



**WHAT SINGAPORE'S '30
BY 30' FOOD SECURITY
GOAL MEANS FOR
BUSINESSES**

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THE FOOD SECURITY CHALLENGE & OPPORTUNITY

ASIA'S FOOD SECURITY CHALLENGE

Rapid food demand growth



Meat and seafood consumption in Asia will rise by **33%** by 2030

Falling yield growth



Corn and soybean yields in Asia are more than **50%** below the US

Access to arable land



Arable land per capita in Asia is less than **half** the global average

Climate related issues



By 2030, the amount of arable land per person in Asia is expected to fall by **5%**

SINGAPORE'S '30 BY 30' GOAL

Singapore currently imports more than **90%** of food



The '30 by 30' goal reflects Singapore's aim to develop the capability and capacity in its agri-food industry to produce **30%** of the nation's nutritional needs locally by 2030

Components of strategy and examples



Developspaces and infrastructure

- Agri-Food Innovation Park



Harness innovation and research

- Singapore Food Story R&D Programme



Grow the industry and ecosystem

- Outcome-based regulations to reduce compliance cost



Engage the public

- Labels for local produce

THE BUSINESS OPPORTUNITY



US\$800 billion additional investment will be needed over the next decade above existing levels to address these food security concerns

Major opportunities in **scaling existing production**, as well as **producing future foods**



What Singapore's '30 by 30' Food Security Goal Means for Businesses

On 13 November 2019, Temasek organised a sharing session by Mr Lim Kok Thai (CEO, Singapore Food Agency), as part of the Ecosperity Conversations series. The Singapore Food Agency (SFA) is a statutory board under the Ministry of the Environment and Water Resources to oversee food safety and security in Singapore. The session discussed the global food supply situation and its impact on Singapore's food security; what the '30 by 30' goal means for Singapore as a responsible global citizen addressing food security amidst climate change; how technology innovations can be harnessed to 'grow more with less' locally and produce affordable food sustainably; and the role of businesses in co-creating solutions to achieve this goal. This summary report covers key topics discussed during the session and includes additional insights to complement the discussion on the potential implications for businesses and policymaking.

The global food system is under severe stress, creating challenges for future food supply

The global food system is faced with several challenges in meeting unprecedented growth in food demand. Food demand is expected to increase by anywhere from 59 to 98 percent

Global food demand is expected to increase anywhere between **59 percent to 98 percent** by 2050

between 2005 and 2050.¹ At the same time, the unmet food demand at present is substantial. Almost 800 million people worldwide are hungry, and over 2 billion suffer from micronutrient deficiencies, in particular vitamin A, iodine, iron and zinc.² There are a number of challenges in meeting this demand:

- **Falling yield growth.** During the 20th century, yields increased at roughly 2 percent per annum largely as a result of greater use of fertilisers and capital equipment, and the diffusion of better farming technologies and practices.³ However, yield growth has

¹ Valin et al. (2015), "The future of food demand: understanding differences in global economic models". Agricultural Economics, Volume 45, Issue 1. Available at: <https://onlinelibrary.wiley.com/doi/abs/10.1111/agec.12089>

² FAO (2015), *The State of Food Insecurity in the World. Meeting the 2015 international hunger targets: taking stock of uneven progress*, FAO.

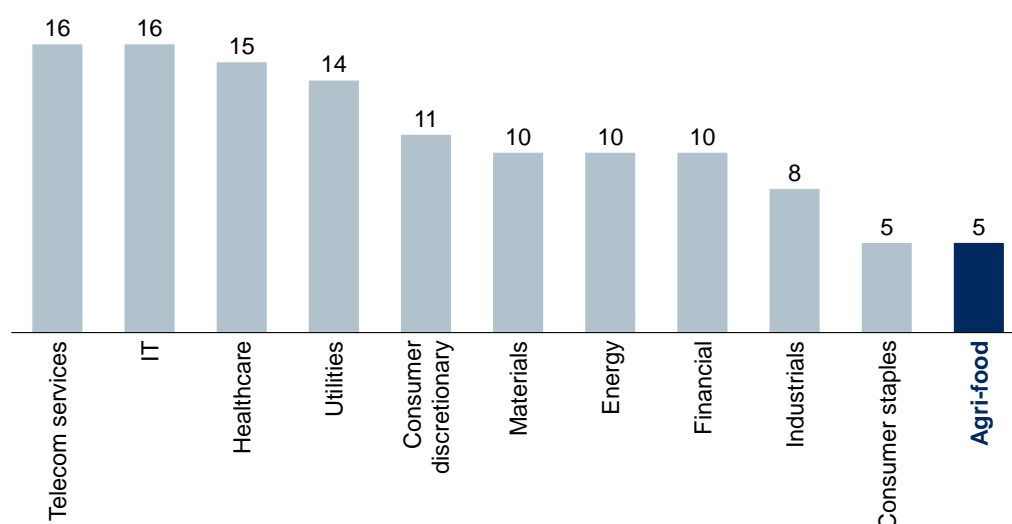
³ McKinsey Global Institute (2011), *Resource Revolution: Meeting the world's energy, materials, food, and water needs*. Available at: <https://www.mckinsey.com/business-functions/sustainability/our-insights/resource-revolution>

