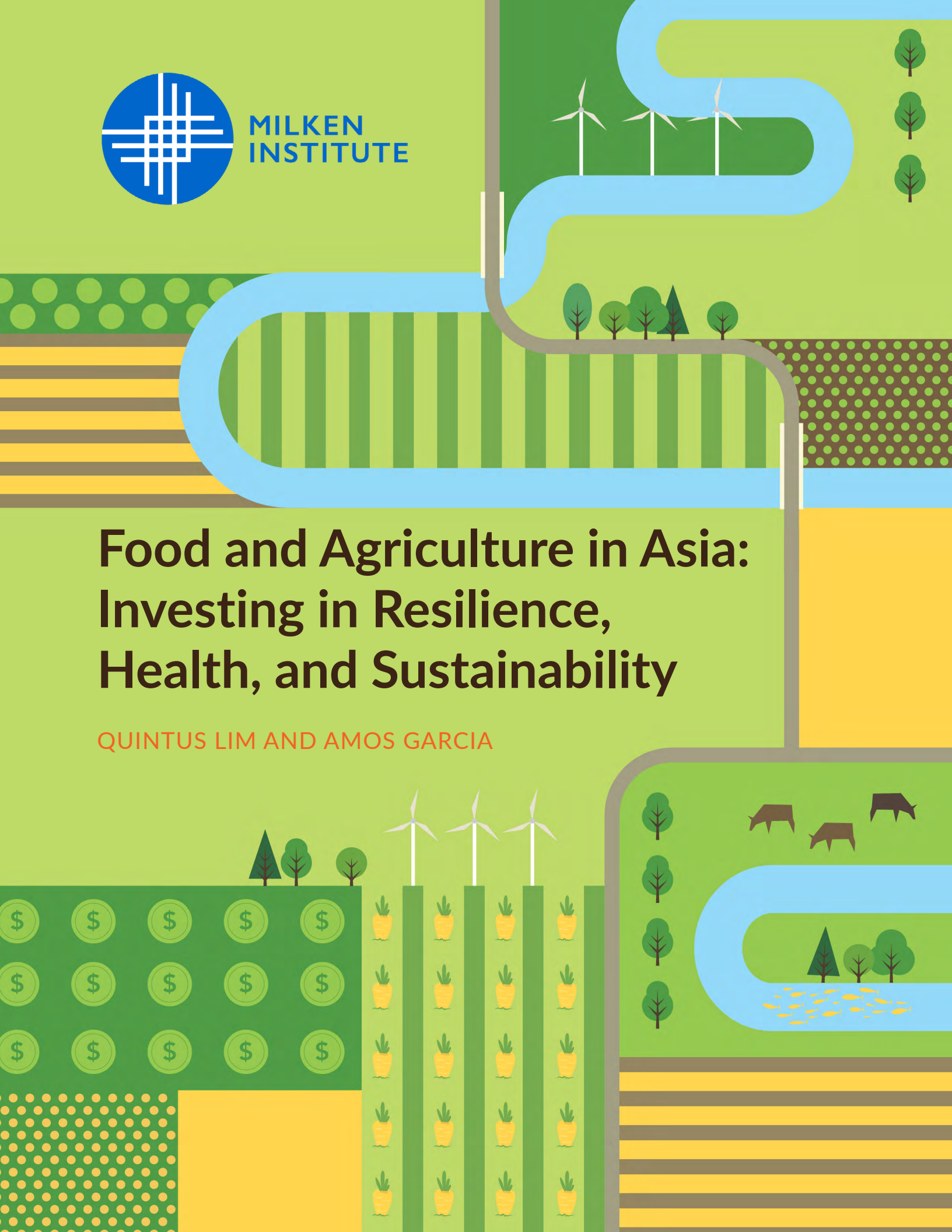

MILKEN INSTITUTE

Food and Agriculture in Asia: Investing in Resilience, Health, and Sustainability

QUINTUS LIM AND AMOS GARCIA

ABOUT THE MILKEN INSTITUTE

The Milken Institute is a nonprofit, nonpartisan think tank focused on accelerating measurable progress on the path to a meaningful life. With a focus on financial, physical, mental, and environmental health, we bring together the best ideas and innovative resourcing to develop blueprints for tackling some of our most critical global issues through the lens of what's pressing now and what's coming next.

ABOUT THE ASIA CENTER

The Milken Institute Asia Center extends the reach and impact of Milken Institute programs, events, and research to the Asia-Pacific region. We identify opportunities to leverage the Institute's global network to tackle regional challenges, as well as to integrate the region's perspectives into the development of solutions to persistent global challenges.

ABOUT THE FEEDING CHANGE PROGRAM

Feeding Change is a program of the Milken Institute focused on improving nutrition, increasing equity across the food system, and promoting sustainability and resilience by activating financial levers, engaging policymakers, and elevating the conversation in public and private discussions. Bringing together top global CEOs, entrepreneurs, investors, academics, philanthropists, and policymakers, Feeding Change hosts meaningful discussions across the latest developments in science, innovation, investment, health, and policy, and delivers programmatic work to accelerate action.

ACKNOWLEDGMENTS

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INTRODUCTION AND EXECUTIVE SUMMARY

As the world reels from multiple crises in rapid succession, the opportunities to set food systems on a more sustainable and equitable path have never been more favorable, and in turn, the importance of multi-stakeholder convenings cannot be overstated.

Since 2018, the Milken Institute Asia Center has partnered with our colleagues in Feeding Change to host multiple public and private convenings with leading investors, industry players, entrepreneurs, and regulators in food and agriculture. These sessions have participants engaging in candid discussions on the systemic challenges confronting food systems, but also the vast opportunities in innovation and investment which accompany each challenge.

Our goal is to spur ideas and action to improve global food systems by spotlighting agrifood-tech innovators, scaling sustainable and resilient processes and practices, encouraging the culture of good nutrition and healthy foods, and unlocking private investments in promising areas.

This report sets out to elevate the key insights from speakers at the Milken Institute's public convenings, as well as participants from private discussions (henceforth "participants"), supplemented with insights from external interviewees (henceforth "interviewees"), and desktop research:

- Section 2 briefly summarizes the long-lasting challenges facing food systems, which will significantly impact both present and future generations, and the opportunities for technological solutions to mitigate such challenges. They include demographic and climate change, supply-chain inefficiencies, and shifting consumer preferences.

- Section 3 covers the technologies that directly address at least one of the challenges from Section 2: namely, controlled-environment agriculture, alternative proteins, e-commerce, and digital supply chains. It also takes stock of existing pain points, such as costs, regulations, energy consumption, misconceptions, and adoption.

- Section 4 surveys the investment landscape for agrifood-tech in the Asia-Pacific (APAC) region. Agrifood-tech investments have surged in the past few years, driven in part by repeat investors. Despite this surge, cross-pollination across borders is low, and agrifood ventures still run into early-stage bottlenecks.

- Section 5 provides a brief overview of non-technological initiatives in which the private sector can collaborate with governments. These include the continued need for agricultural and infrastructural financing, and the potential role of environmental, social, and governance (ESG) criteria in this area; the benefits and limitations of import diversification; initiatives to reduce food waste and entrench urban community farming; and a rich discussion on public communication surrounding the commercialization of novel foods.

CHALLENGES OF TOMORROW

Participants have surfaced several key challenges which make traditional food systems ripe for transformation: demographic and climate changes, supply-chain inefficiencies, and evolving tastes. These are long-lasting challenges that will significantly impact both present and future generations, but more importantly, they are challenges that technologies have shown promise in mitigating. As many of these challenges have escalated in rapid succession, there has never been a better time for private capital to catalyze the transformations needed for sustainable, equitable, nutritious, and resilient food production.

Outpaced by Demographics

Conventional farming models are clearly outpaced by demographic change. Income growth and lengthening lifespans continuously fuel food consumption per person, rapidly increasing food demand in Asia. Conversely, the expansion in arable land needed to feed the world in 2050 is estimated to be 593 million hectares,[1] which is roughly half the size of China.[2] However, due in part to longstanding trends in urbanization, deforestation, and soil degradation, this land simply does not exist.

> *By 2050, food, without question, is going to be a scarce resource.*
>
> *Private Roundtable Participant*
> *(2019 Food Leaders' Retreat, Milken Institute)*

Climate Change

Agriculture contributes around 30 percent of global greenhouse gas (GHG) emissions,[3] exacerbating climate change which, in a vicious cycle, hurts crop production. China, Indonesia, India, the Philippines, and Thailand have all experienced multiple floods that have damaged farmlands in the millions of hectares,[4] while unpredictable weather patterns are deterring fishermen and having an adverse impact on fish supplies.[5]

To worsen matters, few existing solutions properly mitigate climate-related damage. A flooded farm will not yield harvest, regardless of the financing mechanisms and supporting policies, or the number of sensors, distributed ledgers, autonomous vehicles, or machine-learning models deployed.

