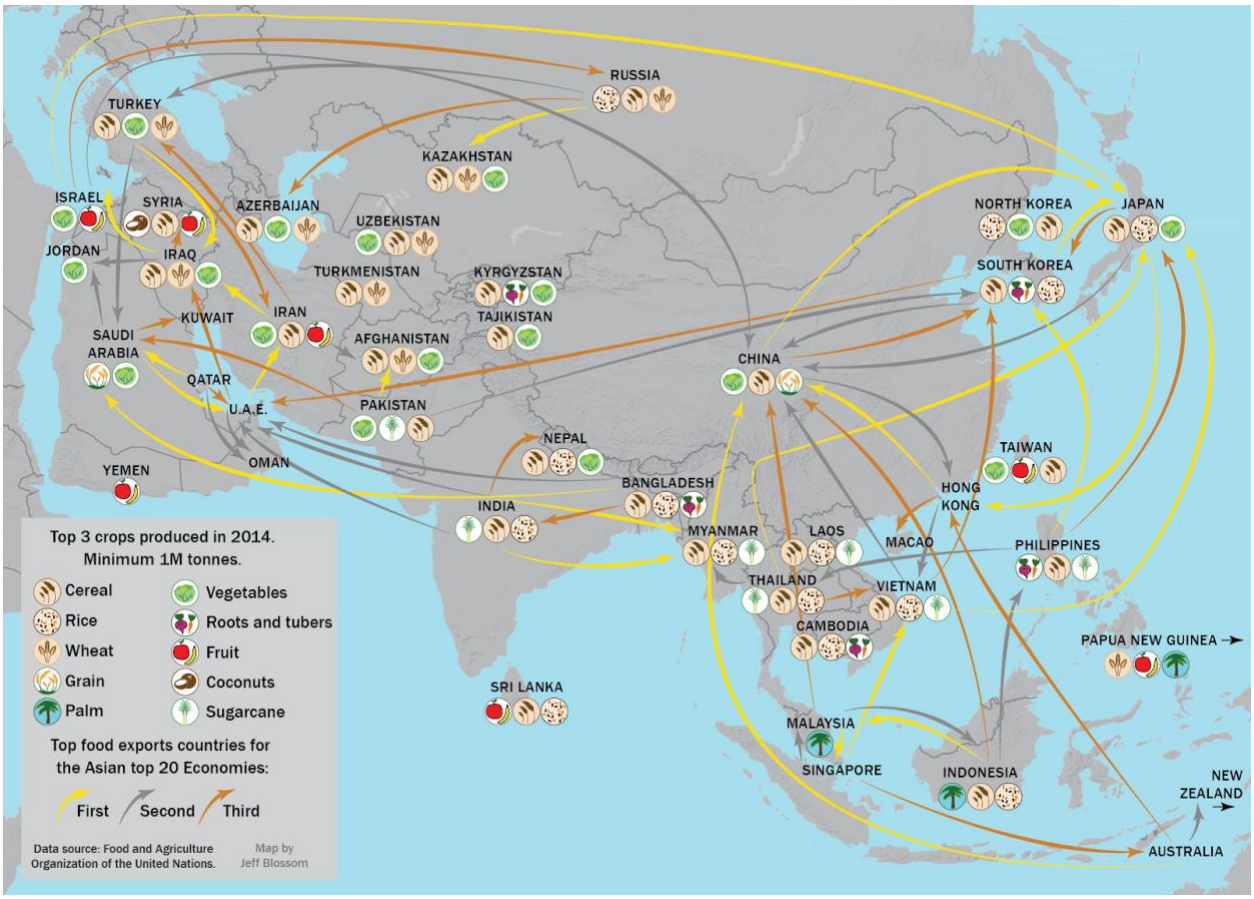
FEEDING THE WORLD ALONG NEW SILK ROADS



(Map by Jeff Blossom)

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The Next Global Transformation

In late 2018, the US-China trade war got serious. In response to the Trump administration's tariffs on Chinese steel, solar panels, and washing machines, China responded by raising duties on American soybeans. While China knew how to hit American farmers where it hurts, there was a particular irony to this move given that soybean cultivation began in China 5,000 years ago, and now China was making it more expensive for its own consumers to buy a crop of which it has become the world's largest importer. Beyond the irony, the unfolding trade war has opened a window into appreciating how the entire global landscape of commodities--the organic building blocks on which our entire human civilization depends--is rapidly evolving in ways very few people properly understand.