steadily fallen due to a combination of land degradation, yield growth approaching maximum limits (based on current technologies) in many countries, and a lack of investment in innovation. While agri-food has traditionally not been a capital-intensive sector compared to other sectors such as energy and telecommunications, the relative degree of underinvestment in agricultural innovation is still considered sizeable. For example, agriculture represents 10 percent of global GDP, but AgTech accounts for only 3.5 percent of global venture capital funds.⁴ Investment in the agri-food sector is far lower than in other sectors (Exhibit 1).

EXHIBIT 1

Currently, investment in the agri-food sector is significantly lower than in other sectors

Corporate R&D and Capex spend as a % of revenue, 2012–18 average



SOURCE: PWC, Rabobank, and Temasek (2019), *The Asia Food Challenge: Harvesting the future*

- **Environmental degradation.** Food production is responsible for about 25 percent of GHG emissions, over 70 percent of freshwater use, and over 80 percent of tropical deforestation and habitat loss.⁵ Conservative estimates indicate that the annual negative impacts associated with the food system are US\$6 trillion; in comparison,

⁴ Business & Sustainable Development Commission (2017), *Better Business Better World*. Available at: <http://report.businesscommission.org/>

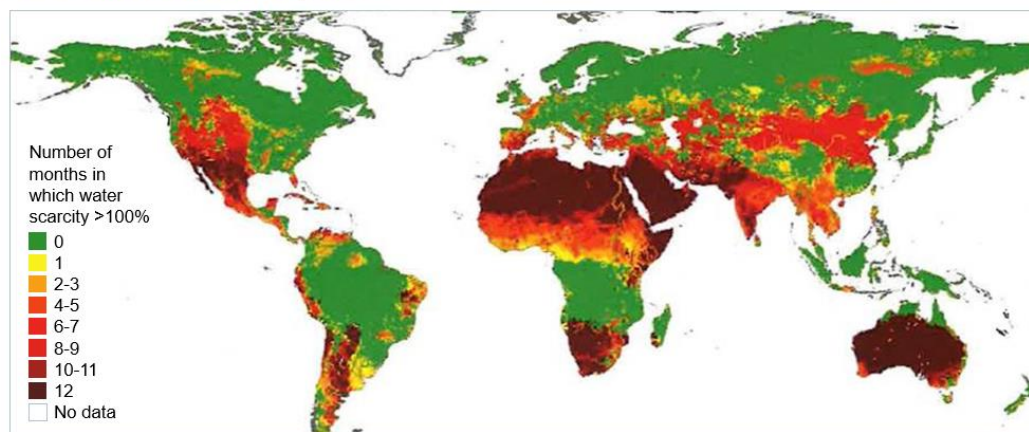
⁵ Global Environment Facility [GEF] (2019), *Seventh Replenishment of the Global Environment Facility*.

only US\$2.7 trillion were lost due to the global financial crisis.⁶ Land degradation due to erosion, nutrient depletion, acidification, salinisation, compaction and chemical pollution is causing the world to lose 24 billion tonnes of fertile land each year⁷; while 61 percent of 'commercial' fish populations are fully fished and 33 percent are fished at a biologically unsustainable level and therefore overfished.⁸

Water constraints will also be significant for agricultural production (two-thirds of the world will be living under "water-stressed" conditions⁹), given roughly 70 percent of global water demand is related to agriculture. Exhibit 2 summarises the degree of water scarcity globally. These environmental constraints could make it harder to supply the same volume of food as in the past.

EXHIBIT 2

At least two-thirds of the global population faces severe water scarcity at least one month every year



At least two-thirds of the global population is now believed to live with severe water scarcity at least one month every year. Roughly 1.8 billion people suffer severe water scarcity for at least six months per year, and 500 million live in places where water consumption is double the amount replenished by rain for the entire year – making them highly vulnerable as underground aquifers are depleted.