> *The global climate crisis and the global food system crisis are the same crisis.*
>
> *Julie Kunen, Director of Sustainability, Oatly North America (2022 Global Conference, Milken Institute)*

Supply-Chain Inefficiencies

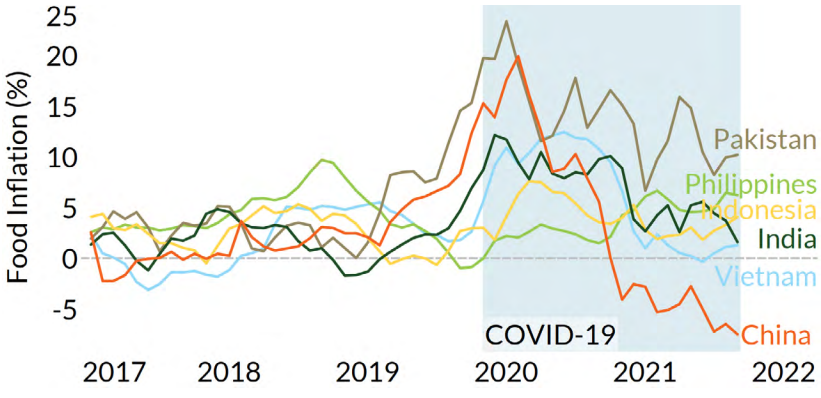
Even if agricultural production were somehow insulated from climate change, vast supply-chain inefficiencies remain that lead to distributional gaps and waste in global food systems. In 2020, Asia was home to more than half the people in the world affected by hunger,[6] yet adult obesity is expected to triple from 5 percent of the population in 2012 to 15 percent in 2030.[7] Up to 40 percent of food in Asia is lost after harvesting,[8]

which partly explains why the region is both a net food producer and an importer. Even before the COVID-19 pandemic, participants had already warned of the need to invest in supply chains to expand and diversify market access, not just technologies to raise yields.

More recently, cities and countries alike have realized that while existing initiatives in food resilience may insure against a single shock, food systems are wholly unprepared for multiple prolonged crises in quick succession. Pummeled by the backlash against globalization, COVID-19, and the Ukraine crisis, food systems have had no time to recover, and heightened food insecurity is increasingly viewed as permanent. In turn, reactive inward-facing responses may become increasingly mainstream, which will deepen distributional gaps. Consequently, volatility in food inflation has spiked (Figure 1), despite various regulatory controls on food prices throughout Asia.

> *Ultimately, the big issue is uneven distribution of the food, not necessarily the overall magnitude of the food.*
>
> *Steve Cahillane, Chairman and CEO, Kellogg Company (2021 Future of Health Summit, Milken Institute)*

Figure 1: Greater Volatility in Food Prices during COVID-19



Source: Food and Agriculture Organization, UN (2022)

Changing Tastes

COVID-19 has also strengthened preferences for healthier, more sustainable diets. Social media amplifies these preferences, which gives virality to novel food trends and sees consumers wielding their food and diet as personal branding. These trends steadily uproot traditional food systems; both Unilever and Nestlé are now working on new nutrition standards and targets.[9]

> *We are seeing consumers focusing on conscious consumption … not only (caring) about the food product itself, but how and where it is made, and the impact on the planet.*
>
> *Julie Kunen, Director of Sustainability, Oatly North America (2022 Global Conference, Milken Institute)*

Shifting consumer preferences can be manifest in various ways, such as increased attention to the origin of food products, preferences for shorter supply chains, healthier foods with fewer additives, or even an insistence on sustainable sourcing, labor standards, organic foods, and higher standards for animal welfare. In addition, the marked tendency to frugality in Asia, which traditionally limits the profit margins needed to drive innovation, is increasingly being offset with high income growth. From 2017 to 2019, Asia was the only developing region to experience an increase in the ability to afford a healthy diet.[10] But at the same time, Asia contributed 63 percent of the global increase in protein consumption from 2000 to 2019, and this proportion appears likely to continue growing.[11] The upshot is that consumer appetite for business-as-usual food production is expected to wane.

SEEDS OF THE FUTURE: AGRIFOOD-TECH

The agrifood sector is brimming with innovations aimed at disrupting food production, distribution, consumption, and disposal. Gene sequencing allows farmers to select livestock that produce higher yield and less methane, on less feed. Genetic editing or modification has even enabled the cultivation of rice in deserts and saltwater. Advancements in robotics have given rise to automated vertical farms, while drones and other robotic technologies are starting to be used for harvesting, pollination, weeding, and deliveries. Entrepreneurs and leading food purveyors alike are even building food halls and supermarkets in the metaverse.

Such technologies are bound by some common caveats. First, most are not new. Blockchains, machine learning, and internet platforms have long surfaced in other industries, and it is often rising business viability that drives their investment and adoption in the food sector. Second, technologies have different impacts depending on the problems they address. Results of a study by the World Resources Institute estimate that shifting consumer diets alone would slash emissions as much as all efforts to reduce agricultural emissions combined, whereas reducing food loss and waste is estimated to lower emissions to a larger extent than raising agricultural yields.[12]

Of these innovations, this report focuses on technologies that primarily address at least one of the challenges from Section 1: Controlled-environment agriculture, alternative proteins, e-commerce platforms, and digital supply chains.

Controlled-Environment Agriculture

Controlled-environment agriculture (CEA) seeks to improve crop yields and reduce resource usage by controlling and optimizing temperature, humidity, lighting intensity and wavelength, airflow, and nutrient composition. It encompasses greenhouses, aeroponics (plants grown in misted air without soil or aggregate growth medium), and aquaponics (fish and plants grown in the same environment), but it is usually hydroponic (plants grown in water without soil)

vertical farms that capture the imagination. For instance, Spread, the largest vertical farm operator in Japan, has an indoor farm 28 tiers high.[13] The architect Carlo Ratti, who directs MIT's Senseable City Lab, had proposed a 51-story skyscraper in Shenzhen, China, with crops lining the facade.[14] Fish and shrimp farms have also adopted such technologies, and Beewise from Israel has even branched into controlled-environment beehives.[15]

To some extent, the incorporation of verticality into farming obviates the need for vast plots of arable land, which would help food systems keep up with rapid demographic changes. Moreover, growing food in indoor environments insulates farms against adverse weather conditions. This permits year-round production and stabilizes farm outputs and food prices—benefits that are often lacking in traditional agriculture. In fact, traditional farming tends to prioritize seed varieties that, on average, grow well across varying environmental conditions, and have strong disease resistance. By growing crops in highly controlled, sterile environments, the crop breeding industry can instead focus on attributes important to consumers, such as yield or taste.[16]

CEA can also heavily reduce the use and leakage of certain resources. For instance, water not absorbed by crops can be recycled back into the water system, while dehumidifiers further capture evaporated water. As such, most vertical farms claim to reduce water usage by 90 percent or more. The self-contained nature of CEA also prevents the release of fertilizers and pesticides into the environment.

Compared to other areas of agrifood-tech, CEA also offers advantages in terms of labor. High qualifications are not required for most laborers engaged in CEA, which helps the sector avoid the talent bottlenecks stunting other areas of agrifood-tech. And while farms worldwide have been losing workers to urban jobs, CEA looks much more glamorous than traditional farming. Perhaps the opportunity to work in clean, futuristic farms under the comfort of air-conditioning could draw younger generations back into agriculture.

Other benefits accrue to specific CEA models. Infarm from Germany has modularized vertical farming units to the size of a vending machine, which can be installed in supermarkets, hotels, and restaurants. This minimizes waste in multiple ways. With crops harvested to order, there is no discarding of unfinished products, less packaging, fewer preservatives, and no washing, as well as no carbon footprint, spoilage, or nutritional loss arising from transportation. Moreover, the transparency of these CEA units in supermarkets and food and beverage (F&B) outlets could increase consumer confidence in the quality and safety of fresh-produce purchases without requiring the cost of an organic label, which is often evaluated as a proxy for food safety.[17]

Known Pain Points

There are, however, several recognized challenges in CEA. Energy consumption and labor costs continue to weigh on business viability, and only the leading players have attained profitability. High CEA production costs also compete poorly against the plethora of farming subsidies throughout Asia, which suppress crop prices.

Greater verticality can also entail greater difficulties for farm labor and in maintaining environmental control. While it is common to hear entrepreneurs boasting that the sky is the limit, CEA production remains dwarfed by traditional farming. One study estimated that even if fully implemented in cities worldwide, urban farms would produce only 10 percent of the global output of legumes, roots and tubers, and vegetable crops.[18]

To have a substantial impact on food production (and attain profitability), CEA needs to be scaled much more. However, the need to scale also runs against the gamut of fragmented regulations for food safety, equipment codes, building codes, need for washing, and so on, which already vary greatly from city to city, let alone across borders. For instance, hydroponic farming can be labeled "organic" in the US but not the EU,[19] and regulations in the Asia Pacific (APAC) do not always permit farming in commercial buildings.