Perhaps more than any other commercial endeavor, the commodities market arguably hold the distinctive position sitting at the cornerstone of global economic activity. At the most basic level, everyone needs to be nourished, otherwise they die. Our vehicles need fuel, otherwise they won't move. Our homes and offices need power, otherwise there will be no light, heat, or cooling. When we talk about commodities, we generally refer to the agricultural component consisting of anything that is grown, harvested, extracted, processed, and transformed into any one of many end-user products. These products can be converted for the consumer into either food, fiber, energy, materials or in some cases a form of currency. Agriculture, then, is much more than just 'food.' It includes all of the suppliers, distributors, processing facilities, fertilizer manufacturers, chemical input providers, forestry companies, pulp plants, solid waste facilities, transportation conglomerates, and many other entities that factor into our supply and demand balance sheets.

Furthermore, the agriculture industry is powered by oil, gas, and other fuels, making it one of the largest contributors to greenhouse gases in the atmosphere. Indeed, many industries that do not immediately come to mind but are in fact largely dependent upon agriculture for raw materials include pharmaceuticals, energy, paper, pet food, construction, and cosmetics. The point here is not to list every product that includes something that is harvested from the Earth's soil. Rather, it is to demonstrate that as agriculture is the backbone of the economy for many countries and many more companies, changes to the enabling infrastructure which guides how these products are produced, shipped, sold, and consumed will likely spill over into just about every sector and subsector of global business. It is this agro-energy industrial complex that is undergoing radical disruption.

The past three decades since the collapse of the Soviet Union have witnessed China, India, Russia and other postcolonial and post-Soviet economies joining the world economy; the commodities "supercycle" of surging West Asian (Persian Gulf) energy exports across the Indian Ocean to the fast-growing economies of the Pacific Rim; and massive infrastructure investments across the developing world that have brought large-scale urbanization and booming trade across the entire zone of the pre-colonial Silk Roads known as "Afroeurasia." China's ever-growing Belt & Road Initiative represents the next chapter in the story, with more than 80 member-states convening in Beijing this April to advance the coordination of trillions of dollars of infrastructure spending across the Afroeurasian realm that contains nearly six billion people. From ports and pipelines to

power plants and railways, the new Silk Roads are being resurrected as never before--and have already brought about enormous shifts in how and where goods are circulated across the world--with even an even deeper overhaul in the global supply chains of commodities and material goods yet to come.

New Demands, New Supplies

The manner in which agricultural products move from their geography of origin to the table of the consumer has changed dramatically over the last several decades. As borders have opened and middle class incomes have risen, the demand palate has also expanded. This goes beyond the well-known 'rising incomes-higher protein demand' relationship. Consumers now want to access more varieties of food, regardless of where on the planet it was cultivated. Just think of ancient grains such as farro rice or *teff* wheat from Ethiopia. Furthermore, in richer countries, the surge in demand for food carrying any number of specialty certifications including organic, fair trade, sustainably sourced, among others, means that food producers have more pressure to cater to a wider variety of interests at a high level of quality. So while changes in the supply chain might be driven by consumer demand, it has actually become a supply-side problem for an industry already operating on tight margins. With bulk commodity production and distribution already a razor-thin margin business, those players who don't adapt won't survive.

Take a look at the ingredient label for any random food product and you will likely find soybeans or a soybean derivative near the top of the list. After soybeans are harvested and crushed, the pasty mash goes through separation into oil or meal. Beyond food for human consumption, soybean meal makes up a significant and growing portion of the global animal feed diet. And we cannot leave out the energy sector, where soybean derived oil is reacted with an alcohol and resultant biodiesel can be found powering vehicles, providing energy to the power industry, or further refined and blended into a composite for a myriad of industrial uses. Indeed, there exists a major unresolved tension and competition for oilseeds between their uses for food production versus biofuels, pitting our need to feed a growing world population against our desire for lower greenhouse gas emissions.