SOURCE: Mesfin M. Mekonnen and Arjen Y. Hoekstra, University of Twente in the Netherlands

⁶ World Bank (2019), "Do the costs of the global food system outweigh its monetary value?". Available at: <https://blogs.worldbank.org/voices/do-costs-global-food-system-outweigh-its-monetary-value>

⁷ UN News (2019), "24 billion tons of fertile land lost every year, warns UN chief on World Day to Combat Desertification". Available at: <https://news.un.org/en/story/2019/06/1040561>

⁸ Food and Agriculture Organisation of the United Nations (2018), *The State of World Fisheries and Aquaculture 2018*. Available at: <http://www.fao.org/documents/card/en/c/19540EN>

⁹ UN News (2019), "24 billion tons of fertile land lost every year, warns UN chief on World Day to Combat Desertification". Available at: <https://news.un.org/en/story/2019/06/1040561>

- **Competing sources of demand.** Meeting future food needs will be complicated by growing demand for feed in the developing world as livestock production increases. Feed consumption is forecasted to grow around 0.7 percent faster per annum than cereal production between 2016 and 2030.¹⁰ First-generation biofuels could add further stresses on cropland, requiring the equivalent of an additional 15 million hectares of land by 2030.¹¹

Asia faces particularly complex food security challenges given its rapid urbanisation and growth of the consuming class

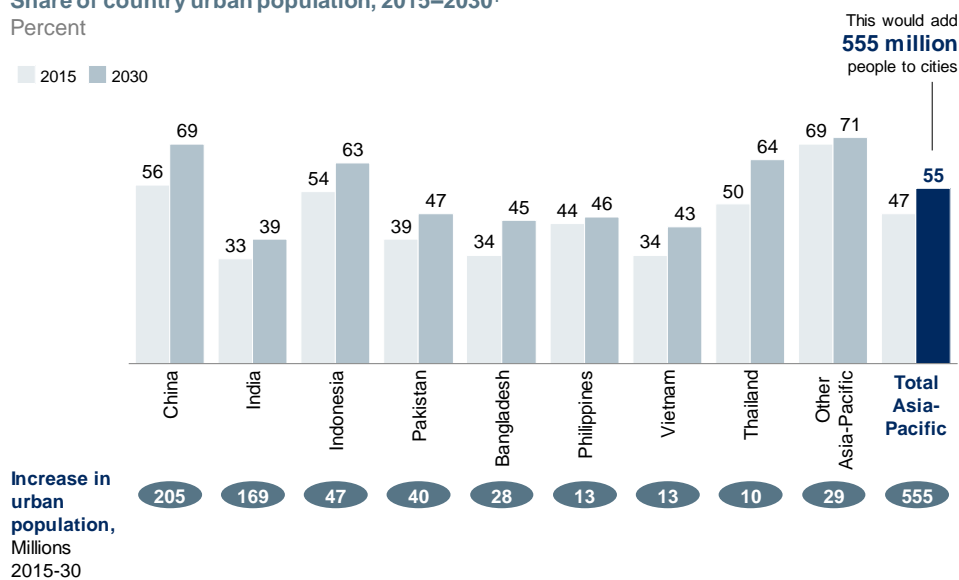
Asia is at the heart of the food security challenge given rapid urbanisation and growth of the consuming class. More than 550 million people are expected to move to cities in Asia-Pacific by 2030 (Exhibit 3), where they will create more than 85 percent of gross domestic product.¹² This rapid growth is not just in mega-cities such as Jakarta, Mumbai, Shanghai, Manila, and Bangkok but also in middleweight regions, with a population between 500,000 and 5 million.

EXHIBIT 3

555 million people are expected to move to cities in Asia-Pacific by 2030

Share of country urban population, 2015–2030¹
Percent

■ 2015 ■ 2030



¹⁰ World Agriculture: towards 2030/2050

¹¹ McKinsey Global Institute (2011), *Resource Revolution: Meeting the world's energy, materials, food, and water needs*. Available at: <https://www.mckinsey.com/business-functions/sustainability/our-insights/resource-revolution>

¹² McKinsey & Company (2015), *No Ordinary Disruption: The forces reshaping Asia*.

Available at: <https://www.mckinsey.com/global-themes/asia-pacific/no-ordinary-disruption-the-forces-reshaping-asia>

As millions move to cities for better job opportunities, the region is gaining a new wave of consumers with considerable spending power. The Brookings Institute estimates that there were approximately 3.2 billion people in the middle class globally at the end of 2016.¹³ By 2030, over 2.1 billion could join the middle class in Asia (Exhibit 4).

