CAPI
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Linking Global Food Security with China's Food Security

Research Report prepared for CAPI by Ted Bilyea

Research Report

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Note from CAPI

Pressures on global supply and demand for food are not new. However, recent increases in demand, from a growing population with increasing incomes, and impacts on production, from changing climates to geopolitics, have increased the pressure to new levels. The impact of these global pressures on Canadian agriculture and food are also increasing.

It is impossible to understand this evolution and what it means for Canada without a deeper understanding of China's impact on the global food system. Canada has experienced fluctuating agri-food trade relations with China, yet with China's population and economy, and willingness to intervene in the global system, it cannot simply be worked around.

In this paper, CAPI Distinguished Fellow Ted Bilyea frames the food security situation facing the world today, outlines China's concerns and perspectives it brings to agri-food trade.

He then links the dynamics inside China and to the position and potential influence of a narrow slice of countries with exportable surpluses (which includes Canada), including China's interaction with them, how this situation could play out, and Canada's potential role.

Key Takeaways

- Global demand for food, and particularly proteins, will continue to rise, and an increasing number of countries are becoming major food importers, with China by far the largest. A smaller number of countries, including Canada, are becoming major food exporters.
- Factors from decreasing stocks, increasing prices, and the invasion of Ukraine have increased food insecurity in Canada and around the world recently. The number of people facing acute food insecurity has soared from 135 million to 345 million since 2019.
- Recognizing its heavy reliance on western countries for food, China aspires to be self-sufficient. This will be extremely challenging due to insufficient arable land and water, underdeveloped technology, and production risks, among other factors.
- China's effort to diversify its food sources away from the West is disrupting sustainable productivity growth and moving demand away from regions of low-carbon intensity agriculture, and creating serious environmental damage around the world.
- A handful of countries are increasingly influential in food. Canada, as a major exporter and importer, has an opportunity and responsibility to reflect these dynamics in its agriculture, food and geopolitical policy and strategy.

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Introduction

In a rapidly changing and currently deteriorating global food security situation, Canada has an important role to play. However, that role is not well understood, and is not well reflected in Canada foreign or agricultural policy. At the same time, international trade relations and multilateral institutions have devolved and become much less friendly or favourable for small export-oriented countries like Canada. To safeguard its prosperity and be a source for international food security, Canada will need to navigate very carefully with a refined agri-food trade strategy.

The purpose of this paper is twofold. First to describe the growing crisis of global food security and second to indicate the enormous effect China has as the largest food importer on global food security, and as such, to encourage China to take greater responsibility for the development of sustainable international food trade- both for its own sake and for the world's sake.

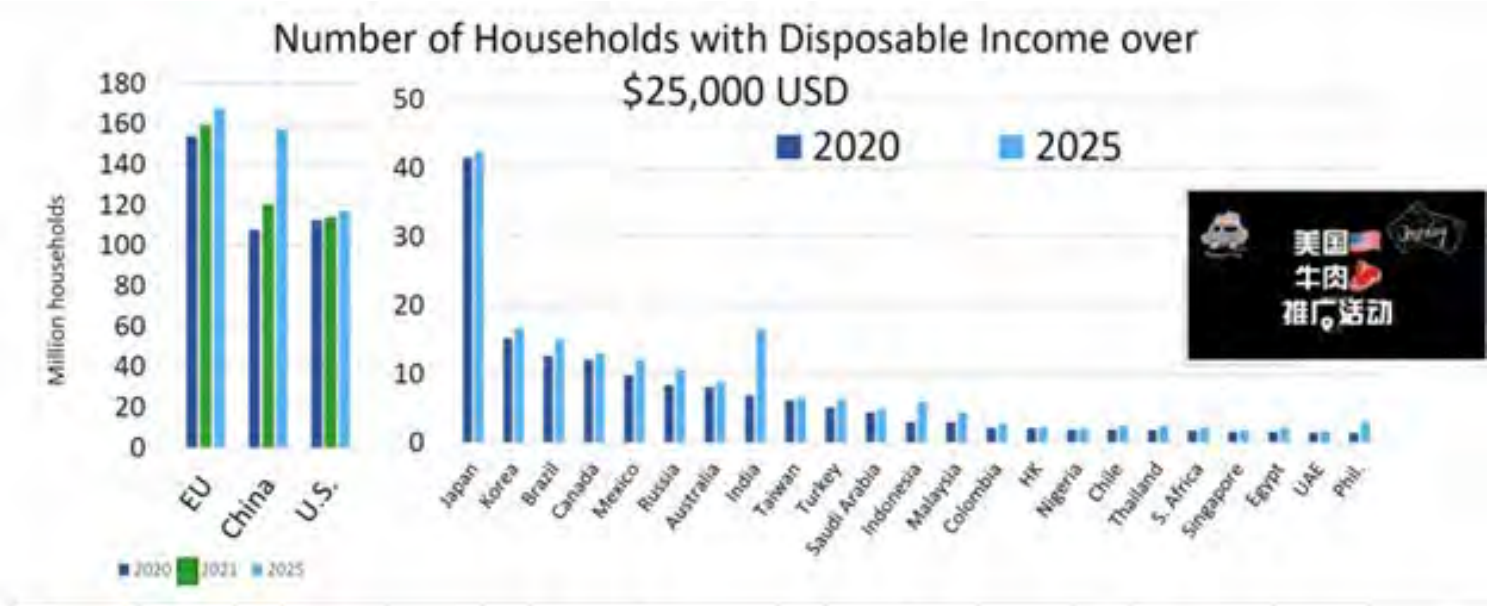
Why The Interest in Food Security?

When I addressed the board of directors of Feed Ontario, a network of 1200 food banks in April of 2021 my message to them was, as bad as it seemed at the time, things will get worse. My concern then, as it is today, was that global stocks of cereals were in no shape to buffer a major crop disruption, as productivity gains have slowed and the growth in incomes outside of North America was pulling product away from people in North America that lacked sufficient income to feed their families.

The chart I used to explain this relatively new phenomena of competition for food that low-income Canadians were beginning to experience is shown in Figure 1 below. 2020 was the first year China recorded more households (160 million) with disposable income over $25,000 than the U.S. (about 120 million). From a Canadian point of view the audience seemed to understand that of the three A's of food security -availability, accessibility and affordability, our significant surplus of staples meant we did not have an availability problem; however, accessibility was an issue for some and affordability was increasingly going to be a major problem. Unfortunately, new data released by Statistics Canada in September 2022 indicates "prices for food purchased from stores continued to increase in August (+10.8%), the fastest pace since 1981" (Statistics Canada, 2022).

For Canadians living in a relatively rich country food affordability should be a manageable social problem not a fundamental agricultural challenge; but for farmers, agriculture organizations and governments the war in Ukraine has been a wake-up call to the shift from the "challenge of abundance" to the challenge of food security.

Figure 1. Households by Disposable Income > $US 25,000



Source: Euromonitor International, Constant 2020 USD

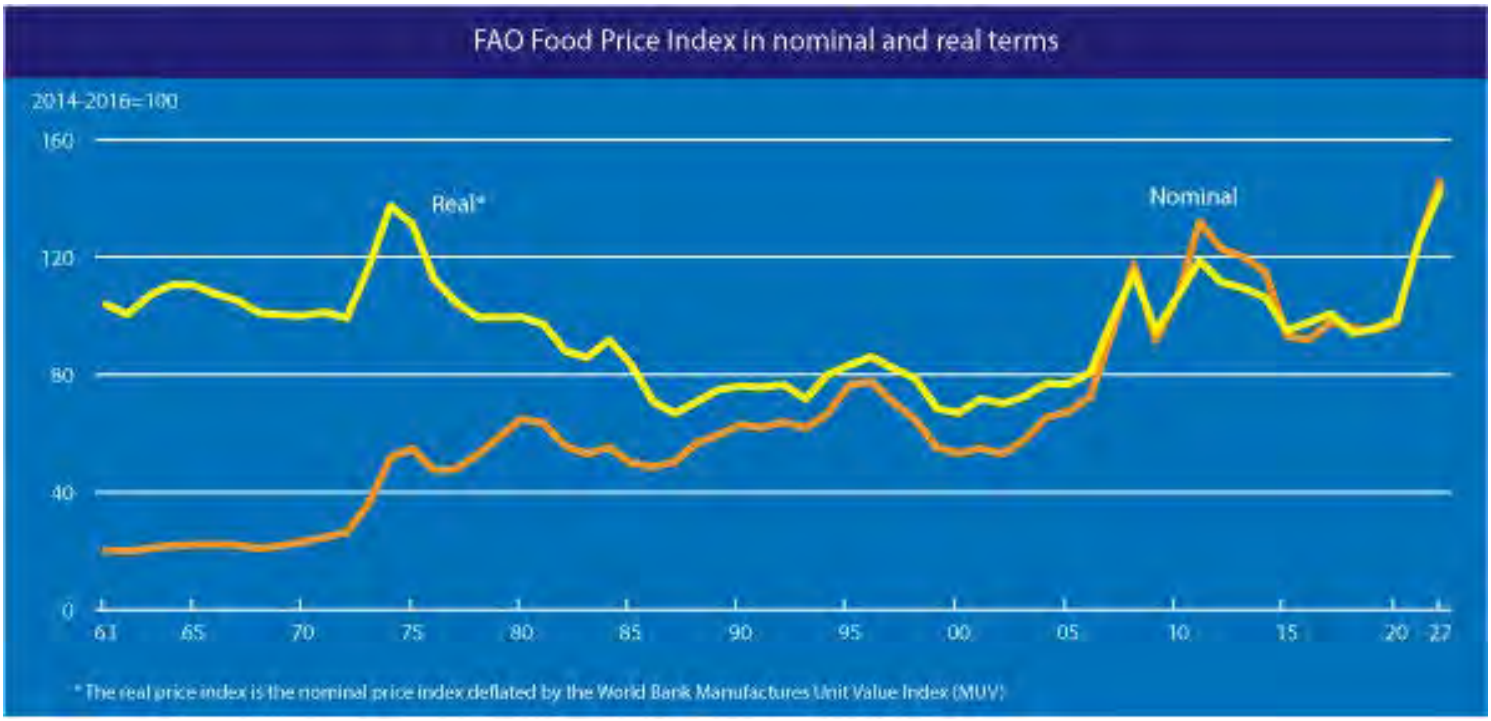
Farmers, agricultural organizations and governments in developed countries have worked under rules and regulations that generally have their origins in the 1950's and 60's to deal with the "challenge of abundance"- the worry that farm productivity and farm product supply would grow faster than demand. Abundance brought concerns of low and unstable farm prices, low farm incomes, inefficient investment in farming, and buyers' market conditions to the terms of trade. However, in short order the world of abundance has been turned on its head by disease, droughts, floods, groundwater depletion, geopolitical trade disruption, failing logistics, slowing productivity improvements, an energy/fertilizer crisis along with food export restrictions and climate and biodiversity mitigation efforts.

But it has taken a war in one of the world's great grain and oilseed surplus countries to move the issue of food security to the top of most countries' agendas. Shortages have brought more instability, and higher input and operating costs. It may be possible to improve the terms of trade between sellers and buyers, and improve food security through investment in sustainable intensification and logistics- if we all understand the seismic shift that has taken place, develop a strategic approach to tame geopolitical trade disruption and repurpose our legacy organizations and structures to accomplish this.