CEA has also witnessed failures when reality cannot meet expectations.[20] For instance, while we want CEA in urban centers, exorbitant rent and transport costs can raise prices to unbearable levels. While we want CEA in restaurants, chef turnover, menu changes, and the need to negotiate individually with each restaurant make scaling difficult. While we want farms to be sterile, the lack of insects for pollination ultimately inflates costs. And while we want crops lining skyscrapers, maintenance expenses would similarly be sky high.

For instance, one interviewee noted that while Singapore has several iconic buildings covered with ornamental plants, the plant species are chosen primarily for their low costs of maintenance. Were these plants crops instead, consumers would be much pickier about what was grown, and the economic equation would be upended.

Other challenges can concurrently be viewed as opportunities. First, CEA is infamously capital intensive. One report estimates that in Singapore, CEA involves up to 10 times the costs of traditional farming.[21] Few investors can deploy capital in the requisite magnitudes, and, indicatively, CEA accounted for less than 5 percent of global agrifood-tech funding in 2021.[22] With that in mind, investors can invest and have done so in the ancillary technologies CEA relies on—from LED manufacturing to ventures that provide seeds and digital services for CEA farms.[23]

Some leading players have also cracked the code for profitability, allowing them to scale in a manner sustainable to both the environment and their internal finances. The Spread company, for instance, plans to produce 100 tons of crops per day in Japan by 2030.[24]

Second, selection remains limited. For instance, most CEA farms are focused on microgreens, leafy greens, and herbs, whereas none seem able to grow high-margin products such as wasabi, truffles, or saffron. CEA is also limited to crops that are physically small: It's hard to imagine vertically farmed rice. That said, leading players continually expand their selections, from mushrooms to berries.[25]

Finally, simplistic hydroponic systems tend to produce bland-tasting crops. Not just any newcomer can produce flavor-packed greens, but at the same time, established players have found success by changing the nutrient mix, tweaking environmental variables, or even editing crop genomes.[26] The ability to customize the taste and texture of crops is further useful in market segmentation, given the diversity of preferences throughout APAC.

All in all, CEA has long been technologically possible; the main challenge is business viability. Whether CEA companies have optimized production lines, expanded their selection, improved flavor, or attained profitability is a matter of their internal secret sauce.

Alternative Proteins

The three key pillars of alternative proteins are plant-based meat, cultured meat, and fermentation. The three can be combined to develop a final food product that closely resembles meat in appearance, taste, and texture. Not surprisingly, the investment readiness of each area varies (Figure 2), but on the whole, participants overwhelmingly believed that alternative proteins presented the greatest opportunity for investment capital to transform the food system. This sentiment is largely driven by the initial public offering of Beyond Meat in 2019 but is also in line with the surge in alternative protein ventures and funding in 2021,[27] and the heightened demand observed during the pandemic.[28]

Figure 2: Investment Indicators for Alternative Proteins

	Valuations	Commercial Readiness	Competition	Incumbency Advantage	Production Cost
Plant-Based	High	Established	High	Low	Stable/Low
Cultivation	Medium	Breakthrough	Medium	Low	Decreasing
Fermentation	Unknown	Established	Medium	Medium	Decreasing

Source: Cleantech Group (2021)

Plant-based foods are the largest segment of alternative proteins, though entrepreneurs have expanded beyond protein into plant-based milks, ice creams, and even honey.[29] While mock meat has been available in Asia for centuries,[30] consumption has mostly been confined to Buddhists and vegetarians. The new wave of plant-based protein is designed to mimic meat's taste and texture better by using novel ingredients. At present, most of the viable crop candidates for plant-based proteins are optimized to yield maximum oil or starch. As the market for alternative proteins grows, crop breeding may eventually be directed toward maximizing protein yield instead.

Cultured meat, also referred to as cultivated meat or lab-grown meat, is meat or seafood that is produced by cultivating animal cells directly. For instance, California-headquartered Eat Just received regulatory approval in Singapore in 2020 for the commercial sale of cultivated chicken,[31] and the company is now building one of its largest facilities in the city-state.[32] Importantly, while cultured meat reduces the number of animals needed to produce meat, it does not completely avoid animal slaughter: The most widely used growth medium is fetal bovine serum, which is isolated from the blood of dead calves. That said, given its high costs, ventures such as IntegriCulture in Japan[33] and Wasna in Singapore are looking to create cheaper and more universally applicable growth media.

Fermentation involves cultivating microbial species such as yeasts, fungi, algae, and bacteria. For instance, a Finnish company called Solar Foods[34] ferments a protein called "Solein," based on unicellular organisms called "hydrogenotrophs" that are fed with hydrogen, carbon dioxide, oxygen, and small amounts of mineral salts.[35] Solein can be used in various foods as its taste is mild. Solar Foods is now working toward full-scale industrial production.[36] However, in contrast to other types of alternative proteins, investment in fermentation has yet to pick up in APAC.[37]

As with all indoor food production, insulation from inhospitable natural environments allows more geographies to participate in protein production. Growing meat or mock meat in sterile environments and controlling the constituent ingredients also preclude contamination by pathogens, heavy metals, microplastics, harmful chemicals, and possibly even antibiotics.[38] This could improve food-production transparency while aligning with efforts to slow the development of antimicrobial resistance.[39]

Alternative proteins can also be more sustainable in some areas. For instance, lab-grown seafood neither depletes natural fish stocks nor causes the environmental damage that can come with fishing practices. Similarly, lab-grown meat eliminates the need for farms and animal feed, the two largest components of agricultural emissions;[40] avoids the deforestation and loss of biodiversity associated with rearing livestock; and partly circumvents issues of animal welfare and livestock emissions. This has led multiple producers to claim that they can reduce land use and GHG emissions by more than 80 percent (Figure 3),[41] though others have called for a pinch of salt.[42]

Figure 3: Environmental Benefits of Plant-Based Meats

Eating this plant-based meat ...	... instead of ...	... reduces this impact by:	
		Land use	GHG emissions
Impossible Burger 2.0	Beef burger	96%	89%
Beyond Burger	Beef burger	–	89%
Grillers Original Burger	Beef burger	93%	85%

Spicy Black Bean Burger	Beef burger	97%	89%
Roasted Garlic & Quinoa Burger	Beef burger	93%	88%
Grillers Crumbles	Ground Beef	99%	90%

Note: Some of these figures are self-reported and may not have been independently verified. More broadly, foodtech figures are often compared to the most polluting industrial practices (such that reductions are larger), rather than average land use and emissions.

Source: The Good Food Institute (2019)

Known Pain Points

"Expensive novelty" was the summary verdict of a former CEO when asked about poor sales of alternative proteins.[43] There are some signs in the West that demand has plateaued since 2021,[44] and the Canadian meat producer Maple Leaf Foods stated outright that "the very high category growth rates previously predicted by many industry experts are unlikely to be achieved."[45] Others believed the market would soon begin to consolidate[46] and, consequently, many investors in APAC are taking a wait-and-see approach.[47]

Alternative proteins are still subject to high costs, large energy consumption, and limited output. One entrepreneur estimated that it currently takes several thousand dollars to produce one kilogram of cultured meat,[48] not least because multiple PhDs are needed on payroll. This means that, in the medium term, alternative proteins are likely to remain unaffordable to the masses. However, some observers have argued that the costs of lab-grown meats[49] and precision fermentation[50] are falling fast—in the former case, even faster than in the tech industry.

Costs aside, Asians are prodigiously picky when it comes to local foods, which obliges developers to invest much R&D in taste and texture to stack the odds in one's flavor. For instance, ventures are exploring blends of cultured meat or fermented proteins with plant-based proteins to impart "meatiness" to the flavor. This is not a problem from the dietary point of view, given that most consumers of alternative proteins are meat-eaters to begin with.

But it is also important to distinguish between tastiness and familiarity. One participant noted that the sterility of growth environments could result in overly pure lab-grown meats that taste "too clean" and thus unfamiliar. Another found that warnings on the packaging about dairy allergens were well received, making plant-based dairy products feel more like normal dairy foods.

Asia's diverse preferences and restrictions are also complex. For instance, many in India do not eat beef, whereas China and Vietnam consume much more pork than beef. This puts alternative beef producers at a disadvantage. But focusing instead on alternative pork may not fare as well in countries with large Muslim populations, such as Indonesia, Malaysia, and India. In fact, Indonesia's Nahdlatul Ulama, the largest Islamic organization in the world, has declared cell-based meat to be non-halal.[51]

Even details like naming matter. For instance, while the term "cultured meat" is widely used internationally, consumers in China most preferred the term "customized meat," given its connotation with tailor-made, high-end products.[52] Counterintuitively, messaging about the "naturalness" of cultured meat tended to evoke concerns about health and safety.