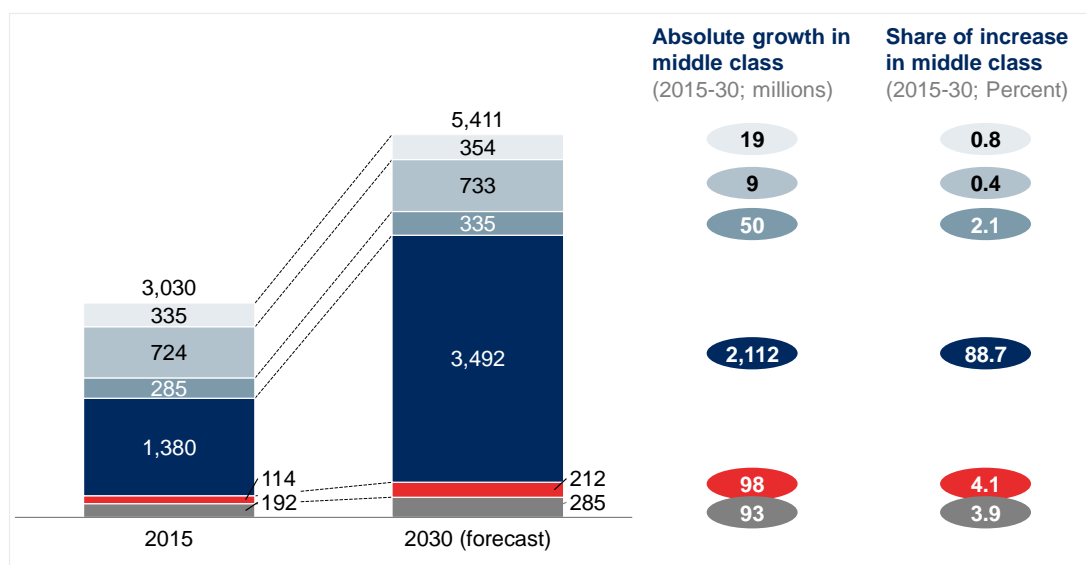
By 2030, over **2.1 billion** could join the middle class in Asia

EXHIBIT 4

Almost 90 percent of the growth in the global middle class to 2030 will be in Asia

Number of the global middle class by region¹
Millions

North America
Europe
Central and South America
Asia Pacific
Sub-Saharan Africa
Middle East and North Africa



¹ The income range for middle-class families is defined by Brookings as ranging from \$11 to \$110 income per day in 2011 Purchasing Power Parity (PPP) terms.

SOURCE: Homi Kharas (Brookings Institute); Team analysis

Spending on food in Asia is expected to double to **US\$8 trillion** by 2030

This growth will fuel demand for more and new types of food. Food consumption in Asia is rapidly shifting from being carbohydrate-reliant to protein-heavy as people look for healthier, more nutritious and tastier food options. Meat and

¹³ Brookings Institute (2017), *The unprecedented expansion of the global middle class*. Available at: https://www.brookings.edu/wp-content/uploads/2017/02/global_20170228_global-middle-class.pdf. The income range for middle-class families is defined by Brookings as ranging from US\$11 to US\$110 income per day in 2011 Purchasing Power Parity (PPP) terms.

seafood consumption is expected to rise by 33% by 2030.¹⁴ There are also demands for healthier food, with greater transparency on food sources and processes, while still maintaining value for money.¹⁵ Food demand is expected to come largely from the developing economies of China, India, and other Asian countries, as well as Africa.¹⁶ In India, calorie intake per person could rise by 20 percent to 2030, while per capita meat consumption in China could increase by 40 percent.¹⁷ Spending on food in Asia is expected to double to US\$8 trillion by 2030.¹⁸

Farmers and producers may find it difficult to address this demand. The challenge is not only in meeting the required quantity, but also the demand for taste, traceability, value, and quality.¹⁹ Currently, Asia cannot feed itself. Net imports of food have tripled since the turn of the century to reach 220 million tonnes a year.²⁰ Some 486 million people in Asia are still undernourished.

There are several reasons why food supply may be challenged in Asia:

- **Food waste.** Globally, about 30% of all food that is produced is wasted, representing US\$1 trillion in lost economic value annually.²¹ By 2030, Asia will be the biggest global generator of food waste, contributing around 500 million tonnes a year. This is driven by a combination of fragmented supply chains, underinvestment in infrastructure such as cold storage systems, and growing consumer waste.
- **Low availability of arable land and yield rates.** The amount of arable land in Asia is far lower than other regions (on a per capita basis) due to the rapid growth in urbanisation and the high population density (Exhibit 5). Yield rates are also lower in Asia, with corn and soybean yields estimated to be over 50 percent below those in the

¹⁴ Asia Research and Engagement (2018). *Charting Asia's Protein Journey*. Available at: <https://static1.squarespace.com/static/5991a3f3d2b8570b1d58cc7e/t/5b8de692562fa736b204bcd/1536026307523/Charting+Asia%27s+Protein+Journey.pdf>

¹⁵ PWC, Rabobank, and Temasek (2019), *The Asia Food Challenge: Harvesting the future*. Available at: <https://www.asiafoodchallenge.com/documents/afc-report-112019.pdf>

¹⁶ McKinsey Global Institute (2011). *Resource revolution: Meeting the world's energy, materials, food, and water needs*. Available at: <https://www.mckinsey.com/business-functions/sustainability-and-resource-productivity/our-insights/resource-revolution>

¹⁷ McKinsey Global Institute (2011). *Resource revolution: Meeting the world's energy, materials, food, and water needs*. Available at: <https://www.mckinsey.com/business-functions/sustainability-and-resource-productivity/our-insights/resource-revolution>

¹⁸ PWC, Rabobank, and Temasek (2019), *The Asia Food Challenge: Harvesting the future*. Available at: <https://www.asiafoodchallenge.com/documents/afc-report-112019.pdf>

¹⁹ PWC, Rabobank, and Temasek (2019), *The Asia Food Challenge: Harvesting the future*.