The United States is by far the largest soybean producer in the world; Brazil is a not-so-close second. As the top producer, American growers rely on exports to drive the soybean economy, and naturally looks to the world's largest consumer, China, as a customer. But when US tariffs on Chinese goods were implemented last year, China responded by reducing soybean imports from America to zero, literally. In October 2018, China imported approximately 4.7 mmt of soybeans from the US. In November this dropped to 67,000 tons. In December 2018, Chinese imports were zero. The Chinese are still buying soybeans; Brazil filled most of the gap. And the US is still selling soybeans, albeit at a reduced premium and to other customers (including Brazil, which has re-exported them to China). Even as China makes promises about restoring substantial soybean purchases from the US, the episode has shed light on the sprawling global commodities trade and large-scale shifts in buyers and sellers that have major ripple effects on global agricultural supply chains.

The Belt & Road process represents an even more fundamental and relentless shift in global agriculture patterns. Look closely at the trade flows in the map above. The new Silk Roads are opening up both large new quantities of imports from, and exports to, buyers and sellers of Russian wheat, central European sugar beet, Chinese grains and oilseeds, South Asian producers of cotton, and other key commodities. China's investments in Ukrainian wheat have been so substantial that

Ukraine has declared 2019 the "Year of China." Similarly, the Maritime Silk Road Initiative will spur an increased flow of goods from East African origins including tea, coffee and grains, as well as revamping the sugarcane, palm oil, and biodiesel trade with Southeast Asia at the epicenter. The food trade between Southeast Asia and the arid Gulf countries across the Indian Ocean has grown by leaps and bounds in the past two decades.

To illustrate this point, we take a closer look at a couple of notable examples. First, Indian tea production increased by 46% from 846 mm kg to 1,243 mm kg between the 2002/03 and 2015/16 marketing years, making the origin the world's 3rd largest exporter following China and Kenya. In 2018, India contributed 11% of the world's total tea exports, with average tea consumption increasing between 4 and 5% annually over the last decade. As continuation of demand will likely not abate anytime soon, many new customers along ASEAN destinations will benefit from expansion of the BRI transect. The next example we highlight is unfolding in near real time: The seemingly insatiable middle class demand for protein will force supplier diversification. But what happens when there is a hiccup with respect to the world's top provider? There have been recent reports of African Swine Fever spreading throughout China's pork producing provinces, and whenever there is a threat of livestock disease, those involved in sourcing the commodity immediately start to look for alternatives. As China's production is more than double the aggregate output from the European Union, this type of event will open up distribution opportunities for many smaller origins who are considered marginal suppliers such as South Korea, Vietnam, Japan, and the Philippines. BRI expansion will only facilitate trade among these origins, and 'robustify' the global supply chain in the face of acute supply shocks. For these and many more reasons, expect additional material transport and trade routes to open as the reach of the BRI grows over the coming few years.

Technology as Trade Enabler

In addition to physical enablers to commerce via trade route expansion, advances in technology will also serve to alter the supply and demand dynamics related to agriculture. The challenges associated with providing sustainable and reliable flow of agricultural goods to all corners of the world can be partially augmented through the application and deployment of new and emerging technologies.

In many cases, technology is not much more than a band-aid, providing only temporary relief to the underlying symptoms that contribute to global supply risk. We are seeing the adaptation of blockchain technologies, which will allow growers and producers to track issues that threaten supply risk and trace problems to the source much more rapidly than was viable only a few years

ago. But large scale outbreaks will still ripple through supply chains and markets faster than the issues can be contained, and less developed origins with a narrow delivery network can not take on this risk. The same goes with the deployment of drones/UAVs and the suite of low earth orbit imaging technologies. While impacts to yield potential may be spotted and managed earlier, there is still a long way to go before the majority of the world's growers can benefit from these tools. Advances in genomics and synthetic biology can allow breeders to select for characteristics that may protect against crop disease, or survive with less water. But crops are still plants. And plants require water. If there is no water there is no life, so water scarce regions will continue to see pressure under challenging physical conditions.