Food texture is also difficult to replicate. The silver lining is that East Asian dishes tend to feature meats that are sliced or minced. Thus, less texturing is involved, in contrast to the thick cuts of meat common in the West. Ventures are also exploring flavorings, such as plant-based seafood flavor packets for noodles, which eliminate the need for texture entirely.[53]

Further complicating matters, consumers may conflate preferences with familiarity, expressing a "preference" for different alternative proteins based on their familiarity with the constituent ingredients.[54] For instance, a vast majority in one survey indicated that they ate rice- or potato-based alternative proteins. In reality, products with these base ingredients are fairly uncommon and form just a small segment of sales. This can overstate the importance of familiar or local ingredients in consumers' purchasing decisions, while understating the role of taste. In parallel, other surveys have found that environmental and health benefits are key reasons for consuming alternative proteins but that taste (which is irrelevant to either) remains the largest impediment.

> *In food, there's a big difference between what people say and what people do.*
>
> *Private Roundtable Participant*
> *(2021 Food and Ag in Asia—Commercializing Innovation, Milken Institute)*

Regulations can also pose challenges. All countries except Singapore disallow the sale of cultured meat. Entrepreneurs have deemed the requirement for pharmaceutical-grade ingredients to culture cells in labs as overly cautious and expensive.[55] Cultivating meat may require the introduction of hormones that livestock naturally produce, but the use of growth hormones in agriculture is prohibited in the EU.[56] And despite the gamut of trade agreements across APAC, there remains much room for harmonization and relaxation of nontariff barriers in agriculture.[57]

Also related to consumer preferences is distribution, with the decline in Beyond Meat's stock price attributed to supply-chain disruptions and lockdowns.[58] Consumers cannot establish trust in a brand if they are unable to sample new products, which may then circle back to negative survey responses.

Of concern, one participant commented that the existing infrastructure for alternative proteins is grossly inadequate. The largest bioreactors today are typically 20,000 liters, but some 450 billion liters of growth medium are needed to produce just 5 percent of current meat consumption. It may be that investments in infrastructure, rather than food-tech ventures themselves, could improve cost structures and provide a clearer trajectory to cost parity with traditional proteins. In fact, since fermentation is not new to Asia (think tofu, kimchi, or miso), some players are looking to repurpose existing fermentation plants for alternative proteins, instead of building from scratch.[59] However, the lack of operational expertise in large-scale biomanufacturing is acutely felt throughout APAC.

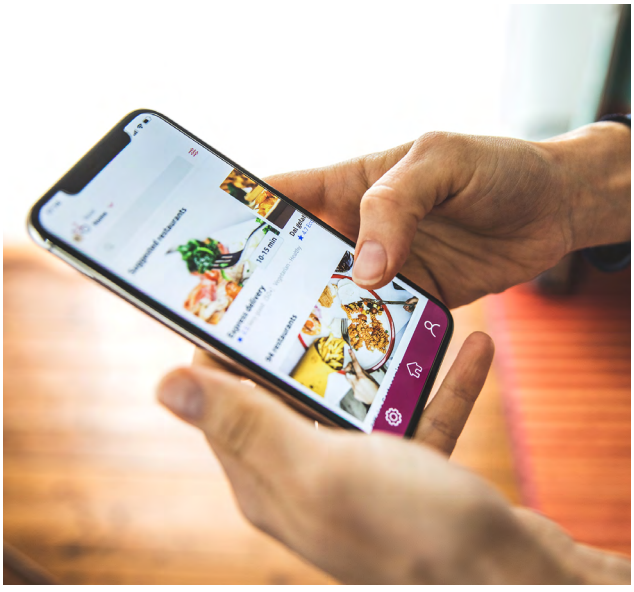
> *The infrastructure investment is in the billions … Governments need to come in to provide these kinds of investment … If not, investing in cell-based protein is going to be quite binary.*
>
> *Private Roundtable Participant*
> *(2021 Food and Ag in Asia—Commercializing Innovation, Milken Institute)*

Finally, it is not a given that alternative proteins are healthy. A 2018 survey in the UK found that, on average, meat-free burgers contained more salt than meat burgers.[60] Some studies have found plant-based meats to be low in select micronutrients, while excessively high in saturated fat, sodium, and sugar.[61] Other critics argue that alternative proteins still pass through today's same extractive food systems,[62] which put out mass-produced, monocultured, and hyperprocessed products.[63] All considered, the effects of plant-based meats on long-term health are unknown.[64] In this vein, the Chinese e-commerce giant Pinduoduo and the Singapore Institute of Food and Biotechnology Innovation are jointly studying the nutritional impact of plant-based meats on human health.[65]

E-Commerce

E-groceries and F&B deliveries have historically dominated all other agrifood-tech categories in securing funding.[66] Asia is no exception, be it with Meituan in China, Reliance in India, Grab in Singapore, or Gojek in Indonesia. The largest funding rounds to date have stemmed from expansions of e-commerce or transport platforms into food, providing the downstream logistical and payment services that enable transactions and move food from farms to consumers.

In addition, platforms improve efficiency in distribution, reducing costs in multiple areas. First, by aggregating demand, platforms can use economies of scale to slash the fees they charge merchants. Second, by removing intermediaries and leveraging consumer data directly, platforms can improve demand forecasting and provide greater certainty to upstream producers, allowing producers to minimize inputs and wastage. The former helps optimize supply chains, while the latter allows producers to pass on savings to consumers.



What is unique about platform companies is their need to ensure the satisfaction of not only consumers but also producers. With more merchants on a platform, more consumers can be attracted, and gross merchandise value can be further expanded. Because of this, platforms' own commercial interests are at times aligned with ecosystem development.

For instance, Pinduoduo in China launched its Duo Duo University program in 2018, training farmers in basic skills, from how to photograph their produce properly to more advanced lessons in online marketing, e-commerce, and business operation. According to Pinduoduo, nearly 500,000 farmers had taken its courses as of April 2022, and 16 million farmers have been connected to buyers on its platform. Pinduoduo has even launched a "10 billion agriculture initiative," recycling RMB10 billion (US$1.6 billion) of its annual revenues back into R&D in agritech, supply chains, and alternative proteins.

Other benefits abound. Thanks to Pinduoduo's integration with WeChat, China's largest social media platform, farmers have taken to live streaming virtual tours of their farms on platforms, answering buyer queries in real time. This provides an in-app channel for farmers to market their goods directly to consumers. Consumer ratings of merchants also help lend some transparency to the quality and origins of farm produce in a low-cost and low-tech manner, though it is by no means foolproof.

Known Pain Points

A thriving e-commerce landscape, however, has multiple prerequisites, often beyond platforms' control. Nationwide transport coverage, widespread internet connectivity, high smartphone penetration, and well functioning e-payment systems are necessary but rarely present. Consequently, outside of China, most of developing Asia enjoys agricultural e-commerce in a few cities at best. Similarly, leading Chinese players that expand overseas fail to replicate the breakneck growth they produced domestically. Even within China, leading platforms themselves continue to invest in cold chains[67] because fresh produce is highly perishable and cannot be pushed through traditional logistical networks.

The second requirement is for scale to make supply-chain optimizations worthwhile. This can generate paradoxes: the more deliveries ordered, the faster goods are delivered. In China, for instance, deliveries typically take less than four days, whereas consumers in Singapore often wait more than a week. This is likely to compromise the timeliness of e-commerce in larger developing countries that have far-flung rural areas and fragmented e-commerce landscapes. Such challenges are exacerbated by lockdowns, border closures, and export bans,[68] during which platforms are not fully in control.

E-commerce also entails some environmental trade-offs. The high convenience of direct delivery to consumers means that delivery sizes are often small and frequent. This translates into increased packaging and heightened emissions from multiple journeys, especially for quick commerce. It is also not yet clear if platforms can widely incorporate circularity, as detours to collect food waste and packaging require deviations from the optimal route, among other logistical challenges.

Moreover, the push for supply chain resilience entails increasing spare capacity, alternatives, and redundancies in logistical networks. In the context of cold chains, this can be akin to keeping the air-conditioning on full blast for a sparsely filled room, ultimately translating into wasteful emissions.

A more recent challenge stems from the substantial layoffs that have been observed in e-commerce.[69] While cooling and consolidation in the sector were inevitable, the timing is worrisome given that market penetration in rural Southeast Asia remains low. As such, distributional efficiency and food accessibility will likely remain out of reach in rural areas.

Digital Supply Chains

In 2008, some 300,000 children in China were poisoned by tainted milk powder.[70] Melamine, which is used to manufacture plastic and fertilizers, was used as an ingredient to boost protein levels artificially. At around the same period, in both Singapore and Malaysia, rumors circulated online that some street hawkers were tossing plastic bottles into the oil used to fry banana fritters, raising concerns that consumers had more than just microplastics on their plates. With successive food scares and scandals, demand in developing Asia for food transparency, visibility, and traceability is largely driven by food safety concerns,[71] in contrast to the West, which prioritizes the environmental footprint.

