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Institute | Food disruption

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# Food innovation: Investing to feed our future

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Our mission is to provide our clients with research that meets their needs and concerns. We do this by listening, understanding, and then harnessing the resources of our firm to answer the challenge. We organize around areas of exploration to develop distinct insights and their practical applications.

# Foreword

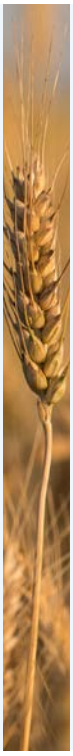
**Anne Simpson**
Global Head of Sustainability
Franklin Templeton

I write this from Cambridge, England, where I just spoke with a group of investors, asset managers and researchers on the growing risk of climate change on increasing vulnerability to famine,[1] which illustrates how critical food security will be in the coming decades. This conversation is happening while the war in Ukraine is a stark reminder of the geopolitical risk in agricultural supply lines. Disruption of the region's critical wheat and fertilizer exports threaten to push an estimated 33 million–47 million more people in 81 countries to the brink of famine in the coming year.[2] It struck me sitting in Kings College—nearly 600 years after it was founded by Henry VI—that we've seen extraordinary progress since that time, yet many people globally continue to face the existential challenges of hunger and war, and we all face the consequences of climate change. What gives me hope is we have a vision and a framework for the future, and the technology and finance to tackle these challenges.

I'm personally thinking of these challenges, set against the Sustainable Development Goal of "zero hunger," which we are a long way from at present, despite the advances of the "green revolution" and the best efforts of humanitarian organizations. The United Nations World Food Programme is currently feeding no less than 115 million people displaced by war, famine and drought—and it forecasts it will raise less than half of the US$18.9 billion needed to feed an estimated 137 million people in 2022.[3] On top of this, COVID-19 pandemic-induced inflation has increased food prices over 30%, creating an additional US$42 million in monthly costs to feed vulnerable populations.[4]

The investment needs are tremendous, which is where the deployment of new, smart capital can be so important. As my colleagues explore throughout this paper, feeding a growing global population in the midst of climate change, geopolitical shocks, and uncertainty over the coming decades requires innovation in food and agricultural technologies; re-thinking old paradigms; and, investing in solutions that not only boost agriculture productivity and food's nutritional value but also reduce negative impacts on the planet—for which agriculture is a significant contributor—and improve the health of our global community.

As asset managers, our job is to actively identify opportunities and risks in the financial markets, and strive to protect our clients assets' while pursuing sustainable risk-adjusted returns. Understanding investment and impact is what sustainability is all about: taking care of people, the planet and prosperity.



# The future of food is technology

**Stephen H. Dover, CFA**
Chief Market Strategist
Head of Franklin Templeton Institute

I am not an expert on climate change. Therefore, I will leave it to those experts and environmental, social and governance (ESG) specialists to talk in detail about the impacts of climate change on our food system and which government policies are required to address or decrease impacts. I am looking at the future of food and the innovation and technology that will be needed to safely produce and distribute the food we need from the perspective of an investor. That said, it is clear the food system—which makes up 10% of the global economy[5]—is increasingly a major driver of climate change, and at the same time is disrupted by climate change. This disruption will impact global investors across asset classes—in equities alone, food makes up US$4.9 trillion or approximately 4% of global market capitalization.[6] So, it's critical that we think about how investors respond—whether they focus on ESG or not—to identify opportunities in the market and potentially avoid risk that could materially impact their portfolios.

## 5 basic food inputs

Companies harnessing technology and driving innovation to maximize efficiency of these inputs will provide growth and investment opportunities for investors, in my view:


I have some history in agriculture being from a fourth generation ranching family in Montana. Anyone associated with a ranching family gains a lifelong education on the food supply chain, commodity prices, and the challenges ranchers and farmers face every day to get their product—whether it's a cow or a bushel of wheat—to market. Despite this experience, I am somewhat surprised by the level of sophistication in today's food business. Food is no longer a story just about land, water and weather; it is a story about technology, innovation and the future. It's clear to me that food innovation, and the future of food production, will play a major role in markets over the coming decades.

> **"The global food system is responsible for 70% of global water use, over 50% of biodiversity loss and over 33% of GHG emissions contributing to climate change."**

## Food's environmental impact

At the recent COP26[7] conference, members of the Glasgow Financial Alliance for Net Zero (GFANZ), of which Franklin Templeton is a member, signed a commitment to deploy over US$100 trillion in financing over the next three decades to move the global economy toward net zero carbon emissions by 2050. The capital will be deployed over 24 major initiatives, one of the largest and most important being the transformation of the global food system—which will need to feed over

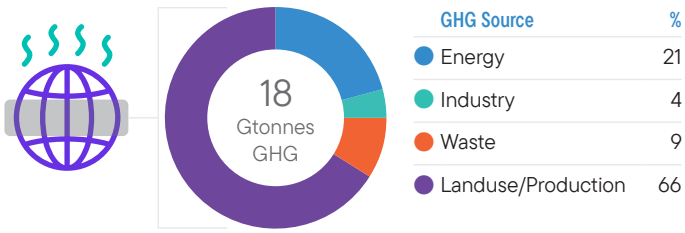
9.3 billion people and produce 70% more food by 2050 than we do today, while simultaneously reducing its significant negative impact on the environment.[8]

While today's global food system makes up nearly 10% of the global economy—the food system is valued at over US$8 trillion a year—it also generates over US$12 trillion a year in negative externalities ranging from water and air pollution to food-borne diseases and health impacts from unhealthy food and exposure to toxic pesticides and fertilizers.[9] In stark terms, the globe is taking on a US$4 trillion loss each year to finance a food system that is unsustainable, unhealthy, inequitable, unstable and one of the biggest contributors to climate change. As seen in Exhibit 1, it is estimated that over a third of greenhouse gas (GHG) emissions—one of the leading contributors to climate change—come from food systems.[10] This estimate accounts for the full cycle of food production—including supply chain, packaging and retail—whereas previous calculations often accounted for GHG emissions only on the farm or pasture.

### Feeding Global Emissions

**Exhibit 1: Annual Percentage of Global GHG Emissions from Food System***

As of 2015




1/3 of Global Emissions Come from the Food System

Source: Crippa, M., Solazzo, E., Guizzardi, D. et al. 2021. Food systems are responsible for a third of global anthropogenic GHG emissions. *Nat Food* 2, 198–209. *Note: Based on most current data available from EDGAR-FOOD, which covers all six stages of the food system: (1) land use/land-use change; (2) production; (3) processing; (4) food distribution, including packaging, transport and retail; (5) food consumption, including domestic food preparation activities; and (6) waste/end of life.[11]

Food system GHG emissions are also creating a negative feedback loop. As emissions continue to grow, global temperatures continue to rise—additionally, higher $CO_2$ levels in the atmosphere reduce nutrient levels in foods. As global temperatures continue to rise, farm yields continue to fall. Decreased productivity depresses supply and leads to increases in food prices. Combining falling yields, lower nutritional value and higher prices creates higher prevalence of food insecurity.

Mitigation of these trends will require a broad range of solutions, including addressing issues around policy, land use, diet, waste, subsidies, trade agreements, etc. These changes are where financial markets and investors will also play an important role—particularly in the deployment of some of the US$100 trillion in capital GFANZ pledged over the next few decades.

## Three reasons food matters for investors

**1. Food industry innovation requires innovation in financing**

So, what does this mean for investors? In my view, three main points. First, innovation in the food industry must be financed. Whether it be funding for improving traditional farmers' production, the move to high efficiency indoor agriculture, startups developing alternative proteins, or helping companies build supply-chain resilience, all will require large capital inputs from equity, fixed income, and private markets. And, if we're expecting the food industry to innovate, the asset management industry must also innovate to create investment vehicles to address these large-scale changes. This may require rethinking traditional funding models, including the duration and types of loans, direct impactful investing and aligning investments to long-term sustainability goals, such as the UN Sustainable Development Goals (SDGs). And, due to the significant impact agriculture has on GHG emissions—discussed in more detail in the macro-view section on the next page—it is critical that carbon trading and carbon markets develop as soon as possible.

**2. Investors should consider unintended consequences**

Second, the food system is highly complex and interconnected, and deployments of capital must consider unintended consequences (read: negative externalities). Changes in the system create ripple effects that have long-term impacts and can lead to severe disruptions. We've seen these disruptions during the COVID-19 pandemic—discussed in more detail in the COVID-19 impacts section on page 7. One ripple effect I have seen firsthand is how the change in diet in China has affected the health of Chinese people and the environment globally. When I first started traveling to China in the early 1980s, most of the diet was plant based with just a small amount of meat—usually pork. In the early 1980s, the average per capita consumption of meat was just over 13 kg per year, as seen in Exhibit 2. Obesity, diabetes and other diet-related diseases were rarely reported during the 1980s in China. With the opening of China's economy and subsequential rise in average incomes and a growing middle class over the last few decades, meat consumption now hovers over 60 kg per year.[12] The significant increase in meat in the Chinese diet corresponds to a nearly 7x increase in beef consumption since 1990.[13] Increasing appetite for

## The growing role of private markets

**Though public markets play a critical role in our food system, I see private markets playing a growing and significant role in food innovation going forward. Here are a few examples:**

**Venture capital** investing in foodtech and agritech start-ups is rising steadily. From 2015–2019, over US$45.6 billion was invested in foodtech startups in 3,200 deals.[14] We believe this space will continue to grow as start-up companies explore lab-grown meat, 3D printed food and other innovations.

**Private equity investing** is playing a major role in mergers and acquisitions of food giants. The deal landscape slowed a bit during COVID-19 but has picked up again, with North American transitions in the third quarter of 2021 exceeding US$13.6 billion, 76% of which was by private strategic buyers and private equity firms.[15]

**Real estate** will play a major role in the expansion of controlled environment agriculture (CEA) and vertical farming. Much of this growth will happen closer to urban areas through in-fill or suburb/exurbs in order to guarantee fresh produce is delivered short distances to consumers. The global CEA market is expected to reach US$172 billion by 2025, and the vertical farming market is expected to exceed US$31 billion by 2030.[16, 17]

**Private debt** will play a key role in the coming years in providing funding to farmers making the transition from traditional to regenerative agriculture. In 2019, US$3.6 billion in private loans was issued in the United States through private debt mangers, with US$2.8 billion having loan criteria tied to regenerative agriculture.[18]

beef in China is linked to accelerating deforestation of the world's greatest carbon sink, the Amazon rainforest, where many cattle are now being raised.[19]

The change in diet is not limited to meat—we're seeing increased consumption of sugar and fat, resulting in significant increases in type 2 diabetes in China's populace. Less than 1% of China's population suffered from type 2 diabetes in 1980; that number is now close to 12% in 2022—in raw numbers, roughly a jump from fewer than 10 million to over 170 million people.[20] This increase has economic ramifications. In 2015, it was estimated that type 2 diabetes generated US$1.32 trillion of negative impact on the global economy, and, by 2030, it is estimated to have a negative impact of US$2.25 trillion–US$2.5 trillion. With the world's largest population, China leads the globe in financial loss from type 2 diabetes. That loss is projected to grow to consume 3%–5% of China's forecasted 2030 gross domestic product (GDP).[21] As China becomes a larger segment of the emerging

### China's Growing Taste for Meat

**Exhibit 2 Top: Average Total Meat Consumption Per Person in Kg/Year, 1980–2017**

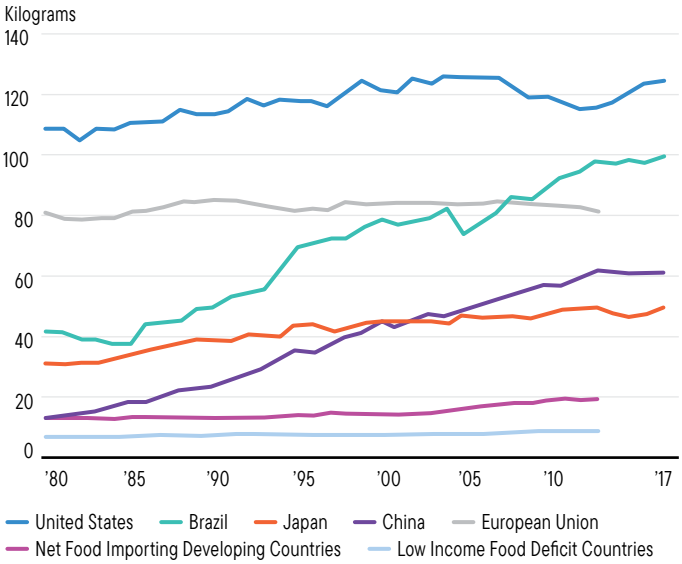
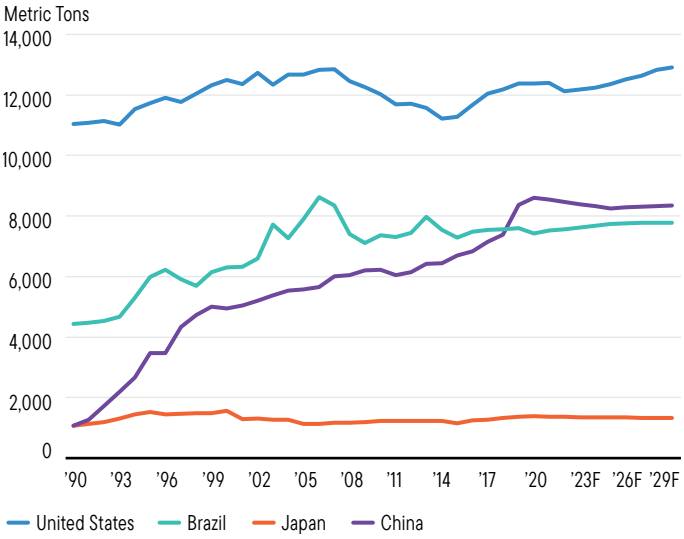



**Exhibit 2 Bottom: Beef and Veal Consumption in Metric Tons/ Year, 1990–2029F**




Source Top: United Nations (UN) Food and Agriculture Organization (FAO). Note: Data excludes fish and other seafood sources. Figures do not correct for waste at the household/consumption level, so they may not directly reflect the quantity of food finally consumed by a given individual.

Source Bottom: OECD-FAO Agricultural Outlook (Edition 2021). There is no assurance that any forecast, estimate or projection will be realized.

market index—and it really should be considered a developed market, in my opinion—this could have a significant impact on investors' assets going forward.

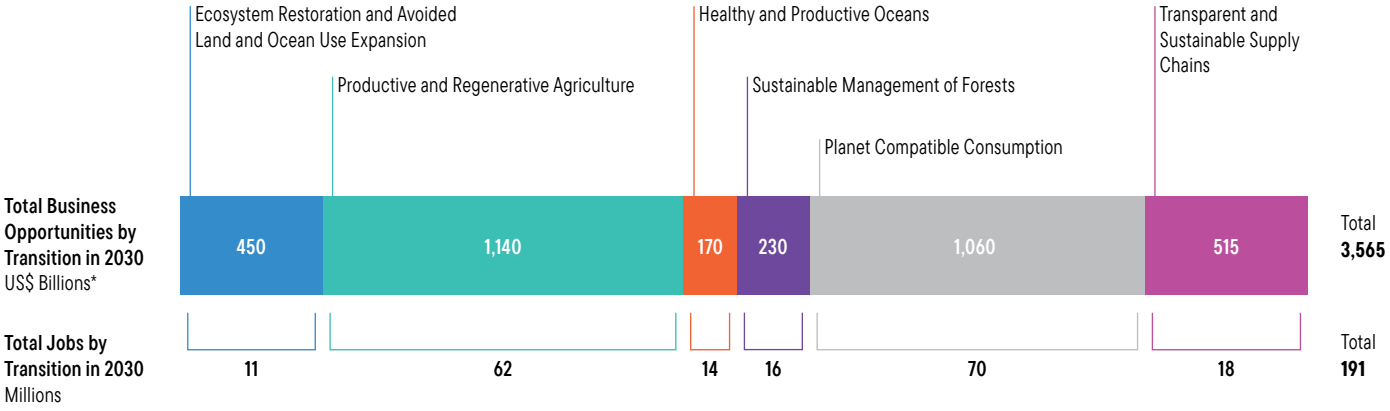
### 3. We need better financial incentives and environmental impact measurements

Third, as we invest in innovation to help reduce negative externalities, a market based approached where we more effectively measure and price environmental impact will be necessary. More directly: the economic value of natural

systems and the risks to these systems' further degradation must be accounted for in asset pricing. To give context, the World Economic Forum (WEF) and PricewaterhouseCoopers (PwC) have estimated that more than half of global GDP, is moderately to highly dependent on natural systems under threat—essentially, half of global GDP has significant risk exposure to changes in nature.[22] Like me, I expect that number may make you gasp. However, for investors, there is opportunity on the other side of this equation. The opportunity to help fund the global economy's transition to a nature-positive economy—which the WEF has defined as "enhancing the reliance of our planet and societies to halt and reverse nature loss." It is estimated this transition will generate US$10 trillion in additional business revenue and cost savings and over 395 million jobs by 2030—of which US$3.6 trillion and 191 million jobs are directly related to changing the food system, as seen in Exhibit 3.[23] Examples in the food sector include funding regenerative agriculture; creating sustainable and healthy fisheries; stopping biodiversity loss (food production is one of the leading contributors); reducing food waste; and creating efficient, transparent and sustainable supply chains.

## Transition = Investment Opportunity

**Exhibit 3: Six Transitions in the Food System Fueling Job and Business Opportunities (US$)**




Sources: Food and Land Use Coalition (FOLU); Business and Sustainable Development Commission (BSDC); The Nature Conservancy (TNC); World Resources Institute (WRI); McKinsey Global Institute (MGI); Market research; Literature review; AlphaBeta analysis. *Based on estimated savings or project market sizing in each area. These represent revenue opportunities that are incremental to business-as-usual scenarios. Where available, the range is estimated based on analysis of multiple sources. Rounded to nearest US$5 billion. There is no assurance that any forecast, estimate or projection will be realized.

## COVID-19 impacts food security

The COVID-19 pandemic was a wake-up call and glaring reminder of the fragility of our food system. Nearly a billion global citizens faced moderate to severe food insecurity in 2020, according to the United Nations (UN)—over 320 million more than 2019.[24] During 2020 and 2021, the pandemic accelerated the number of people with food insecurity faster than the previous five years combined, and 2022 projections are expected to exceed previous numbers.