Available at: <https://www.asiafoodchallenge.com/documents/afc-report-112019.pdf>

²⁰ Food and Agriculture Organisation of the United Nations.

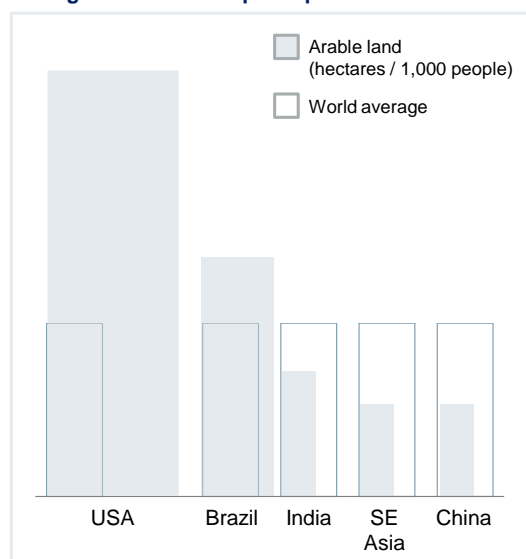
²¹ Global Panel on Agriculture and Food Systems for Nutrition; Food and Agriculture Organisation of the United Nations.

US (Exhibit 5). Reasons include lower average farm sizes, a lack of access to high-quality inputs, as well as improved farming practices.

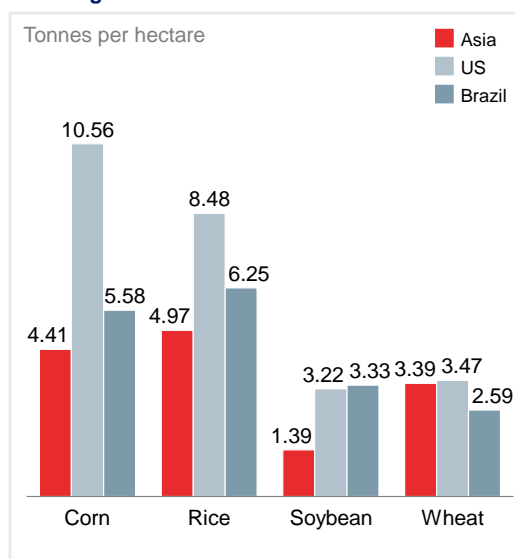
EXHIBIT 5

Arable land availability and yield rates remain low in Asia versus other regions

Asian countries have less than half the global average of arable land per capita



Yield rates for major crops are also lower than other regions



SOURCE: FAO; USDA; PWC, Rabobank, and Temasek (2019), *The Asia Food Challenge: Harvesting the future*; AlphaBeta analysis

- Declining workforce.** The average age of farmers continues to increase and succession remains a challenge with many younger workers moving to cities in search of better jobs. The absolute decline in agriculture workforce in developing countries is exacerbated by the fact that most farming operations are driven by smallholders, where compensation and benefits typically lag. For example, Indonesia is expected to lose 8 million farmers due to urbanisation by 2030.²² To overcome the decline in workers, Indonesia's farms will need to raise productivity by more than 60 percent.²³ This may require a consolidation of smallholders and significant capital investment in more advanced production systems.

²² McKinsey Global Institute (2012), *The archipelago economy: Unleashing Indonesia's potential*. Available at: <https://www.mckinsey.com/featured-insights/asia-pacific/the-archipelago-economy>

²³ McKinsey Global Institute (2012), *The archipelago economy: Unleashing Indonesia's potential*. Available at: <https://www.mckinsey.com/featured-insights/asia-pacific/the-archipelago-economy>

- **Environmental challenges.** Climate-related disasters such as typhoons, storms, fires and rising temperatures could exacerbate this situation, further impacting food security. The warming climate will exacerbate the damage caused by disease and pests, and desertification and salinisation could have a growing impact on arable land. By 2030, the amount of arable land per person in Asia is expected to fall by 5 percent.²⁴ Anthropogenic drivers are also increasingly threatening ecosystem services which are critical to food production. For example, agriculture and industrialisation have resulted in more than 50% of India's groundwater becoming too contaminated to use.²⁵ Growing demand for water-intensive crops like fruit and vegetables could exacerbate the problem.
- Arable land per person in Asia could fall by **5 percent** by 2030
- **Diversity within the region in agriculture and food systems.** There is widespread variation not only in dietary preferences in Asia, but also in terms of farming practices and levels of economic development. This can make it potentially challenging to develop region-wide approaches.
 - **Rising global tensions.** Rising global trade tensions could also see potential geopolitical issues interfering with trade flows, creating further risks to food supply.