If we borrow a page from modern portfolio theory, diversification of assets acts as a hedge against poor financial performance resulting from external market forces. Applied to AgTech, securing a multi-origin suite of technological enablers in the face of drought, disease, demand and climate disruption, will help to keep supply flowing when one or more catalysts threaten the physical market. Many of these evolving and emerging technologies augment suppliers' ability to produce a crop in the face of such challenges, while also serving to lower the barriers to entry for newer or smaller origins on the global agricultural stage. This diversification of supply gives buyers more sourcing options. In addition, this leads to supply decentralization, which as we see in finance, acts as a global hedge against supply disruption. The agricultural beneficiaries of BRI enabled suppliers spread the risk against deficits in supply.

Technology-enabled risk management may be starting to change, and a few sectors which stand to benefit more quickly such as aquaponics/hydroponics and data analytics. While not new, each has seen a strong uptick in scale and adaptation that will aid many of the potential BRI originating suppliers. Food producers and distributors employing a combination of these tech domains have the potential to capture market share without the typical ramp-up time that can be associated with more traditional technology cycle deployments. Aquaponic/hydroponic technologies have been in use for decades, but we have seen a surge in the commercialization of these methods in recent years, particularly those with roots in water-stressed areas. This has more to do with open borders than it does with the technology curve, but the timing is right for agriculture players to capitalize on lower production costs combined with larger reach.

On the data side, we are hard-pressed to find an industry that does not claim to be undergoing a transformation connected to data, AI and related technologies, and agriculture is no exception. When we think of data-driven businesses in agriculture, the hardware side comes to mind: weather stations, satellites, plant sensors, Internet-of-Things, and so forth. Large industrial technology companies such as Siemens have developed AgPods, large and mobile vertical farming units that use IoT sensors to constantly monitor and optimize crop yield. Benson Hill biosystems in the US uses machine learning to simulate potential cross-pollinations of various plant species, accelerating by half the pathway to developing new seeds for farmers.

Indigo Ag is one example of a company that is infusing a data driven approach to food and fiber which touches every stage in the agriculture value chain between seed and product. This includes machine learning to guide variety and trait selection, so real time satellite crop monitoring, to

transport and logistics optimization. Further, Indigo's platform builds recommendations and solutions that are customizable to the grower's field of origin, removing the barriers of geography. Indigo's data driven approach to is just one example of what can be a new model for sustainable agricultural production.

While these are all in their own way helping to make the food chain more robust, we can go much deeper with respect to data. Embedded in agriculture are inherent properties which, perhaps, make the category among the most nuanced with respect to the nature of the underlying business drivers. Every region of every country has endemic characteristics related to what they eat, many of which are tied to evolution and culture as well as to necessity. Food, therefore, is the conduit to not only preserve what is unique from origin to origin, but also to expand to new destinations as the notion of homeland erodes. Along with this edible diaspora comes new markets and new customers, and the potential applications of data-driven commercial opportunities as they relate to every step of the food chain from genotype/phenotype selection to destination, are innumerable.

Bumpy Roads: Risks to the Global Agro-Energy Nexus

We need to examine how potential changes in the global climate will dictate future supply lines, and also how climate driven consequences will interact with other risks to the agricultural value chain. Among the threats to food production and distribution that warrant a fresh take on climate-related supply disruption, we include physical, financial, water, disease, technology, and contagion risks.

Consumption Risk

The first supply side risk is largely behavioral, and in turn magnifies other risks. Overconsumption, and the resultant byproduct food waste, is perhaps the most important risk as it is predicated upon choice. Having a seemingly infinite selection of choices, year-round, seems like a positive attribute associated with financial security. But being able to purchase pineapples in New York in February carries a cost: A tremendous amount of resources, chief among them include water and fossil fuels, are utilized to attain a food-on-demand world. Further, this conveyor belt of continuous supply depletes soil, water, and biological resources at an unsustainable pace. Efficiency gains resulting from growing technologies and infrastructure expansion and improvements will help, but may actually exacerbate the problem when the consumer demands continue unabated. This also does not even begin to address the important but oft-overlooked distinction between food security and nutrition security. Today, we may have the technology network in place so that we are able to feed the population (some argue that hunger is more of an access issue than a production one), but for much of the world their calories consumed are empty. In other words, access to cheap mass-produced food with refined grains as the staple ingredient is not providing the adequate nutritional benefit commensurate with daily calorie consumption. If we are to look at food sustainability seriously, as population centers in the east are growing at a faster rate than their western counterparts, the provider community should be looking to develop affordable food products that carry and retain the nutrition that the crops were harvested with.