Developing economies in Africa, Asia and Latin America experienced the fastest growth rates of food insecurity. However, developed countries, like the United States, also experienced significant jumps. Prior to the COVID-19 pandemic, US household food insecurity had hit a 20-year low largely due to historically low unemployment numbers and dropping poverty rates.[25] All three of these numbers saw significant jumps in 2020, with food insecurity jumping from 11% of US households prior to the pandemic to over 15% in 2020.[26] US households with children saw even larger increases, with over 17.5% experiencing food insecurity, and communities of color—who already were experiencing disproportionate food security issues—saw rates rise to 19%–25%.[27]

Countries in the European Union (EU) reported less significant jumps; however, that may be in large part due to the significant role food banks played in maintaining food security—with European food banks distributing almost 70% more food in 2020 than they did pre-pandemic.[28] While the EU may have escaped food security issues at the levels seen elsewhere, it did not escape the inflationary pressures seen globally on food prices. Food price inflation hit a peak early in the pandemic, at over 4% in April 2020, and has been on the rise again since late-2021, hitting a new peak of 8.9% in April 2022[29]

## Food-water-energy nexus

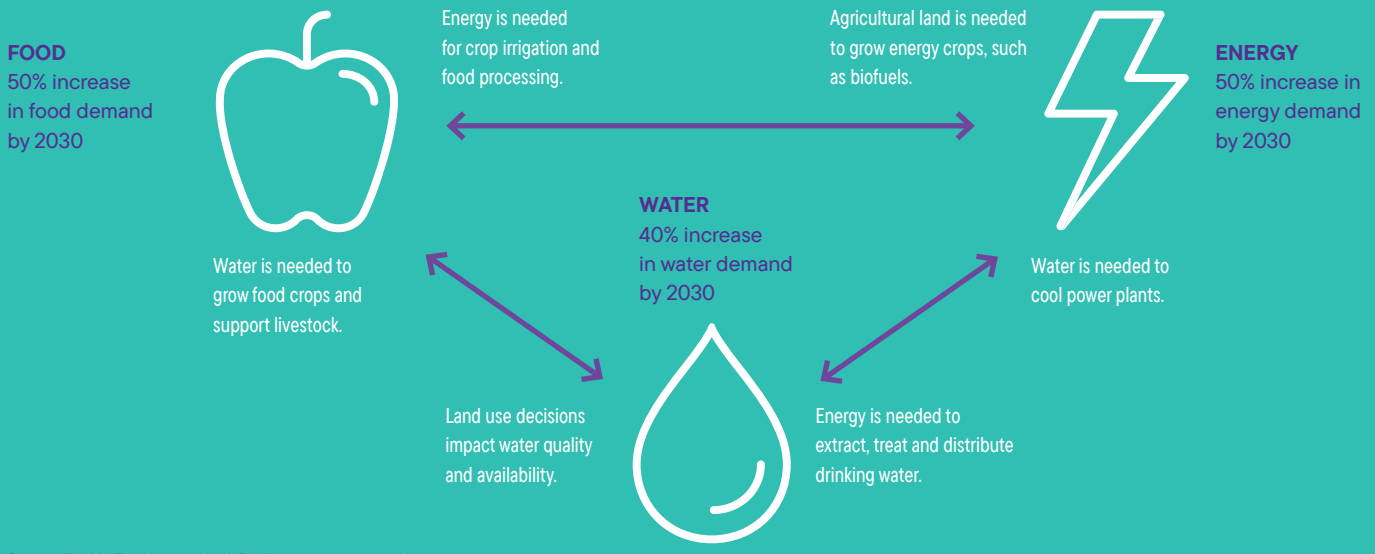
It is the intersection of food, water and energy—commonly referred to as a "nexus"—where the interdependencies and complexities of the global economy peak. These interactions rank among the most complex global challenges today and will only grow over the coming decades. Food production cannot happen without energy production and water availability. As investors, our goal is to seek to understand the effects of these complex interactions on companies and industries.

Agriculture accounts for 70% of global freshwater use, and over 25% of global energy production is consumed by food production and supply.[30] Due to urbanization, population growth, climate change and increased adoption in developing economies of high caloric diets now common in developed economies, the World Bank estimates global agricultural production will need to expand 70% by 2050 in order to meet demand.[31]

With climate change-related temperature increases, the United States Agency for International Development (USAID) has estimated crop yields of major staple crops, like corn and wheat, will drop up to 30% between 2030 and 2050. At the same time food demand rises, we are likely to see drops in production if major changes are not implemented. Without action, global financial markets, trade and food security may suffer major shocks.

Can't Have One Without the Others

**Exhibit 4: Food-Energy-Water Nexus**




Sources: Franklin Templeton and UN. For illustrative purposes only.

Our first piece in this Food-Water-Energy Nexus series, *Water disruption: investment risk from multiple angles*, focused on water. In this piece, we focus on food, and our final piece on environmental disruption will delve into energy. It is this trifecta where we see the most potential for risk, price disruption and overall market impacts as we move into the next years and decades.

# Disruptive nature: extreme weather's impact on food prices

**Ashley Allen**
Research Analyst, Corporate Credit
Franklin Templeton Fixed Income

The current market environment is showing us one aspect of the potential long-term trends caused by climate change and extreme weather events—increased consumer prices. Over time, these increased incidences of intense weather conditions and the market dynamics they create may lead to long-term changes in how agriculture is produced and how food is consumed. These changes—such as sustained price increases or a change in consumption patterns (should they occur)—present an investment opportunity for those credit issuers who can lead with innovative solutions to meet rising global demand, or those who consciously work to mitigate the social impact of climate change, specifically within the communities they source from.

## Extreme weather impacting food prices

In 2021, extreme weather in the United States cost US$145 billion in economic damages[32]—the third costliest year on record behind 2017 and 2005. Intense December tornados across parts of the South caused extensive damage to chicken hatcheries and grain silos, while record heat this past summer in the Pacific Northwest caused potato crops to produce lower yields, and fruits, such as berries and apples, to ripen and rot faster than farmworkers could pick them.

However, the United States was not alone in experiencing the impact of climate change as the entire world witnessed a higher frequency of severe weather events. In South America, Brazil saw some of its coldest weather in more than 25 years, causing frost to impact both coffee and sugar crops.[33] Dryer than normal conditions across most of the South American continent have also caused severe drought in countries such as Argentina, Chile and Bolivia, and have impacted important crops in those countries, such as soybeans and corn.

These challenging weather conditions have not been limited to just the Western Hemisphere. In Russia, the world's largest wheat exporter, the total wheat harvest for the first half of the 2021–2022 planting season was down 21% Y/Y, due to hot weather conditions that resulted in lower yield.[34] And in several EU countries such as Germany, Belgium and Austria, severe flooding this past summer lowered the harvesting yield of grain crops there as well.

Recently, these lower crop yields have coincided with high global consumer demand and have contributed to higher commodity pricing. As seen in Exhibit 5, the commodity price of corn and wheat grew 23% and 20% respectively in 2021.[35] Year-to-date (YTD), the geopolitical conflict between Russia and Ukraine placed additional upward pressure on several

**"These challenging weather conditions have not been limited to just the Western Hemisphere. In Russia, the world's largest wheat exporter, the total wheat harvest for the first half of the 2021–2022 planting season was down 21% Y/Y, due to hot weather conditions that resulted in lower yield."**

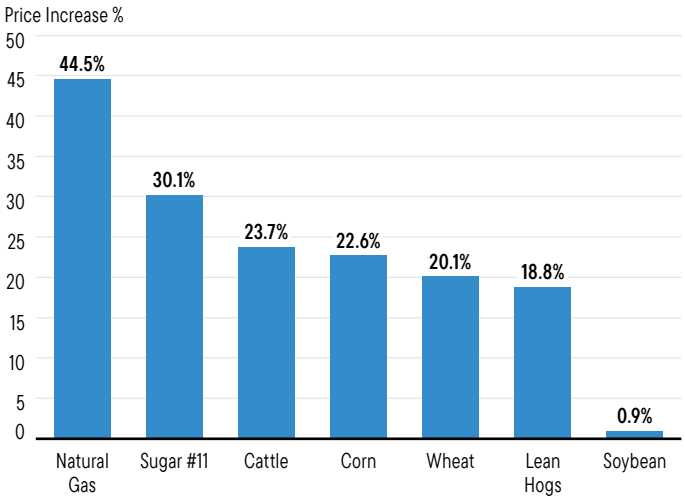
commodities, including wheat and corn (up 56% and 28% YTD, respectively), as concerns regarding limited export/supply from the region has increased.[36] It's also worth noting that input costs to grow these crops (and others) have risen as well, placing additional financial strain on farmers across the globe. Key inputs such as nitrogen fertilizer have more than doubled in cost following global price increases in another commodity: natural gas, which rose 44% in 2021.[37] This is an acute challenge in developing economies where small famers lack access to the capital/credit needed for upfront fertilizer purchases. Without the use of fertilizer, crop yields will decline and contribute to a further reduction in supply, resulting in continued price pressure (to the upside) on commodities. As a result, input costs for food manufacturers, who must purchase commodities for use in manufacturing, have risen. To help maintain their profit margins, many food manufactures have raised prices on the goods they sell, which has contributed to rising food costs for consumers across the globe.

According to the UN Food Price Index, food prices globally rose 28.1% in 2021 vs. 2020 levels. The biggest year-over-year (Y/Y) price increases were seen in vegetable oils (+66%), followed by sugar (+38%), cereals (+28%), dairy (+17%) and meat (+13%).[38] Senior Economist Abdolreza Abbassian of the UN Food and Agriculture Organization (FAO) is further quoted as saying "While normally high prices are expected to give way to increased production, the high cost of inputs, ongoing global pandemic and *ever more uncertain climatic conditions* leave little room for optimism about a return to more stable market conditions even in 2022."[39]

### Higher Commodity Prices Driving Higher Input Cost

**Exhibit 5: 2021 Commodity Price Increases**

January 4, 2021–December 31, 2021




Source: Bloomberg.

## Consumer impact

In addition to rising commodity costs, other rising supply chain costs such as transportation, paper and packaging, and labor have also added to food price pressures in the United States. For example, the USDA Grain Transportation Cost Indicator for Barges (GTRIBARG) shows that grain shipping costs via barges have nearly doubled over the past year, while median US Y/Y wage growth as measured by the Atlanta Fed (WGTRMDWG) rose to its highest level ever (since the Federal Reserve Bank of Atlanta began tracking the data in January 1997), coming in at 5.8% (Y/Y growth) in February 2022.[40]

Recent Consumer Price Index (CPI) data from the US Bureau of Labor Statistics (BLS) show that prices for food items consumed at home increased 7.9% Y/Y in the month of February 2022, as seen in Exhibit 6. By magnitude, the largest increases in key categories were seen in meats, poultry, fish and eggs (+13.0%), followed by cereal and bakery products (+7.8%) and fruits and vegetables (+7.6%).[41] These prices also reflect higher commodity costs in non-agriculture products such as aluminum, paper and packaging, and transportation (oil), and taken together, they represent some of the largest Y/Y increases in recent memory. For context, food at home inflation has averaged just 1.5% over the last 10 years. And it's not only at the grocery store that consumers are feeling the pinch. Prices within the food away from home category (restaurants) increased 6.8% Y/Y, which is the largest increase in over 40 years (since 1981).[42]

It has become clear that US consumers are facing increasing food costs, and there is reason to believe more increases lie ahead as several consumer packaged goods companies have announced further price increases to take effect in 2022, in part due to persistent supply-chain pressures. Pressures on consumers could cause a shift in how consumers allocate food at home vs. food away from home spending (i.e., eat out less) or in the purchase patterns/dynamics between branded and private label food. Given that food as a good is generally inelastic, these cost pressures—in addition to high inflation in other essential goods such as shelter and energy—may also lead to lower discretionary spending elsewhere in consumer budgets. For now, companies have reported that consumers have absorbed prices better than anticipated, but with more pass-through price increases slated for 2022, this notion may soon be challenged.

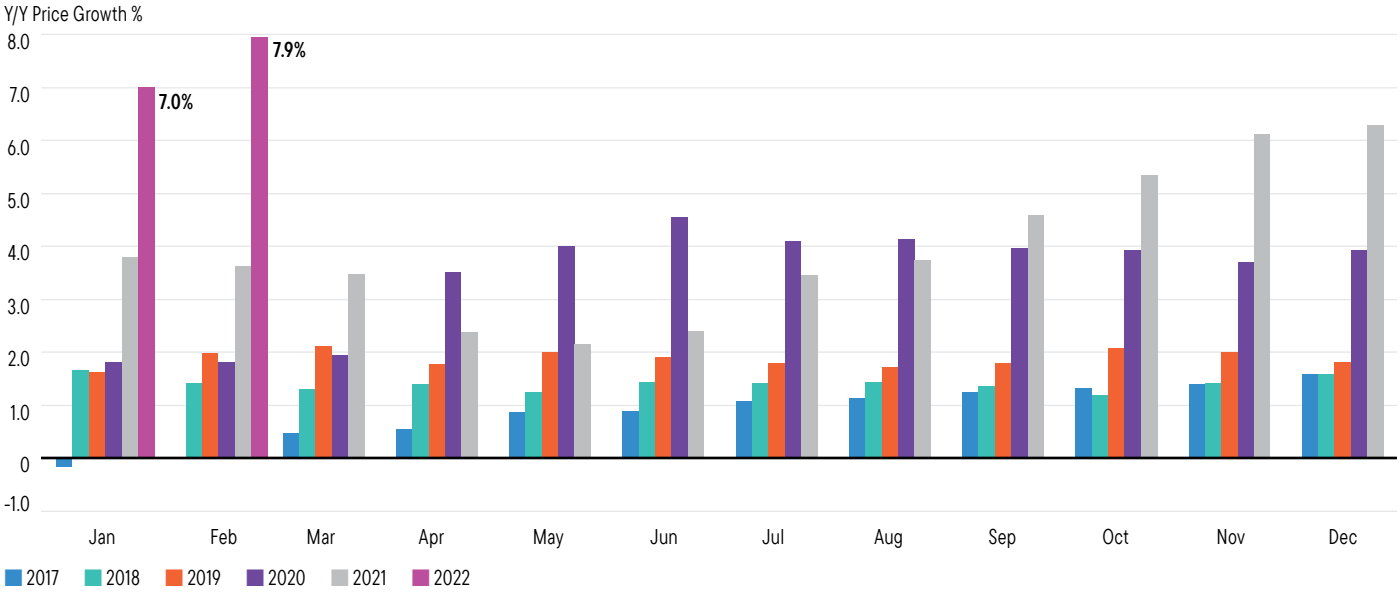
## Credit issuers' roles in mitigating social harm

Lost and damaged crops not only contribute to higher commodity and, ultimately, food prices, but also impact local communities and the farmers who grow the crops. Credit

## US Consumers Face Rising Food Prices

**Exhibit 6: US CPI Food at Home (Y/Y Monthly Inflation)**

January 2017–February 2022




Source: US Bureau of Labor Statistics. As of March 10, 2022.

issuers should also make strategic investments in the relevant stakeholders that support the agriculture systems they profit from. Building goodwill in the communities where credit issuers operate can build brand and company loyalty and help companies maintain their leadership position in the industry. One area of focus worth exploring more is increased small farmer support, specifically for land management practices.

To foster goodwill and build resiliency in the food supply chain, credit issuers should work to provide local farmers with education and capital investments, perhaps in the form of micro loans or via other local partnerships, to implement best practices in land management, water efficiency and crop resiliency. Not only would credit investors be able to earn an investment return, but these actions would also contribute to overall increased agriculture sustainability and lead to positive outcomes such as reduced GHG emissions through lower tilling needs, improved crop resiliency and increased farmer profitability. Without these investments, local communities with agrarian economies may become financially challenged as the climate continues to change. It has been well documented that as the climate warms, agricultural climate zones are expected to shift toward the poles.[43] Moving farmland to friendlier climate zones may prove to increase overall global crop yields but will also stress existing farm-based economies in more tropical and subtropical zones. Current farms in these communities could cease to exist as growers move to better suited environmental climates, in turn causing devastation in their local economies.

The impact of a changing climate and the potential loss of farmland will be felt the hardest in countries with the highest value of crop per capita: Argentina, Canada, Spain, Ukraine, Brazil and the United States. Credit issuers who source from farmlands in these countries should take care to ensure the land remains healthy for all stakeholders involved. As shown in Exhibit 7 on the next page, each of these countries have at least some "strong human-induced land degradation" within their borders.

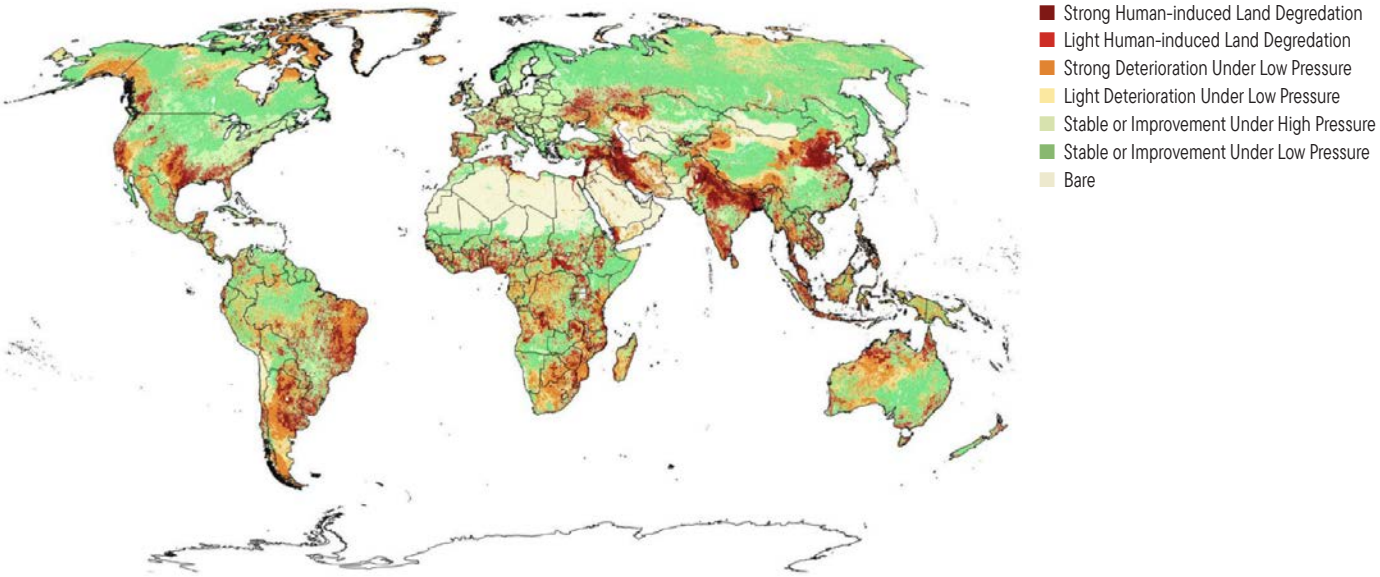
## Innovation's role in mitigating food-price risks

One of the biggest opportunities companies have to mitigate the risk of higher input costs resulting from shrinkage of supply-induced impacts related to climate change is investing in agricultural innovation and technologies that support more sustainable land practices, more resilient crops and higher crop yields. Indeed, agricultural innovation is already on display in the United States, where more than 90% of all soybeans, corn, canola and sugar beets planted and harvested each year are genetically modified (GMO) to reduce the use of herbicides and pesticides, to increase yields, and to help maintain land health.[44]

However, continued technological innovation—including further developments of GMO seeds—are needed to specifically protect crops from increasing extreme heat, cold, drought and flood, and to *prevent* a shift of the agriculture climate zones, which will require moving farmers and/or disrupting the local communities built around the industry.

## Human-induced Land Degradation

**Exhibit 7: Land Degradation Classes Based on Severity of Human-induced Pressures and Deteriorating Trends**
As of 2015




Source: UN FAO, *The State of the World's Land and Water Resources for Food and Agriculture—Systems at breaking point. Synthesis report 2021.* Rome: FAO. Note: Based on most current data available.

The promise of such innovations could be worth billions, economically speaking. In addition to potentially protecting crops and increasing yields, the above-mentioned technological innovations could also help reduce food waste by increasing the shelf life of crops, especially fruits and vegetables. Collectively these developments—higher crop yields and longer lasting foods/less agricultural waste—could be a link in the chain to building a more resilient food supply chain.