Food Security as a Problem but not a Priority Before the War in Ukraine

Prior to the invasion of Ukraine, we had the highest global food price index since the "Great Grain Robbery" of the early 1970's and no increase in global cereal stock/utilization ratio despite a good global crop in 2021. Figures 2 and 3 below provide the historical context. In Figure 2, the "real" food price index (adjusted for broader inflation) breached 130 by the fourth quarter of 2021, rivalling that of 1973-74. Between March and June 2022, the index spiked up above 150, and has since settled in just over 130 as of writing this- but still alarmingly high by historic standards.

Figure 2. Global Food Price Index



Source: UN-FAO World Food Situation https://www.fao.org/worldfoodsituation/foodpricesindex/en/

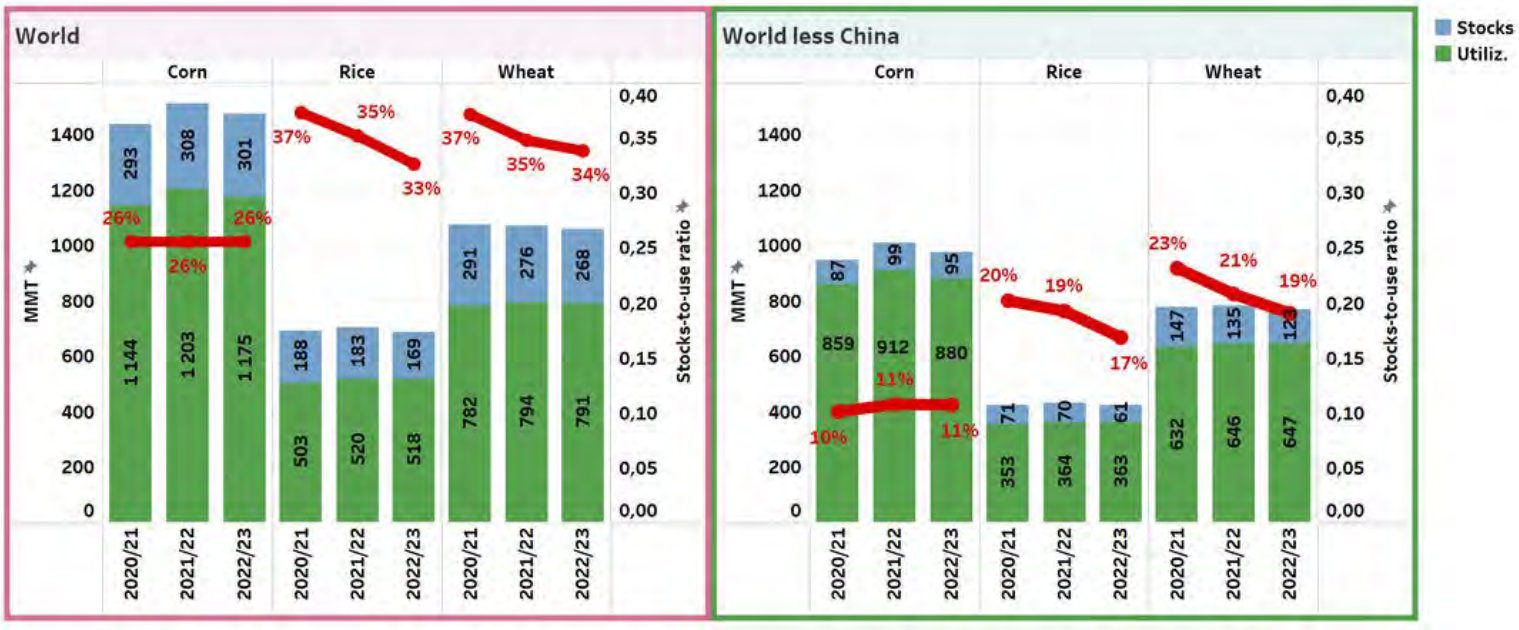
Figure 3 presents global cereal production, utilization, and stocks. Both production and utilization of cereals have been increasing over the period illustrated, but increasingly production has had difficulty keeping pace with utilization, with resulting difficulty in building stocks. Recent data on global cereal stocks appear somewhat better than actually is the case as they reflect cereals that remain trapped in Ukraine with only three ports open, and slowing utilization reflects logistic disruptions and price escalation making cereals unavailable or unaffordable for many. Reduced stockholding means that the world is increasingly feeding itself hand-to-mouth, or harvest-by-harvest, with less in terms of buffer stocks.

Figure 3. World Cereal Production, Utilization and Stock

Source: UN-FAO World Food Situation

Moreover, stocks are increasingly, and overwhelmingly, held by importing countries, especially China. This is illustrated in Figure 4, which compares stocks and utilization of corn, rice, and wheat on a global basis, and for the world excluding China. Using 2021/22 as a base, China's share of corn stocks is 68 percent (1-[99/308] in Figure 4); its share of rice stocks is 62 percent; and share of wheat stocks is 51 percent. Globally the stocks/use ratio, a measure of relative market balance at existing price levels, ranges around 26 percent for corn; 33-37 percent for rice, and 34-37 percent for wheat. However, when China is excluded, the global stocks/use ratio falls to 10-11 percent for corn; 17-20 percent for rice; and 19-23 percent for wheat. If it is assumed that cereal stocks held by China will remain in China, these low stocks/use ratios excluding China suggest the prospect of major price inflation in the event of supply disruptions in these products.

Figure 4. Major Cereals Stocks and Utilization, World and World Less China



Source: USDA WASDE November, 2022. 2022/23 are USDA Estimates

With the Russian invasion of Ukraine, the global food security challenge immediately worsened. Using 2020 FAO data illustrated in Figure 5, Ukraine accounts for 15% of global exports of corn and 13% of barley thus playing a considerable role in global feed grains that has had an immediate negative effect on Western European and to a lesser extent animal agriculture elsewhere including China. However, the media and aid organizations have been more focused on the 9% share of Ukraine global wheat exports, the 20% share of sunflower seed oil and meal and the 10% share of rapeseed exports that have created food shortages in East Africa and food security concerns in Middle East and Asia.

Figure 5.

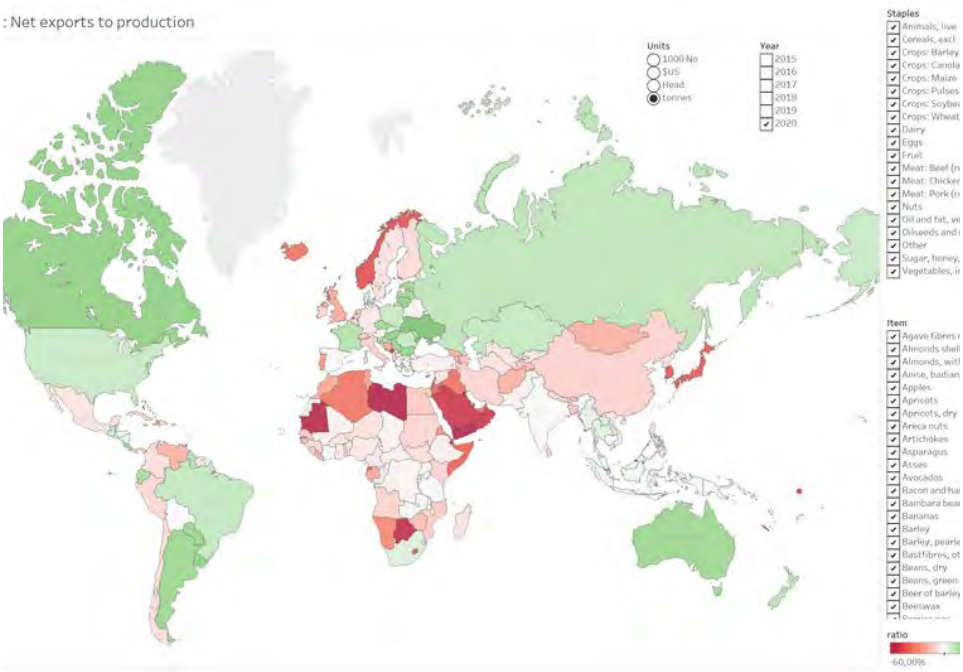
Data source: FAOSTAT. (2020). Crops and livestock products. [Database]. https://www.fao.org/faostat/en/#data/TCL. Image created internally.

Unfortunately, with only three Ukraine Black Sea ports allowed to export under the UN Black Sea Grain Corridor arrangement, there is no way to efficiently move out the remainder of the 2021 crop in storage along with the new crop which is now harvested. When the invasion occurred, there was about 20 million tonnes of grain remaining in Ukraine storage. In August, Ukraine official reports claimed 1.7 million tonnes of foodstuffs were exported through the ports of Odesa region while almost 1.6 million tonnes were exported through the Danube ports, (1 million tonnes – by rail, and over 600,000 tonnes by road). Other sources indicated lower export numbers. However, sticking with the Ukraine numbers and knowing that there remain a few million tonnes of old crop it will be difficult to achieve anything like normal exports in the fall of 2022.

Why Was Food Insecurity Growing Even Before the Invasion?

Figure 6 below presents agri-food net exports (exports-imports) as a share of production by country – a measure of the relative surplus of agri-food products by country. It shows that much of the world does not produce sufficient food to satisfy its own nutrition requirements, and that a growing number of countries import more than they export to meet domestic food demand.

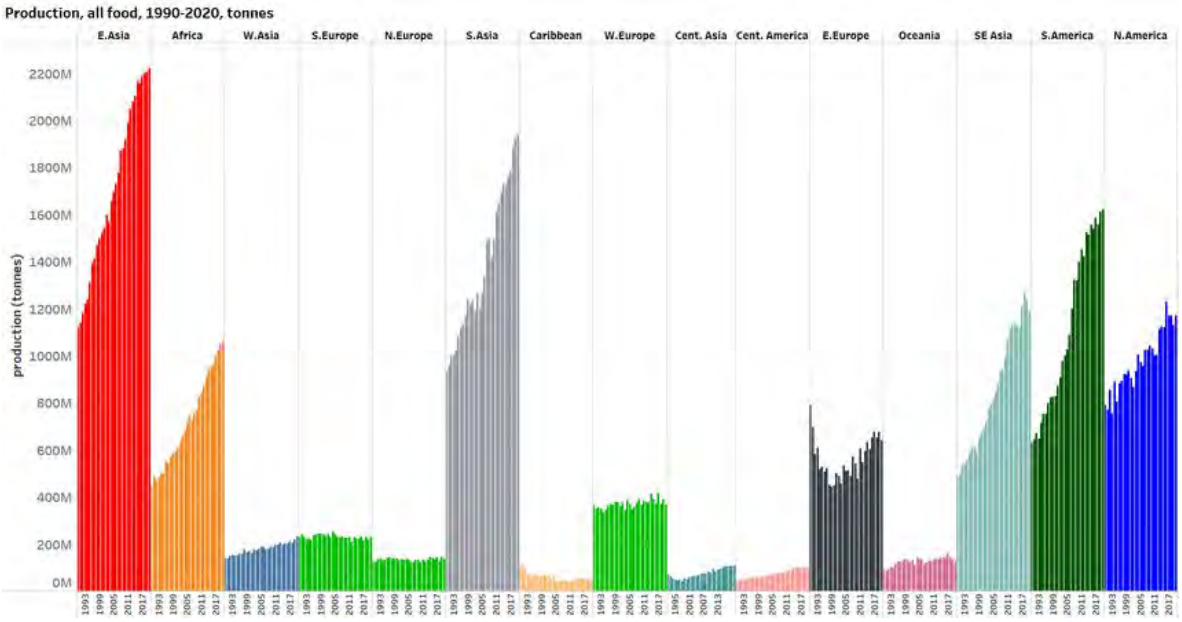
Figure 6. Net Exports as a Share of Production, 2022



SData source: FAOSTAT. (2020). Crops and livestock products. [Database]. https://www.fao.org/faostat/en/#data/TCL. Image created internally.