> *There is growing awareness of the importance of looking throughout the entirety of the supply chain, and not only in your discrete area.*
>
> *Steve Cahillane, Chairman and CEO, Kellogg Company (2021 Future of Health Summit, Milken Institute)*

The sheer complexity of supply-chain visibility and resilience necessitates multiple data sources, including inventory, food safety, environmental footprint, animal welfare, genetics, nutritional value, trade documentation, and payments. These in turn require multiple technologies. Radio frequency identification (RFID) technology has been deemed the most important technology for food traceability in some surveys[72] and is increasingly used in the food sector to automate tracking and inventory stock-taking. Internet-of-Things (IoT) devices can help assess if food is being maintained at the correct temperature and humidity during transportation, or if vehicles need to be sent for maintenance. In a similar vein, S4S Technologies in India seeks to reduce food waste by better preserving food in storage, through techniques such as dehydration.

Point-of-care devices can perform more complex measurements, such as identifying the presence of contaminants like food additives or pesticides. For instance, Veritide in New Zealand uses noninvasive fluorescence techniques to identify visible and invisible fecal contamination on beef and lamb meat in real time.[73] Other ventures are working on smart packaging that reflects the real-time temperature or freshness of the foods inside.

Blockchains can authenticate all the data and, on verification, automate subsequent decision-making through smart contracts, such as by executing transactions or generating invoices. Digital documents on the blockchain will not be lost in transit, which can't always be said for physical trade documentation. In addition, the decentralized nature of blockchains enables trust across the supply chain because all members agree to the same protocols. This alleviates the burden of proof should conflicts arise, as shared data are authenticated by all, which makes it easy to pinpoint the sources of conflicts reliably.

Blockchain Initiatives across Sectors

PRIVATE

Chinese e-commerce giant Alibaba began piloting the Food Trust Framework in 2018, in partnership with Blackmores, Fonterra, Australia Post, and New Zealand Post.[74]

PUBLIC-PRIVATE

The Singapore Trade Data Exchange was launched in June 2022 to connect global supply chains through a common data infrastructure verified by the Trade Trust Framework.[75]

More than 70 participants have signed up.

PUBLIC

Countries including Australia,[76] China,[77] and Singapore[78] have released various whitepapers, roadmaps, and strategies for blockchain development.

Finally, digital twins can be built by using authenticated IoT data on warehouse throughput, shipment sizes, transport timings, and food quality. This enables real-world simulations that companies can use cheaply, in conjunction with machine learning, to assess the impact of supply-chain shocks and route changes, and improve forecasting accuracy.

With all these data unified and authenticated, consumers can use the information to make better purchasing decisions, and producers to meet varied regulatory requirements across APAC. Some have further suggested that first-movers can leverage these insights for greater certainty and oversight, which they could sell as a mark of reliability, or as a competitive advantage to help downstream suppliers with their own regulatory compliance and consumer demands.

Known Pain Points

Supply-chain technologies suffer prerequisites that are extensive and expensive. Most crippling is that where physical infrastructure does not exist, most technologies have limited practicality. There is also little incentive to measure certain metrics better if no ready solutions are available. For instance, if vehicle fleets cannot cheaply be upgraded to run on cleaner energy sources, it is harder to justify investments in tracking fleet emissions, especially since technologies such as blockchain are themselves criticized for high emissions.

Beyond that, interoperability and high costs are the usual barriers when multiple technologies are involved among multiple organizations. Regarding newer technologies such as blockchain, past missteps in the deployment of RFIDs may be instructive, particularly on the need for large companies to help defray costs when they mandate technological investments by their smaller suppliers.[79] On the other hand, for very large-scale investments such as warehouse automation, case studies, lessons learned, and international financiers with cross-border expertise are all in short supply.[80]

"Trust" means different things to technologists than to the general public. For instance, nearly a decade after China's milk powder scandal, milk powder remained one of the few categories where consumers preferred foreign to local brands—even more than wine.[81] This is despite the implementation of a digital tracking system that provides information across the supply chain.

Finally, even with full visibility across the food supply chain, it is not likely that consumers themselves will read the dozens of metrics across the dozens of products in their baskets, let alone for the dozens of competing brands for each product. In 2021, the top nutrition influencers on Instagram had follower counts on the lower side of six digits,[82] which is small compared to other fields. That easily digestible, bite-sized content on nutrition fails to break out on social media suggests that public scrutiny of food systems, while growing in prevalence, remains exaggerated for now.

It is likely that wellness companies, lifestyle influencers, F&B businesses, downstream suppliers, or third-party accreditors will perform this analysis, whether to meet regulatory requirements or as a consumer service. Retailers might even sort products by carbon footprint.

THE AGRIFOOD INVESTMENT LANDSCAPE

There has never been a more compelling time to invest in food and agriculture, and participants have listed multiple investment theses in common. Governments are doubling down on food resilience initiatives in light of the Ukraine crisis, climate change, and threats to global trade, not to mention foot and mouth disease,[83] avian flu, swine fever, and a host of other diseases and parasites[84] that have plagued agriculture over the years. Consumers have accelerated shifts toward healthier, responsible diets in the face of a global pandemic, while high food inflation has also made innovative food products look less pricey in comparison. Established agrifood companies see food innovation as a potential game changer and are cementing their involvement through partnerships and funding. Investors have witnessed each of these shifts, plus a growing track record of successful exits in the industry, and are looking to increase their exposure to the agrifood sector.

> *We've invested over US$5 billion in the agrifood space in the last five years, and we intend to pick up that pace. I think there are terrific investment opportunities, terrific return opportunities across the value chain. Agriculture is … an attractive end market.*
>
> *Private Roundtable Participant*
> *(2020 Opportunities in Food, Milken Institute and UNDP Global Centre)*

Investment Theses

In Japan, the average age of farmers is 67 and increasing,[85] and the inability to attract the younger generation will gradually result in a loss of farm labor and experience. Given the primacy of Japanese rice as a diet staple, the decline of farming could have large dietary and cultural implications.[86] The 2011 Fukushima nuclear disaster was also a painful lesson, where fears of radioactive contamination saw local and export markets alike banning food shipments.[87] Eleven years later, the US is restarting food imports from the prefecture, but the economic damage has already been done.[88] This has partly prompted many Japanese conglomerates to apply their longstanding expertise in manufacturing and automation to agriculture. As a result, in 2020, more than 200 vertical farms were operating in Japan.[89] Moreover, in June 2022, the Ministry of Health, Labor, and Welfare set up a team to study the health risks and necessary regulations for cell-based meats.[90]

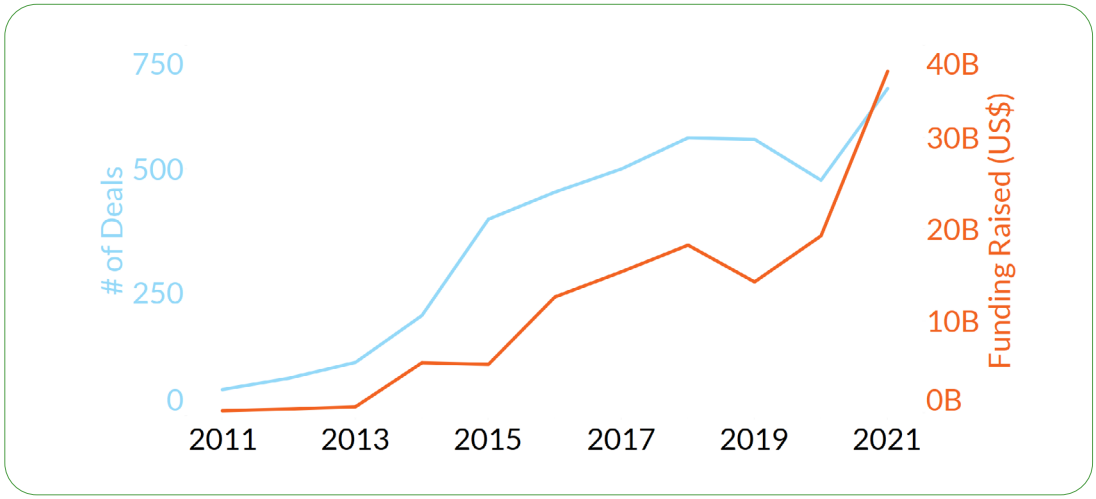
In China, the outbreak of African swine fever in 2019 saw pig stocks plummet by as much as 19 percent.[91] To this day, new outbreaks continue to wreak havoc with prices,[92] as do volatile trade relations. The government's 14th Five-Year Plan for agriculture laid down the importance of food security, self-reliance, and rural revitalization, presenting agricultural science and technology as a strategic interest.[93] Cultivated and plant-based meats were included for the first time in the blueprint, which could spur broader interest and investment, since China is already the world's largest meat consumer and soy protein isolate producer.[94] The Ministry of Agricultural and Rural Affairs has also published draft rules on genetic modification[95] and gene editing,[96] and approved the safety of some genetically modified crops, such as corn and soybeans.[97]

Singapore already experiences the food challenges of tomorrow, having always lacked the farmland and labor to meet its food demands fully, while being highly exposed to climate change and trade volatility. The government now views domestic production and technology as existential and targets production of 30 percent of nutritional needs domestically by 2030.[98] In 2020, Singapore was the first in the world to allow the sale of lab-grown chicken, having consulted with stakeholders on science-based, forward-thinking regulations for several years prior.[99] Multiple research institutions and programs have been created,[100] universities are offering world-first courses on alternative proteins,[101] and undergraduates are increasingly gunning for food science.[102]

More Investment, Same Investors

In light of these trends, it is unsurprising that agrifood investments have risen in recent years (Figure 4). While trade tensions and COVID-19 briefly knocked funding off course, indications now are that the pandemic accelerated investment activity, as seen from the strong rebound in 2021. With that in mind, there seems to have been an over-correction in 2021, as 2022 investments do not appear to extend the upward trend.