To achieve the aforementioned outcomes, long-term investments must be made. The debt capital markets currently provide some of the best investments vehicles to address the wide scale mitigation of climate risk in our food supply, be it deploying capital to support research and development or funding capital projects to reduce land use intensity. For example, Sustainability Linked Bonds and Green Bonds are two existing credit instruments that are currently either funneling capital toward corporate green projects or are linking the cost of capital a company borrows at with its corporate sustainability metrics, such as scope 1 or scope 2 GHG emissions.[45]

Additionally, many investment-grade credit issuers are already accustomed to raising capital with long commitments/payback periods—most commonly 10 and 30 years, but in some cases as long as 50 years—which reduces the need for a more immediate return on investment typically sought after by equity investors. Debt investors, broadly speaking, can accept relatively lower rates of return on their investment (versus their equity peers) given the debt's seniority status within the capital structure. Historically, sustainability linked bonds and green bonds have also been able to receive a 25–50 basis-point (bp)[46] discount upon issuance versus non-ESG focused debt. As monetary policy begins to tighten globally, this added dynamic may make several climate resiliency projects more financially attractive for credit issuers, since the cost of capital is driven even lower. Taken all together, it is apparent that the debt capital markets are well-positioned to play an important role in providing capital for the resiliency needs of our food supply chain.

## Continuing impacts and opportunities

To conclude, climate change has and will continue to impact our food supply over the coming decades. The risk of persistent commodity supply disruption due to weather challenges will only continue to grow. While this piece focused on the potential implications for the US consumer, the impacts of a warming climate will be felt globally with similar ramifications around the world. Credit issuers who invest with specific credit innovations designed to address environmental and social impacts across the supply chain and those that work to promote good social outcomes in the communities they operate in are likely to become long-term industry leaders.

# Happenstance, a ripe tomato and opportunity

**Mohieddine Kronfol**
Chief Investment Officer, Portfolio Manager
Global Sukuk and MENA Fixed Income
Franklin Templeton Fixed Income

For me, one of the silver linings of the pandemic has been the chance to spend more time at home with family, enjoying meals together. In recent months, we've been buying locally grown produce for meals, most notably delicious fresh-from-the-vine tomatoes. Naturally, given the harsh climate and arid conditions surrounding Dubai, locally grown produce is the exception, not the rule. In fact, most fruits and vegetables consumed in the region are imported. Anything comparable grown locally is likely the product of hydroponic farming, as was the case with the delectable ruby-red tomatoes we had been enjoying. These fruits were so good they even went down easily with the children. As any parent knows, the struggle to get kids to eat fruits is real. The quality of these tomatoes left an impression on me and my family.

As fate would have it, a few weeks later, an accomplished entrepreneur with a background in technology walks into our offices pitching an opportunity to participate in an equity raise for a venture he was pursuing with classmates from Stanford University. He and his partners, using controlled environment agriculture (CEA) technology, successfully recreated a Mediterranean climate in the middle of the desert in Abu Dhabi. They built sophisticated greenhouses that could yield more produce per square meter than the best farms in the Netherlands, doing so with a fraction of the water other processes require. Beyond water, food security is a major issue for the Gulf Cooperation Council (GCC) region.[47] Some reports suggest countries such as Qatar, Bahrain and the United Arab Emirates import 80%–90% of their food.[48] Any scalable technology with potential to address this dependency piqued my interest. What is it they were growing?

Those same tomatoes I was putting in my kids' lunch boxes. I knew I was onto something.

## Beyond fossil fuels

Before we get to the story of tomatoes and what they mean for future investing opportunities in the GCC, let's talk about the evolution under way in the region, and aspects of change that may not be fully appreciated by the world.

Over the last several decades, we've seen cities and markets go from small trading outposts to significant regional blocks, with representation in broad emerging market indexes,[49] and from small towns with a hardship allowance to major metropolitan tourist destinations that contain the highest average nightly spending in the world.[50] At the same time, emerging markets went from comprising 5% of global markets to almost 25% today.[51]

Despite these changes, investor perceptions have generally stayed the same. I have often observed that investors have a fundamental misunderstanding of the risks in the region. They tend to associate GCC bonds with volatile oil prices, or worse, volatile geopolitics. The reality—albeit counterintuitively—is that these bonds have very little correlation to oil, and in fact, they may help portfolio risk management.[52]

Today the apprehension is about climate change—fossil fuels still play a significant role in GCC economies. Given this reality, GCC states are thought to be behind the curve in terms of applying ESG best practices. In our view, this is a misconception, particularly as it pertains to the "E" in ESG.

GCC states are in fact pushing the policymaking envelope with programs to address sustainability challenges, in areas such as carbon emissions and food security. These regional initiatives present unique opportunities for investment.

Naturally, the assumption is that ESG trends—and the transition to a low carbon emissions future—will decimate oil producers everywhere, leaving the GCC region devoid of economic opportunity. While it would be foolish to suggest that climate change will not impact the region in the coming decades,[53] the reality is that the nature of that impact will be much more nuanced and gradual. In a world that is on track for the Paris Accord goals, the International Energy Agency (IEA) estimates the world will still use 80 million barrels per day of oil in 2030, and 65 million in 2040.[54] Efficiency in oil production must be continually improved, and many producers are pivoting by decarbonizing oil and gas production, shifting their energy mix to renewables, and emphasizing their ability to compete on emissions intensity,[55] as well as cost. Bottom line, it is not a binary choice of economic life or death for the region.

First, we believe GCC markets are better placed than most in terms of adopting ESG protocols because the largest emitters of greenhouse gas—national oil companies and utilities—are government owned. This gives governments much more control in terms of implementing necessary technological upgrades and regulation changes.

Second, the eventual changes to the oil markets over the next century—that is, the expected decline in demand for oil globally—have been recognized by governments and agencies in the GCC area. This recognition has influenced policymaking in the region for several years; and will continue going forward. One set of initiatives, which brings us back to our story about tomatoes and investment opportunities, centers on food security and water conservation.

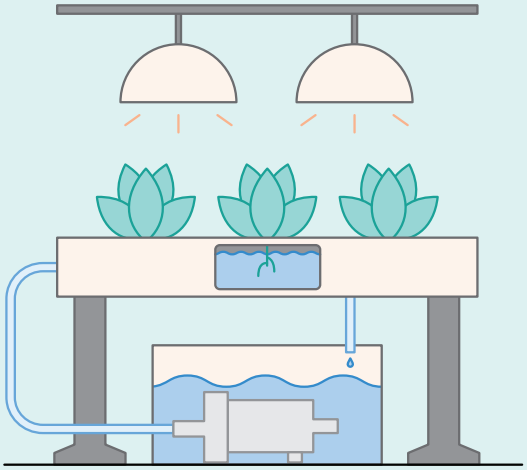
## A garden grows in the GCC

In recent years, countries in the GCC have established ambitious food sustainability and security programs aimed at improving food production in the region, outlined in Exhibit 8 on the next page. Member countries have been sponsoring and funding research and development of new and innovative farming technologies, such as drip irrigation, vertical farming, hydroponics, aeroponics and aquaponics.

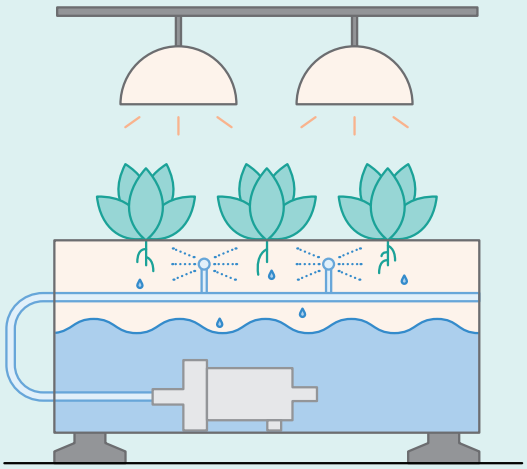
In addition, initiatives like seawater harvesting, soil improvement techniques, microalgae production and groundwater conservation have all played a part in improving food production. These programs are critical to food production in the

### Hydroponics and aeroponics

**Hydroponics** is a method in which nutrient-rich and oxygenated water is substituted for soil, while the plant root base is supported by some type of substrate. Typical materials for a support substrate include vermiculite, perlite, peat moss, coconut fiber and rockwool. There are multiple approaches to designing hydroponic systems, but generally the core elements are the same.



**Aeroponics** is the process of growing plants in an air or mist environment without the use of soil or an aggregate medium. Aeroponic systems nourish plants with nutrient-laden mist. The concept builds off hydroponic systems, but dispenses with the growing medium. The roots simply dangle in the air, where they are periodically puffed by specially designed misting devices.



Source: Franklin Templeton. For illustrative purposes only.

region due to the arid and inhospitable climate in the GCC, as well as the lack of fertile land.

As part of this ongoing effort, in 2020 the UAE's ADQ[56] created Silal, a new company seeking to diversify food sources and increase locally grown, raised and manufactured food. Silal's mandate includes implementing knowledge-transfer programs related to desert farming technology, as well as other research and development (R&D) projects to increase the local production of fruits and vegetables from small farmers in the emirate. The program includes plans for a major agriculture technology park—intended to become the regional food hub of the Middle East—designed to produce 39 kilotons of locally grown fresh fruits and vegetables annually. This will represent roughly 12.5% of the forecast market for fruits and vegetables in the UAE.[64] Firms such as Pure Harvest and Madar Farms are building commercial-scale, semi-automated, high-tech greenhouses that will contribute to this food supply system.

In summary, the food and agriculture industries in the GCC are at a critical inflection point. The sector is transforming due to innovation and state-sponsored policies, but this change is slow, and many challenges remain. Of note, despite the bold and ambitious policymaking and programming, the GCC is still on average only 31% food secure (see Exhibit 9). In addition, production, storage and transportation of locally cultivated produce is still very inefficient. More needs to be done.

### Policy Solutions

**Exhibit 8: GCC Policies Aim to Improve Food Efficiency and Sustainability**

| Country | Program Examples |
|---|---|
| **Saudi Arabia** | In 2020, the kingdom launched the National Transformation Program (NTP), intended to promote diversification of the economy. Through this policy, the government is investing in new technologies to improve crop yield, such as remote sensing, artificial intelligence, machine learning, and data analytics.[57] |
| | In February 2019, Saudi Arabia signed a US$93 million agreement with the FAO to improve the production, processing, and marketing of Arabic coffee, beekeeping, fruit, fish, and livestock.[58] |
| | In May 2019, Red Sea Farms, a Saudi-based startup developing salt water-tolerant crops and saltwater-based greenhouses, secured US$1.9 million in funding from King Abdullah University of Science and Technology (KAUST). The funds were used to build a 2,000 $m^2$ saltwater greenhouse designed to produce 50 tons of tomatoes annually.[59] |
| **UAE** | In May 2019, the Abu Dhabi government announced an AED 1.0 billion (US$272.3 million) incentive package to support the development of the domestic agritech industry. The program targets three agricultural segments to increase food production—precision farming and agricultural robotics, bioenergy and indoor farming. It offers rebates of up to 75% of R&D costs, along with other fiscal and regulatory concessions, to firms working in the area.[60] |
| | In May 2019, the Environment Agency of Abu Dhabi announced a Sustainable Aquaculture Policy for the emirate focused on promoting the growth of the local aquaculture industry to reduce pressure on local fisheries.[61] |
| **Qatar** | In May 2019, Qatar's Department of Agricultural Affairs imported and installed 350 greenhouses across the country. It also provided 500,000 packing boxes to 100 farms, and allocated US$19 million annually to support the agricultural sector through 2026.[62] |
| | In March 2019, the Qatar Ministry of Municipality and Environment announced measures to increase the rate of self-sufficiency in vegetable production. It offered 10 projects to private investors to grow vegetables in greenhouses, seeking production of ~21,000 tons of vegetables annually.[63] |

## A fertile investment opportunity

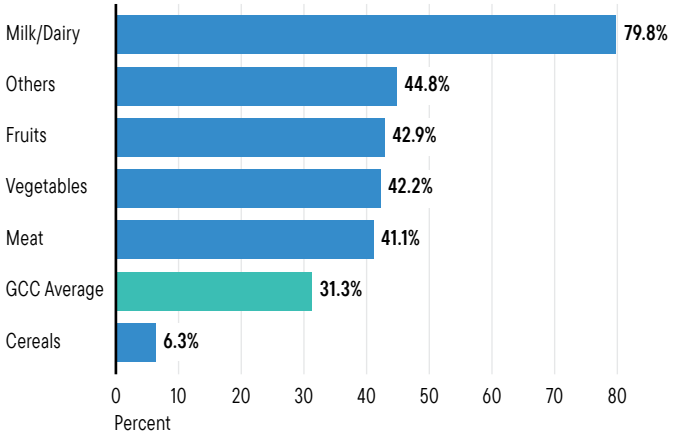
While there are clearly tremendous challenges facing the Gulf region as it seeks to achieve food security, there are also significant opportunities for investment. According to ADQ, it is estimated that US$200 billion of investment is required annually until 2050 to meet the GCC food supply and demand gap.[65]

Investments are needed across the full value chain. In production, investments will help improve efficiency gains, technology and the development of novel processed foods. In distribution, investments will support better logistics,

### Importing Food Security

**Exhibit 9: Percentage of Food Imported to GCC by Category in 2019**

As of 2021




Sources: FCSA of UAE, NCSI of Oman, CIO of Bahrain, MDPS Qatar, GAS of Saudi Arabia, FAO.

help reduce waste across the system and improve storage capabilities. Multi-stakeholder collaboration between government and private enterprise are needed to achieve sufficient food security in the region.

We continue to believe investors generally underappreciate the potential for returns from the GCC public debt markets to private credit opportunities.[66] From our perspective, there is opportunity to invest in companies applying technologically advanced production and farming capabilities to disrupt the region's reliance on imported food. We also anticipate the abundant domestic natural resources available to leverage—ample sunlight, cheap land, competitive labor (compared to Europe), and affordable electricity, all against the backdrop of a supportive regulatory and tax environment—will help drive cost-effective, and profitable, production of better food.

## CEA: an ideal solution

Which brings us back to the delicious tomatoes my family and I enjoy over dinner, and the investment opportunity we see in technologies such as CEA.

## Regional food security challenges

Currently, most GCC countries and farms deploy unsustainable farming practices. This includes excessive groundwater use, high carbon-intensity diesel-fueled desalination, relentless pesticide use, and maximum residue levels[67] unsafe for human consumption. For example, the UAE uses approximately 60%–70% of its freshwater resources to produce less than 15% of its food needs, representing less than 1% of GDP.[68] Similar statistics exist for most other GCC states. These practices need to evolve. To do so they will need capital. Here are some key challenges:

**Climate**

Given their geographic location, where average annual temperatures regularly reach over 100°F (38°C) in the summer months, it is no surprise GCC countries face significant agronomic headwinds. In addition to the arid/hyper-arid climatic conditions, the region suffers from a lack of arable land, water scarcity, groundwater salinity and anemic rainfall. Indeed, a lack of water is one of the most significant problems for GCC countries.

**Heavy reliance on imports**

Due to the difficulty in growing and sourcing locally produced foodstuffs, GCC countries today still rely heavily on imports, bringing in roughly 85% of total food consumed.[69] This dependence has been increasing in recent years, as regional food consumption is on the rise.

**Increasing demand**

Implicitly, increased consumption is leading to increased demand in the region. Demand for food in the GCC is projected to be 60.7 metric tons by 2023. Growing populations, tourism and high per capita incomes are driving this demand.[70]

**Population growth**

The Gulf region is forecasted to reach a population of 63.4 million by 2023, adding 6.8 million people from 2018.[71] This expanding consumer base will drive growth in food consumption, as will increasing urbanization and the growing affluence of expatriates.

**Geopolitics**

In places like Qatar, for example, the focus on food is existential. Geopolitical tension, such as regional sanctions, can result in a food crisis. The most formidable of these sanctions was a comprehensive blockade of Qatar, which involved the closure of the land border between Qatar and Saudi Arabia, as well as the banning of Qatari planes from entering Saudi, UAE and Bahraini airspace. The blockade disrupted all established supply routes in the process.

Part of Qatar's response was to put in place a comprehensive food security policy with clear key performance indicators that met its need to diversify trade partners for critical commodities. These included increasing local production by establishing a hydroponics greenhouse cluster, with the intent of reaching 70% self-sufficiency in perishables by 2023.[72] The country also put in place adequate but sensible reserves to act as a buffer against temporary import or production disruptions, improved the food supply chain to be more transparent and efficient, and closed half of the gap in food waste in Qatar (~14%) versus Europe (~5%).[73]

Recently we witnessed the establishment of the Qatari-Saudi Coordination Council to advance bilateral relations, signaling the formal end of the diplomatic boycott and sanctions war that lasted almost four years.

As we have observed, demand for produce is high in the region and growing. Furthermore, given the increase in lifestyle diseases and obesity, there is heightened awareness of the need for healthy eating habits. Awareness has increased interest in locally sourced and organically grown fruits and vegetables. CEA is ideally suited to meet this demand. Through technology, regulated environments can yield resource-efficient food anywhere in the Gulf, year-round. These farming methods are more sustainable as well, and we believe they offer the most competitive solution for products with short shelf lives and low value-to-weight ratios in terms of transportation logistics.

The bottom line is that CEA is a uniquely suitable industry for profitable, large-scale impact—truly doing good and doing well. What's good for the world is also good for the cost structure, achieving about 10x to 15x the yield per square meter versus incumbent lower-tech solutions, while using a seventh to a tenth of the water.[74]

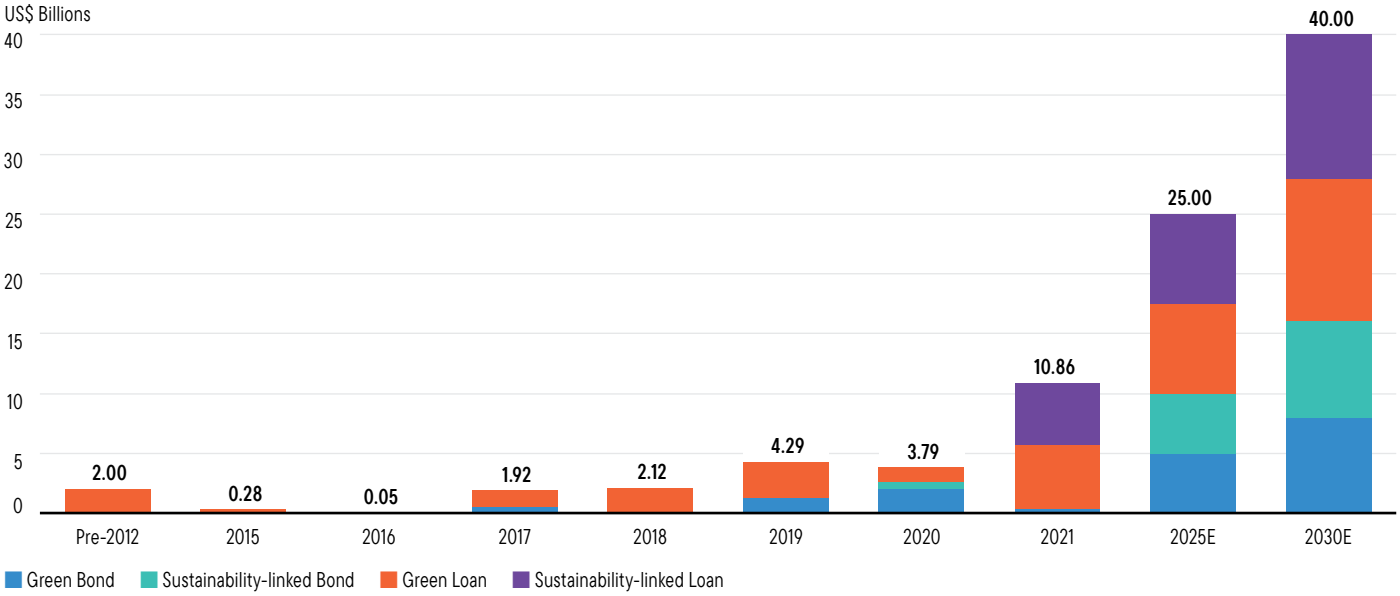
Finally, while established, highly rated companies can access capital efficiently today—the GCC, for example, issued more than 30% of emerging market sovereign dollar debt in 2021—there is work to do to develop credit strategies that can help new start-up businesses like CEA develop.[75] The funding gap for cash flow-based credit to mid-size companies is estimated to exceed US$170 billion annually,[76] creating enormous opportunity in private credit to earn higher yields without necessarily assuming much more risk (see Exhibit 10).