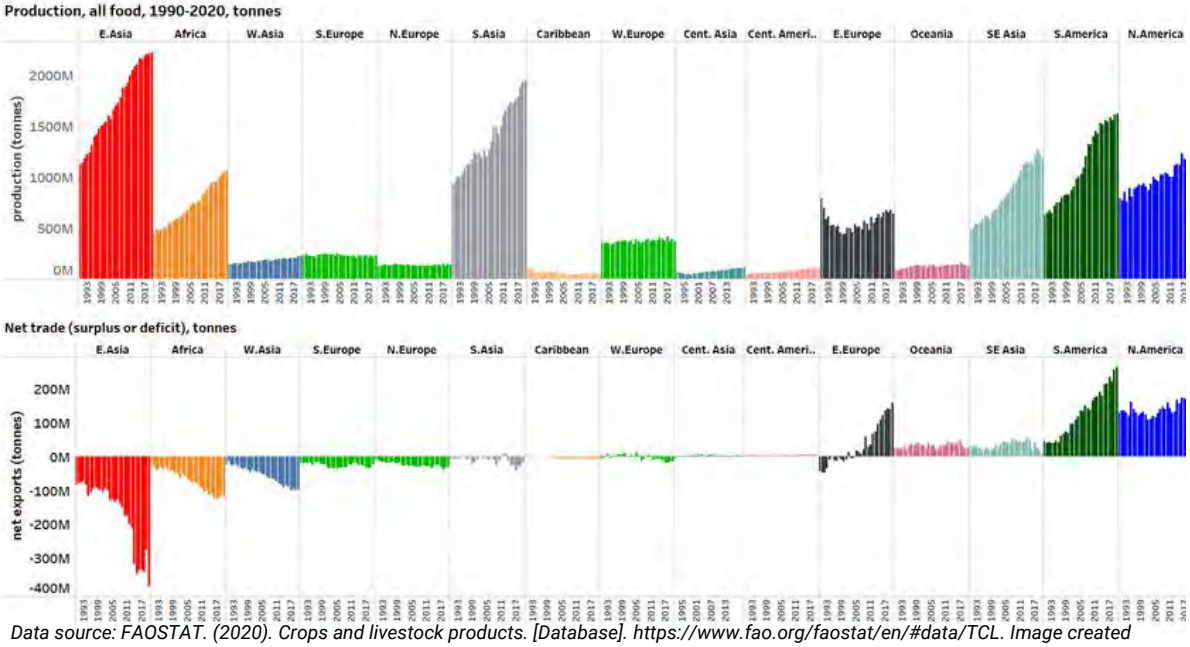
In order to better understand this, Figure 7 presents total agri-food production in tonnage by region. The key observation is that East Asia production (led by China, Japan, South Korea, Taiwan and others) is the largest producing area for agri-food products, followed by South Asia (led by India, Pakistan, Bangladesh, Sri Lanka and others). These are the two most populated regions of the world, but given the enormous wealth gap between these two regions net food imports are very different as we can see if we use the same regions and compare the production chart to the net food import or export by region in Figure 8.

Figure 7. Agri-food Production by Global Region



Data source: FAOSTAT. (2020). Crops and livestock products. [Database]. https://www.fao.org/faostat/en/#data/TCL. Image created internally.

Figure 8. Agri-Food Trade Balance by Global Region



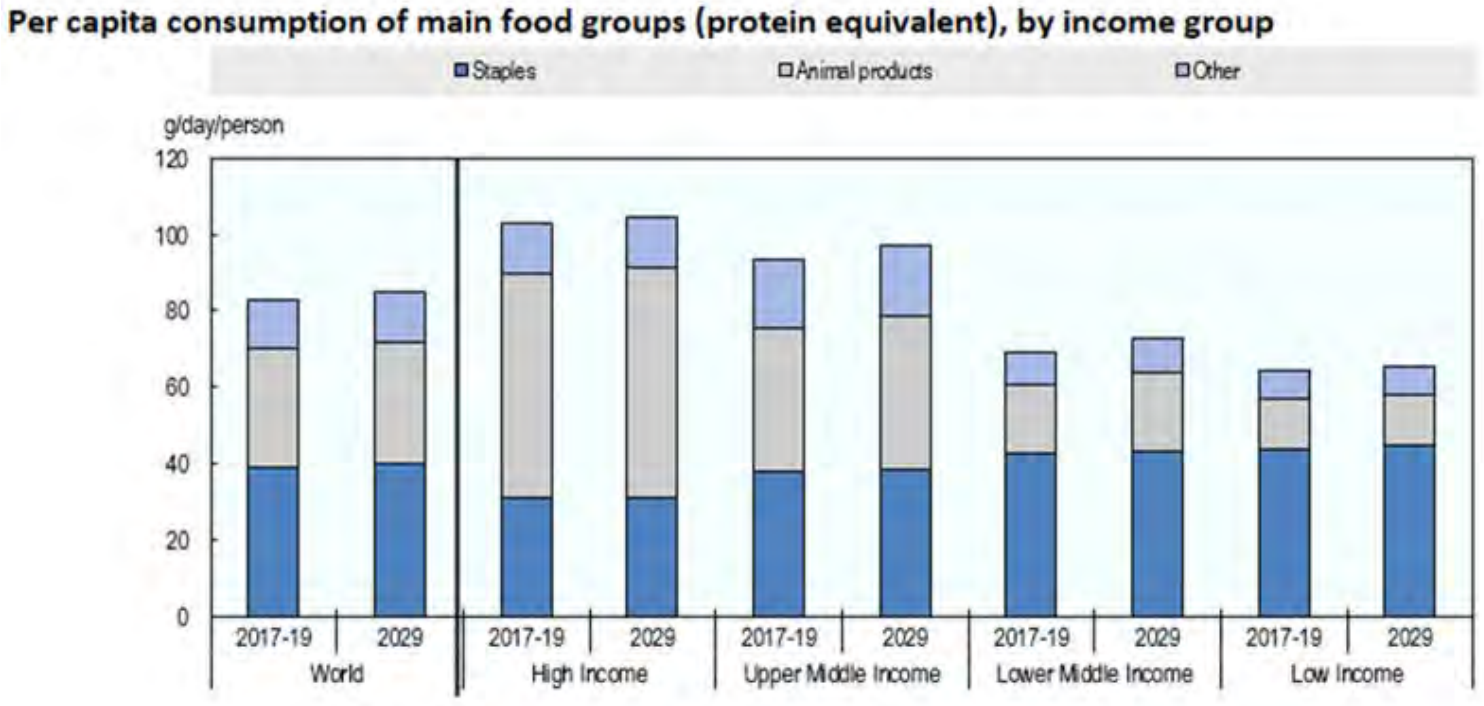
Data source: FAOSTAT. (2020). Crops and livestock products. [Database]. https://www.fao.org/faostat/en/#data/TCL. Image created internally.

Remarkably, although East Asia is the largest agri-food producer, it is also by far the largest net importer and imports have been growing rapidly. The figure essentially shows that imports led by East Asia, West Asia and Africa have been satisfied by rapidly increasing net exports from South America, Eastern Europe (led by Ukraine, Russia and others in Eastern Europe), and North America.

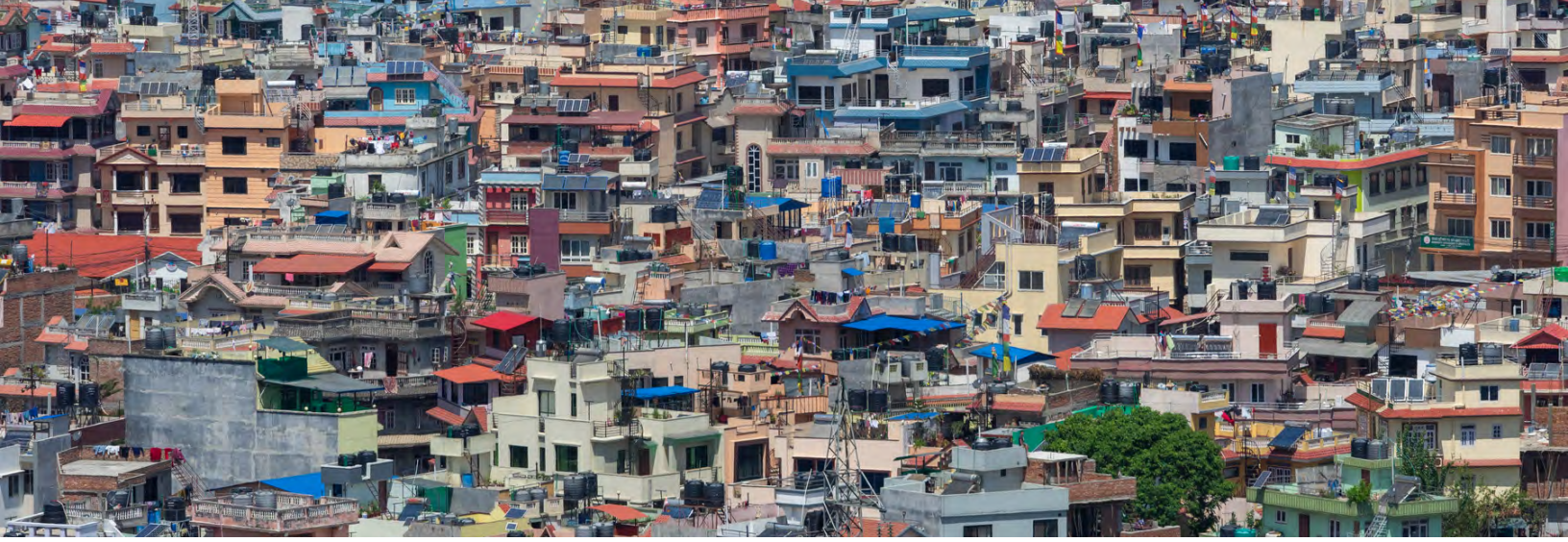
However, perhaps the most striking observations are that Western Europe, Southern Europe and Northern Europe all have moved into net agri-food trade deficit. Secondly South Asia is beginning to move into a net agri-food trade deficit as its population increases, and its disposable income is growing. Analysis of population projections shows that population growth will level off and then decline in some key countries, for example China after 2040, but significant population increases in Africa will offset these declines, fostering population growth until approaching 2100.

In turn, there will be an inevitable increased demand for protein- a function of both population and income growth in India and elsewhere in South Asia, and the prospect of continued household income growth in China. Figure 9 clearly shows the linkage between animal protein and increasing income, with the level of animal protein consumption the lowest in low-income groups, increasing with increasing income group. This relationship is expected to continue out into the future and presents the prospect and logic for very significant increases in China's meat consumption if income growth can continue.

Figure 9.



OECD. (2020). Per capita consumption of main food groups (protein equivalent), by income group. https://www.oecd-ilibrary.org/agriculture-and-food/per-capita-consumption-of-main-food-groups-protein-equivalent-by-income-group_4c70c742-en.



Why is Agriculture Now Having More Difficulty Keeping Up with Population and Income Growth?