Physical-Climate Risks

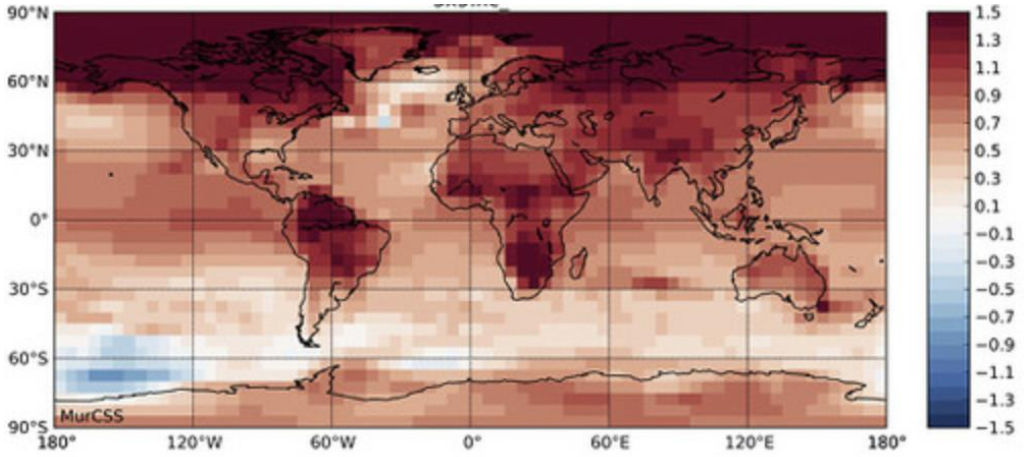
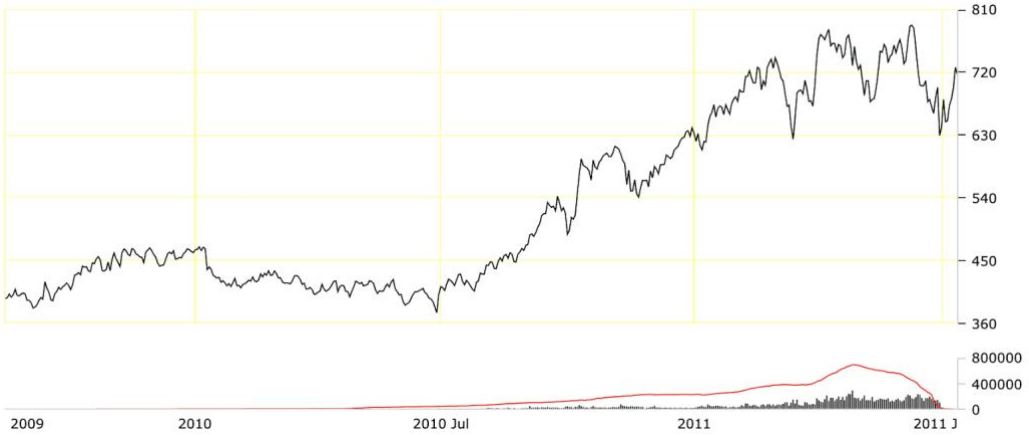