Singapore's '30 by 30' goal aims to enhance food security and sustainability amidst global and regional challenges

Singapore is heavily reliant on the world for its food needs, with more than 90 percent of food currently imported (Exhibit 6). This makes Singapore highly vulnerable to the global and regional imbalances in food supply and demand. Food producing countries face pressure due to climate change, more frequent extreme weather events, loss of arable land and outbreaks in plant and animal diseases. This sometimes results in countries prioritising feeding their populations, as Malaysia's yearly seasonal ban on the export of five fish species to Singapore has shown.²⁶

²⁴ PWC, Rabobank, and Temasek (2019), *The Asia Food Challenge: Harvesting the future*.

Available at: <https://www.asiafoodchallenge.com/documents/afc-report-112019.pdf>

²⁵ PWC, Rabobank, and Temasek (2019), *The Asia Food Challenge: Harvesting the future*.

Available at: <https://www.asiafoodchallenge.com/documents/afc-report-112019.pdf>

²⁶ Straits Times (19 December 2018), "Singapore well-prepared for Malaysian seafood export ban".

Available at: <https://www.straitstimes.com/singapore/singapore-well-prepared-for-malaysian-seafood-export-bans-ava>

Currently, Singapore is in a strong position on food security – retaining its top position in the world in food security for a second consecutive year, according to a report by the Economist Intelligence Unit (EIU).²⁷ The report assesses

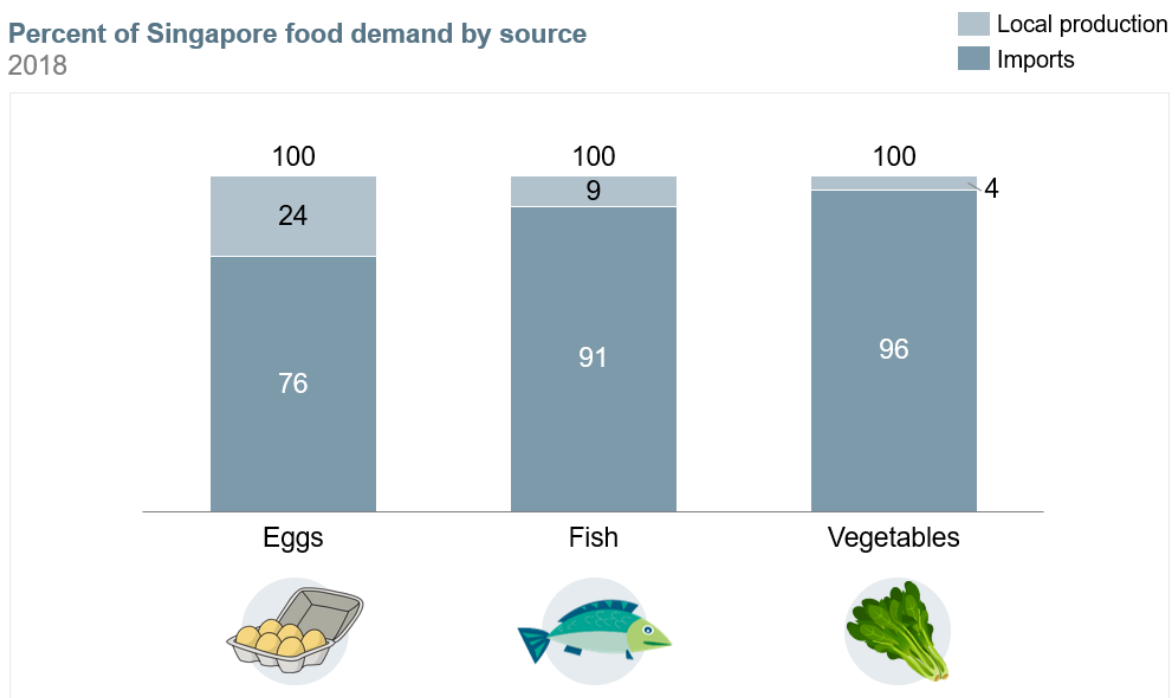
Singapore ranks **1st** on EIU's food security index but **falls to 12th** when climate-related and natural resource risks are considered

food affordability, accessibility, and quality. However, when climate-related and natural resource risk factors are considered, Singapore falls to 12th place on the index, indicating the need to strive continually to ensure its food security strategies remain robust.