Our recent experience corroborates the view that extensive security packages and widespread use of covenants can be relied on to control credit risk, contrasting the hyper competition and "covenant-lite" documentation prevalent in developed markets.

In summary, we saw an opportunity to invest in a company that could disrupt the business model of trading imported food to the GCC into a technologically advanced industrial production model. This coincides with recently articulated policies around food security, sustainable practices and water conservation. To take advantage of these opportunities, investors would do well to consider credit in emerging markets, particularly those with a commercial environment and macro policy framework that support investments in similar growth opportunities.

## Forecasting Greener Investments

**Exhibit 10: GCC Sustainable Debt Issued by Instrument (US$ Billions)**
2015–2030F




Source: Bloomberg NEF, Bloomberg Terminal, forecasts from Franklin Templeton Investments (Middle East) Limited. As of February 4, 2022. There is no assurance that any estimate, forecast, or projection will be realized.

# Real estate investing opportunities in vertical farming

**John G. Levy, CFA, CAIA**
Director of Impact
Franklin Real Asset Advisors

> **"Humanity must now produce more food in the next four decades than we have in the last 8,000 years of agriculture combined."**
>
> World Wildlife Foundation, 2012[77]

Like clean energy infrastructure before it, vertical farming will mature into a defined real asset sector that will be a part of well-diversified portfolios. Over the next several years, vertical farms will create alternative use cases for underutilized land and vacant buildings, and create opportunities to drive lasting social and environmental impact.

Vertical farming is a part of our sustainable future and brings with it attractive investment opportunities for real asset investors, in our view. A confluence of powerful short-term and long-term market factors give vertical farms the potential to become a major disruptor in the food and agriculture space. The global population is growing, the supply of arable land is shrinking, weather patterns are becoming far less predictable, eating habits are shifting and demand for sustainable products is growing. We need solutions that increase yield; use less water, chemicals and land; and reduce our dependence on long, wasteful and complex food supply chains. Vertical farming promises to not only increase global food security, but also to provide forward-thinking investors with strong opportunities to bring scale to this burgeoning space. Private equity and venture capital investors have poured money into vertical farm operators, but the capital-intensive sector will need cheaper, asset-backed financing to build farms at scale across the globe. This creates an intriguing investment opportunity for real estate and infrastructure investors that want attractive and diversifying financial returns from assets that also may provide positive environmental and social change.

## Burgeoning technology

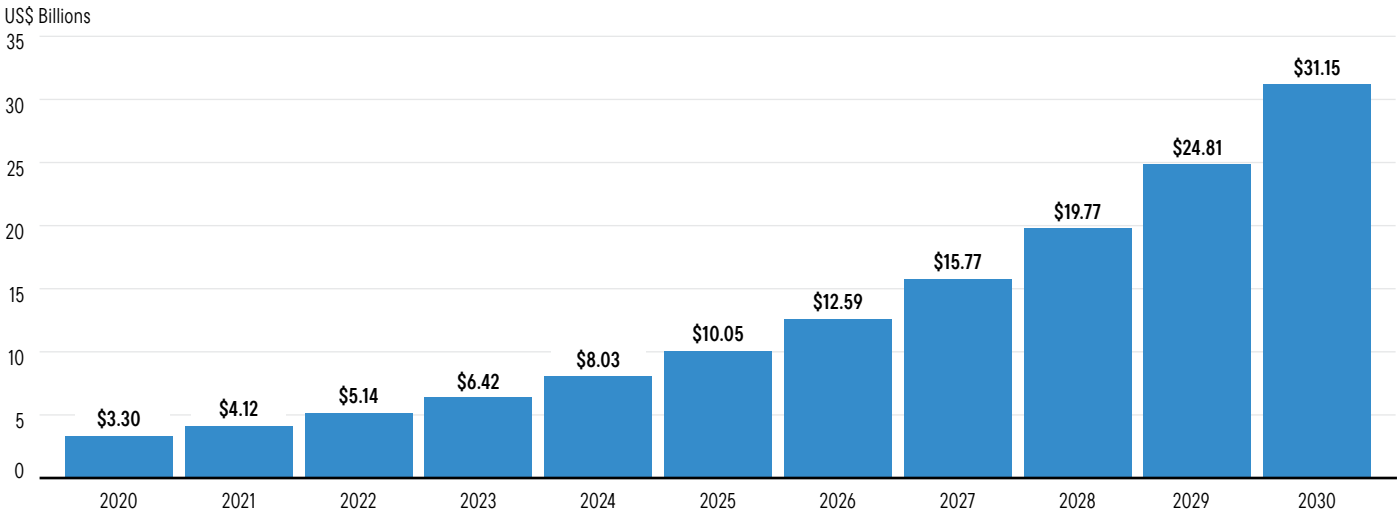
Vertical farming is the practice of growing produce in vertically stacked layers indoors in order to increase yield per unit of land. Current growing methods in vertical farms include hydroponics (roots placed in nutrient solution), aeroponics (nutrient mist sprayed on plants) or aquaponics (closed loop systems with plants and fish), all three of which are soil-less solutions that dramatically reduce the amount of water compared to outdoor farms. Indoor farming operators rely heavily on multiple technologies to precisely control growing conditions, to maximize yield, and even to customize the flavor and nutrient profile of their crops. Commercial scale vertical farms are typically housed in warehouses and industrial buildings near population centers or food-distribution centers.

As seen in Exhibit 11, the global vertical farming market was valued at US$4.1 billion in 2021 and is projected to reach US$24.1 billion–US$31.2 billion by 2030, with North America currently leading the market and the Asia-Pacific region seeing the fastest growth.[78] Most operators in the vertical farming space are privately owned, and dozens of well-capitalized companies have emerged in the past few years, backed by private equity and venture capital investors.

## Vertical's Growth

**Exhibit 11: Forecasted Growth of Vertical Farming Market Size, 2020–2030 ($US Billions)**

As of January 2022




Source: Precedence Research. There is no assurance that any forecast, estimate or projection will be realized.

## Competitiveness

Investing in vertical farming has not been for the faint of heart as the space is still early in its development, with many success stories but also many failures. However, when looking at product demand trends, falling input costs, predictable yields and even the profitability of existing operations, one can begin to see how the space is being "de-risked" and will need new forms of scalable capital to make vertical farming a staple of every modern urban landscape.

### Improving economics

The industry is evolving rapidly. Currently, not all foods can be grown viably in vertical farms. As of now, technological advances have allowed companies to profitably grow phase 1 crops such as lettuces, micro greens and herbs. Phase 2 crops, such as tomatoes, cucumbers, root vegetables and various berries, are also being grown but not yet at the scale of phase 1 foods. Producing the most energy-intensive, dense-calorie foods such as grains and rice (phase 3) still requires significant technological advancements but could be a reality soon given the trajectories of rapidly falling input costs, yield and efficiency improvements and technological advancements. The cost of LED lighting, which now accounts for 30% of capital expenditure in build out and 25%–30% of operating costs,[79] is expected to fall by a factor of 10 every 10 years, potentially bringing scalable opportunities in phase 2 and 3 crops in the coming years.[80]

### Higher and more volatile food prices

The rising and volatile prices of food globally can not be overlooked when discussing the price competitiveness of vertical farms. While much focus is on bringing down the price of vertically farmed produce, research also predicts higher and more volatile prices for food globally as a direct result of extreme weather, competition for arable land and climate change.[81] By their very nature, vertical farms will be more climate resilient, and their output will be more stable and predictable. Vertical farms will even be able to react rapidly to changing consumer preferences, producing in-demand crops without regard to environmental factors and growing conditions.

### Demand

The cost competitiveness of foods produced in vertical farms will not be the only driver of growth in the sector. Vertical farms can also produce foods that taste better, are free of

**"While much focus is on bringing down the price of vertically farmed produce, research also predicts higher and more volatile prices for food globally as a direct result of extreme weather, competition for arable land and climate change. By their very nature, vertical farms will be more climate resilient, and their output will be more stable and predictable."**

harmful chemicals, last longer, are more nutritious and are available year-round. Consumer preferences for organic, sustainable and locally sourced foods are also growing rapidly, and vertical farms typically outcompete most traditional farms by these standards.

**Profitability**

Many tailwinds exist for the growth and viability of vertical farms, and their economic viability is clear. A recent survey showed 58% of farms are already making a profit and 20% are at breakeven, with more mature farms being more likely to be profitable.[82]

As demand rises, input costs fall, technologies improve and variety increases, vertical farms will have the potential to outcompete many traditional farms, thereby disrupting the agriculture ecosystem and dramatically increasing the size of the vertical farming sector.

## Real estate investment opportunity

So, as the competitiveness and demand for vertically grown produce increases, the amount of investment capital to fund the growth in the vertical farming ecosystem will increase exponentially. Funding continued growth through traditional venture capital and private equity investment is expensive, and vertical farming operators will look to cheaper forms of capital that can be backed by physical assets. Here lies the opportunity for real estate and infrastructure investors.

Vertical farming is capital-intensive and requires complex equipment. A recent Canadian case study by the Alberta Agriculture and Forestry department estimates equipment costs for larger industrial warehouses at C$17,000,000 (US$21,255,510).[83] However, the buildings that house the equipment do not have complex requirements. Leo Marcelis of Wageningen University in the Netherlands notes, "The technology itself is very sophisticated, but you do not necessarily need a sophisticated outer skeleton to put it in."[84]

In fact, many derelict or underutilized industrial, office or retail spaces can be repurposed into vertical farms, often without excessive capital expenditure. Basic warehouse-style farms can also be erected with high ceilings while remaining usable for alternative industrial or logistics use should a vertical farm tenant exit the space. This creates a level of downside risk management that helps make the asset class more attractive for investors. The building specifications do not present a material hurdle, but picking the right locations will be key.

## Competition with last-mile logistics

One of the competitive advantages of vertical farms when compared to traditional farms is the proximity to population centers, which reduces transportation times, lowers transportation costs and reduces food wastage. Vertical farms also need access to water and substantial power infrastructure. The rise of e-commerce has created a voracious demand for last-mile logistics in areas that are often prime locations for vertical farms. So, while the opportunity in vertical farming is substantial, the focus on finding suitable and affordable spaces is still critical. Finding a balance between location and cost will require active management and thoughtful planning by investors and operators alike, but there is ample room for growth in both last-mile logistics and vertical farming. In fact, one can see economies of scale for e-commerce retailers to enter the vertical farming space to distribute fresh food more efficiently through their last-mile delivery networks. This is especially true for logistics warehouses already used for food storage and distribution, which now make up 9% of the logistics real estate market.[85] A symbiotic relationship between e-commerce and vertical farming is yet another compelling reason vertical farming should be on investors' radar.

## Impact potential

The attractiveness of investing in vertical farms is not purely financial. Vertical farms also have significant and multifaceted impact potential. As investors look to contribute to solutions to the world's largest problems, vertical farming may prove to be a scalable way to achieve an attractive financial return and material positive impact.

When looking at the SDGs, a powerful guide for global citizens and organizations seeking to achieve positive impact, it becomes clear that vertical farms have the potential to be significant contributors to a better and more sustainable future for all. Vertical farming has the potential to contribute to most of the 17 SDGs, (some highlights are on the next page).

## Impact measurement and management (IMM)

Positive impacts are not guaranteed, and the vertical farming industry must grapple with issues of high energy demand and the automation of work. Fully understanding the impact of each investment will require sophisticated measurement and management of both positive and negative impacts so that positive impacts can catalyze further investments and negative impacts can be aggressively mitigated. For this, investors should consider using an Impact Measurement and Management (IMM) system.

## What is impact investing?

**"Impact investments are investments made with the intention to generate positive, measurable social and environmental impact alongside a financial return."**
Global Impact Investing Network

This definition distinguishes impact from other forms of sustainable investing such as ESG-integration, thematic and negative or norms-based screening because impact investing requires a logical link between investment actions and superior (and measured) social or environmental *outcomes*, where the other strategies are defined more by inputs into financial analysis or measured outputs that are not directly linked to an investment action.

At Franklin Real Asset Advisors (FRAA), we share the view expressed by Tideline[86] in its paper "Truth in Impact Labeling" that impact investing is anchored by three key pillars:

**Intentionality:** Explicitly targeting specific social or environmental outcomes—such as the UN's Sustainable Development Goals (SDGs);

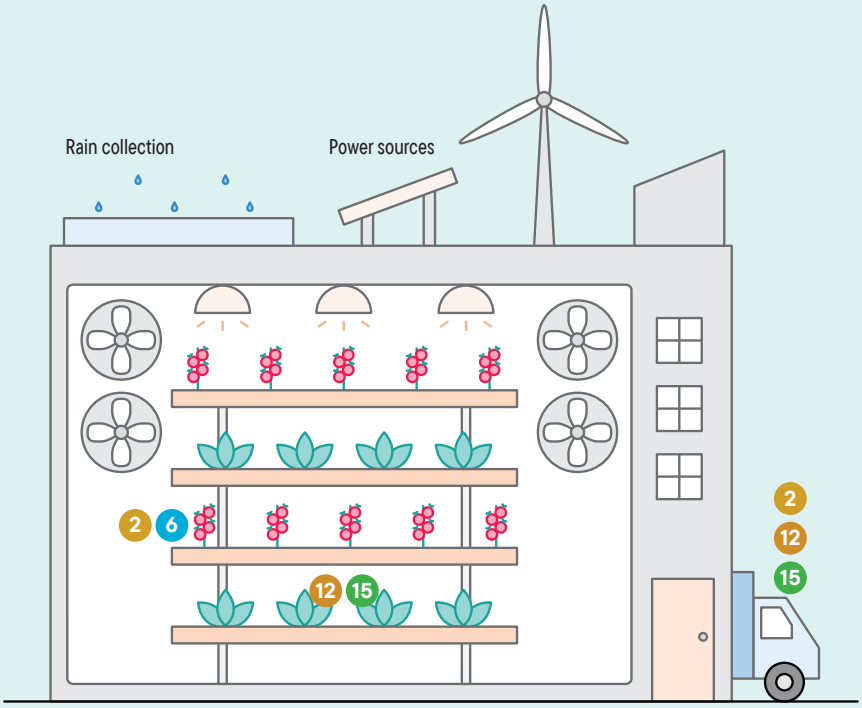
**Contribution:** Playing a differentiated role to enhance the achievement of the targeted social or environmental outcomes; and

**Measurement:** Monitoring and reporting impact performance based on measurable inputs, outputs and outcomes

## Vertical farming highlights

Vertical farms grow more nutritious food with less spoilage and can greatly increase food security with shorter supply chains and built-in climate resilience. They use considerably less water than traditional farms; the food typically does not use pesticides, fertilizers or herbicides; has no need to be washed; and uses fewer chemicals. Being grown locally also reduces the carbon footprint of food transportation.

The growing demand for farmland is hurting biodiversity and destroying ecosystems, contributing to species loss and exacerbating climate change. Because of its small foot print, it is potentially a critical piece to slowing demand for additional farmland, and maybe even catalyzing the return of land to its natural state.




Source: Franklin Templeton. For illustrative purposes only.

### SDG 2 zero hunger

**Less food waste:** 40%–50% of fruits and vegetables are lost between harvest and distribution using existing farming techniques.[87]

**Shorter supply chains:** In the United States, most food travels an average of 2,000 miles before it reaches your plate[88] versus less than 50 miles for a typical vertical farm.[89]

**Climate dependence:** Growing conditions are consistent and independent from outdoor climate—its fluctuations and permanent changes.

### SDG 6 clean water and sanitation

**Vertical farming techniques:**

Tomatoes use 3 L/kg of water in vertical farms, 200 liters outdoors.[90]

Lettuce use 1 L/kg of water in vertical farm, 250 liters outdoors.[91]

### SDG 12 responsible production and consumption

Zero fertilizers/pesticides/chemicals with a smaller carbon footprint due to being locally grown.

### SDG 15 life on land

Vertical farms produce 516 times as many tons of produce per square meter.[92]

> **“For investors considering vertical farms, an IMM system can quantify the expected and actual results and can tie these results to the SDGs and specific investor objectives. A strong system is also critical in creating honest dialogue around negative impacts and can shine light on mitigation best practices.”**

**Impact measurement** “is the process of assessing how much social and environmental impact has occurred and the proportion of observed impact that has been caused by an organization’s actions.”[93]

**Impact management** “is the process of overseeing the creation and measurement of impact, identifying relevant risks that may prevent the achievement of impact and restructuring an organization’s activities based on results to maximize impact.”[94]

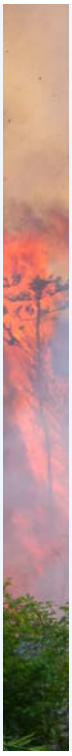
Another way to distinguish measurement and management is to think of measurement as the process of accurately attributing actions to specific reportable outcomes, while management is the actions taken to improve those outcomes. Together, an IMM system:

1. Sets impact objectives;
2. Identifies and executes the actions needed to optimize impact; and
3. Reports the outcomes.

For investors considering vertical farms, an IMM system can quantify the expected and actual results and can tie these results to the SDGs and specific investor objectives. A strong system is also critical in creating honest dialogue around negative impacts and can shine light on mitigation best practices. Finally, systematically scoring impact at the company or project level will allow comparability of opportunities, making it easier for investors to efficiently allocate their capital. What can be measured can be managed, and what can be managed can be optimized to create the best outcomes for all stakeholders and ensure that the full positive impact potential of vertical farms is achieved.

## Conclusion

Vertical farming has the potential to significantly disrupt how we produce and consume food. If done sustainably and thoughtfully, vertical farms have the potential to better society, improve the health of our planet, and do so while providing attractive and diversifying returns for real asset investors.