Figure 4: Rising Agrifood Investment in APAC



Source: Milken Institute analysis of Crunchbase (2022)

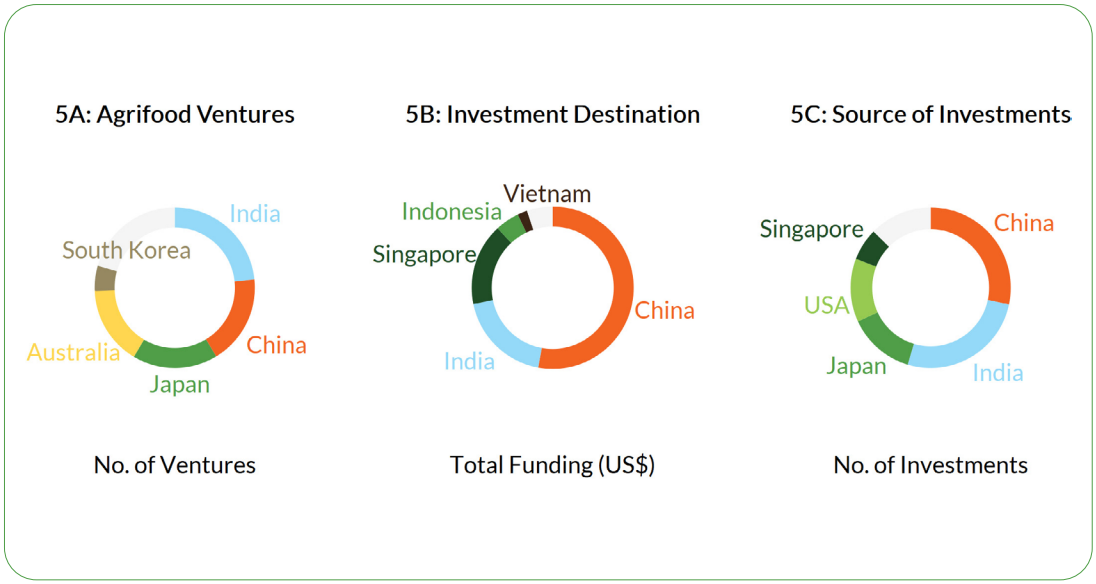
In absolute terms, the number of investors in 2020 onwards nearly doubled that of 2012—2015. However, investor composition has mostly remained unchanged. Venture capital remains the most common investor type by far, though its share in agrifood deals fell by nearly 10 percent in 2020 onwards compared to 2012—2015. Private equity has had a slightly lower share of deals from 2020 onwards, while individual and angel investors, and accelerators, have stepped up slightly. All in all, funding sources have not substantially diversified over the years.

With all these points in mind, there are also positives to consider. Notably, the agrifood sector has fewer one-off investors than other sectors that the Milken Institute has previously studied.[103] Approximately one in four investors have invested in more than one agrifood venture in APAC, which contributes to a steady build-up of investor familiarity in the sector. Moreover, repeated activity by the same investors in agritech indicates their confidence in the sector and presages success for the ventures concerned.

Investment Hubs in Asia-Pacific

India, China, Japan, and Australia have the most agrifood ventures (Figure 5A), but China is the dominant recipient of agrifood investments, attracting more funding than the rest of APAC combined (Figure 5B). In terms of deal volume, China and India have each provided a quarter of the cumulative agrifood investments in APAC-based ventures (Figure 5C). US-based investors, too, invest frequently in APAC. Also interesting is that although Australia has many ventures (Figure 5A), its deals are relatively few.

Figure 5: Agrifood Investment Flows in APAC



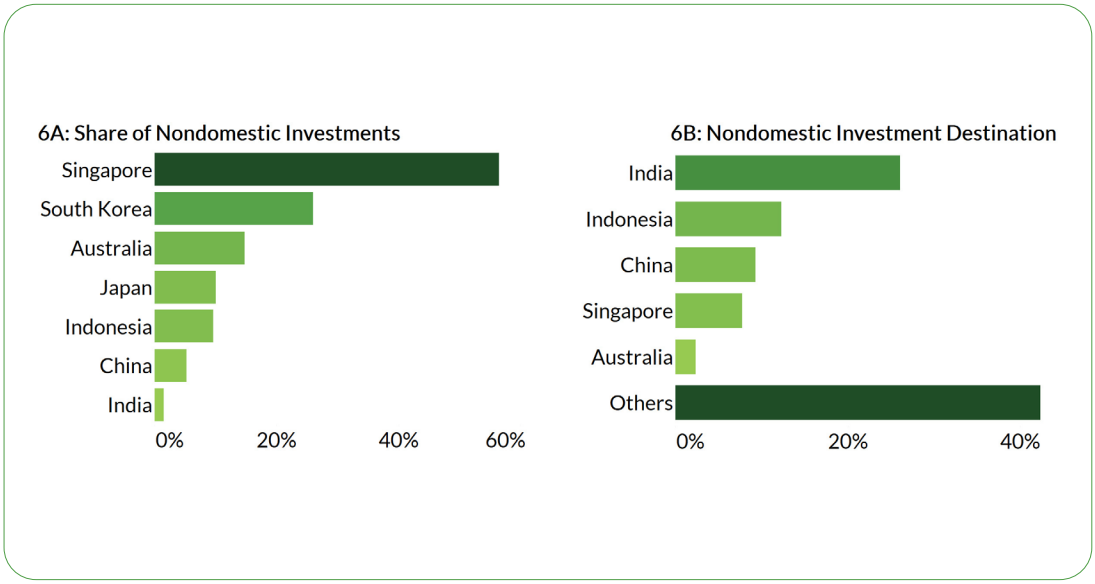
Note: In 5C, when a funding round has more than one investor, each investor's location is counted once. Hence, locations that tend to have many coinvestors (e.g., Japan) will show larger proportions, whereas locations with fewer coinvestors (e.g., China) will show smaller proportions.

Source: Milken Institute analysis of Crunchbase (2022)

Low Cross-Pollination across Borders

Unfortunately, cross-pollination is rare: Most investors invest within their domestic markets and not the broader APAC. For instance, a Milken Institute analysis of Crunchbase data found that more than 90 percent of Chinese and Indian investments were domestic (Figure 6A). This is not to say that APAC investors are inward-looking, rather that when they look outward, it tends to be to the US, not their neighbors.[104] The only substantial exception is Singapore, where three in five investments from Singapore-based investors were regional. This reflects the city-state's efforts to attract international investors who focus on the broader region. Within APAC, India attracted the most nondomestic deals (Figure 6B), while China obtained the most nondomestic funding.

Figure 6: Nondomestic Investors and Investments within APAC



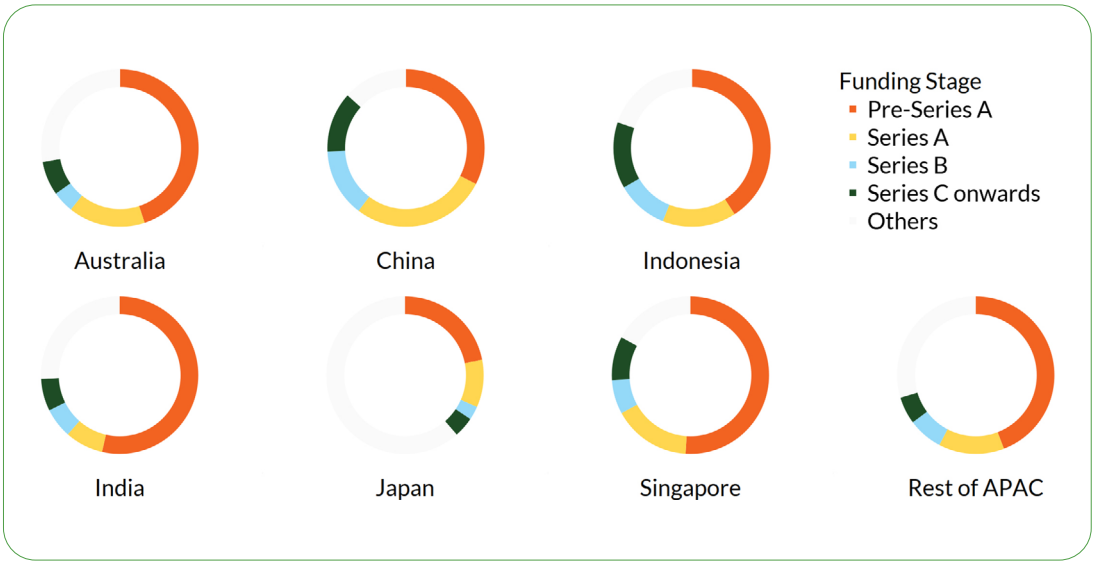
Note: Investments are included only if both investor and venture are headquartered in APAC. Fig. 6A shows the proportion of investments in each market that were targeted at a nondomestic venture based in APAC. Fig. 6B shows the share of nondomestic investments in APAC each market received.