EXHIBIT 6

More than 90 percent of Singapore's food is imported

Percent of Singapore food demand by source
2018



SOURCE: Agri-Food and Veterinary Authority of Singapore

In a bid to reduce its heavy reliance on imports and buffer impacts of supply disruptions, SFA announced a goal to transform Singapore's agri-food industry into one that is highly productive, innovative and sustainable, to produce 30% of the nation's nutritional needs locally

²⁷ Available at: <https://foodsecurityindex.eiu.com/>

by 2030. This '30 by 30' goal starts with leveraging existing industry segments such as the production of vegetables, eggs and fish. While Singapore will not be able to produce all its food needs locally, it will continue to go beyond increasing local production, ramp up efforts to diversify the range of countries from which Singapore imports and encourage local farms to develop operations overseas with produce exported back to Singapore.

The '30 by 30' goal is ambitious but achievable. It is also a chance for Singapore to turn challenges into opportunities:

- **Developing advanced urban food solutions to overcome land and resource-constraints.** The adoption of urban agriculture and aquaculture is rising rapidly in Asia in response to the growth of cities and the rise of new technologies. Technology is advancing rapidly particularly in the areas of high-intensity, closed-contained and automated farming operations that can overcome land and resource constraints and erratic weather conditions to 'grow more with less'. For example, vertical farming, integrated sensors, and controlled lighting allow urban farms to use relatively small plots of land to grow crops (even those that are not possible in Asian climates) faster and with fewer resources.²⁸ Urban agriculture and aquaculture improves food security of cities by increasing the supply of food to growing populations and lowering costs due to reduced transportation and storage.

Singapore has a growing number of first movers in both urban agriculture and aquaculture. For example, *Apollo Aquaculture Group* has developed a land-based, vertical fish farming system that produces six times more than traditional aquaculture, through remote control of operations and careful management, including the amount of fish feed dispensed.²⁹ The *Singapore Aquaculture Technologies (SAT)* farm adopts a closed-containment aquaculture system where the fish is separated from the seawater, enabling fish production to be resilient to fluctuations in external environmental conditions. *Sustenir* has an indoor vertical set-up that produces kale and strawberries all year round with a consistent quality. Interest continues to grow

²⁸ EcoWatch (2015), "3 Creative Solutions Emerging in Urban Farming". Available at: <https://www.ecowatch.com/3-creative-solutions-emerging-in-urban-farming-1882052831.html> and Ayoka Systems (2016), "7 Emerging Agriculture Technologies".

Available at: <https://www.ayokasystems.com/news/emerging-agriculture-technologies/>

²⁹ The Straits Times (2017), "Next-gen farming concepts on show at exhibition".

Available at: <http://www.straitstimes.com/singapore/next-gen-farming-concepts-on-show-at-exhibition>

and there is an increasing number of vertical farms over the past three years – 12 farms in 2016, 29 farms in 2017 and 34 farms in 2018.

- **Consumer demand is shifting towards safer, healthier food, grown in a sustainable way.** Consumer trends towards safer, healthier food, with a greater focus on sustainability could provide opportunities for Singapore. For example, vertical farming can save up to 99 percent of water compared to traditional farms.³⁰ Similarly, increasing demand for alternative proteins in both food (e.g. plant and cellular-based) and animal feed (e.g. insect or microbial-based) could help achieve the twin objectives of better nutrition and lower environmental impact. Aquaculture and alternative proteins are expected to see the largest growth in value terms to 2025.³¹ One example is microalgae. Microalgae are microscopic single-cell plant species found in fresh-water and marine systems. Their health and nutritional benefits have only recently been recognised. Microalgae can grow up to 10 times faster than terrestrial plants, making them a potentially highly scalable option for food and animal feed supply.
- **Singapore has existing strengths that could provide a comparative advantage.** Given the increasing focus on innovation in the food sector, intellectual property governance and research and development expertise could become increasingly important – areas in which Singapore is well placed to compete. For example, Singapore is ranked 2nd in the world and top in Asia for having the best IP protection in the World Economic Forum's Global Competitiveness Report 2019.³² Singapore also ranks 2nd in the World Bank's 2019 "Doing Business" index (top 3 in the past 13 consecutive years), underlining the strength of its overall business regulatory environment.³³

³⁰ Microsoft (2018), "Indoor vertical farming in Asia and beyond: Digging deep in data".

Available at: <https://news.microsoft.com/apac/features/indoor-vertical-farming-digging-deep-data/>; and Ozy (2017), "The Robots Are Coming ... For the Farms". Available at: <https://www.ozy.com/rising-stars/the-robots-are-coming-for-the-farms/70693>

³¹ Food Industry Australia Limited (2019), *Protein market: Size of the prize analysis for Australia*.