# Sustainable beef is key to slowing Amazon deforestation

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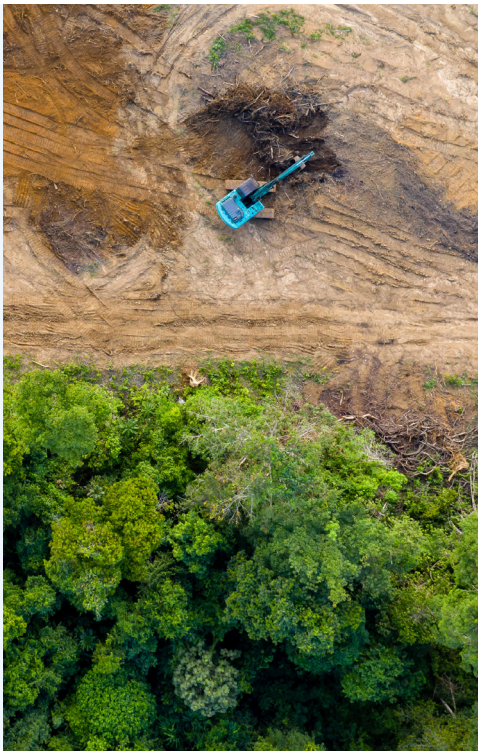


For over a decade, Brazil's beef industry has faced pressures over deforestation as ranchers clear Amazon forests to make room for grazing livestock. Despite calls for corporate and regulatory changes from investors representing $US17 trillion in assets in 2019,[95] and a subsequent intent to divest from Brazil assets in 2020 by 30 asset managers,[96] Amazon deforestation accelerated in 2021. For our equity analysts, the threat of deforestation-related export bans from markets like China and Europe requires a thorough risk assessment for Brazil's three largest meatpackers—JBS, Marfrig and Minerva[97]—responsible for 50% of Brazil's beef exports in 2021.[98] In this chapter, our analysts in Brazil discuss three areas critical to gauging future market risks for Brazil's meatpackers and sustainable beef production at the farm level.

- **Digital tracking solutions.** The ability to trace cuts of beef to a single animal and ranch already exists in countries like Uruguay. With a focus on food safety, many of the world's largest beef exporting countries use national livestock tracking systems. This could be a silver bullet for Brazil's meatpackers.
- **Carbon-neutral beef.** Sustainable beef production starts on the ground with farmers—long before cattle reach meatpacker auctions. Our analysts review new regenerative grazing techniques that farmers in Brazil, and across the globe, are using to boost soil quality and carbon sequestration.
- **Carbon market incentives.** There's good news for Brazil coming out of COP26—namely, the ability to monetize the Amazon's carbon sequestration capacity through global carbon markets. We discuss how carbon markets could accelerate sustainable grazing practices among farmers and ranchers.

## The push for sustainable beef

Pressure on Brazil's publicly listed meatpackers is mounting as more supermarkets and consumers steer clear of beef linked to the Amazon's demise. Six European grocery chains, including Britain's Sainsbury, Lidl Netherlands and Belgium's Carrefour, recently announced they will stop selling some or all Brazilian beef in their stores.[99] The bans came on the heels of an investigation in 2021 by Repórter Brasil alleging Brazil's large meatpackers indirectly source cattle from illegally deforested areas via under-the-radar ranchers.[100] Known as "indirect" suppliers, these ranches typically sell or transfer small batches of cattle to new ranches before eventually reaching the "direct" suppliers who interface with Brazil's meatpackers at auctions. Without proper enforcement of, and ready access to, the legal paperwork that exchanges hands at each point of transfer, it's easy to launder cattle linked to deforestation.

In January 2022, Bloomberg published a similar expose on beef in the Amazon, this time using 1 million cattle delivery logs from Brazil's largest meatpacker, JBS, which it acciden-tally posted online. Since 2009, an agreement signed by Brazil's Federal Prosecution Service and over a hundred Brazil

meatpackers prohibits the slaughter of cattle raised on deforested properties without environmental licenses. This puts the onus on meatpackers to work backwards from their direct suppliers to verify cattle weren't originally reared years earlier on illegally deforested land. Bloomberg acknowledges that Brazil's laws aren't helping. When it comes to cattle and deforestation, the legal system is "so full of loopholes that prosecutors, environmentalists and even ranchers themselves consider it a farce."[101] In a live interview with Bloomberg, a small indirect rancher in São Félix do Xingu, a municipality in the state of Pará in northern Brazil, said "we don't have government, education or infrastructure here...so we do whatever we need to do to get by."

## Tracking cattle digitally

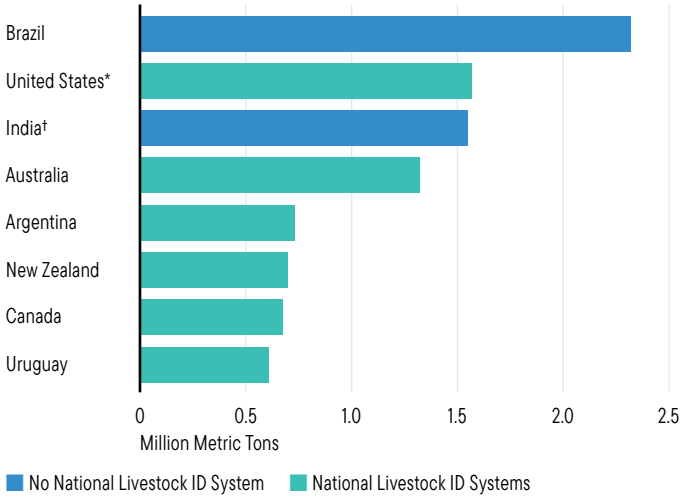
Today's ESG spotlight on Brazil's largest meatpackers isn't new. Pressures to stop Amazon deforestation have been building for over 10 years. For our research analysts, direct engagement has been indispensable to gauging the sustainability of corporate business models and near-term strategies for navigating Brazil's sprawling system of 2.5 million cattle ranchers and 446 meatpackers.[102] Some key discussion points include ways to verify cuts of beef are free from deforestation and future impacts from export bans. For example, if a publicly listed meatpacker excludes all cattle linked to deforestation, this can reduce cattle availability and increase purchase prices, potentially impacting valuations. In this hypothetical scenario, we've modeled how smaller rivals (most Brazil meatpackers aren't publicly listed) could increase their market share despite links to deforestation.

To level the playing field, one panacea solution that often comes up in our discussions with meatpackers—tagging cattle with chips after birth to digitally track movements—has yet to arrive in Brazil. But it's not a futuristic concept. Uruguay, Brazil's neighbor to the south, rolled out a national cattle identification (ID) tag system back in 2004, placing readable chips on all livestock.[103] Required by law and free-of-charge to Uruguay's ranchers, these chips mean individual cuts of meat can be traced back to a single animal and the ranch it was born on.

### Tracing Back to the Source

**Exhibit 12: Largest Beef Exporters by Country in 2021 (Million Metric Tons)**

As of January 2022




Source: United States Department of Agriculture, Foreign Agricultural Service. *Notes: United States begins tracing on January 1, 2023; †India mainly exports water buffalo, not beef cows.

Similar national livestock ID systems exist today in Argentina, Canada, the European Union, Australia and New Zealand, as shown above in Exhibit 12. The key purpose is combatting infectious livestock viruses, like foot and mouth disease, by quickly tracing and then containing outbreaks at the point of origin. In 2020, China gave a small preview of what food safety export bans might look like. Fearing contamination from COVID-19 outbreaks, China suspended meat imports in June 2020 from over a dozen meatpacking facilities across the globe, including a Marfrig beef processing facility and a JBS poultry facility, both located in Brazil.[104] That ban reminded us that livestock traceability programs are crucial for minimizing revenue losses and reputational damage from food safety concerns. Indeed, with infectious livestock diseases on the rise, the United States is rolling out radio-frequency ID tags on cattle by January 2023 despite objections from some cattle lobbyists over costs.[105]

For the World Wildlife Fund (WWF), national traceability infrastructure for livestock is key to tackling deforestation. After all, focusing solely on Brazil's three biggest meatpackers

**"For the World Wildlife Fund (WWF), national traceability infrastructure for livestock is key to tackling deforestation. After all, focusing solely on Brazil's three biggest meatpackers won't curtail deforestation if Amazon ranchers simply sell to Brazil's unlisted meatpackers."**

won't curtail deforestation if Amazon ranchers simply sell to Brazil's unlisted meatpackers. Now that China has signaled that its own meat and livestock feed production will be free of deforestation, the WWF thinks Argentina could take the lead in sustainable beef exports to China given Argentina's traceability system.[106]

Without similar traceability infrastructure in Brazil, and under sustained pressure from climate-conscious consumers and investors, JBS and Minerva are building out their own home-grown traceability systems. As Bloomberg's interviews with Amazon ranchers reveal, it's hard to see how the blockchain system under development by JBS can be foolproof without a legal system that enforces accuracy and compliance at the ranch level. What's worse, Brazil's legion of smaller meat-packers simply don't have the resources to implement digital tracing systems. Given this backdrop, we see a growing consensus that Brazil's federal government needs to step in and implement a traceability solution much like Uruguay's.

**Analyzing export ban risks**

Without digital traceability, Brazil's largest meatpackers face potential bans from lucrative markets like Europe, and potentially China. The risks of future deforestation bans, however, aren't evenly distributed across JBS, Marfrig and Minerva, as we outline in Exhibit 13.

As the world's largest animal protein company and second-largest food company, JBS's revenues from Brazilian beef are just 15% of its global revenues that span every continent. Marfrig has a bit more exposure to Brazilian beef at 19% of revenues. That said, the main revenue sources for both JBS and Marfrig come from their North American operations, not Brazil. Minerva, on the other hand, gets 40% of its revenues from Brazil beef exports, with most of the rest coming from beef processing in nearby Argentina, Paraguay and Uruguay.

As for deforestation bans, the European Union (EU) appears close to implementing a law forcing companies to prove agricultural commodities destined for the EU's 450 million consumers aren't linked to deforestation.[107] For all the attention Brazil's three largest meatpackers have garnered from journalists and organizations like Greenpeace, an EU ban has limited impact relative to giant export destinations like China. From our discussions with Minerva, we know China's beef importers are thus far solely focused on procuring high-quality beef from cattle no older than 36 months. Since China's regulations require traceability going back 24 months, this leaves the door open to indirect suppliers to launder young cattle during the first 12 months. If China eventually imposes a deforestation ban, the pressures on Brazil's beef exporters to deliver deforesta-tion-free beef will be immense.

Meanwhile, climate-conscious citizens across the globe look at the Amazon with increasing despair. A recent report published by Brazil's National Institute for Space Research estimates that deforestation increased 22% in 2021 from the prior year, marking the greatest area of land lost to deforestation in Brazil since 2006. As shown in Exhibit 14, clearing the Amazon to make room for cattle is Brazil's biggest

## Brazil's Top Three Beef Exporters

**Exhibit 13: 2021 Revenues and Market Share from Business Operations**

As of February 2022

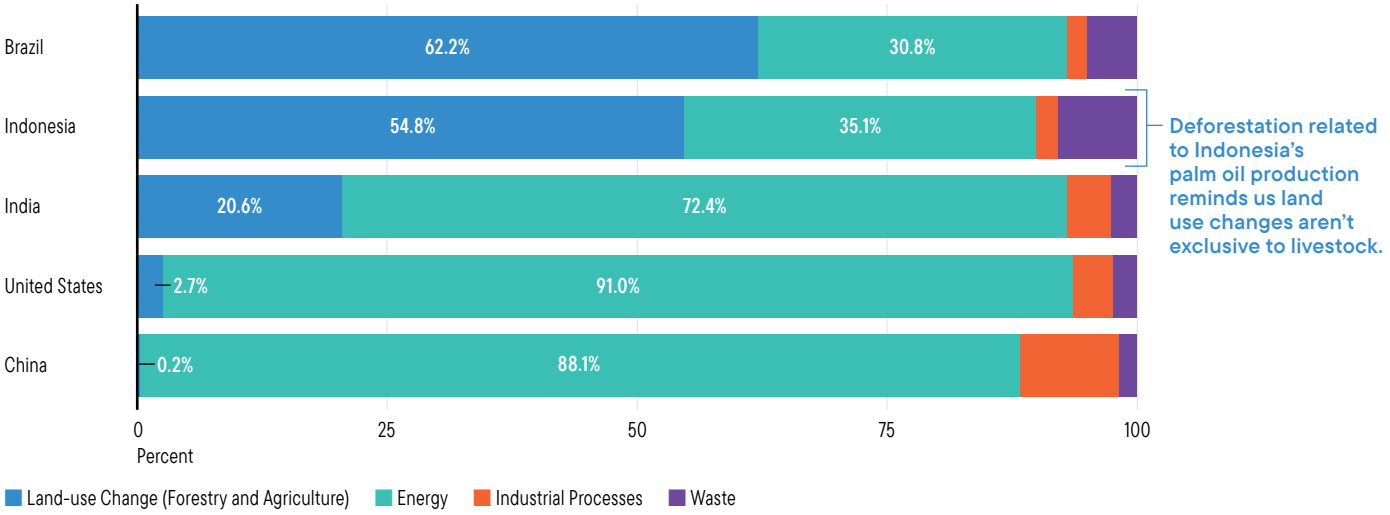
| Business Profile | JBS | Marfrig | Minerva |
|---|---|---|---|
| **Animal Protein Type** | Beef, Poultry, Pork, Lamb | Primarily Beef | Primarily Beef |
| **Consolidated Net Revenue (2021E; US$ Billions)** | 65.7 | 15.9 | 4.9 |
| **Geography of Operations (Production Assets)** | North America, South America, Europe, Oceania | North America, South America | South America, Australia |
| **Brazilian Beef** | | | |
| **Revenue as % of Total (2021E)** | 15.1% | 19.0% | 40.6% |
| **Estimated Market Share (%)** | 18.3%–30.5% | 6.6%–11.0% | 6.0%–10.0% |
| **Export Markets** | China & Hong Kong, Middle East, Europe | China & Hong Kong (63%), Europe (17%), Middle East (7%), USA (6%), Others (7%) | Asia (63%), NAFTA (10%), EU (7%), Middle East (6%), Americas (6%), CIS (4%), Africa (3%) |

Source: Company annual reports, reference documents, sustainability reports, and investor presentations. Market shares are calculated based on production capacity, with the lower value assuming 150 working days per year, and the upper value using 250 days. There is no assurance that any forecast, estimate or projection will be realized.

## Deforestation Driving Brazil Emissions

**Exhibit 14: GHG Emissions by Sector as % of Total**

As of 2018




Source: World Resources Institute, Climate Analysis Indicators Tool.

source of GHG emissions. Without a national traceability system on the near-term horizon, we turn next to the farm and ranch level, where integrating grass-fed livestock directly alongside crops can increase soil quality and sequester carbon underground.

## Tackling carbon on the farm

When looking at the Amazon, some sustainability thinktanks argue the best way to curb Brazil's GHG emissions is to simply have no cows at all.[108] For Felipe Villela, a Brazilian agribusiness expert and co-founder of reNature, a regenerative agriculture startup, livestock can be part of sustainable climate solutions when used properly. Indeed, some ecosystems don't function properly without grazing animals.[109] By integrating grass-eating ruminants like cattle or sheep alongside cropping systems, livestock can perform valuable ecological functions, like building up soil organic carbon through carbon sequestration.[110] As we outline in the 'Soil science and livestock' section on page 28,—FAO lends credence to reNature's global mission.[111]

In Brazil, reNature works directly with farmers and ranchers to transition from monoculture systems that rely on inputs like synthetic fertilizers to rotational polycropping systems that incorporate grazing livestock to mimic natural ecologies. Some healthy byproducts of this approach include enhancing soil's ability to retain water and increasing farmer profitability. Overall, reNature's farming solutions have the potential to sequester 36–45 tons of carbon per hectare each year, compared with monoculture systems that often emit more carbon than they capture.[112]

Villela is adamant that industrialized monocropping is "undermining the health and self-sustaining capacities of nature, causing damages to soils, biodiversity, water and climate."[113] Indeed, soil scientists in Germany estimate that 52% of agriculture land is moderately to severely impacted by soil degradation and desertification—costing farmers upwards of US$10.6 trillion annually in ecosystem losses.[114] reNature's efforts dovetail with similar sustainable workshops for ranchers run by Brazil's Solidaridad, in partnership with JBS and Minerva and funded by the Norwegian International Climate and Forestry Initiative.[115] Without these efforts to transition Brazil's ranchers to sustainable practices, Brazil's meatpackers can't meet export and consumer demand for low-carbon beef that's free from deforestation.

### All-in-one grazing solutions

So how exactly do grazing livestock improve soil health, hydrology and biodiversity? By acting as mowers, seed pushers, ground indenters, composters and fertilizer spreaders. As mowers, ruminants chew grasses (or cover crops) that would otherwise oxidize and become kindling for fires. As indenters, livestock hooves create indentations for puddles that enhances water infiltration into soils. As composters, ruminants quickly break down cellulose (grasses) inside their rumen—the largest stomach compartment—via bacteria. As fertilizer spreaders, livestock manure and urine build up soil organic matter by increasing the amount and diversity of soil microbes, which improves soil fertility. Greater soil health, in turn, improves soil's capacity to sequester carbon and atmospheric methane via soil

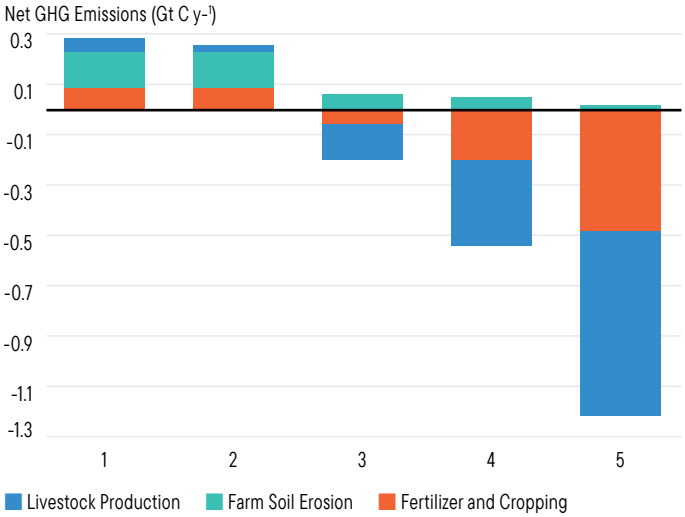
bacterium called methanotrophs.[116] Accurately measuring livestock's climate impact, therefore, requires a holistic view of their interaction with soil and vegetation. It's not like measuring tailpipe emissions from a car.

Soil scientists who've studied the carbon impact of rotationally grazing ruminants note the capacity to recapture GHG emissions underground is immense. As shown in Exhibit 15, simply cutting the livestock population in half within a traditional (i.e., industrialized) agriculture system barely reduces GHG emissions in Scenario #2. By contrast, shifting 25% of agriculture practices to a regenerative approach that involves multi-paddock grazing rotations in Scenario #3 removes more GHG emissions than the rest of the system produces. If there's a critique about soil carbon sequestration globally, it's the challenge of teaching 570 million farms (comprised of 3 billion rural practitioners) to switch to regenerative practices quickly enough to counteract GHG emissions from high-carbon sectors like transportation and industry.[117]

In Brazil, reNature not only helps farmers transition to scalable regenerative methods, it also links them to consumer packaged goods (CPG) companies eager to expand their zero-carbon supply chains. Take Brazil's Marfrig, for example. In collaboration with the Brazilian Agricultural Research Corporation (Embrapa), Marfrig launched a carbon neutral line of beef in 2020 called Viva, produced by farmers

Soil Carbon Sequestration

**Exhibit 15: Hypothetical North American GHG Emissions Soil Sequestration Based on Five Grazing Scenarios***




Source: Teague, W. et. al. 2016. The role of ruminants in reducing agriculture's carbon footprint in North America, *Journal of Soil and Water Conservation*, vol. 71 (2), 156–164. *Note: Hypothetical North American net GHG emission scenarios for: (#1) current agriculture; (#2) current agriculture with 50% current ruminants; (#3) 25% conservation cropping and adaptive multipaddock (AMP) grazing with current numbers of ruminants; (#4) 50% conservation cropping and AMP grazing with current numbers of ruminants; and (#5) 100% conservation cropping and AMP grazing with current numbers of ruminants.

who integrate livestock and cropping holistically.[118] This effort dovetails with Brazil's UN climate commitment to develop 5 million hectares of land that integrates livestock sustainably into cropping and forestry systems.