Asia and most notably China has rapidly risen as the world's second dominant economic power. Today, Asia, the Americas and the rest of the world including Europe now each contribute almost one-third of the world's GDP. Agriculture has been able to produce ever-increasing amounts of food both because additional land was brought into cultivation where there were relatively fewer people and because innovation consistently increased yields. However, there is a finite amount of land, given that about two-thirds of the world is ocean and one-third land. Figure 10 below provides an overview. Arable land comprises about 1.5 billion hectares, and pastures about 3.4 billion hectares. This compares with about 20 billion acres in forest cover and other uses/features.

Figure 10. Global Land Use Shares

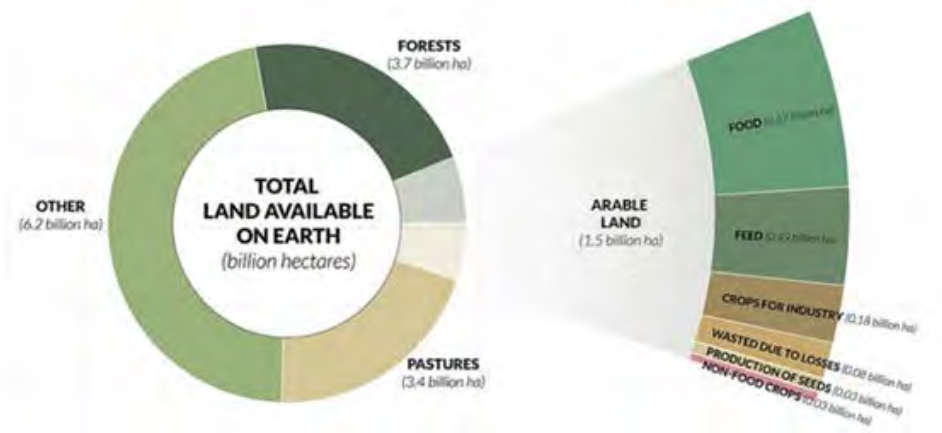


Figure 2: A breakdown of how global land is divided into basic functional categories and how arable land is specifically divided into different functions. (FAOSTAT, 2015).

Source: Gladek et al. (2017). The Global Food System: Trends, impacts, and solutions. Metabolic. https://www.metabolic.nl/publication/global-food-system-an-analysis/.

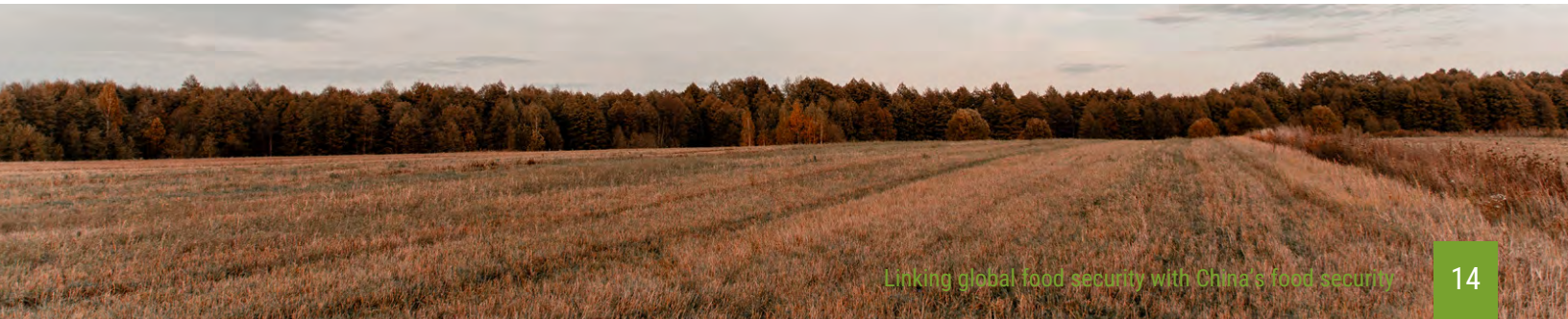
The best suited land for agriculture has already been converted to agricultural use. Conversion of forests results in marginal agricultural land, typically requiring substantial ongoing fertilization and an episodic release of sequestered carbon. Moreover, the world has actually been losing agricultural land to desertification and land use change for non agricultural purposes.

However, in order to keep up with growth in demand for food, yield growth has not been able to keep up, and conversion of land into agricultural use has had to make up the difference – the "yield gap." The extent of substitution of additional land in lieu of yield growth was the subject of a recent study by Zulauf (2022a). He observed:

> *"In 2000, world feed grains transitioned from needing less harvested land to needing more harvested land to satisfy growing consumption... The yield gap has increased since. For oilseeds, trend yield has always been less than the increase in yield needed to satisfy the growth in trend consumption… in 2002 food grains transitioned from needing slightly less land to needing slightly more land each year"* (Zulauf, 2022).

With the growing realization that bringing more land into production is no longer the solution, then the priority turns to innovation and productivity, and accompanying challenges:

Firstly, scientific advances and technological changes including mechanization, chemical fertilizers, irrigation, plant breeding, antibiotics, animal nutrition, and genetics etc. have allowed us to move from feeding 26 people per acre pre WW2 to 265 people per acre today. However, many of these innovations came with unintended side effects, and externalized cost. These include climate change, soil degradation, pesticide residues, eutrophication of lakes and ocean dead zones, groundwater depletion, biodiversity loss, plant and animal disease particularly rising zoonotic disease and antimicrobial resistance etc.



Secondly, the OECD-FAO Agricultural Outlook 2022-2031 projections further emphasise that a “business-as-usual” approach will not only put global food security at risk but also see GHG emissions from agriculture continue to increase:

> *"Average global agricultural productivity would need to grow by 28% over the next decade to meet SDG targets and stay within climate commitments. That’s a lot; in fact, it’s a 3x increase over the experience of the past decade. For crops, it means a 24% increase in average global yields, almost double that achieved over the past decade (13%). Global animal productivity would also have to increase by 31% on average, a rate of growth vastly exceeding growth recorded over the past 10 years"* (Jansen, 2022).

Finally, the World Bank recently issued a report indicating agricultural productivity growth has slowed by 21% globally due to climate change and indicated areas of the world most affected. This finding highlights the problem that agricultural research is effectively split between innovations that prevent losses and sustain existing output level, and others that generate additional output and new possibilities. Moreover, the report pointed out that a “BAU” basis would bring a doubling of emissions from agriculture by 2040 and pull 56 million hectares of new land into production (Gautam et al., 2022).

Unfortunately, these challenges are coming to the forefront at the same time as geopolitical and geoeconomic forces are disrupting normal agri-food trade and raising the risk premium on investment in sustainable agricultural intensification and innovation as access to the largest market has arbitrarily closed for some of the most sustainable exporters.

For the largest agri-food importer in the world with the goal of becoming the dominant economic power, it may be timely to rethink its food security strategy given the global food security headwinds.

The China Food Security Plan and its Effects

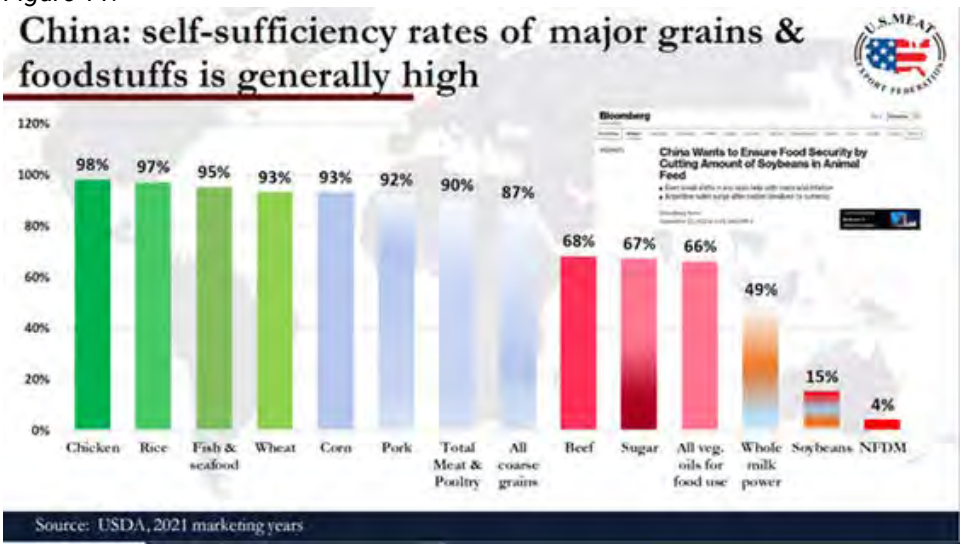
Food security has risen to the top of China's agenda as it faces the increasingly difficult challenge of feeding about one-fifth of the world population with only about one-tenth of the arable land. Despite a detailed plan to increase self-sufficiency China's rate of food self-sufficiency has fallen from over 100% in 2000 to 76.8% in 2020 and is projected to fall to 65% by 2035 (Wang, 2022).

In general, China has a fairly high level of self-sufficiency in a number of grains and meats as noted in Figure 11 below.

However, there can be significant fluctuations in domestic production which will be hard pressed to keep up with increased protein consumption at a time of increasing headwinds which will be described in the next section.

Despite the high level of self-sufficiency as the largest agricultural importer at $205 billion in 2021 China sees itself as dependent on food imports from countries allied with the U.S. and fears such dependence particularly for meat, dairy and oilseeds.

Figure 11.

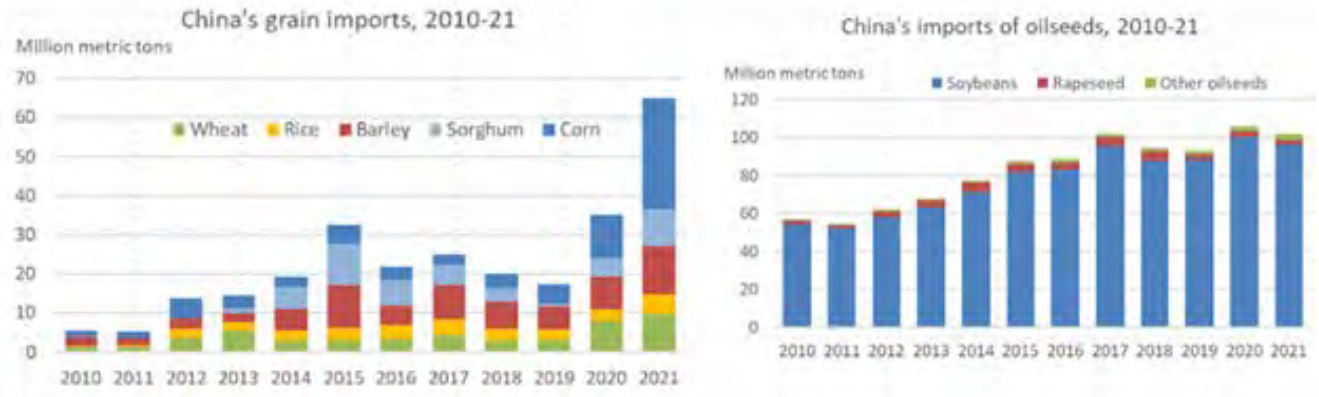


Agri-food exporters tend to view China as an essential market, but highly risky due to China's arbitrary use of tariffs and non-tariff barriers (NTBs) to control trade flows as needed to balance its domestic market, along with the use of market denial for geopolitical leverage. (See, for example, Brown & Wang, 2022, April 25: China's recent trade moves create outsize problems for everyone else).