Image courtesy of the Max-Planck-Institut für Meteorologie

Weather-crop disruption is the first climate related consequence. Extreme and acute examples come to mind first: widespread drought decimating the Brazil coffee crop in 2016, US corn in 2011 (see price chart below), and Australian wheat in 2016. Excess precipitation can be equally devastating as the global grains complex is currently coping with the effects of flooding in the US Midwest, Brazil, Central Europe, and several FSU origins. Less publicized but equally damaging can be the slower insidious risks that develop over decades. Among these are the gradual lowering of the water table limiting yield potential of shallow rooted crops, the trend of increasing evening temperatures which disrupt the diurnal cycle exhausting the plant's energy reserves, and multiple consecutive days of triple digit temperatures that increase respiration rates and deplete sugars carbohydrates. All of these culminate in reduced supply and lower yields. Regardless of the causes, climate change and variability will alter the way both agricultural commodity and specialty products are grown, how they are distributed, and even consumed against the backdrop of a growing and more affluent global population. With changes in climate, there will be winners and losers with respect to growing origins. While we can use long range models as a guide, many of the significant changes important to agriculture are expected to continue to occur between 30N and 30S, as we see when we look at the map above depicting projected global mean temperature anomalies changes for the 2015-2022 time frame vs. the 1971-2000 reference period. Slow and steady increases in daytime and evening temperatures are among the more likely outcomes in these regions. New varieties and new origins will likely need to be developed or converted for production, and much of this potential expansion in farmable land will benefit producers operating along the transect of BRI participating countries in the East where projected temperature rises may not be as extreme.



Corn futures chart from tradingcharts.com. This price chart shows the reaction of the corn futures contract to the 2011 US drought, liming supply to the physical market.

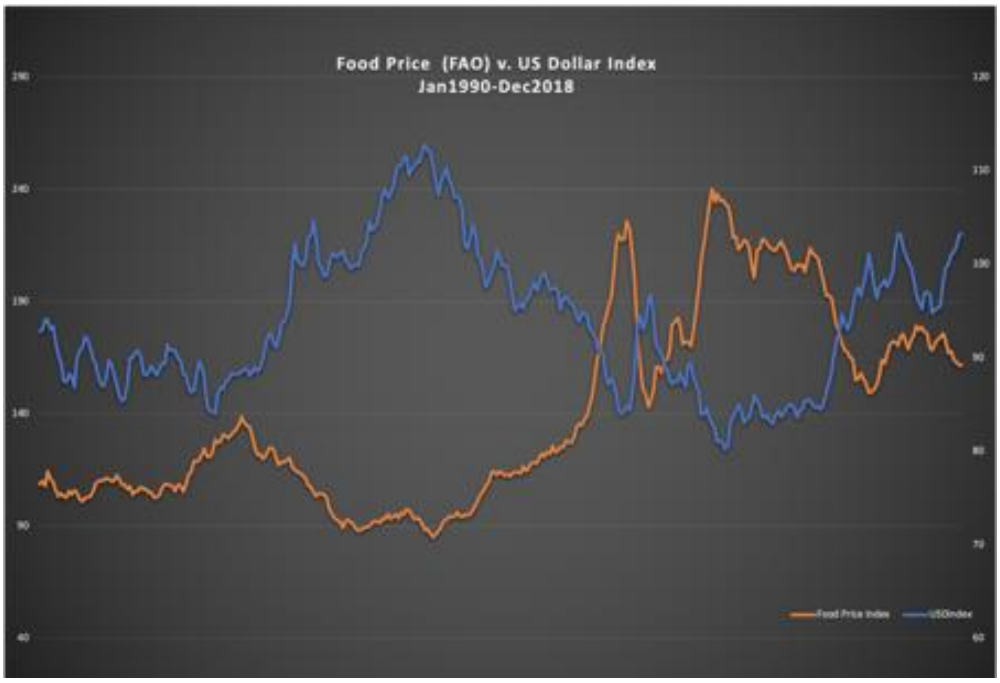
Water-Climate Risks

Perhaps more important than changes in temperature will be how temperature shifts manifest the movement, availability, and distribution of fresh water across the continents. Decadal climate models project a continuation of ongoing trends: Typically wet areas will get wetter, and moisture deficient areas will get progressively drier. Water, particularly a lack of water, is a tricky problem to anticipate. Unlike other environmental resource issues where there is often times an acute trigger before a collapse, a lack of water can have multiple competing factors, and the onset of a problem is somewhat insidious; that is until it becomes an 'event' and there are no viable supply alternatives. Changing water dynamics will alter not only the varieties of annual crops that can be supported in certain geographic regions, but will also impact the investment cycles around longer maturing assets such as tree crops. These perennial biological assets, once planted, are expected to produce commercially viable yield quantities for decades. Beverage plants are another example of physical assets with a longer time horizon underlying ROI. A change in water availability one or two decades after a capital expenditure in these industries complicates the calculus of risk and return.