## Brazil's carbon market victory

At the close of last November's UN climate summit, nearly 200 countries agreed to implement Article 6 of the 2015 Paris Agreement, setting out rules for a global carbon market. This opens the door to trading carbon credits with public and private entities and will ostensibly include offsets generated from agriculture, forestry and land use (to be ironed out after more UN meetings later this year). For Brazil's environment ministry, this is a clear victory for the country.[119] Brazil's former minister of finance, Joaquim Levy, sees this as an opportunity to not only accelerate forest regeneration, but to expand Brazil's low carbon agriculture programs.[120] In Levy's view, nature-based solutions that store carbon in trees and soils have the benefit of trapping carbon immediately while boosting biodiversity and incomes for farmers.

We think trading carbon credits gives Brazil's government a tangible monetary incentive to enact and enforce more climate-friendly policies that will limit deforestation. This could also lead the way to a national, government-sponsored traceability system that would ultimately benefit Brazil's meatpacking industry, as well as producers who can pocket carbon credits.

To understand how ag-related carbon credits work in practice, the Dutch bank Rabobank has already launched a carbon marketplace, called Acorn, that's geared to small farmers. In partnership with reNature and a Brazilian cooperative of farmers, Rabobank recently distributed R$25,000 (US$4,647) to the Cooperativa Agricola Mista de Tomé-Açu (CAMATA) for generating 242 carbon removal units.[121] The carbon units were measured using satellite imagery technology and sold as offsets to Microsoft, which aims to be carbon negative by 2030. Rabobank and reNature hope to sign up 15 million farmers across the globe by 2025, eventually covering an area of agroforestry systems three times the size of the Netherlands that can sequester 150 million metric tons of $CO_2$ emissions annually.

reNature's Villela thinks that carbon credits will add momentum to Brazil's capacity to increase soil health, water quality and farmer socio-economic resilience. This vision is shared by Brazil's Embrapa, which has partnered with reNature to spread regenerative practices across Brazil more quickly. If Villela has concerns, it's whether carbon credits

will get scooped up mostly by farmers using conventional industrialized techniques—therefore, no cover crops and intensively tilling the soil.[122]

## National policy solutions

In the face of escalating climate risks, it is critical that equity analysts uncover future ESG risks and opportunities that can be easy to miss by just scrutinizing a balance sheet. In our discussions with Brazil's meatpackers about deforestation bans, it became clear that national traceability infrastructure is a better solution than one-off systems that only a handful of meatpackers can afford to deploy. Without more support from Brazil's government agencies, Amazon deforestation caused by cattle farming is unlikely to decline.[123]

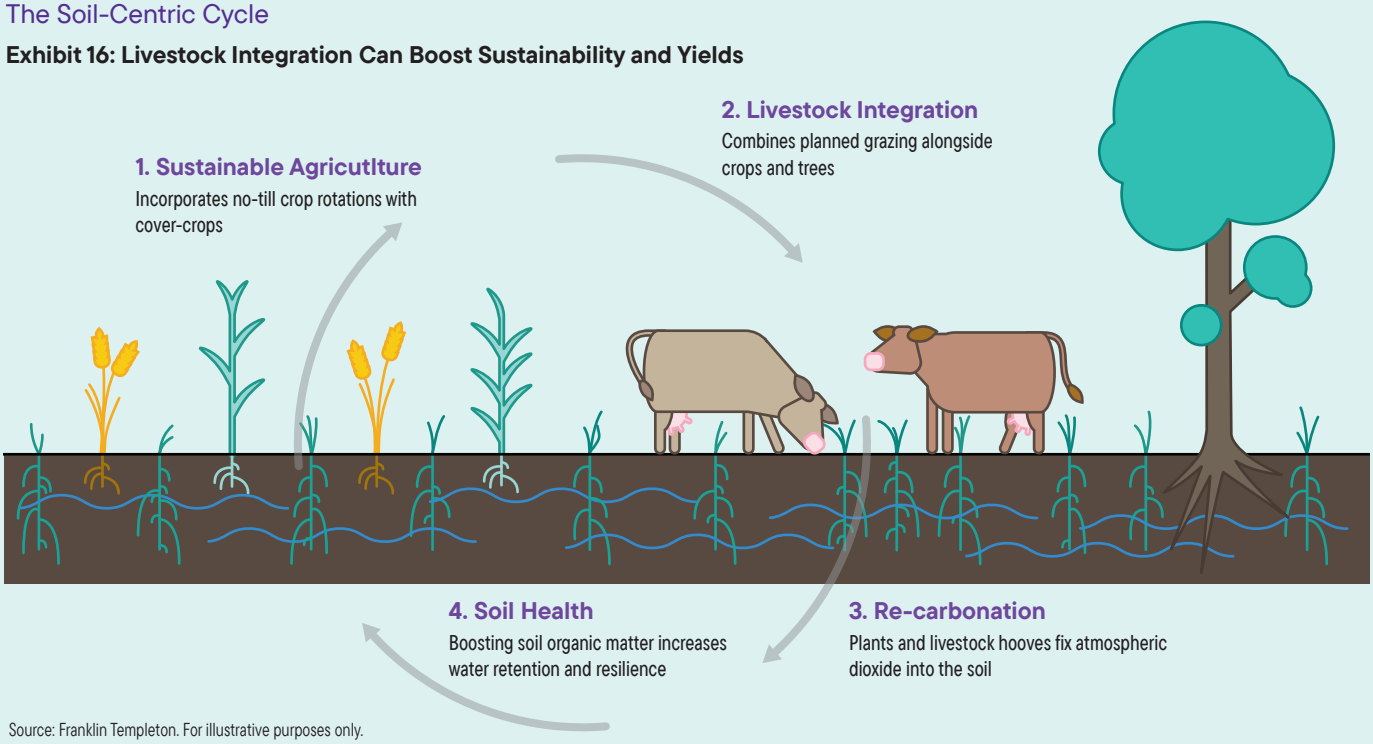
Looking ahead, a global carbon market that confers monetary value to forests and farmland soils could be a victory not just for Brazil and the Amazon, but also for other rainforest countries like Indonesia and the global agriculture sector. That said, we think it's unlikely that entities will buy carbon offsets from Brazil if large-scale Amazon deforestation from ranchers and farmers continues unabated. If big export markets like China move toward an EU-style deforestation ban, we expect Brazil's government will move quickly to enforce sustainable Amazon policies. More broadly, systemic problems like climate change means sustainable practices by private farmers, ranchers and pastoralists in Brazil play an equally important role in delivering potentially carbon-free beef to consumers.

## Soil science and livestock

Amid escalating calls to eliminate meat and dairy from our diets, the UN's top livestock expert, Anne Mottet, set out to clear the record in late 2018.[124] "I came to recognize that people are continually exposed to incorrect information about livestock and the environment that is repeated without being challenged."[125] For example, when you strip out industrialized livestock processes like feedlots and simply measure direct GHG emissions from burping ruminants, livestock make up just 5% of global emissions.[126] For Mottet, it's important to understand how cattle are raised (grass-fed vs. feedlots) and their interactions with soil ecology. With sustainable grazing, farmers use livestock as a tool that saves money by avoiding heavy doses of fertilizers and agrochemicals.[127] Conventional agriculture, by contrast, depends heavily on energy-based inputs like biocides for short-term yields that degrade soil quality.[128] A blanket message of "meat and dairy are bad" shouldn't apply to low-impact pastoralism.[129]

### The Soil-Centric Cycle

**Exhibit 16: Livestock Integration Can Boost Sustainability and Yields**




Source: Franklin Templeton. For illustrative purposes only.

# The reduced carbon emissions diet

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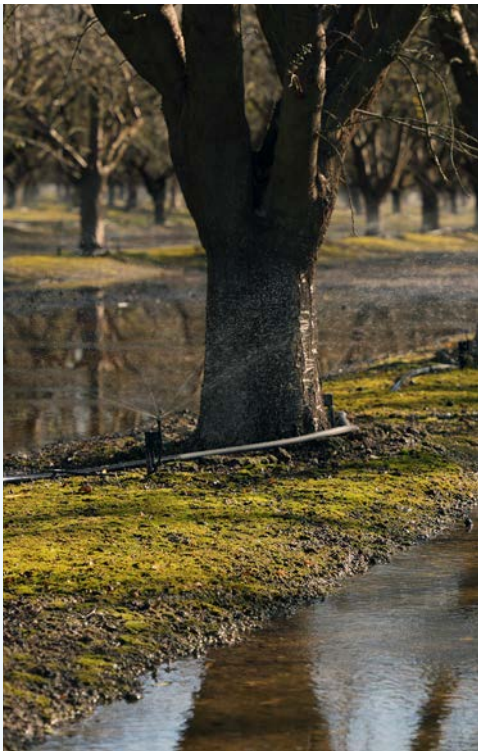


## Key takeaways

- The face of agriculture is changing as it adapts to and mitigates climate change, with the development of plant-based foods having a potential impact on the sector's carbon emissions.
- While many look to plant-based milk for emissions reductions just as they do to plant-based meats, there are many variables that drive the total environmental impact of a product.
- For investors, large-scale emissions reductions in agriculture are a long way off, although plant-based food categories look to be growth stories.

With agriculture and the food industry emerging as a focus for sustainability-minded consumers and investors looking to mitigate climate change and bolster biodiversity, there could be much at stake in your next meal. Agriculture finds itself doubly beset by climate change challenges: it is at once a large emitter of GHGs contributing to climate change and a victim of the effects of climate change on ecosystems. Indeed, two goals of COP26, the 2021 United Nations (UN) Climate Change Conference—curtailing deforestation (often related to growth of agricultural land) and building resilient agriculture—highlight this dual nature of agriculture.

Accordingly, food companies and consumers have a host of solutions at their disposal, although there are few easy fixes, and often appearances don't align with reality. With the growing popularity of plant-based foods, the development of carbon capture technologies and the advent of—or return to—regenerative farming, the face of agriculture is changing as it adapts to and mitigates climate change. Some of these developments may be visible in the grocery store aisle and some may not, but all are now part of how we put food on the table. For investors, large-scale emissions reductions in agriculture from developing technologies are a long way off from monetization, although plant-based food categories look to be growth stories and in many cases are getting a push from large consumer staples names.

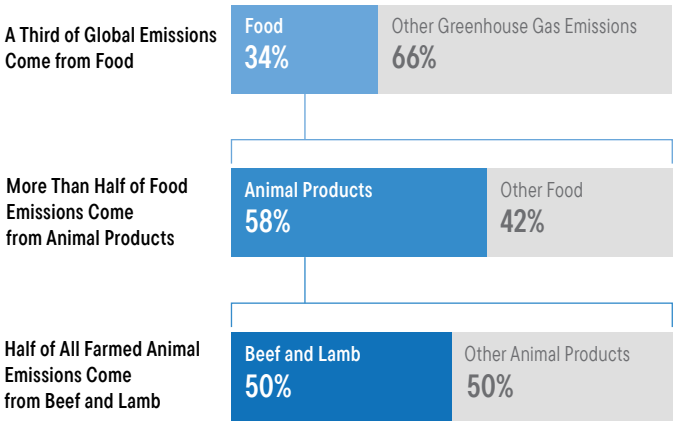
## Emissions: plant over animal

Although there are many arguments for increasing the proportion of plant-based foods in our diet, helping solve the emissions problem of animal-based agriculture is usually near the top of the list. As discussed in Chapter 1, the food system accounts for over a third of global GHG emissions, with beef and milk production accounting for most of the world's agricultural emissions, as seen in Exhibit 17 on the next page. It is here plant-based foods offer the greatest gains—most of these gains are through efficiency.

> **"Roughly a quarter of Earth's ice-free land is used for livestock grazing; plant-based meat, however, uses 47%–99% less land than conventional meat (measured as $m^2$ per year of land per kg of meat), according to studies."**

## Food's GHG Footprint

**Exhibit 17: Proportion of Total GHG Emissions from Food**
As of 2018




Sources: Crippa, M., Solazzo, E., Guizzardi, D. et al. 2021. Food systems are responsible for a third of global anthropogenic GHG emissions. *Nat Food* 2, 198–209; Poore, J. and T. Nemecek. 2018. Reducing food's environmental impacts through producers and consumers. *Science*, 360 (987).

Roughly a quarter of Earth's ice-free land is used for livestock grazing; plant-based meat, however, uses 47%–99% less land than conventional meat (measured as $m^2$ per year of land per kg of meat), according to studies.[130] In terms of emissions, plant-based meats emit 30%–90% less GHG than conventional meat (kg $CO_2$ emitted per kg of meat).[131] Without positing the scalability of these efficiencies in a switch from conventional meat to plant-based meat, plant-based meat has a clear efficiency advantage.

It's possible to see plant-based foods as more efficient than animal-based foods not just in the land they require, but in the energy they provide. Animal-based proteins are in effect an extra—and some would argue unnecessary—step in the food chain, considering the amount of plant matter and water it takes to grow an animal to full size to be slaughtered and produce animal protein. Some estimates suggest that over 50% of global food-related emissions come from animal-based products, yet they yield just under 20% of consumed calories. In a way, plant-based foods are to animal-based foods what the electric powertrain is to the internal combustion engine: a more efficient energy source.

At the same time, changes in consumer preference are already reducing the harmful climate effects of cultivating beef. Changes in consumption from beef to chicken have resulted in less land used for meat production. From 1961 to 2016, although global pastureland expanded by an area almost the size of Alaska, land use peaked in 2000 and then declined due to a shift to chicken production and consumption and the increased use of industrial farming methods.[132]

In other words, there is evidence we may be already shifting away from heavier-emission meat consumption.

Furthermore, the overall emissions gains from switching from conventional meat to plant-based meat may be less than they first appear. Although going vegetarian in a developed country reduces GHG emissions from agriculture, total emissions decline only slightly, with one study finding only a 4%–5% reduction in the $CO_2$ footprint, on average.[133] This is because a cheaper plant-based diet frees up money for consumer goods, the greater consumption of which offsets much of these $CO_2$ "savings."

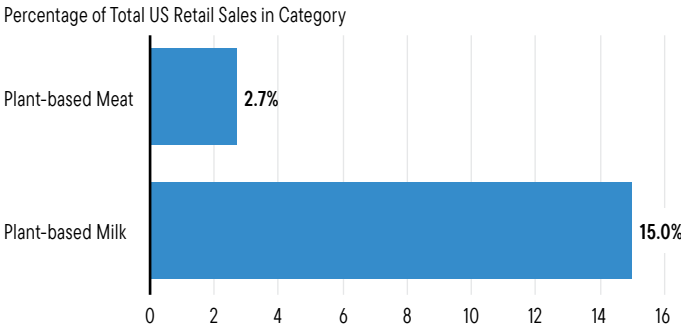
## Milk: oat over almond

For all the attention plant-based meats have received since Beyond Meat went public in May 2019, it is plant-based milks that are the most advanced in terms of category development. Whereas plant-based meat accounted for 2.7% of total US retail packaged meat sales in 2020,[134] plant-based milks represented 15% of all dollar sales for retail milk.[135]

Yet while many look to plant-based milk for emissions reductions, just as they do to plant-based meats, there are many variables that drive the total environmental impact of a product, and emissions are not the only factor to consider. The overall environmental impact can vary quite widely depending on the plant substrate. By a wide margin, almond milk, for example, has significantly lower direct emissions than dairy milk—one study estimates 3x the GHG for dairy milk over almond milk.[136] Almonds don't create the emissions cows do. But the water usage of almonds is significant. It takes about three gallons of water just to grow a single almond through its growth cycle. Additionally, almonds require roughly 9x the amount of water that dairy milk does.[137] Furthermore,

## Consumers Got Milk

**Exhibit 18: Plant-Based Meats and Milks as Percentage of Total US Retail Sales in Category**
As of December 27, 2020




Source: Food Dive, 2021; Good Food Institute, 2021.

> **“Oat milk, on the other hand, solves some of these problems. It has similar overall emissions as almond milk—both represent roughly a 70% reduction in emissions over dairy milk—yet oats are much easier to grow than almonds, can be cropped multiple times a year, and grow essentially anywhere and in variable conditions.”**

roughly 80% of the world’s almonds are grown in California, a water-stressed state subject to extreme drought conditions.

Stressing water resources can also lead to negative climate effects as water shortages contribute to climate change. Globally, droughts result in reduced electricity generation from hydroelectric plants, which in turn increases reliance on coal and natural gas plants for power, exacerbating emissions problems. High liquified natural gas (LNG) prices in 2021, for example, were partially linked to drought conditions in Brazil, where LNG imports rose 60% through the first half of the year.[138]

Oat milk, on the other hand, solves some of these problems. It has similar overall emissions as almond milk—both represent roughly a 70% reduction in emissions over dairy milk—yet oats are much easier to grow than almonds, can be cropped multiple times a year, and grow essentially anywhere and in variable conditions. Most importantly, oats can be grown in water-stressed areas (see Exhibit 19).

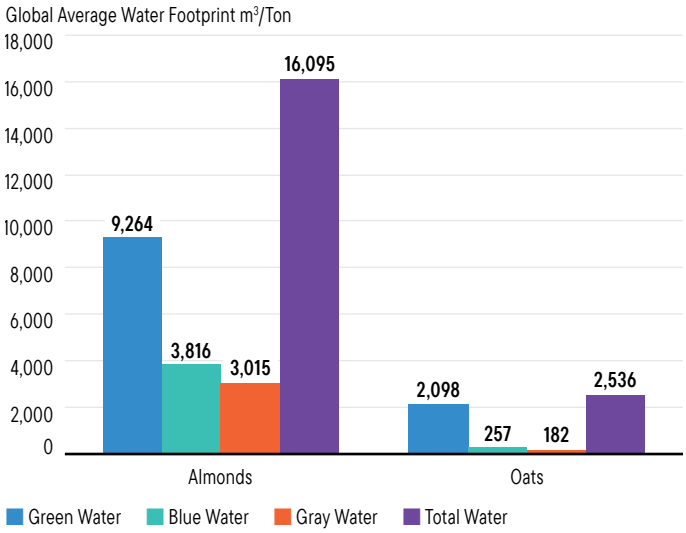
## Consumer taste reigns, and may be changing

For any diet-based strategy geared to lowering carbon emissions, consumer taste is a critical variable. In the case of plant-based meat, the category must appeal to consumers

### Almond’s Water Problem

**Exhibit 19: Global Average Blue, Green, Gray and Total* ($m^3$/Ton) Water Requirements to Grow Oats and Almonds, 1996–2005.**

As of 2010




Source: Mekonnen, M.M. and A.Y. Hoekstra. 2011. The green, blue and grey water footprint of crops and derived crop products. *Hydrology and Earth System Sciences*, 15(5): 1577–1600. *Note: Green water is rainwater. Blue water is surface and groundwater used for irrigation. Gray water is fresh water used to dilute pollution to meet water quality standards. Total water accounts for all three combined.

beyond the vegetarian cohort that makes up roughly 5% of the US population.[139] Data suggest many omnivores are trying plant-based foods, in particular plant-based meats. With NDP Group survey data from 2019 suggesting 90% of those trying plant-based meats are not vegetarian or vegan, plant-based foods appear to be getting traction with the broad population.[140] Consumer taste is also relevant in the milk arena, as consumers have been gravitating toward replacing almond milk and soy milk with oat milk, citing oat milk’s superior natural sweet taste. Oat milk’s previous robust growth has attracted a lot of innovation to the segment including barista-style varieties. The rapid sales growth of plant-based milk has brought about new product development from established players and new entrants alike.