Meat and dairy products are particularly problematic, as with more economic growth, the more that demand expands relative to supply, and the less likely that China will be self-sufficient. From the broad economic point of view, grain and forage cannot competitively be moved to animals; animals must be moved to feed, simply as a matter of the feed conversion ratio (weight of feed relative to weight of gain) and transportation costs. But China lacks the feed grains and (especially) oilseed meals to support growth in livestock production that it wishes to control.

Nevertheless, to become more self-sufficient in meat production, China is growing more dependent on imported feed grains, oilseeds and forage (Figure 12) in addition to increasing meat imports (Figure 13). Assuming economic growth returns as the pandemic recedes, meat consumption in China may well also resume its growth track. One of the more detailed forecasts (Zhao et al., 2021) indicates a doubling of meat and dairy requirements between 2010 and 2050.

Figure 12.

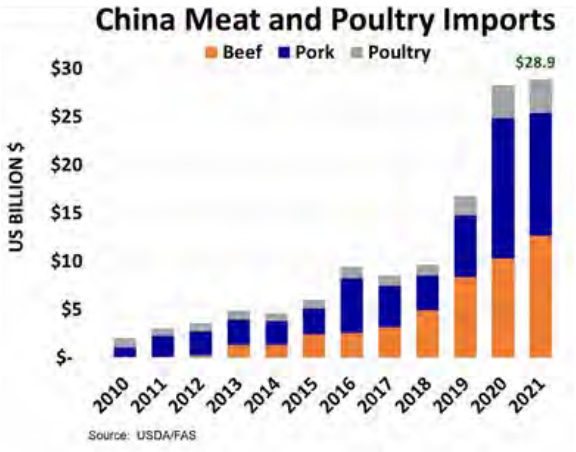


Source: Zhao, H., Chang, J., Havlík, P., van Dijk, M., Valin, H., Janssens, C., Ma, L., Bai, Z., Herrero, M., Smith, P., & Obersteiner, M. (2021). China's future food demand and it's implications for trade and environment. Nature Sustainability, 4(12), Article 12. https://doi.org/10.1038/s41893-021-00784-6.

China's key priorities for its food security plan are reiterated regularly by Xi Jinping and other CCP officials and academics. China's food security priorities include:

- Ensure arable land does not drop below 120 million hectares and ensure supply of–pork and vegetables – Xi Jinping
- Stabilize grain acreage and increase the production of soybeans–and other oil crops - Premier Li Keqiang
- Improve agricultural technology, invest heavily in biotechnologies, curb food waste and boost grain storage – Tang Renjian, Minister of Agriculture
- Diversify food supplies away from the West to countries along China's Belt and Road Initiative – Tang Renjian
- Actively encourage Chinese enterprises to go global and bring capital and technology to areas rich in natural resources but economically underdeveloped i.e., Russia – Lun Zhengzhou et al.

Figure 13.

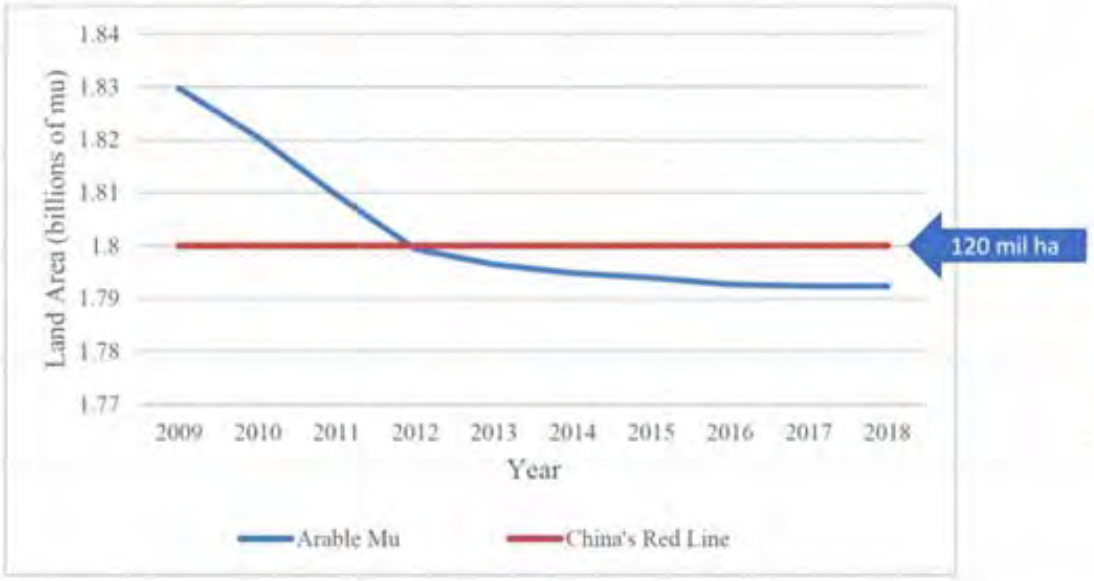


Some observations on the progress of the food security plan priorities:

- Ensuring arable land does not drop below 120 million hectares is proving difficult, as suggested from Figure 14. However, like most agricultural data, no one is quite sure what the real numbers are when it comes to Chinese agricultural statistics. For example, there is a recent claim by Cong Liang, director of China's National Food and Strategic Reserves Administration that China has increased its arable land to "128 million hectares among which 71 million hectares are designated as production areas for grain and key agricultural products" (China Daily, 2022). The takeaway message is China knows it will need more agricultural land as its economy recovers.

Figure 14.

Figure 1: China's Arable Land Declines below Red Line (World Bank/Food and Agriculture Organization), 2009–2018



Source: World Bank. Food and Agriculture Organization. "Arable Land – China," 2018. *https://data.worldbank.org/indicator/AG.LND.ARBL.ZS?end=2018&locations=CN&start=2000&view=chart.*

- Stabilizing grain acreage and increasing the production of soybeans and other oil crops is possibly achievable, but even the current plan to increase oilseed self-sufficiency by increasing soybean production to 23 million tonnes by 2025, from 16.4 million tonnes in 2021, (14th five-year plan Ministry of Agriculture and Rural Affairs (MARA) is only a fraction of the 100 million tonnes of soybean imported. Progress on both increases in grains and oilseeds remains challenging as can be seen in Figure 15 (soybeans) and Figure 16 (wheat).

Figure 15.

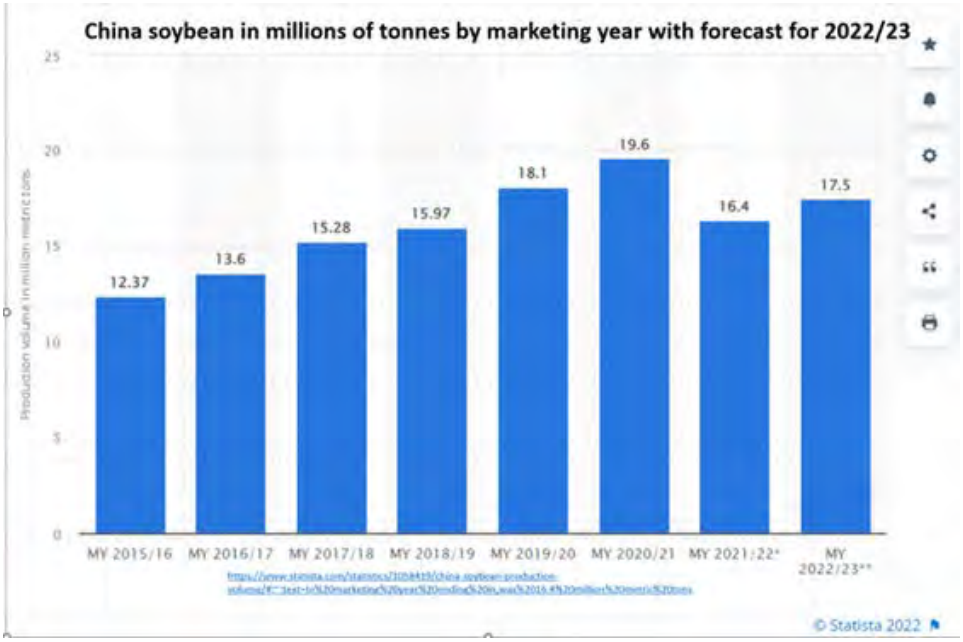
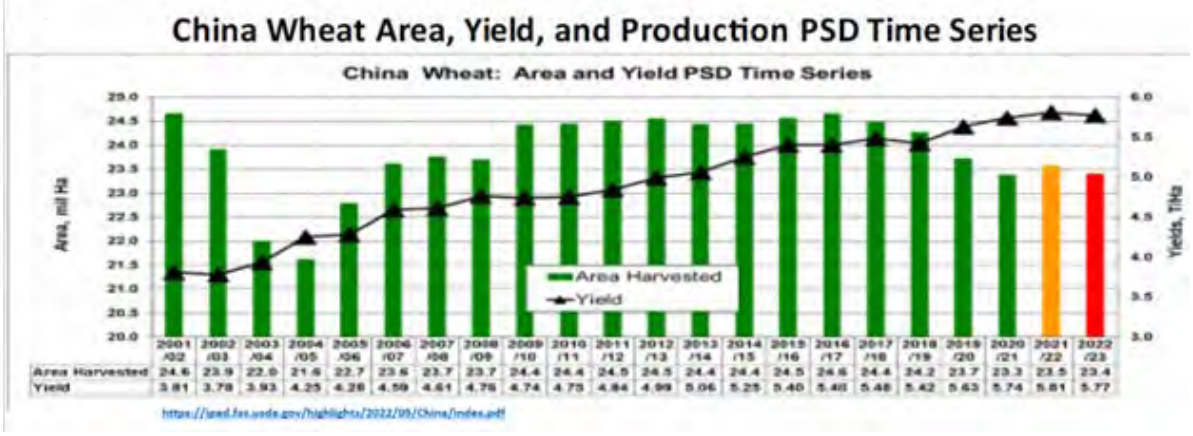
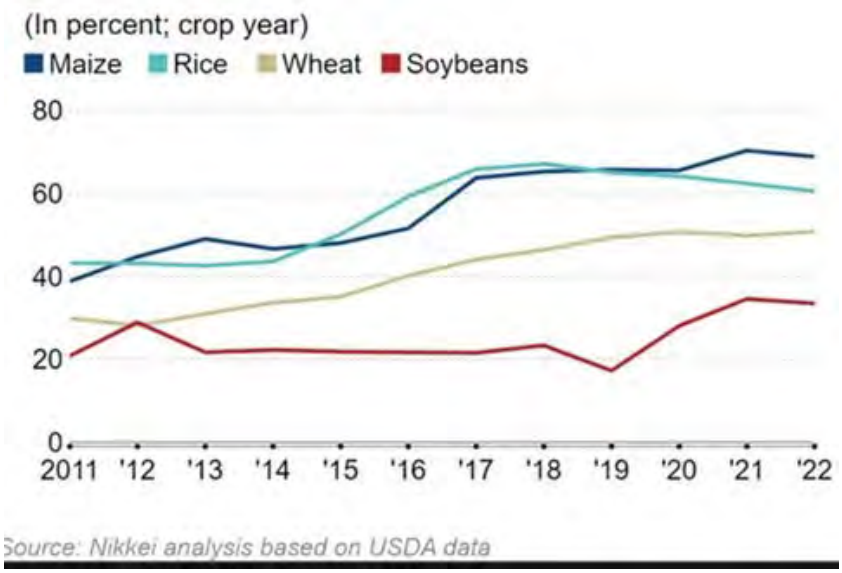


Figure 16.