The water dynamic needs to consider not only the food production component, but also what happens when a 'commons' resource is depleted and the surrounding population suffers the effects. This issue was highlighted most dramatically in recent years when bottling plants affiliated with The Coca-Cola Company (Coke) were held largely responsible for a reduction in freshwater supplies across India and Latin America. Since then, Coke has taken ownership of this issue and started to implement a series of precautionary measures to ensure that this situation is not repeated. Further, they have pledged to ensure that communities in regions where they operate are provided with a more favorable water balance situation than they had prior to their arrival.

How this unfolds in the decades to come in the face of accelerated climate change, however, remains to be seen.

Financial-Climate Risks



Accompanying climate driven changes in the supply side will be another big risk in the liquidity of commodities: Foreign exchange (FX). Using the US dollar as the global commodity benchmark, the 'typical' relationship between currency and commodities has been inverse: A stronger dollar tends to correlate with a suppression of food prices. The chart above shows a high level relationship between USD and the global Food Price Index as determined by the United Nations Food and Agriculture Organization (FAO). Traders typically look for this FX relationship to signal price reversals. While this is a generalized relationship, it does not always hold true, and it is likely to erode further as Asian nations become more important players on the global agriculture stage. A growing number of regional exchanges around the world have started to offer liquid futures and options contracts for commodities, decentralizing the risk and in the process reducing the importance of contracts which originate in New York, Chicago or London.

As more regional exchanges appear across the landscape, two things follow. First there is the availability of a decentralized liquid market, which is the necessary fuel for price discovery. Many market transactions work on paper, then fall apart when faced with real world risk. As markets need buyers and sellers, liquidity brings more participants to the table and as we see in the technology example above, lowers the barrier to entry for new origin participants. Second, once liquidity reaches a critical mass, well functioning markets offer financial instruments such as futures and options, which in turn attracts more capital liquidity and more market entrants. As additional vehicles become available to market participants, price transparency starts to emerge, which leads to a more equitable platform for buyers and sellers. Smaller producers are not squeezed during the procurement and contract negotiation process, and once again, this works in favor of commodity suppliers and distributors that are not among the ABCDs (ADM, Bunge, Cargill &

Louis Dreyfus) of the agriculture complex. While the general idea behind the chart shown above may still apply, as more BRI participant companies grow to become major commercial supply side players, we should expect to see the US Dollar relationship as the global benchmark diminish in prominence. New commodity-currency relationships will emerge to guide market expectations; however, forward views on price may be more tied to an ensemble of foreign exchanges, rather than that of a single country.

Disease-Climate Risks

Changing climate patterns may also enable or suppress the conditions that lead directly to plant or cultivar disease. Moreover, these mechanisms indirectly alter the biomes that disease transmitting vectors call home. Both scenarios can lead to an increase in risk to the food system. There is already evidence over the last few decades documenting the expansion or migration of biogeographical parameters related to certain species' survivability ranges. As temperature shifts, this can lead to the forced migration into/out of traditional biogeographic delineations. As non-endemic species travel into new ecosystems, existing flora and fauna comprised of plants, pollinators and parasites, all are subject to new evolutionary pressures they are not equipped to handle. Evolutionary fitness is tested within one or two generations. Technology can help to protect against some of the stresses, but in the biological arms race, traditional monoculture, the de facto method for most commercial agriculture, is increasingly at risk of collapse. Monoculture cropping is efficient at producing large quantities of food and fiber, with limited diversity, at scale. From the business perspective, this seems to make good sense. As demand increases, companies in charge of satisfying these requirements are providing a product and maintaining profitability, and it is in their best interest to limit the varieties of cultivars. Biology tells us otherwise. Limiting genetic diversity on the supply side leads to susceptibility to disease - particularly those diseases whose vectors have roots in rapidly changing environmental conditions. Biomes in tropical regions where expanding temperature habitability ranges are attractive to microbial invaders immediately come to mind.

Climate change will only serve to exacerbate this potential problem on a global scale. In addition, managing these risks requires significant quantities of field applications including pesticides and herbicides, much of which could be unnecessary. The above mentioned risks notwithstanding, in many of the top grain and oilseed producing origins including the United States, China Brazil and the EU where large agribiz and the resultant relationships are is in the driver seat, there is little financial incentive to operate differently.