# Natural capital's key role in sustainable food systems

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Head of Stewardship and ESG
Martin Currie

The food system as it currently stands is exposed to three significant gaps—the food gap, the land gap and the GHG mitigation gap. Addressing these gaps simultaneously is particularly challenging; see the Three gaps sidebar for more information. The financing of the food and agriculture industries and the role banks play will be key to building a more sustainable food system. The main barriers to success to date center on the lack of frameworks to effectively value natural capital[141] and the paucity of meaningful and consistent biodiversity metrics that are currently available to measure risk and monitor success.

However, we believe that the finance sector is waking up to this. We have seen that some of the leading banks are recognizing their impact in the way they are now approaching agricultural lending activities and the support and education that they provide alongside this. The development of reporting frameworks is the other key step—in particular the Principles of Responsible Banking (PRB) and the Task Force on Nature-related Financial Disclosure (TNFD). These frameworks will facilitate lenders and investors to make more informed assessments on the risks and opportunities associated with the food supply chain overall. Ultimately, we are encouraged by the progress we are seeing but recognize that there is a huge task ahead—if we are to build a more sustainable food system the financing of it needs to play a key role.

## The role finance can play

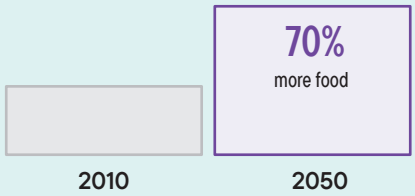
Recognizing the intertwined challenges of climate change and biodiversity loss and the food chain's key role in both,

### Three gaps

With an eye on the future, three substantial "gaps" need to be addressed to create a sustainable food system to support the rising global population by 2050.[142]

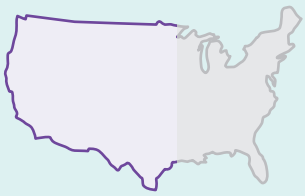
**Food gap**

Additional amount of food production necessary to meet likely demand in 2050.[143]




**Land gap**

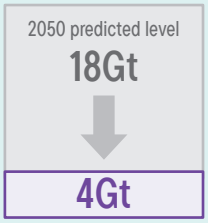
Global agricultural land area required in 2050 is estimated to need to expand by nearly 600 million hectares (almost 1.5 billion acres).



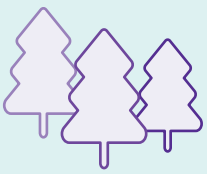
That's equal to roughly two-thirds the size of the United States[144]

**GHG mitigation gap**

Predicted level of annual GHG emissions from agriculture and land-use change in 2050 needs to drop to hold global warming below a 2°C above pre-industrial temperatures.




To hold global warming below 2°C increase...



...with aggressive reforestation to hold global warming below 1.5°C increase[145]

an important lever to help drive change is the consideration of natural capital and biodiversity, particularly in financing the agricultural sector. By applying a value to natural capital and the tangible benefits that this provides, capital flows can start to be redirected to more sustainable businesses alongside promoting best practices that are beginning to emerge.

**The banking sector's key role**

Banks provide a wide variety of finance to companies involved in agriculture—as seen in Exhibit 20—and food supply chains. These services include term loans, trade finance, revolving credit alongside project finance and more. It is therefore important to understand the different roles and approaches that are taken by the banking sector.

Domestic finance—here we are referring to national development banks and private banks—frequently provide finance in the form of low-cost loans. They can incentivize change by setting eligibility criteria that preclude, for example, the conversion of forest or ecosystems. These conditions can then be applied either retrospectively—looking at what food producers/landowners have done and removing eligibility where that is the case—or prospectively, whereby a penalty interest rate is applied where this activity takes place once the loan has been received.

International bodies, such as the World Bank, also play an important role and can use targets focused on agricultural productivity or protection of forests, or ideally in combination, to help support both goals.

Supply-chain financing can have a broader influence with buyers or financiers supporting "conversion-free" supply chains, whereby they choose to buy or finance only those agricultural commodities that are not linked to deforestation or to the conversion of other ecosystems.

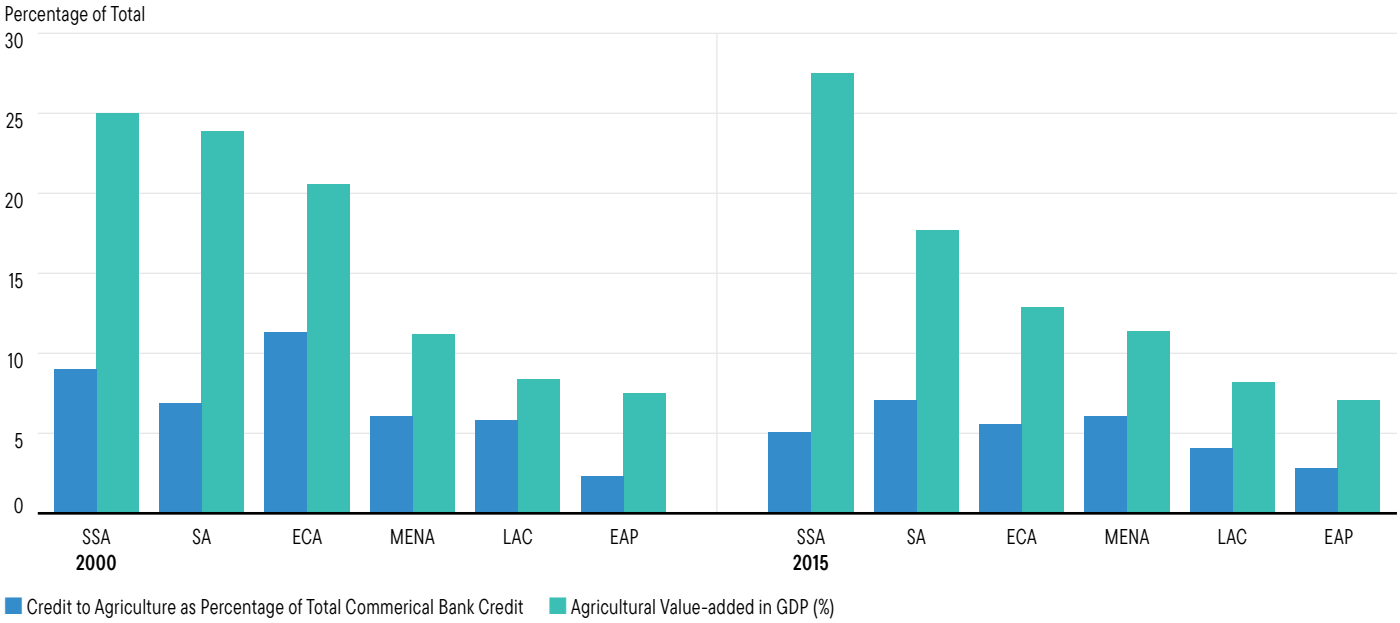
**Soft commodities compact**

The Soft Commodities Compact (SCC) is an example of how this might work. Set up in 2014, the SCC[146] was a joint sustainability initiative of the Consumer Goods Forum (CGF), an organization of chief executive officers from consumer goods manufacturers and retailers, and the Banking Environment Initiative (BEI), a group of sustainability focused global banks, and was signed by 12 major European and US banks. The goal of the SCC was for the banking industry to support clients to achieve net zero deforestation in their commodities supply chain by 2020. In particular, this initiative focused on the soft commodities—soy, palm oil, beef and timber-related products identified as the four key "forest-risk commodities." Under the SCC, the 12 signatory banks committed support to their clients in soft commodity supply chains to reduce deforestation through an approach largely focused on requiring clients to sign up to certification schemes.

## Commercial Lending to Agriculture

**Exhibit 20: Agricultural Credit and Agricultural GDP Share by Region, 2000 vs. 2015**

As of 2019




Source: Data from World Bank (2019). Note: Sample size 127. EAP = East Asia and Pacific, ECA = Europe and Central Asia, LAC = Latin America and Caribbean, MENA = Middle East and North Africa, SA = South Asia, SSA = Africa south of the Sahara.

> **"Reliable and robust biodiversity data, which is critical to enabling target setting, are not readily available in a format that can either be easily understood by banks or that can be readily fed into the decision-making process. As such, there is a real need for more streamlined biodiversity-related KPIs. Encouragingly, we are seeing extensive effort put into building potential frameworks."**

So what was the outcome of this initiative? BankTrack published a report looking at what progress was made and the extent to which the goals of this initiative were met.[147] While there was clear progress in most cases, the report found that none of the banks succeeded in ensuring all their clients were certified by 2020. Cambridge Institute for Sustainability Leadership (CISL) has published a follow up report,[148] which makes some recommendations based on the lessons from the SCC, the most important of which we believe are: ensuring that there is collaboration between global and local banks; aligning standards for measurement; and setting specific, short milestones and key performance indicators (KPIs) in order to achieve the ultimate goals.

## Addressing gaps

Reliable and robust biodiversity data, which is critical to enabling target setting, are not readily available in a format that can either be easily understood by banks or that can be readily fed into the decision-making process. As such, there is a real need for more streamlined biodiversity-related KPIs. Encouragingly, we are seeing extensive effort put into building potential frameworks.

A key one for us is the PRB, which has recently issued guidance on biodiversity target-setting for banks.[149] The PRB recognizes that, to date, the financial sector has failed to channel significant capital into biodiversity, whether it be conservation, restoration or sustainable use. This suggests, to some extent, there is a lack of understanding of biodiversity and its importance among banking professionals. The aim of the PRB framework is to address this gap by establishing KPIs and targets that are understandable, relatively easy to measure, report and verify alongside robust guidance for lenders. These are key elements to support capital flows, and the framework looks to address some of these shortcomings. Structured in the right way, these can also have a direct impact on the profit or loss for the client and the bank issuing the product and potentially drive improvements in practices, in our view.

Under the PRB framework, signatory banks commit to taking three key steps enabling them to reduce their impact on biodiversity:

1. Analyze their current impact on the environment, society and their economies. This may include identification of their impacts and dependence on biodiversity, where this is relevant to their portfolios.
2. Based on this analysis, set targets in their areas of most significant impact (and dependencies), such as biodiversity, which should include clear implementation plans.
3. Publicly report on progress (based on measurement of the targets), including biodiversity where this is identified as an area of significant impact.

The framework that the PRB is establishing aims to ready the banking sector for developing science-based targets—requiring them to be achievable, verifiable and supported by a clear rationale. The framework sets expectations around the lending due diligence process, the need for exclusions—not financing activities with high negative impact—and setting out clear policies and targets (for example, zero deforestation). The report also cites examples of strong practices across some of the global banks—notably ING, Rabobank, Credit Suisse and Mitsubishi UFJ Financial Group.

The other framework that we are focusing on is the TNFD. This is a market-led global initiative that aims to support financial institutions and companies in assessing nature-related risks and opportunities. Its stated goal is to *"support a shift away from nature-negative impacts and toward nature-positive global financial flows, by providing a framework for organizations to report and act on nature-related risks, including impacts and dependencies."*

The TNFD will play a key role in providing a reporting framework that will allow for consistent and comparable reporting. The reporting framework will be designed to complement the Task Force on Climate-Related Financial Disclosure's (TCFD) framework and is expected to be launched in 2023.

## Banks leading the way

Our own analysis has also identified interesting examples of the work banks are doing in driving more sustainable agricultural practices in economies dominated by agriculture.[150] In the emerging market space, India is a prime example. Agriculture is huge industry in India, and HDFC Bank is the country's largest private sector bank.[151] For agriculture-related loans, which potentially present higher credit risks due to exposure to climate change impacts, the bank supports food producers by connecting them to government initiatives and expert advice on weather, soil health and cropping patterns. The bank has also specifically outlined a goal to "provide access to capital for environmentally sustainable projects that contribute to climate change mitigation." The group has a specific Social and Environmental Management System (SEMS) framework, which assesses various parameters, including negative environmental impact when deciding whether to lend to a business. These include pollution, waste management and climate change, alongside the ecological impact.

Another Indian bank, ICICI Bank, takes a very proactive approach. Rather than excluding firms with poor practices, it has a specific group that seeks to find and lend to projects promoting biodiversity or environmental sustainability. It has also intervened with many rural agricultural businesses and farmers to provide education to help transform their crop rotation, paddy cultivation, pest control and food security. The group has also recently started to use satellite technology to assess the creditworthiness and risks associated with agricultural lending, with the intention of expanding this capability rapidly in the near future.[152] While these are small steps, we believe they can start to have a real impact once at scale.

Of the banks in developing economies, we view some of the best practices are from National Australia Bank (NAB). Agriculture is an important sector for the Australian economy, and NAB was a founding signatory to the PRB. Additionally, NAB is the only Australian bank to sign up to the Natural Capital Declaration (NCD)—a global statement recognizing the potential risks and opportunities that natural capital poses to the finance sector. NAB has clearly identified finance as a potential driver for more sustainable agricultural practices.

The bank has set out a Natural Value strategy, which leverages its understanding of the linkages and dependencies of natural capital upon customers, operations and supply chains. A crucial element of this is the work it is doing on valuation, with a focus on the connections between strong management of natural capital, financial risk and business resilience—essentially trying to put a "dollar value" on investments in natural capital. NAB has worked with valuation experts to explore the links and dependencies between the good management of natural capital assets, financial performance and business resilience. Initially, this approach has been focused upon agribusiness customers; however, it plans to extend this across the entire business. By integrating this understanding into products and services, NAB can reward clients that demonstrate they are working to lower their impact and risk across issues such as soil health, water scarcity, energy cost, runoff and waste.

The aim here is to encourage sustainable agricultural practices by enabling landholders who manage their assets sustainably to access more competitively priced debt, obtain premium prices for their land and enhance the value of their produce. Such products include discounted loans for energy efficient and renewable energy assets, like water-efficient irrigators and fuel-efficient agricultural equipment, and green bonds to assist investors in prioritizing investments that finance climate change solutions.

## Conclusion

Finance, particularly the banking sector, has a key role to play in managing and mitigating the impact of the food supply chain on biodiversity and climate change. Banks that are leading this process will both seize the potential opportunity as well as effectively manage the potential risks associated with the sector. Frameworks such as TCFD, which is focused on climate, and the emerging TNFD, focused on natural capital, will increase transparency of both practices and impact and consequently increase investor scrutiny on the sector. The PRB guidance on biodiversity target-setting also provides a strong starting point for how banks can approach this.

At Martin Currie, we have been working to create a framework to help identify those companies with the highest potential exposure to biodiversity risk, focusing in particular on those exposed to the food supply chain. This framework and the learnings that we have taken from the emerging disclosure standards and the engagement that we have already had with the banks involved in these sectors will help us identify those companies that really are prepared for this important and emerging issue.

# Financing a regeneration for healthy soils

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As discussed in Chapter 1, the way we produce food today is a major contributor to emissions, as well as biodiversity loss and ecosystem destruction. In the coming decades, agricultural production must feed more people with fewer resources. However, there are severe warning signs that the singular pursuit of increasing yields has obscured costs made to planetary and human health, which pose long-term threats to our global food supply.

In order to address urgent climate challenges, we need to remove more carbon from the atmosphere than is being emitted through both emissions reduction and carbon removal. Nature-based solutions seek to restore and rebuild natural systems such as agricultural lands, and can provide low-cost and low-tech ways to work with nature to sequester carbon[153] and restore ecosystem health.

However, natural systems remain severely under-invested by both private and public sectors. A UN report on the State of Finance for Nature estimated that only US$133 billion goes into nature-based solutions annually, 14% of which comes from private finance.[154] Companies and financial institutions

## Industrial agriculture and the US food system

To transform the global food system, we might start by understanding the challenges posed by the US food system, a prime model of industrial agriculture. Since World War II, the increased use of synthetic fertilizers in the United States has enabled an incredible increase in yields and an abundance of cheap calories. US food production is characterized today by large-scale monocrop agriculture and the heavy use of chemical fertilizers and pesticides, practices influenced and supported by US food policy. The US Farm Bill passed every five years provides substantial federal fiscal support to industrial agriculture in the form of commodity price supports, crop insurance and loan programs. As a result, the dominant crops grown are corn and soybeans, which largely go into animal feed, biofuels and heavily processed ingredients.