Source: Milken Institute analysis of Crunchbase (2022)

Early-Stage Bottleneck

Opportunities for private capital to make a substantial impact are limited, as the APAC agrifood landscape remains very young. More than 60 percent of agrifood ventures in China have recorded funding, but this figure falls to the mid-twenties for India and Singapore, and even lower for other major APAC markets. Among funded ventures, the main bottleneck is getting to Series A (Figure 7).

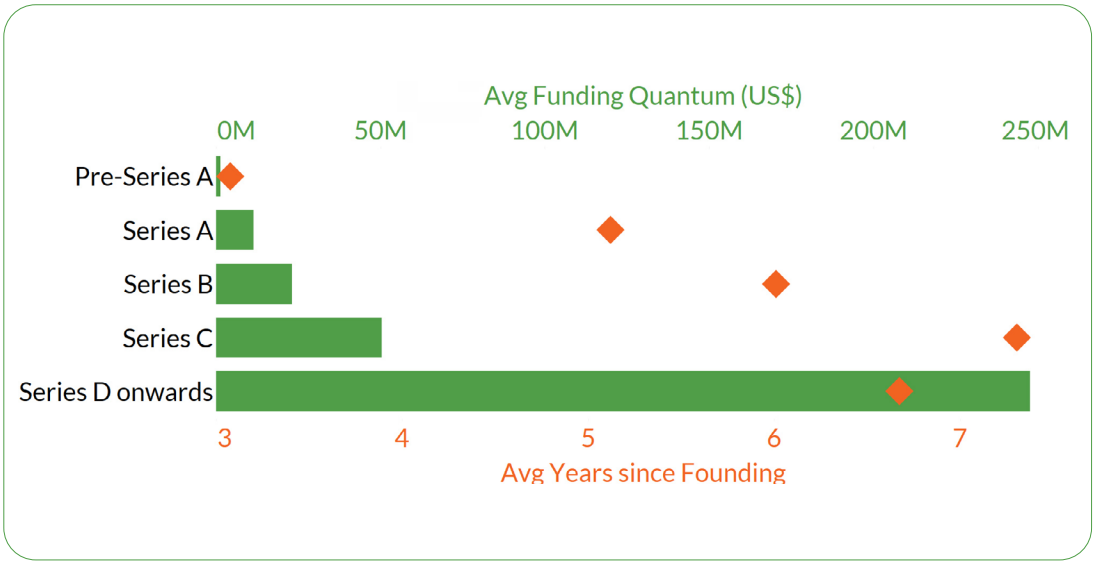
Figure 7: APAC Agrifood Still in Early Stages



Note: The majority of "Others" are undisclosed rounds.
Source: Milken Institute analysis of Crunchbase (2022)

There are indications to suggest that this bottleneck is not to do with venture financing per se. The increase in funding quantum from pre-Series–A to Series–A stage is relatively small compared to later stages, but the time gap is the largest (Figure 8). On average, ventures are three years old when they receive pre-Series–A funding, but five years old when they attain Series–A funding. Even so, this two-year gap still understates the severity of the bottleneck because the vast majority of pre-Series–A ventures never attained Series–A funding to begin with. More broadly, this early-stage gap is not just due to younger ventures' difficulties in finding product-market fit. It also reflects a lack of infrastructure, which limits the ability of ventures to scale across the region, thereby deterring later-stage investments.

Figure 8: Funding Quanta and Timelines



Source: Milken Institute analysis of Crunchbase (2022)

OPPORTUNITIES FOR PUBLIC-PRIVATE PARTNERSHIP

Finance and Infrastructure

The need to provide farmers in APAC with microfinance and invest in infrastructure is neither new nor diminishing. Dirt roads and potholes will naturally result in bruised fruits and vegetables, causing entire consignments to be rejected. Poor access to buyers, suppliers, and peer networks can concurrently squeeze farmers' margins while leaving their produce to waste. Participants also noted that banks have become more cautious in lending to smallholder farmers during the pandemic, at times forcing farmers to turn to exploitative private lenders. Multiple participants and interviewees noted with concern the impact of COVID-19 on smallhold farmers across Asia, and many believe that forward-looking investors should be exploring the use of microfinance to help revitalize smallhold farms.

Here lies an opportunity for ESG capital to push food systems toward greater sustainability. Several participants and interviewees stated that they had not faced any shareholder pressures to incorporate or improve ESG performance. But concurrently, agriculture contributes substantially to GHG emissions, and greater climate progress could be made if existing interest in ESG financing could be directed toward food.

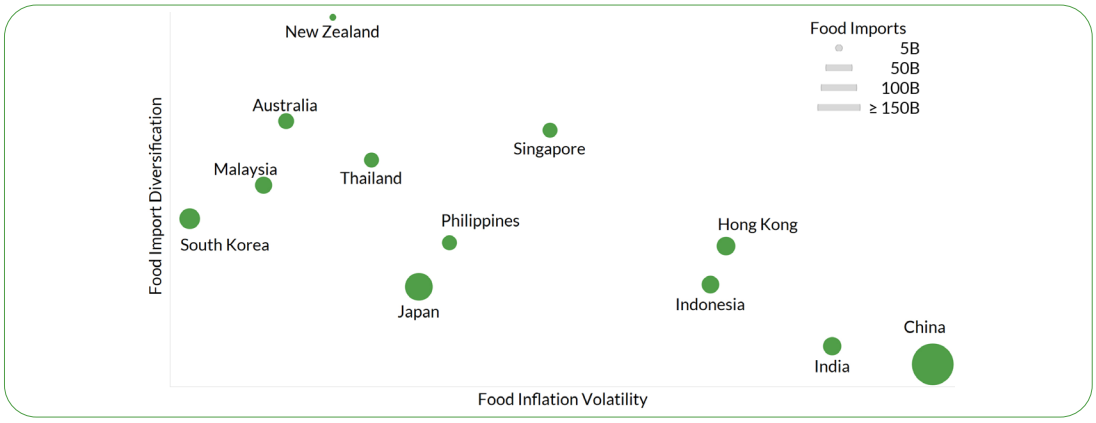
> *We need more investors who are willing to break the rules of legacy investment institutions … to support the opportunities for real impact as well as financial return.*
>
> *Private Roundtable Participant*
> *(2020 Opportunities in Food, Milken Institute and UNDP Global Centre)*

The Milken Institute has long been involved in agricultural, infrastructural, and ESG financing, and has offered multiple solutions across the years. In food, recommendations include advanced market commitments, food-assistance bonds, swing-donor facilities, guaranteeing funds, multiyear funding structures, and climate-smart bond banks.[105] Infrastructure-related financial innovations include first-loss equity funds, project bonds, infrastructure debt funds, hybrid funds, and land value capture.[106]

Import Diversification

Cities and geographies that import a large share of their food also need to guard against supply shocks. One way of doing this is import diversification: sourcing food and cultivating relationships with multiple markets, such that when one cross-border node fails, backups can quickly and reliably be called upon. During COVID-19, markets with higher food import diversification witnessed lower food inflation volatility, and vice versa (Figure 9). Diversification also has social benefits; trade-reliant markets are less likely to impose export controls during tough times, due to their own susceptibility to retaliation.

Figure 9: Greater Diversification, Lower Volatility



Note: The Gini coefficient formula was used to compute the "inequality" of 2019 food imports for each market across all 424 food categories and trading partners. To reduce noise, only imports above US$50,000 were considered. Food Import Diversification is simply (1 – Gini coefficient); it ranges from 0 to 1, with higher being more diversified. Food Inflation Volatility is the standard deviation of monthly food inflation figures from April 2020 onwards; higher is more volatile. Bubble sizes are based on 2020 food imports in USD.

