resilient Agriculture (CRA)[xvi] is a promising approach which combines traditional knowledge with modern technology.

Figure 7 Building food security climate resilience[xvii]





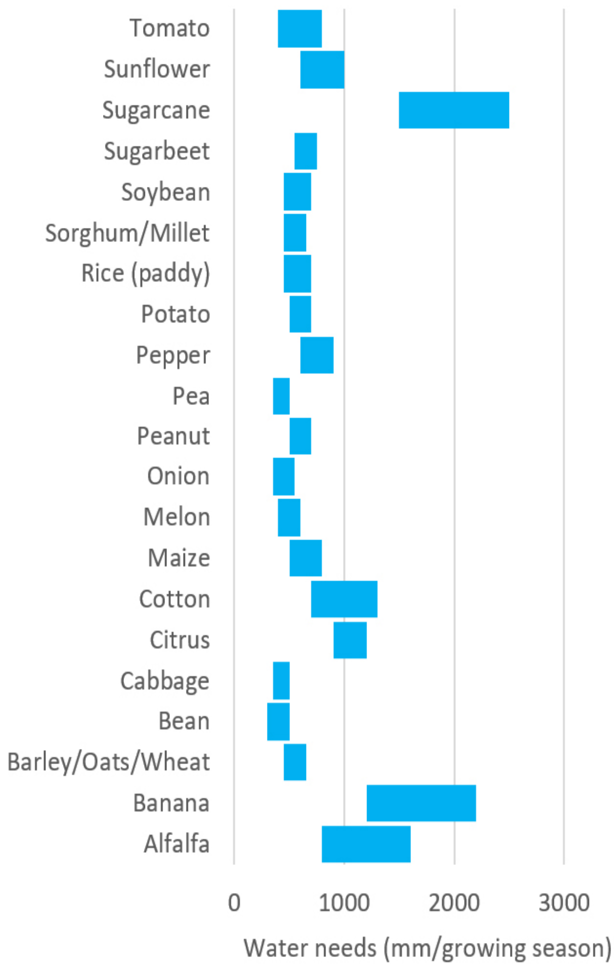
POLICIES TO ENSURE FOOD SECURITY IN THE FACE OF CLIMATE CHANGE

Resilience balances the three tasks of increasing food production, mitigating GHGs, and adapting to a changing climate. On adaptation, areas of focus include:

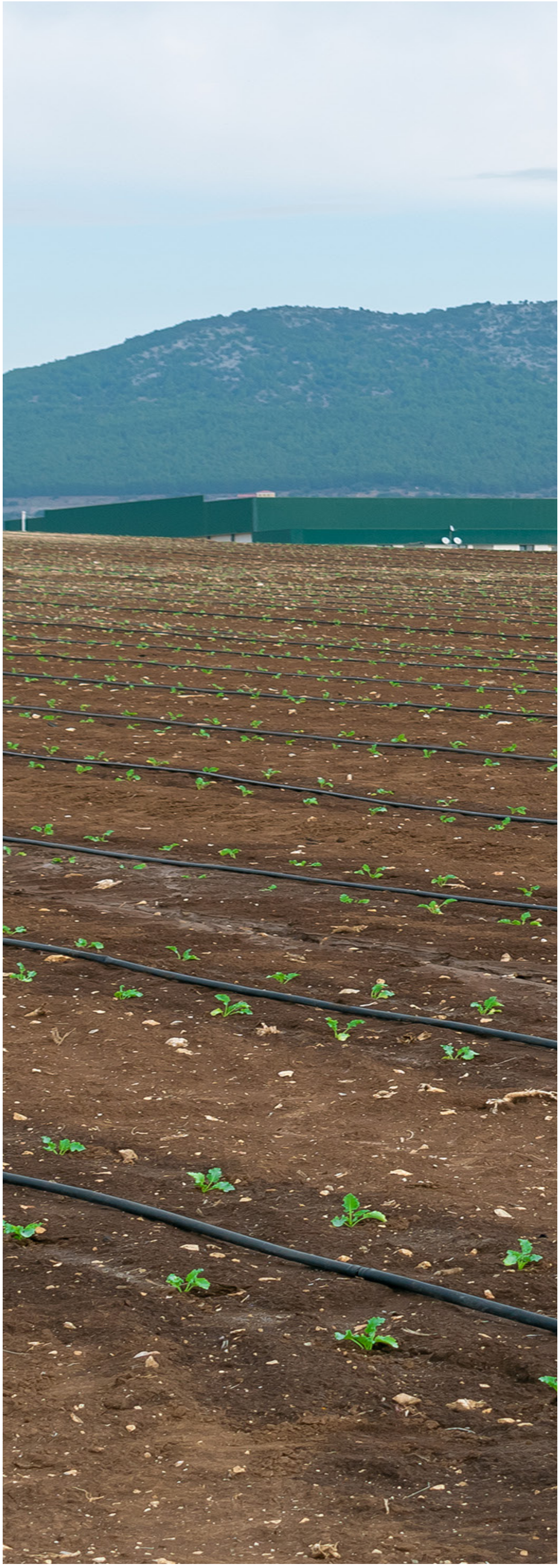
- Physical infrastructure, e.g. water storage, sea defences to prevent marine flooding of farm-land, dams to make use of heavy rainfall and limit downstream flooding;
- Shifting cultivar types by moving to higher altitudes and latitudes;
- Diversification of crops to limit exposure to a single bad weather or disease event;
- Selective breeding and genetic modification to produce crops and livestock able to tolerate drought, higher temperatures, pests and other effects of climate change;

- Changing staple crops to those more tolerant of new climates. Figure 8 shows typical water needs over the growing season for some main crops. Peas, cabbages, beans, barley, oats and wheat stand out as relatively using less water; bananas, sugarcane and alfalfa (for animal feed) have very high water demands.
- Alternative farming locations, including aquaculture, biosaline agriculture, and vertical farming. Biosaline agriculture grows halophytes (salt-tolerant plants), for human consumption, medicinal use, animal feed or biofuels. Vertical farming grows crops indoors in trays, in climate-controlled environments.

Figure 8 Typical water needs for crops[xviii]



- Non-animal products. The growing consumption of meat and dairy is problematic because of high methane emissions from ruminants (particularly cows) and the large requirement for feed. Insect protein is much more efficient than mammals and birds for feed and water use, and can be used for human consumption or for fish farms. Meat-like products made from soya, fungus (quorn) and others, as well as almond milk, soy milk and similar substitutes, have been available for some time.
- More efficient use of water, including drip irrigation. Drip irrigation saves energy by avoiding the use of high-pressure sprays, and is 90-95% efficient versus 30-60% for sprays and rotors and even less for traditional flood irrigation;
- Provision of additional water, for example via:
    - o Movement of water from other basins, as planned in China.
    - o Recycling of waste-water or clean-up of subsurface waters, e.g. from oil-fields (Oman's Greening the Desert initiative).
    - o Cloud seeding, albeit unreliable and requires specific conditions, and would have to be carried out at a national level.
    - o Desalination (such as the Red-Dead plan between Jordan and Israel).
- Integrated sensing (including internet-connected within greenhouses, and remote sensing via drones and satellites), with artificial intelligence, to optimise application of water and fertiliser, temperature and harvesting patterns.



POLICIES TO ENSURE FOOD SECURITY IN THE FACE OF CLIMATE CHANGE

Many of these techniques are promising but require high levels of expertise and capital. Therefore, investment and technology transfer is required to ensure that low-income and small-scale farmers can make use of them.

Protecting against food shocks can involve physical, market and institutional mechanisms. Physical approaches include investment in transport and buffer stocks. These help food supplies to be moved around or imported to meet areas of shortage and provide reserves to cover for a bad harvest or other negative events. Institutional protection includes trade agreements to forestall export bans; reciprocal reductions in food tariffs or other restrictive trade measures; and cooperation in international organisations such as the UN Food and Agriculture Organization[xix] , coordination of international responses to food crises.