The Rockefeller Foundation estimates that the US food system creates more than three times the cost of food in negative externalities that are not priced in, including ecosystem degradation and negative human health outcomes.[155] The production and use of synthetic fertilizer contributes 1.3 billion tons of GHG emissions, representing roughly 20% of agricultural emissions.[156] Fertilizer overuse creates nutrient runoff, polluting waterways. Conventional agriculture practices have depleted US soils, which are eroding faster than they can be replenished, creating poor resilience to climate change and causing biodiversity loss in pollinator communities and soil microbiome. As discussed in Chapter 1, biodiversity loss and its mounting costs are key components of the work at the Taskforce on Nature-related Financial Disclosures (TNFD), Task Force of Climate-Related Disclosure (TCFD), and the fall 2021 UN Climate Change conference—commonly referred to as "COP26."

are being called on, alongside public actors, to triple capital flows into nature-based solutions by 2030 and quadruple them by 2050 in order to meet the world's climate, biodiversity and land degradation targets.[157]

A productive and sustainable agricultural system starts with rebuilding healthy soils through nature-positive practices. While the food system is significantly influenced by policy and demand drivers, private capital has an important role to play to bring responsible production and consumption practices to scale. More than US$700 billion of financing is needed to scale these agricultural solutions in the United States over the next 30 years, representing a significant opportunity for investors to invest in a more sustainable food system.[158]

## Regenerative agriculture as a nature-positive solution

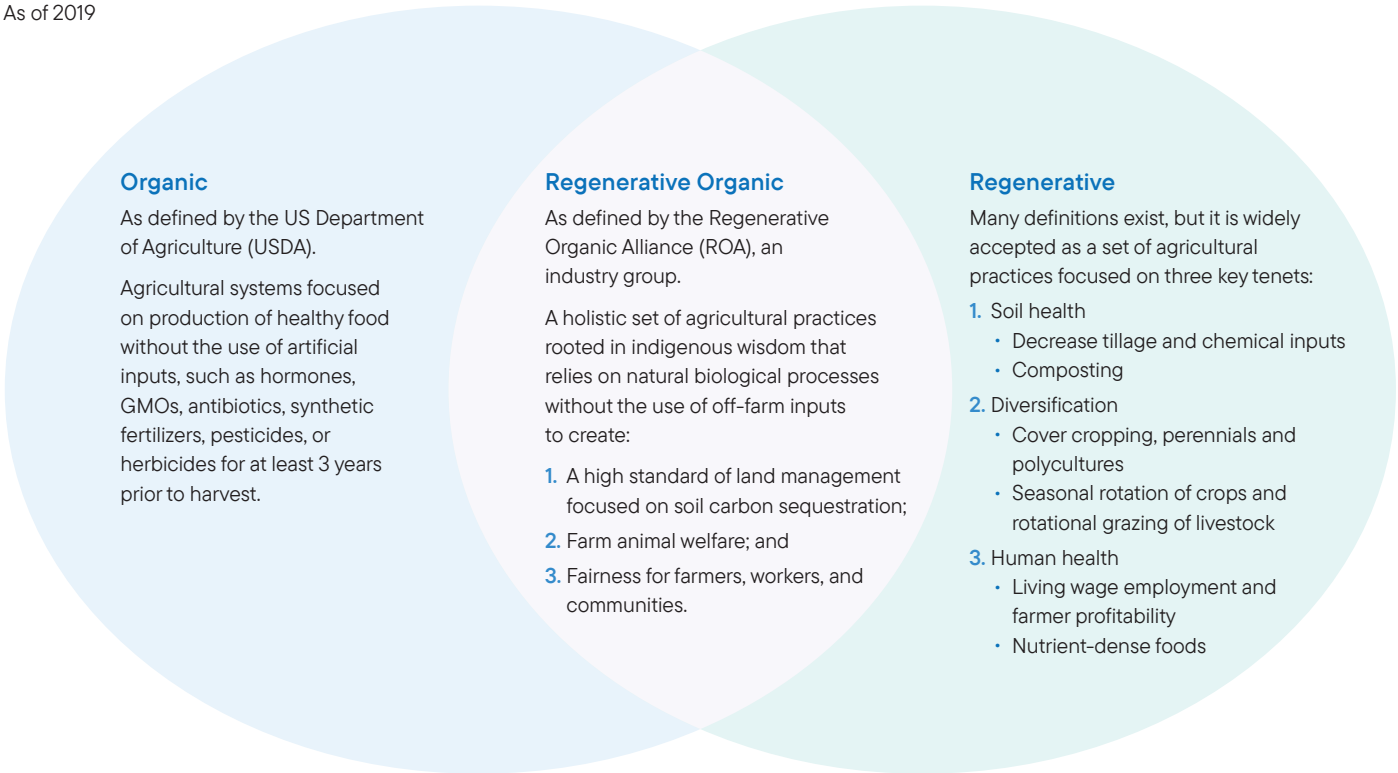
Organic agriculture and regenerative agriculture represent two alternatives in the US market to industrial approaches; however, they make up a small portion of current food production. Less than 1% of US farmland is certified organic,[159] and only 3.6% of cropland receives funds to implement soil health practices.[160]

While often used interchangeably, these two terms are distinct. Organic is a US Department of Agriculture label backed by a set of certification guidelines and designed to identify produce grown without the use of non-organic compounds such as fertilizers or genetically modified seeds. However, certified organic does not necessarily result in practices that reduce ecological damage or rebuild soil health. Regenerative agriculture does not have a set definition or certification; it refers to a set of agricultural practices that can be adapted to local contexts to promote long-term stewardship of that land. The simple Venn diagram in Exhibit 21 further outlines the basic distinctions between these systems.

A regenerative system is one that not only reduces environmental impact, but also actively restores ecosystem health, taking a holistic approach to address human and animal welfare. Regenerative practices focus on three key tenets: soil health, diversification and human health. This includes adopting practices such as cover cropping,[161] reduced or no tillage,[162] and reduced use of inputs such as herbicides and fertilizers. The "purest" version of this is regenerative organic, which is rooted in indigenous wisdom, incorporating these practices while eliminating the use of non-organic compounds.

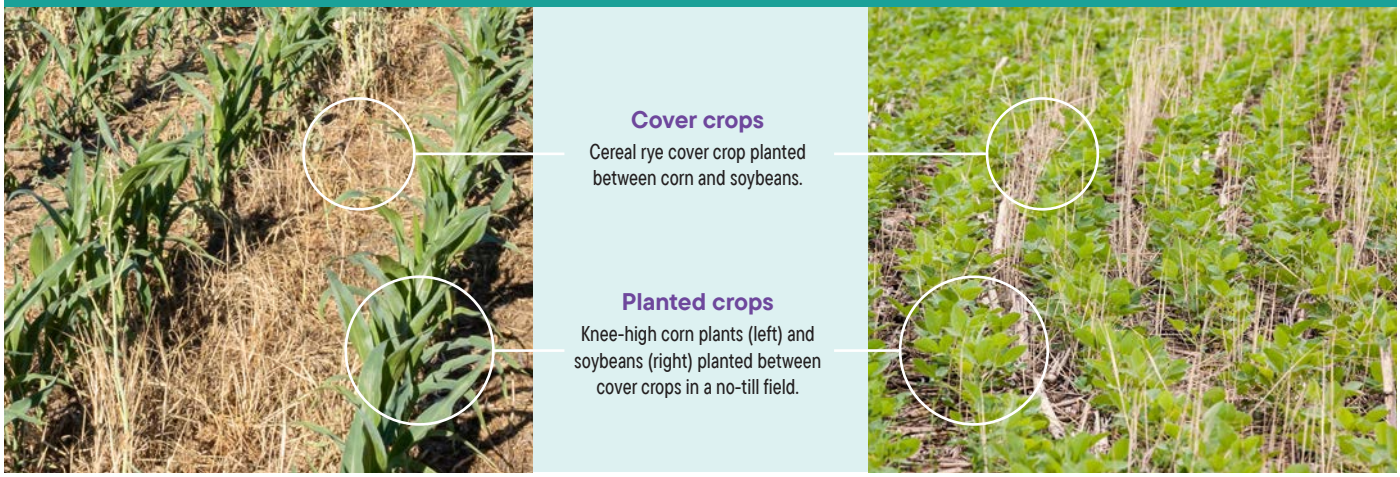
### Alternative Practices For Soil Health

**Exhibit 21: Venn Diagram of Sustainable Agricultural Systems in the United States**
As of 2019




Sources: Chart created using definitions from USDA, ROA and Croatan Institute. Franklin Templeton and Gratitude Railroad, *Private Capital Solutions for a Sustainable Food System in the US*, Landscape Review, October 2021. For illustrative purposes only.

## Regenerative practices in action



**Cover crops**
Cereal rye cover crop planted between corn and soybeans.

**Planted crops**
Knee-high corn plants (left) and soybeans (right) planted between cover crops in a no-till field.

Regenerative practices can provide an array of ecosystem services, including ecological biodiversity, carbon sequestration, improved financial returns for farms, and long-term climate resilience of soils, as well as nutritional and health benefits. The Croatan Institute estimates that regenerative practices have the potential to mitigate 170 gigatons of $CO_2$ emissions through emissions reduction and carbon sequestration, and could generate nearly US$10 trillion in net financial return over the next 30 years.[163]

With the current buzz around investment opportunities for high tech carbon capture and sequestration, more attention must be paid to the role of regenerative agriculture as an extremely low-cost and scalable form of carbon removal. Healthy soils promote biological processes that support the soil's natural ability to drawdown and store an estimated 25–60 tons of carbon per acre.[164] A one percent increase in soil organic matter is estimated to allow soils to hold up to 20x its weight in water, reducing flooding, which prevents erosion and nutrient and chemical runoff to waterways.[165]

These practices may provide further cost savings to human and ecosystem health. Restoring healthy soil microbiome can enhance the nutrient density of food, and the reduction of chemical inputs can reduce the risk of associated health problems among growers and local communities.

## Barriers and opportunities

Private capital is not a panacea, and the food system is significantly influenced by policy and demand drivers. Large barriers exist across the entire food value chain, limiting the broad adoption of regenerative practices. Investment opportunities in regenerative agriculture are limited but growing across a spectrum of impact and financial returns. Market gaps can also present key opportunities for managers who can navigate them to invest in soil health.

One of the major challenges is the three-year transition period and related drop in yields required to rebuild soil health. In the United States, farms have become fewer and larger, while the amount of farmer-owned and operated land has diminished. Thirty-nine percent of total US farmland today and over half of cropland is rented by farmers, creating agency problems that limit the consideration of long-term land stewardship.[166]

Regenerative practices must be customized for local land and soil conditions and therefore require a different set of machinery and tools compared to conventional operations.

### Clear as Mud

**Exhibit 22: The Market is Saturated with Confusing Eco-labels**

Of the over 200 eco-labels in the US market, half are food-related and only a few have some form of certification standard, including:

- USDA Organic (95–100%) Certified Organic
- Certified Naturally Grown
- Non-GMO Certified

While many more lack any certification standards:

- Natural or Made with Natural Ingredients
- No Additives
- And 30+ More (Hormone Free, Free Range, Etc.)

Source: Ecolabel Index.[167]

This includes the ability to closely monitor soil conditions, verify ecosystem benefits, and manage a more complex and diverse set of operations. Farmers are not adequately compensated for taking on these upfront costs and risks in exchange for providing long-term ecosystem benefits. In the absence of carbon pricing or a regenerative price premium, the transition period remains cost-prohibitive for most farmers. Producers also face bottlenecks midstream, as many of these small-scale regenerative operations lack the appropriate aggregation, processing, and distribution markets to sell into. Yet demand for organic continues to grow, outpacing US domestic supply by 4–5x.[168] Consumers who may be willing and able to pay a premium for regeneratively grown goods also face opaque labels and certifications (see Exhibit 22).

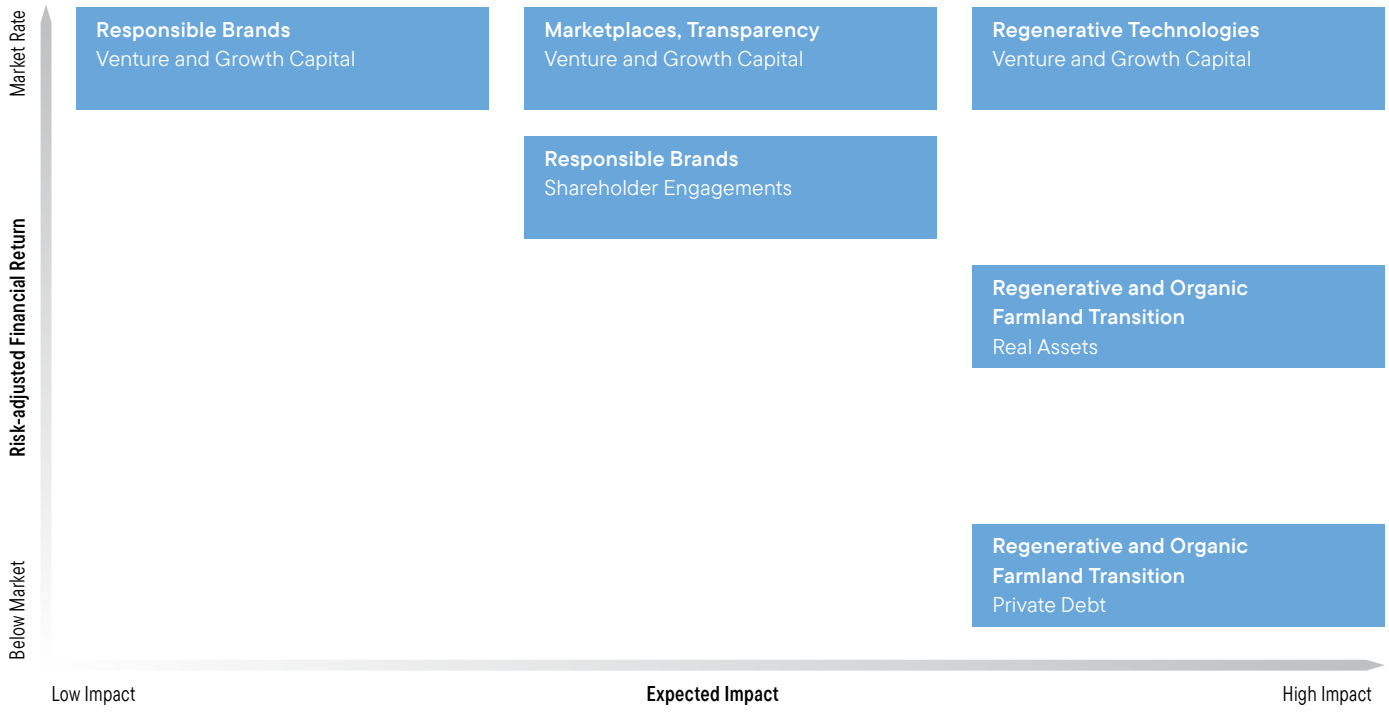
While data is still limited on the economics of regenerative agriculture, the transition to regenerative farming can provide farm operations with cost reductions over the long term, lower risk and create potential for premium crop pricing.[169] Carbon markets can also be a compelling way to compensate farm operators for providing ecosystem services. In the absence of a global and comprehensive carbon policy, two markets have developed for carbon credits. Compliance carbon markets are traded and regulated by mandatory regimes, and mostly cover heavy emitting sectors like power and industry. Voluntary carbon markets (VCM) are traded by companies and individuals, represented mostly by nature-based solutions. The voluntary market overall is still nascent and relatively small, totaling just over US$1 billion in market value as of 2021.[170]

As corporations, investors and governments begin to grapple with achieving their interim 2030 targets, natural solutions will play an increasingly important role. VCM has the potential to reach US$5 billion–US$30 billion in market value by 2030, 65%–85% is expected to come from nature-based solutions.[171] The challenge for voluntary carbon offset markets is the need for a clear system to determine additionality,[172] durability and verifiability in order to avoid greenwashing [173] and carbon leakage, as well as ensure appropriate pricing. In addition, offsets should be used to address unavoidable emissions, and not distract from corporate commitments to decarbonize products and operations. Companies can also look to agricultural portions of their supply chain for "carbon insetting"[174] opportunities to incentivize the adoption of regenerative practices.

Novel financing frameworks, outcomes-based financing, and loans to farmers with flexible terms can enable more operator land ownership and incentivize better long-term stewardship.

## Current Investment Landscape for Regenerative Agriculture

**Exhibit 23: Expected Impact Versus Risk-based Financial Returns by Asset Class and Opportunity Set**




Source: Franklin Templeton. For illustrative purposes only.

> **"Farmland provides investors with a differentiated source of return from current income through cash yields, capital gains through land appreciation and potential portfolio diversification. Farmland investing can provide a hedge against inflation because higher commodity prices make the land more valuable."**

Scaling up the regenerative food system requires innovations across the value chain that enable the adoption of climate-positive practices.

Most of the opportunity set today remains in private vehicles with long lockup periods financed by accredited investors and/or qualified purchasers, including family offices, institutions and strategic investors.

In the United States, the landscape of real asset and private credit funds covers a diverse set of geographies growing a variety of different crops—from row crops in the Midwest to permanent crops such as citrus and nut farms in California.

Real asset strategies can provide direct exposure to sustainable agriculture, particularly farmland. Fund managers pursue land conversion strategies, acquiring conventionally managed land to transition to regenerative or organic farmland. Most strategies focus on generating return through rentals. Investment teams will source, execute and manage these transactions and develop partnerships with local operating teams to manage day-to-day needs. Some strategies have operational capabilities in house.

It is critical that investment teams have agronomic operational expertise related to organic transition and regenerative practices. Due to the midstream processing and distribution bottleneck, most strategies also provide marketing assistance or develop partnerships with off-takers to connect regenerative products to the broader supply chain. Strategies may also participate in conservation and carbon credits.

Farmland provides investors with a differentiated source of return from current income through cash yields, capital gains through land appreciation and potential portfolio diversification. Farmland investing can provide a hedge against inflation because higher commodity prices make the land more valuable. Premium organic pricing provides attractive cash yield after the transition period and long-term asset value appreciation. For row crops, organic commodities can generate more than 2x the revenue for conventional commodities,[175] and cropland can generate a 25% rent premium compared to conventional cropland.[176] These real asset strategies are generally available through private vehicles with 10-year lockup periods.

Private credit managers have created unique financing structures to help farmers transition farmland. Managers typically provide direct loans to farmers, employing outcomes-based financing and blended finance, which combine philanthropic and private capital. These loans may have flexible terms over the transition period, followed by a revenue share model attached to organic or regenerative pricing premiums and ecosystem benefits. These efforts include technical assistance to lower operational risk and support farmers. These strategies provide concessionary returns relative to the risk and illiquidity generated, with long lockups that range between five and 10 years.

Innovations are also needed to help accelerate the transition to a regenerative food system. Venture and growth equity strategies will typically invest across the entire food value chain. Venture stage managers invest in early-stage innovations to improve on-farm management, as well as regenerative inputs and biologics. This includes technologies such as drones, satellite imagery, soil monitoring sensors and biological inputs. Investments in market-making platforms and automation that improve the traceability and diversification of supply chains can also facilitate the distribution of locally sourced and responsibly grown products. Growth stage managers can help scale the regenerative supply chain; however, these strategies are currently concentrated in responsible brands targeting the premium product market. Venture and growth equity funds seek to generate returns typical of the asset class.

While there is a critical need to invest in midstream infrastructure for regenerative products, this is an area that has received limited investment to date. Midstream infrastructure must be able to operate at a scale to compete with conventional production or ideally be built as regionally focused networks.

Finally, large food and agriculture-related multinationals also have a substantial role to play in reducing emissions. For example, it is estimated that the consumer package goods industry must reduce GHG emissions embedded along supply chains by more than 50% in order to meet 2050 climate targets.[177] Shareholders can engage with these

companies to make time-bound sustainability commitments to responsible sourcing policies and net-zero emissions to bring the sustainable value chain to scale.

## Conclusion

Nature-based solutions have the potential to mitigate 10–12 gigatons of $CO_2$ per year, providing a cost-effective, sustainable and scalable way to achieve over one-third of climate mitigation needed over the next 10 years.[178]

Improved measurement, transparency and coordinated action across private markets, consumer behavior and public policy can support and scale regenerative practices. While there are no cure-all solutions, it is critical to transform the agriculture and food system toward nature-positive solutions to help manage risk, meet our climate targets and preserve the environment for future generations.

### Endnotes

1. As global temperature rises, crop yields fall. By 2100, an estimated 2.5 billion people will be at risk of starvation. Africa and Asia are both projected to have over a billion people each dealing with acute hunger. This will create global consequences. Source: Allwood, J. "Valuation and risk as the rhetoric-action gap on climate mitigation closes." Paper presented at the Fiduciary Investors Symposium, Cambridge, UK, April 20, 2022.
2. Source: World Food Programme (WFP). 2022. *Projected increase in acute food insecurity due to war in Ukraine.* Rome: WFP.
3. Source: WFP. 2022. *Unprecedented needs threaten a hunger catastrophe.* Rome: WFP.
4. *ibid.*
5. Source: van Nieuwkoop, M. "Do the costs of the global food system outweigh its monetary value?," *World Bank Blogs*, June 17, 2019.
6. Source: FactSet, as of February 21, 2022. Calculation contains market cap of 2,114 companies in these categories: food distributors, food retail, hypermarkets and super centers, agriculture products, packaged foods and meats, and the soft drinks industry. Total market cap of US$117.1 trillion calculated on 48,325 companies.
7. The 2021 United Nations Climate Change Conference, commonly referred to as COP26.
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56. ADQ is one of the UAE's largest holding companies, with a broad portfolio of major enterprises spanning key sectors of Abu Dhabi's diversified economy. It is both an asset owner and investor in target sectors, locally and internationally, which align with the Abu Dhabi leadership's economic vision. Any companies and/or case studies referenced herein are used solely for illustrative purposes; any investment may or may not be currently held by any portfolio advised by Franklin Templeton. The information provided is not a recommendation or individual investment advice for any particular security, strategy, or investment product and is not an indication of the trading intent of any Franklin Templeton managed portfolio.
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# Notes

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