Again, this uncertainty around a reliable and continuous supply chain will force those responsible for sourcing material to diversify their supply base, favoring new origins in the East where opportunistic BRI participants can be leveraged for a market advantage. Vietnam went from a small producer to a major coffee exporter in a period of a few years. India is now the first or second largest producer of many crops that barely registered on global balance sheets a decade ago. And the potential for new origins throughout Africa shows promise for dozens of commodity and specialty crops impacting millions of small shareholder growers. Decentralization via BRI expansion will hedge against these crop disease via new origin expansion.

Contagion-Climate Risks

This cursory overview of the risks described above should highlight the precarious nature of the global food supply network. However, while each of these individual risks carry significance, when one or more of these factors occur in a short duration, we potentially move into threat multiplier territory. The cascading effects from supply disruption in one market can easily spill over into several other markets, and this in turn reintroduces additional pressure on underlying FX risk. When supply origins are in an unfavorable currency position and physical material and product decisions for delivery several months forward are shifting in near-real time, the fallout can be severe. Again, low margin producers get squeezed and bear the brunt of the losses. We have seen this play out numerous times on a smaller scale with LatAm and East African origins, and with BRI opening up avenues for new trade partners, the likelihood of increased risk, and the subsequent effects of contagion will surely heighten.

For a reminder of potential contagion risk, recall the Arab Spring protests from 2011. While this was undoubtedly the consequence of myriad of contributing factors, one of the key catalysts for this event was tied to the ability of citizens to access ingredients to make or purchase bread, namely milled wheat. By 2010, numerous Arab countries had Russia as their largest wheat supplier, but Russia's heat wave and drought that summer forced Moscow to ban wheat exports, leading to a significant spike in prices for which Arab governments were unprepared to respond. We of course can not say for sure that having access to additional supply markets would have prevented the Arab Spring. Again, if we apply a blend of the precautionary principle with basic functioning of biological systems via evolutionary fitness, we could argue that redundancy (ie., expanded supply) favors the prepared when faced with stress, and monoculture (i.e. limited supply or resources) is the precursor to bottlenecks, adaptations, and collapse.

The (Belt and) Road Ahead

It is no secret that traditional agricultural commodity traders have experienced a difficult time maintaining an edge in the hypercompetitive market space in recent years. The BRI will change that. As more data has become available to an ever increasing number of market participants, longstanding commodity corporates who once dictated physical and financial stocks and flows no longer have eminent domain with respect to market moving information. As a result, funds have closed, banks have sold off entire commodity units, asset managers have literally become a commodity themselves, and high frequency traders are picking up the financial crumbs. But this in no way supports the notion that the commodity complex does not have massive opportunity, particularly with a more decentralized and inclusive global trade.

With BRI and other evolving network partners operating with one another, countries who had no previous relationships can become trading partners within months. Further, many models that were built and quantified on historical trade partnerships no longer have merit. As an increasing number of supply-side entrants will now be contributing physical agricultural supply to a world market which demands more products with greater diversity, suddenly any given country's currency is now exposed to that of every other country in the world. It is not just the strength of the Dollar versus the Real/Renminbi/Rupee, but rather the USD versus any country of choice. Being able to navigate through this new interconnected world where borders are less important than regions is where the smart money should be placed. The BRI, and other forthcoming initiatives that might choose to replicate this example, may hold the potential to serve as the only viable means to sustainably feed the world. We maintain that the expansion or the diversity with respect to supply-side sources in commodity networks coupled with lower-cost and low latency technological solutions, can dissolve barriers to entry for emerging market participants, while at the same time providing opportunity and hedging risk.

Global infrastructure connectivity and integrated markets further propel us towards a supply-demand world of more decentralized service providers and equal access to resources, essential conditions for our collective survival and stability in an unpredictable world. A decentralized approach towards global agriculture may ensure that global supply meets growing demand requirements, while also encouraging equitable participation regardless of geography. Bringing food and fiber to the world while minimizing origin control by a few large players may be the only way that these challenges can be met.

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