- China's leadership has embraced biotechnologies as key to improving food security. Although biotechnology will certainly improve yields, it is unlikely to by itself resolve China's food security problems. The vision has been that as China invests in genetics, the yield gap, for example between U.S. and Chinese corn production, will close. To some degree that may indeed happen, but it is likely to disappoint as the geography, soil quality and method of farming favours the U.S. For example, China has 270 million farmers engaged in production compared to 3.2 million for the U.S., resulting in less than two acres per capita, on average – not ideal for row crops (Zhang and Li, 2018)). In addtion to the intention to lead the world in biotech to boost agriculture, there is a comittment to build more storage to hold more grain and oilseeds. No one doubts China can increase storage, but with the current global food security crisis, China is already being singled out as a grain hoarder. The accusation seems rather unfair as China is doing what other large net import countries arguably should be doing to protect their citizens. Nevertheless, as shown in Figure 17, China appears to be carrying a large proportion of global cereal and oilseed stocks.

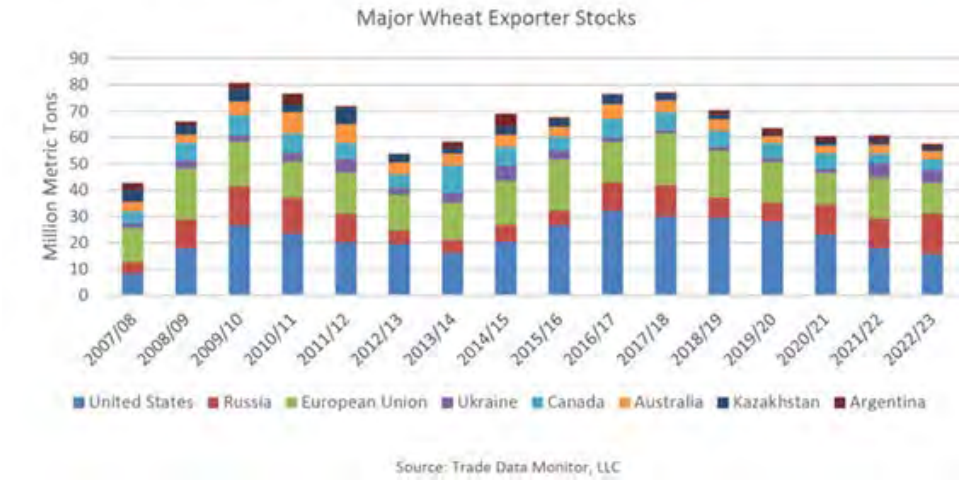
Figure 17.



That leaves less stock in the hands of the large export countries and therefore less ability to deal with shortages in the less well-off import countries. An example of this is the fifth year of exporter-held wheat stocks decline as shown in the USDA World Grain Markets and Trade report reproduced in Figure 18 below.

Figure 18.

Wheat Prices Remain High as Major Wheat Exporter Stocks Contract

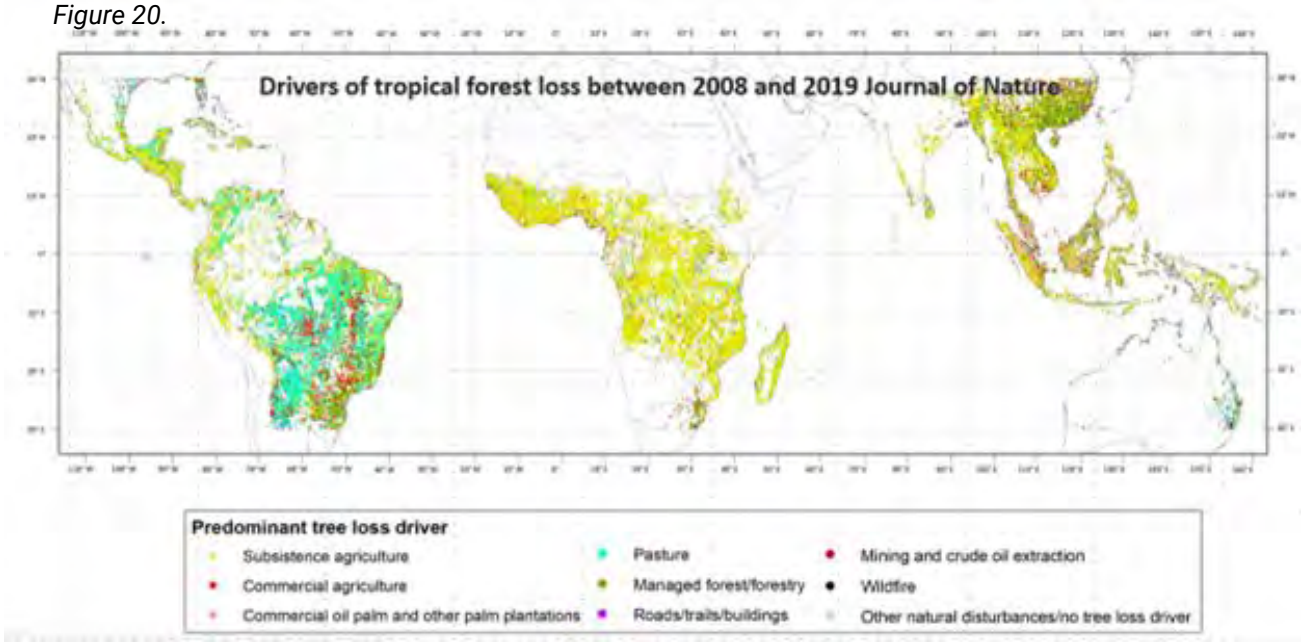


- The diversification of food supplies away from the U.S. and its allies to countries along China's Belt and Road Initiative and to countries that have not officially joined BRI has moved forward, but not without creating significant disruption to the global food trade, environmental damage from unsustainable agriculture expansion, and in some cases, social unrest from food inflation as product is bid away from countries that have rapidly grown food exports. The unintended consequence of trade diversion as a result of a Chinese retaliatory tariff on U.S. soybean was laid out quite well by Fuchs et al. (2019) which projected the conversion of 12.9 million hectares of Brazilian rainforest to replace soybeans previously sourced from the U.S. as illustrated in Figure 19 below.

Figure 19.

Indeed, China has made significant progress replacing trade with the U.S. and its allies while becoming the most important trading partner of most of South America. However, this entails significant unintended costs in the form of environmental destruction. as described by Laso Bayas et al (2022) in a paper entitled "Drivers of tropical forest loss between 2008 and 2019." Figure 20 reproduces a map contained in the article showing the sources of tree loss- heavily concentrated in the Amazon basin, and broadly associated with conversion to commercial agriculture and to pasture.

Figure 20.

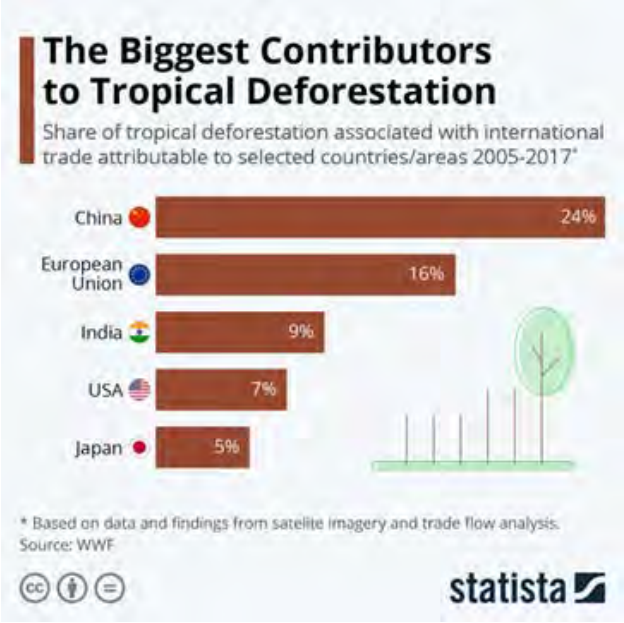


(Laso Bayas et al., 2022)

According to the World Wildlife Fund, China is the single largest driver of forest loss (Figure 21) which is likely to bring increasing admonishment and penalties to firms which are complicit. For example, some European countries are refusing to buy beef from cattle originating from Amazon protected areas. This is an understandable reaction as the E.U. is the second biggest contributor to tropical deforestation. However, significant quantities of Brazil's beef defies zero-deforestation agreements as detailed in a study published by West et al. (2022):

> *"We estimate that approximately 2.8 million cattle head from properties in Protected Areas were sold to slaughterhouses participating in the zero-deforestation cattle agreements (86% of the total cattle from indirect suppliers in Protected Areas)"* (West et al., 2022).

Figure 21.



Diversifying sources of agri-food products from South America, Russia, Central Asia and Southeast Asia looks attractive as a backup for food security for China. To illustrate, in a recent paper, Chinese researchers Zhou & Tong (2022) observe that:

> *"As the initiator of the Belt and Road Initiative, China should actively encourage Chinese enterprises to go global and bring capital and technology to areas rich in natural resources but economically underdeveloped, so as to make full use of agricultural resources, ensure adequate supply in the international market and promote local employment" (Zhou & Tong, 2022).*

The paper was supported by the BRI initiative so the policy suggestions likely have a degree of traction. Two of the findings encourage Chinese leadership to lean into maximizing agricultural trade along the Belt and Road Initiative particularly with food rich South East Asia especially countries which are members of Regional Comprehensive Economic Partnership (RCEP) and “to promote multilateral and regional preferential systems for trade and investment” along the Silk Road (Zhou & Tong, 2022). However, the suggestion that now appears provocative but was not necessarily when it was made prior to the invasion of Ukraine involves investment in Russian agriculture. It reads as follows:

"We will actively promote international cooperation on agricultural production capacity. There is a common mismatch between natural resources and financial resources in areas along the Belt and Road, which leads to the failure of the two to combine into competitiveness. As the initiator of the Belt and Road Initiative, China should actively encourage Chinese enterprises to go global and bring capital and technology to areas rich in natural resources but economically underdeveloped, so as to make full use of agricultural resources, ensure adequate supply in the international market and promote local employment. Russia, for instance, agricultural products' competitive power is weak, but the current political diplomacy between China and Russia is in the best historical period. Not only is cultivated land per capita more than nine times that of China, but China and Russia are also neighboring countries, so China's capital, technology, and agricultural equipment can be transferred to Russia to make full use of the Russian rich farmland and relatively cheap human resources, expand agricultural production, promote world food supply, and help the local economy develop and farmers get full employment" (Zhou & Tong, 2022).

The difficulty with this approach is that, if these regions experience economic growth and increased disposable income, they will consume more of what they produce and there will not be enough to go around. The BRI countries will also be subject to most of the headwinds that will challenge China's food security as outlined in the next section.