Managing food insecurity has to be achieved collaboratively. The negative impact of climate change on agriculture is likely to be disproportionately more felt in poorer countries. These reality suggests a continuing focus on supporting poverty alleviation, climate change adaptation and the Sustainable Development Goals.

Early-warning systems for food crises would be useful. It would also be helpful to raise the profile of climate change threat to food security as a core component of risks to human and international security.

POTENTIAL CLIMATE POLICY RISKS AND OPPORTUNITIES

Agriculture has to cut its own climate footprint. Farmers are often politically influential, so may be able to block limits on their emissions. But as noted, agriculture accounts for about 20% of total GHG emissions, and so it will be impossible to approach net-zero without major cuts in this sector.

The key areas of emissions to address are:

- Reducing and eventually reversing deforestation.
- Reducing emissions associated with fertiliser production.
- Reducing emissions from fertiliser use.
- Limiting methane emissions.

Costs for fertilisers and energy are likely to rise because of decarbonisation measures elsewhere. This is a further challenge to containing food price rises and expanding output.

Soil carbon sequestration, that includes techniques such as no-till, low-till and cover cropping (planting crops on bare fields), is an option for carbon sequestration, with great potential, in the agricultural sector.

Studies suggest soil carbon could account for about 6 $GtCO_2e$/year of carbon sequestration (40% from preserving existing soil carbon, 60% from rebuilding depleted levels)[xx]. However, the potential would likely saturate over time. Also, further work suggests that soil carbon may be much less stable than thought, and that techniques such as cover crops may simply raise carbon from deeper in the soil or encourage microbes that decompose carbon[xxi].

Biochar is produced by the partial combustion of biomass (producing energy), leaving a residue of solid carbon. This can be used as a soil additive to trap carbon, water and nutrients. Suggested potential is about 3.7-7.3 $GtCO_2$/year[xxii] and production costs about \$55/tonne CO_2e.

Finally, enhanced weathering relies on the reaction of certain minerals, notably olivine from the ultrabasic rock peridotite, with carbon dioxide to form stable carbonates. The common rock basalt could be powdered and applied to soil, where it would sequester carbon and raise fertility[xxiii].

The use of such techniques by farmers would have to be encouraged by appropriate payments and provision of information. Nature-based carbon credits are becoming a popular means of generating the required incentives, especially among companies seeking to meet pledges on emissions reductions. The use of these credits would become increasingly essential as corporations and countries approach net-zero limits and struggle to eliminate their remaining emissions. However, these financial mechanisms have often faced the criticism of 'greenwashing'. There are concerns about forests that later burn down, or were never likely to be cleared in any case, or where deforestation is simply moved to another location.

By paying farmers and foresters for other environmental services – notably, carbon sequestration, water retention and biodiversity preservation – food production would become more economically diversified, so farmers would be able to cope financially with a few bad harvest years.

CONCLUSIONS

The impact of climate change on agriculture, and broadly on food security, is one of the most serious economic impacts and likely to affect the most people. The macroeconomic effects, including affecting inflation, are important. It also has major further ramifications for driving conflict and mass migration.

Climate policy in agriculture has to manage difficult trade-offs, as unintended negative consequences could easily occur – such as inadvertently encouraging deforestation by mandating biofuel use, shifting clearance from one area to another, or increasing food output at the cost of damage to water supplies or biodiversity. The social structure of farming and herding communities is also vulnerable.

The issue is further compounded by the fact that the agricultural sector has its own large GHG footprint, that is focus of much public scrutiny. There is perception that emissions from this sector receives less attention than that of relatively smaller emitters such as the aviation, shipping, cement and iron and steel industries.