Source: Milken Institute analysis of Food and Agriculture Organization, UN (2022)

> *Never has the importance of diversified supply chains been more evident than in the outcomes of this pandemic.*
>
> *Private Roundtable Participant*
> *(2020 Opportunities in Food, Milken Institute and UNDP Global Centre)*

Problematically, diversification does not address systematic risk, which tends to arise during major crises and cause the most damage. For instance, with Ukraine and Russia normally providing nearly a third of global wheat exports,[107] the Ukraine crisis is causing even greater volatility in food prices than COVID-19. In fact, true diversification may not even be possible if a few countries dominate inputs or supply nodes. For instance, as chicken and fish feed are often made from wheat, the prices of both chicken[108] and fish[109] have also spiked with the Ukraine crisis, regardless of where they are sourced.

Similarly, sourcing crops from various markets may not truly diversify risk if seeds and fertilizers all come from the same country, if they all transit through the same port, or if a small handful of big players dominates global commodities trading.[110] In fact, such scenarios bear a haunting resemblance to the 2008-2009 financial crisis, in which multiple aggregations of collateralized debt obligations gave the appearance of de-risking, while masking vulnerabilities in their underlying assets.

In parallel, obsessing over "diversification" in the source countries of final food products can obscure an underlying dependence on just one or two major input suppliers or supply nodes. In these cases, countries and cities alike must turn to other options: reducing food waste, producing domestically, and changing consumption patterns.

Food Waste

As stated in Section 3, reducing food loss and waste is expected to lower emissions to a larger extent than raising yields. Across APAC, increasing attention is being paid to food waste. In 2020, Chinese President Xi Jinping called China's food-waste problem "shocking and distressing."[111] Conversely, Australia hopes to halve its food waste by 2030.[112]

Regulations

In France, recycling is mandatory for businesses,[113] and supermarkets are banned from discarding any food considered edible.[114] Surplus food must be donated to charities and food banks, and up to half of the value of such foods is tax deductible.[115]

South Korea introduced a "pay-as-you-throw" policy in 2013, which made households in Seoul pay for their food waste according to weight,[116] much as buffets charge for uneaten food. People who report cases of noncompliance receive a monetary reward.[117] In 2019, 95 percent of food waste was recycled,[118] while payments were used to fund identification, waste, and recycling systems. The initiative is gradually being expanded nationwide. Japan and New Zealand also have pay-as-you-throw scheme.

Ugly Foods

Edible but physically deformed "ugly" foods are usually sold at a discount in farmer's markets. The lack of farmers' markets in many cities leads to ugly foods being discarded. It is difficult to ban such wasteful practices because enforcement is labor intensive and oversight of imported foods is limited.

But weaknesses can be turned into strengths. Sainsbury's, a UK supermarket chain, proposed in 2008 to sell ugly foods and vegetables in its "Halloween special" category, until regulatory barriers scuttled the plans.[119] It is a wasted opportunity that Asia's retailers don't attempt a similar approach, especially as Asia has far more ghost festivals and superstitions than Great Britain.

Intermarché, a supermarket chain in France, chose to rely on humor. Its "Inglorious Fruit and Vegetables" campaign in 2014, which was designated the European Year Against Food Waste, used witty slogans on ugly foods to generate both huge media buzz and store traffic.[120]

Gift-giving and social-media buzz are other contemporary trends that sellers can tap into. Chinese farmers and companies have used molds to shape fruits into all kinds of cute, photogenic, or outright wacky shapes[121] to great commercial success.[122] The upshot is not to give up on ugly foods too hastily. Creative marketing can unleash massive demand.

Urban Community Farming

Urban farming may mean squeezing crops into unused spaces or even installing beehives on rooftops, but it is no substitute for industrial-scale food production (see Section 2).[123] Rather, it serves as a conduit to build awareness and interest. People who grow their own crops gain a greater respect for food, where it comes from, and how much time and effort are needed. This can help de-commoditize food and reduce waste. Depending on the sourcing of inputs, community farms may also contribute to nutritional diversity by adding local variants of foods to the homogeneity and commoditization that characterize global food systems today.

For instance, Tainan city in Taiwan introduced food education into the school curriculum in 2012. Today, most of its schools have students tending to school farms and preparing their own fresh lunches.[124] Some schools even incorporate agricultural themes into art and literature classes. New Taipei City has also incorporated locally grown organic vegetables into school lunches, thus contributing to both healthier diets and farmers' livelihoods.[125] Elsewhere, ventures such as Grobrix in Singapore are developing vertical farms for household installation, using farming racks that look aesthetically pleasing as home furniture.

The issue is that locations where the natural climate is suitable for growing crops also tend to foster biodiversity. It is not all that clear how community gardeners can stop pests, which are more than happy to consume produce long before it's adequately ripe—or photogenic—for human consumption. Food safety is also hard to guarantee when humans or animals have free access to the farm. This contributes to the lack of regulatory clarity on whether community farms should be allowed and encouraged to sell their produce, let alone derive direct support from public procurement.[126] The lack of a steady source of revenue in turn hinders proper investment of time and resources into promoting a culture of farming within urban communities.

Commercialization and Communication

Participants themselves were split on consumer awareness and education. To begin with, it is neither cheap nor easy to educate the mass market on the environmental and nutritional benefits of new foods, much less to convert awareness into sustained dietary change. For instance, both product packaging and restaurant menus rarely (if ever) state the reductions in water consumption and carbon footprints of vertically farmed crops or plant-based proteins. It is thus unclear how consumers could learn of such benefits, let alone act on them.

> *Communication feels like it's neglected by companies that are in the cell-based space … Industry has a real opportunity to debunk these misconceptions and get ahead of the curve.*
>
> *Private Roundtable Participant*
> *(2021 Food and Ag in Asia—Commercializing Innovation, Milken Institute)*

Moreover, as many foodtech producers do not directly sell to consumers and have little control over distribution, it is unclear what their call to action for consumers would be.

Conversely, others believed it was mostly niche consumers who wanted to know the nitty-gritty details of the science or production process. Participants recalled that decades earlier, high transparency around the science of genetically modified foods had over-communicated potential risks to consumers, while failing to convey the value consumers would get in return. This partly contributed to negative perceptions of genetically modified foods, which persist to this day.

> *We have to be very careful … not to communicate with 10 percent of the consumers but scare away 80 percent of the consumers who don't really care.*
>
> *Private Roundtable Participant*
> *(2021 Food and Ag in Asia—Commercializing Innovation, Milken Institute)*

Some participants thus believed that messaging should instead focus on perceptions, brand equity, taste, texture, culinary versatility, and emotional connection—targeted at the largest common denominator. For instance, a participant recounted that although consumers viewed margarine as highly processed and less healthy than butter, when margarine was rebranded as "vegan butter," sales spiked. Others stressed the importance of consistent messaging, honest communication, and transparency regarding ingredients, noting that although consumer preferences have not solidified, it takes only a few negative examples to sour tastes. Interestingly, Chinese foodtech companies have gone full throttle in infusing entertainment into food education. Whether through live-streaming, cooking competitions, social media influencers, or celebrity chefs,[127] entertainment value and virality have become key ingredients in the broader campaign of consumer education.

> *People buy brands they love, in categories they respect, and from companies that they trust.*
>
> *Private Roundtable Participant*
> *(2021 Invest and Innovate—Food and Ag in Asia, Milken Institute)*

Participants also stressed the importance of customer segmentation when targeting marketing campaigns. Even within a market, food preferences vary widely with demographics such as age and gender. Finally, partnerships with supermarkets, restaurants, and fast-food chains can help familiarize consumers with new products. Concurrently, F&B businesses trying to reduce their environmental footprint or shorten supply chains may also benefit from sourcing local foodtech products.

MOVING FORWARD

As food systems throughout Asia and the world reel from multiple crises in quick succession, private capital has never had a better opportunity to make its mark and contribute systemically to a resilient food system.

Financing and infrastructural development remain sorely needed, including facilities for CEA and alternative proteins, but not forgetting the basics: roads, cold chains, internet connectivity, and payment systems that bring food from farm to fork.

Further R&D is needed to make novel foods—and their price tags—palatable. But to reduce emissions substantially, stakeholders should also continue devoting attention and resources to the longstanding needs to shift diets and reduce food waste.

Partnerships and collaboration are needed more than ever for the future of food, be it regulatory engagement for commercialization, R&D financing, or other initiatives to secure mass consumer awareness and adoption.

For its part, the Milken Institute continues to develop resources for food and agriculture, from innovative financing mechanisms to philanthropic prize competitions. The Milken-Motsepe Innovation Prize program is a series of multiyear, multimillion-dollar prize competitions, open to all, with a spotlight on Africa. The first prize focuses on agritech solutions. The Financial Innovations Labs® team is currently collaborating with Feeding Change to identify technological and private market opportunities to scale food-as-medicine interventions for diet-related disease prevention and treatment. Multiple centers across the Institute hold regular agrifood convenings with leading innovators, businesses, and entrepreneurs. The Institute will continue to leverage its platform, together with the insights from this report, as a catalyst for future progress toward a more nutritious, equitable, sustainable, and resilient food system under its Feeding Change program.

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