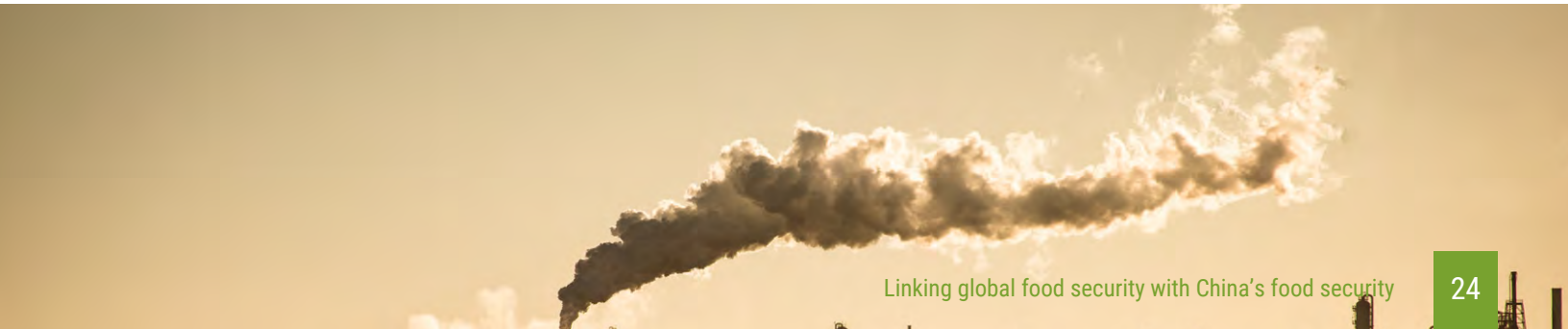
The Challenges for China's Food Security Plan

China must balance policy conflicts in striving for more food production, while at the same time promising carbon neutrality by 2060 and peak carbon dioxide emissions by 2030. China recognizes it has an emissions problem. China has emitted more greenhouse gases, including carbon dioxide, methane, and nitrous oxide, per year than any other country in the world in the last 10 years. It surpassed the United States as the top emitter in 2005, according to Climate Watch (Maizland, 2021). President Xi Jinping has recognized climate change as one of his administration's top concerns, and Beijing has made a variety of pledges to address it (Climate Action Tracker, 2021). These include:

- achieving carbon neutrality by 2060;
- reaching peak carbon dioxide emissions before 2030;
- having renewable energy sources account for 25 percent of total energy consumption by 2030;
- reducing carbon intensity, or the amount of carbon emitted per unit of GDP, by more than 65 percent by 2030;
- installing enough solar and wind power generators to have a combined capacity of 1.2 billion kilowatts by 2030; and,
- boosting forest coverage by around six billion cubic meters by 2030. Two of the more difficult examples of conflicting policy both involve agriculture and agricultural land:
- having renewable energy sources account for 25 percent of total energy consumption by 2030;
- reducing carbon intensity, or the amount of carbon emitted per unit of GDP, by more than 65 percent by 2030

As solar and wind farms are taking up large tracts of arable land near cities, they are now seen to be in conflict with Xi Jinping's red line of 120 million hectares of arable land which has triggered consideration of a "draft regulation by three government agencies, including the Ministry of Natural Resources, that would prohibit new solar projects from cultivated land or forests" (Bloomberg News, 2022).

It is also clear that China is pulling back on its original plans to incorporate biofuels in its emission reduction plans. When Xi Jinping announced China's plan to reach carbon neutrality by 2060, biofuels were not mentioned. China's E10 mandate is not being enforced and "China's 2022 ethanol blend rate at 1.8 percent, down from 2021 and well below the peak blend rate of 2.8 percent eleven years ago" (USDA, 2022). Biodiesel produced from Chinese used cooking oil is mostly exported at high prices to Europe. This suggests China is opting for food over biofuel.



The second point of conflicting policies is the need to deal with what is widely seen as excessive fertilizer use with the resulting contribution to emissions and water pollution. Much of global agricultural production is now subject to air and water pollution from nitrogen and phosphate fertilizer which crops are unable to fully absorb, while at the same time now dealing with the high-cost fertilizer due to disruptions in supply.

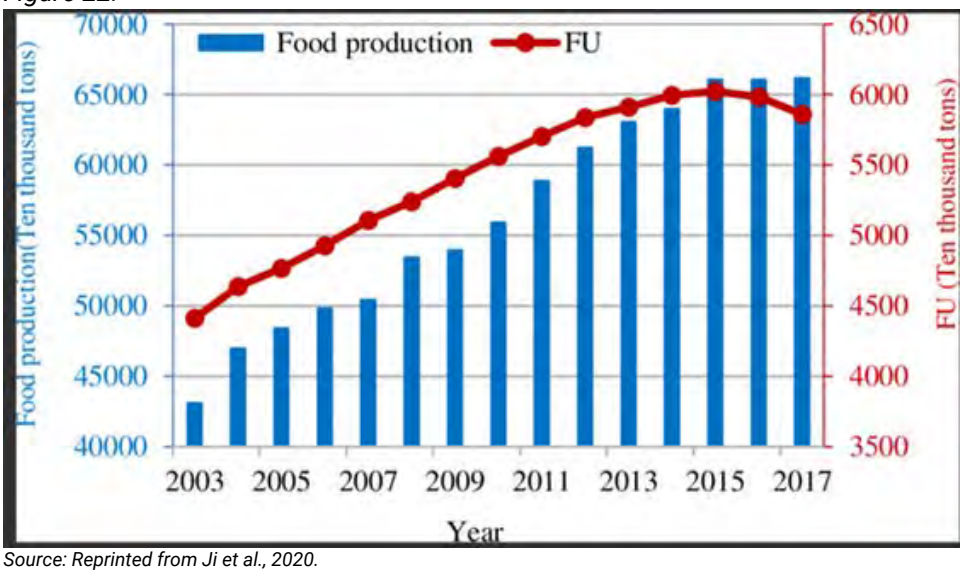
As a net exporter of fertilizer, China doesn't have to worry about its own supply, having been quick to restrict exports as shortages appeared, but it will be concerned as fertilizer shortages reduce food supplies from areas of the world where China procures its imports. However, with the major spike in fertilizer prices driven by disruption of Russian natural gas to Europe and the subsequent curtailment of nitrogen fertilizer production in Europe, we may see reduced crop yields in Europe and much of the world in 2023. As such, China will find it difficult to hold food costs and/or supplies at pre-Ukraine war levels.

Leaving aside the cost issue, Asia utilizes comparatively large amounts of fertilizer to maintain crop yields. Even before the fertilizer price surge, China was attempting to curb what the Chinese government considered overuse of fertilizer causing environmental and ecological damage. Ji et al. (2020) note:

> *"According to the data of the China Statistical Bureau, fertilizer use (FU) in China increased from 44.116 million tons in 2003 to 60.226 million tons in 2015, which accounted for more than one-third of the world's total amount. … In 2016 and 2017, Central Document No.1 noted that the "zero growth action of fertilizer should be carried out"* (Ji et al., 2020).

The results of phasing in a reduction in fertilizer use without lowering crop yields is still being studied but there is concern that after some initial success, growth in production seems to have flattened, as illustrated in Figure 22. This poses a serious long-term challenge to China's food security.

Figure 22.



Source: Reprinted from Ji et al., 2020.

However, there are other significant challenges to China's food security plan. China's soil and water degradation goes well beyond fertilizer as food security must also contend with food and water unfit for human consumption. A South China Morning Post article in 2020 pointed out that food security in China requires major and sustained soils remediation effort to clean up heavy metals: "According to a report from the Chinese Academy of Engineering, it is estimated that 12 million tonnes of grain are polluted by heavy metals every year" (Bao, 2020).

China has a significant problem with both surface water and ground water. As Collins & Reddy (2022) indicate:

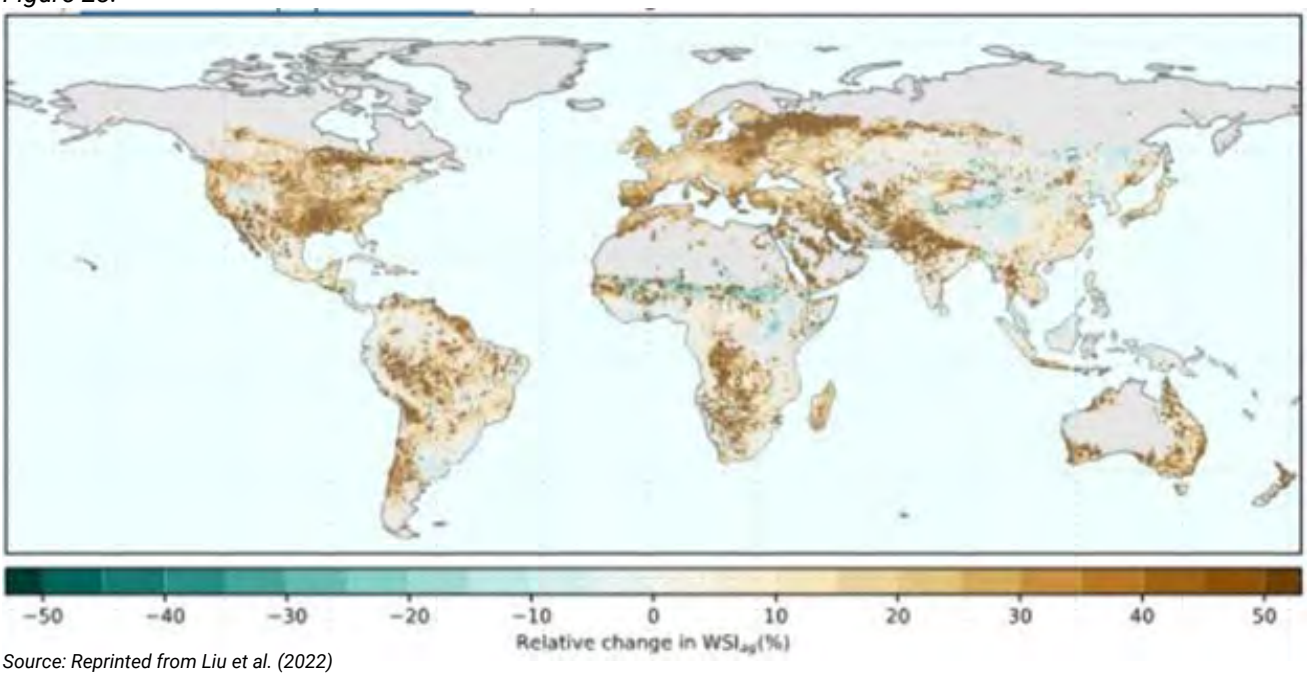
> *"19 percent of China's surface water was classified as unfit for human consumption and roughly seven percent was unfit for any use at all. The quality of groundwater…was worse, with approximately 30 percent being deemed unfit for human consumption and 16 percent deemed unfit for any use"* (Collins & Reddy, 2022).

The global water picture appears threatening to food security more broadly. Figure 23 below maps an estimate, based on Liu et al. (2022). They observed that:

> *"~3.8 million km2 (~39% of total) croplands experienced water scarcity in the baseline period [1981-2005] and it would expand by more than 3% in the future. Under the two scenarios, projections [for 2026-2050] are similar overall and are higher than that under the baseline in 83%–84% of global total croplands"* (Liu et al., 2022).

As is evident from Figure 23, the regions in which water scarcity is expected to worsen overlap heavily with regions of the world where agricultural production is concentrated, many of which have suffered drought in the last couple of years and some in both years.

Figure 23.



Source: Reprinted from Liu et al. (2022)

Drought conditions in 2022 were well covered by global media and coming at a time of falling cereal stocks shown earlier have raised food security concern not only for those in industry and government but citizens everywhere. For many in China, the summer drought and heat experienced in 2022 put at risk both crops in central China and import supplies from areas of the world it has targeted for increased sourcing of food.