Food security therefore has to be managed holistically, with an important role for international organisations such as the UN FAO. But at the same time, agriculture depends on local cultures and situations much more than most industries. Both high technology and traditional knowledge are important, and climate adaptation has to be compatible with farmers' and fishers' customs and capabilities. Prescriptions for future food also have to take into account the tastes and fashions of consumers and seek to meet them in an environmentally-sensitive way. International policy should manage the risks of conflict and avoid counter-productive approaches such as trade wars.

Ultimately, shifting the role of farmers back to that of being the custodians of both food production and the environment, and ensuring they are properly supported and rewarded for this, offers a sustainable way forward for 21st century food and climate security.

APPENDIX

i. https://www.csis.org/analysis/beyond-yields-mapping-many-impacts-climate-food-security
ii. https://ourworldindata.org/hunger-and-undernourishment
iii. http://www.fao.org/faostat/en/#data/FS
iv. Data from https://data.ene.iiasa.ac.at/iamc-1.5c-explorer/#/workspaces/3
v. https://news.climate.columbia.edu/2018/07/25/climate-change-food-agriculture/
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viii. https://www.bloomberg.com/news/articles/2021-07-24/world-s-food-supplies-get-slammed-by-drought-floods-and-frost
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xiii. http://www.fao.org/3/ca9362en/ca9362en.pdf
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xv. https://gulfnews.com/world/gulf/saudi/saudi-arabia-triples-agriculture-investments-abroad-1.76579785
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xvii. Based on https://www.researchgate.net/figure/A-Climate-Smart-Agriculture-showing-the-interrelationships-between-resilience-food_fig3_329146089
xviii. Data from http://www.fao.org/3/s2022e/s2022e02.htm
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xx. https://www.nature.com/articles/s41893-020-0491-z
xxi. https://www.greenbiz.com/article/carbon-sequestration-farms-actually-working-fight-climate-change
xxi. http://biomassmagazine.com/articles/4080/beyond--the--hype
xxiii. https://www.nature.com/articles/s41561-021-00798-x

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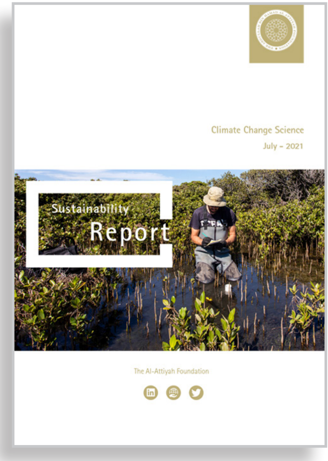

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Strategies for Sustainable Production and Consumption of Natural Resources

Natural resources encompass a wide range of physical and biological materials, entities and systems, from coal or iron ore, to a freshwater lake, North Atlantic cod, the Amazon rainforest, sunlight or the atmosphere.

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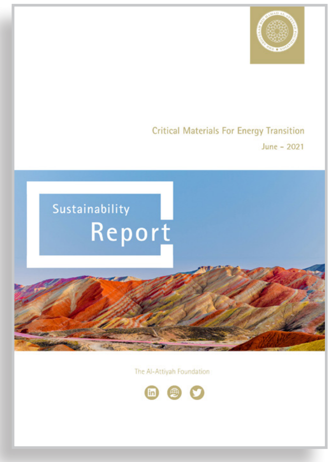

June- 2021

Critical Materials For Energy Transition

The emerging new global energy system requires new materials that were not traditionally in high demand. Their currently known reserves are often small, technically difficult to obtain, or concentrated in politically challenging countries.

(QRCO.DE)

May - 2021

Strategies for Sustainable Production and Consumption of Natural Resources

Natural resources encompass a wide range of physical and biological materials, entities and systems, from coal or iron ore, to a freshwater lake, North Atlantic cod, the Amazon rainforest, sunlight or the atmosphere.

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OUR PARTNERS

Our partners collaborate with The Al-Attiyah Foundation on various projects and research within the themes of energy and sustainable development.

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