When rivers dry up, people drill more wells but large global aquifers are already depleting rapidly. For example, Aldaya (2017) found that approximately 11% of global non-renewable groundwater use was exported through agricultural trade. Logic would suggest that large importers of virtual water embodied in agri-food imports, besides looking to how they can protect and conserve their own water, should be supporting sustainable intensification of food production in those regions where water is more abundant and renewable.

Arguably, the greatest challenge for Asia and particularly China's goal of food security is the growing threat of agricultural and zoonotic diseases. It will be difficult to increase meat and dairy production given the already high density of animals and people sharing the same soil, water and air driving continuous emergence of new diseases. Some diseases, such as African Swine Fever, have demonstrated that they can eliminate a large portion of a country's meat supply and supporting capacity in short order. Others of zoonotic origin such as COVID-19 have human pandemic potential.. The World Health Organization (WHO) regularly checks for mutations that would allow the H5N1 variant of High-Pathogenic Avian Influenza (HPAI) to cross the species barrier more readily or pass from person to person. The world is substantially increasing poultry numbers at the same time as we are seeing a major uptick in HPAI H5N1in wild birds. The result has been large outbreaks affecting chickens and turkeys in Europe, and the Americas, chickens and ducks in Asia and even penguins in South Africa, with the prospect that mutations are allowing it to pass to mammals more readily (Sidik, 2022).

Bacterial infections have also made it difficult to raise animals in the high densities found in Asia without heavy use of antibiotics. This in turn is resulting in high numbers of human cases of antibiotic resistance. The organization for Global Research on Antimicrobial Resistance reported that 1.2 million people died from antimicrobial resistance in 2019, more than either HIV/AIDS or Malaria (The Lancet, 2022).

Even greatly enhanced biosecurity which China and other nations are putting in place is unlikely to work if animal and human densities continue to rise and particularly if they continue to move into previously natural areas where they increasingly come in contact with migrating flocks and wild animals.

The pandemic reminded us how dependent the world food supply is on global shipping. Reliable shipping is critical to food security with about 20% of cereals and a third of vegetable oil moving at some point by water. At the height of the COVID lockdown of Shanghai in April of 2022, 477 bulk cargo ships waited to deliver cargoes such as metals and grain while people in the city were having trouble accessing food. Chinese ports have since largely recovered; however, other ports have not been as resilient, with the port of Vancouver among the world's worst.

Conclusions: How Can the Resilience of the Global Food System Be Improved, and What Is Canada's Role?

This report has established the detailed and diverse context of today's global agri-food system, within which China is the dominant importer, and Canada is among the few net export surplus suppliers. This context can be summarized as follows:

- Demand for food and particularly protein will continue to rise with population and return to economic growth
- Apparent inability to increase global stocks-use ratio of cereals before the war in Ukraine and continued difficulty building useable stocks as war continues and productivity growth is dragged down by climate change, groundwater disappearance, soil contamination, disease, geopolitical trade disruption & infrastructure
- The Ukraine war has driven natural gas prices to levels which make it unprofitable to produce nitrogen fertilizers in European plants and the cost of fertilizer will ration usage, restraining agriculture production globally.
- Energy supply disruption is adding to demand for biofuels diverting increasing amounts of agricultural products from food to fuel
- Cattle and hog numbers are in decline in a number of countries due to high feed costs related to the war, climate challenges, increasing disease and environmental curbs to lessen water pollution
- China's geopolitical effort to diversify its food imports away from the West to suboptimal locations is disrupting investment in sustainable intensification in regions of low carbon intensity agriculture, while creating serious environmental damage in other regions.
- Many countries are imposing forms of export restrictions on food to maintain their food security and affordability, but adding to volatility in prices and global access.
- The pandemic and the war have badly disrupted global food shipments. While some ports have recovered, Canada's largest port remains unreliable and has been waiting for approvals to expand for a decade
- The number of people facing acute food insecurity has soared from 135 million to 345 million since 2019, and 50 million people in 45 countries are approaching famine, while food affordability is a growing crisis in Canada.
- Canada has not recognized the leverage it could have as one of the few net exporters of food staples with potential for substantial sustainable intensification of safe food.

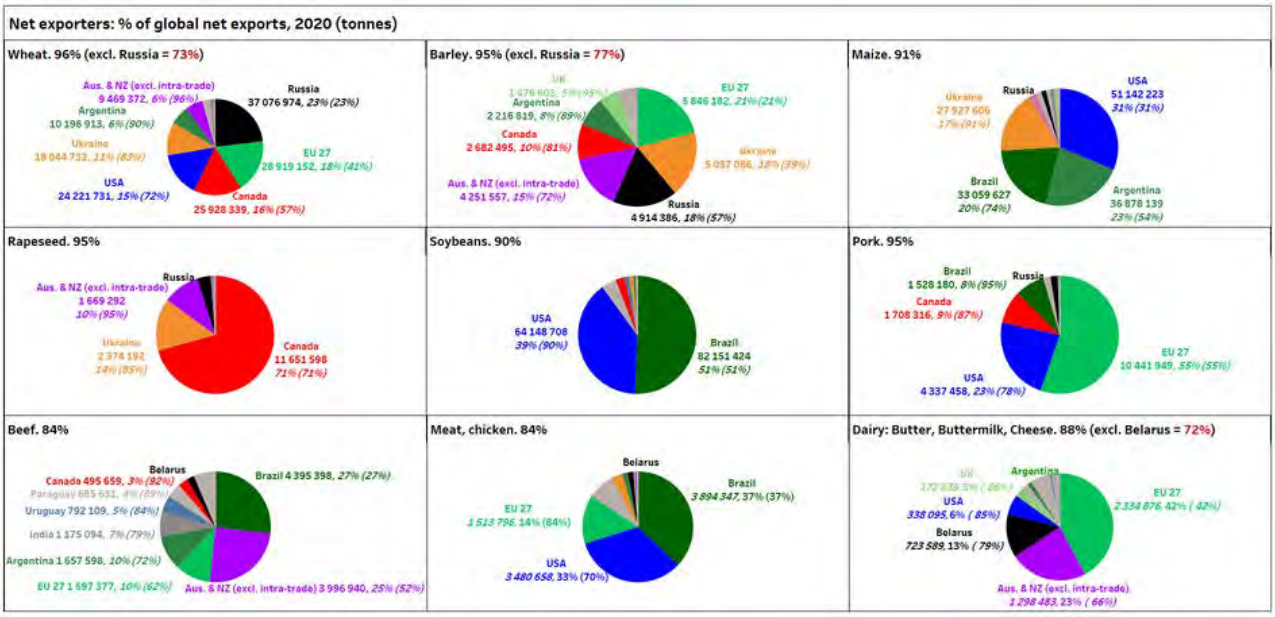
There are major physical challenges to food security without adding geopolitical disruption, which has significantly increased food insecurity. As exports from countries that are actually net food deficit have shown, those exports can rapidly disappear when food gets tight at home (e.g., Indian rice, Indonesian palm oil, Argentinian beef, Chinese fertilizer, etc.).

It is important to identify which countries have production truly surplus to their own needs, and have material and reliable export supplies to offer. This means identification and examination of what net food exports look like for major staple food commodities.

Figure 24 below presents a composite of food staple products by top individual net exporters as a share of total exports. At a cross-commodity level, the figure illustrates that only a handful of countries make up the vast majority of staple food exports. In fact, excluding Russia and Belarus it takes only 3 to 6 countries to account for 72% to 95% of net exports of the staple commodities shown.

As the multilateral institutions governing rules-based international trade have eroded, it should not be surprising that the investment needed to drive sustainable intensification required to feed more people has declined in the face of geopolitical/geoeconomic maneuvering.

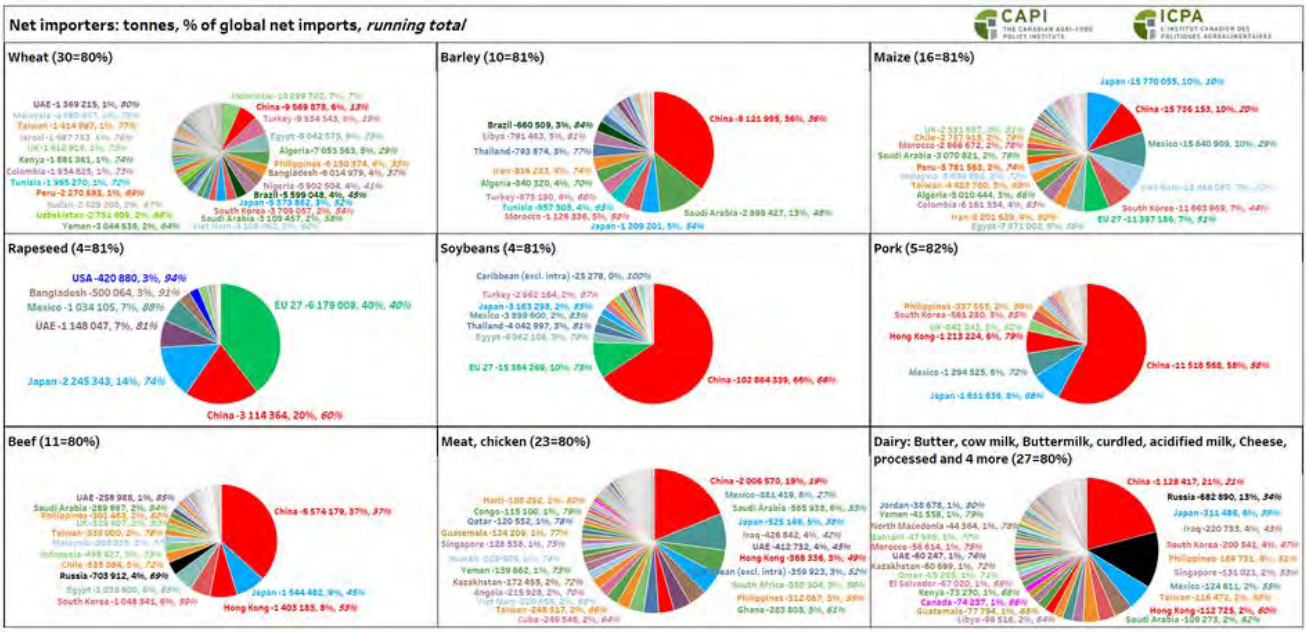
Figure 24.



Data source: FAOSTAT. (2020). Crops and livestock products. [Database]. https://www.fao.org/faostat/en/#data/TCL. Image created internally.

What is perhaps surprising is that the handful of commodity net surplus suppliers have not been able to come together to create a more secure agri-food investment climate. This is particularly the case because, on the net import side of commodity staples, it is a very different story with much less concentrated importers, and many countries lining up for product and concerned as to how much the largest food importer, China, will need in any given year.

Figure 25.



Data source: FAOSTAT. (2020). Crops and livestock products. [Database]. https://www.fao.org/faostat/en/#data/TCL. Image created internally.

The key observation is that the global agri-food system cannot readily respond to food crises when geopolitical/geoeconomic barriers disrupt growth of a sustainable food supply. It is a considerable accomplishment when China can be fairly self-sufficient in many of its key staples from its domestic production. But when and where it cannot, the global markets cannot supply China without drastically shorting other net importers – unless the sustainable net exporters can securely invest to regularly supply China. It would seem in China's best interest to take a proactive role in the development of sustainable international trade – to guarantee their own food security, as well as the food security of other countries in a peaceful world.

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