Available at: <https://www.alphabeta.com/our-news/protein-market-size-of-the-prize-analysis-for-australia/>

³² World Economic Forum (2019), *Global Competitiveness Report 2019*. Available at: <https://www.weforum.org/agenda/2019/10/competitive-economies-world/>





³³ <https://www.acra.gov.sg/news-events/rankings>

A series of policy strategies are in place to realise the ‘30 by 30’ goal

As a city-state constrained by limited land and resources, Singapore is a natural living laboratory to test-bed and develop sustainable urban food solutions for the future and export these solutions to other cities. To achieve the ‘30 by 30’ goal, SFA is working with various government agencies on four main strategies (Exhibit 7).

EXHIBIT 7

The Singapore Food Agency is working with other Singapore government agencies in four areas to achieve the “30 by 30” goal

	 Develop spaces and infrastructure	 Harness innovation and research	 Grow the industry and ecosystem	 Engage the public
Activities	Agri-Food Innovation Park (AFIP) Industrial spaces Agriculture land Sea space Alternate spaces (e.g. rooftops)	Singapore Food Story R&D Programme	Create a pro-enterprise regulatory environment Enhance incentives for local production Develop local talent pipeline Industry standard for clean, green produce	Increase demand for local produce Raise awareness on food security
Key government agencies¹	SFA with EDB, ESG, JTC, URA, SLA, MPA, HDB, PUB, EMA, NEA	SFA with A*STAR, IHL, RI	SFA with ESG, BCA, SCDF, IRAS, WSG / SSG	SFA with MOE, PA, NParks

¹ Singapore Food Agency (SFA); Economic Development Bank (EDB); Enterprise Singapore (ESG); Jurong Town Council (JTC); Urban Redevelopment Authority (URA); Singapore Land Authority (SLA); Marine and Port Authority (MPA); Housing Development Board (HDB); Public Utilities Board (PUB); Energy Market Authority (EMA); National Environment Agency (NEA); Agency for Science, Technology and Research (A*STAR); Institutes of Higher Learning (IHL); Research Institutes (RI); Building and Construction Authority (BCA); Singapore Civil Defence Force (SCDF); Inland Revenue Authority of Singapore (IRAS); Workforce Singapore (WSG); Skills Future Singapore (SSG); Ministry of Environment (MOE); People's Association (PA); National Parks Board (NParks).

SOURCE: Singapore Food Agency

1. Develop spaces and infrastructure

To ensure that land and sea space are available for farms to expand and scale-up food production, SFA is working with agencies such as the Urban Redevelopment Authority, Singapore Land Authority, and JTC Corporation to develop spaces and infrastructure. For example, the upcoming Agri-Food Innovation Park (AFIP) will help catalyse innovation by co-locating urban agriculture, aquaculture and novel food activities. District-level planning can also support resource-efficiency and sustainability with the ambition of achieving a ‘zero watt, zero water, zero waste’ concept.

2. Harness innovation and research

To drive innovation, funding of up to S\$144 million from within the Research, Innovation and Enterprise 2020 (RIE2020) Plan was committed to the Singapore Food Story R&D Programme, which focuses on three themes:³⁴

- a. ***Sustainable Urban Food Production.*** This aims to strengthen Singapore's food security by developing technological solutions for tropical aquaculture and urban agriculture in Singapore. Some target research areas include genetic improvement of key tropical aquaculture species and vegetable varieties with traits adapted for indoor farming and developing solutions for improved disease and health management.
- b. ***Future Foods: Advanced Biotech-based Protein Production.*** This aims to position Singapore as a comprehensive R&D hub for alternative proteins, focusing on plant-based proteins, microbial proteins, and cultured meat. This could include a) Discovery of novel and underutilised protein sources and new protein functionalities for food applications; b) Development of biotech-based methods for high-value, sustainable and nutritious protein production; and c) Diversification and scale up technologies to enable circular bio-economy of materials and improve sustainability of natural resources.
- c. ***Food Safety Science & Innovation.*** This aims to increase Singapore's food safety using evidence-based science through a) Ascertaining emerging safety risks of novel foods and new food innovations; b) Developing early warning and predictive modelling systems for emerging pathogens, food frauds, and other food safety risks; and c) Understanding consumer perception and social considerations of food innovations to improve their acceptability.

SFA and A*STAR have launched grant calls for R&D to invite local researchers and industry players to develop innovative solutions that can increase productivity for tropical aquaculture and urban agriculture beyond what is achievable by current best-in-class technologies, as well as to address fundamental challenges in alternative proteins, including but not limited to plants, vegetables, microbes, animal cell culture, insects, and commercial side streams. The

³⁴ Singapore Business Times (March 27, 2019), "Singapore to invest more in digital, food tech, cell therapy R&D". Available at: <https://www.businesstimes.com.sg/government-economy/singapore-to-invest-more-in-digital-food-tech-cell-therapy-rd>

grant calls were launched in December 2019, for Theme 1 - 'Sustainable Urban Food Production'³⁵ and Theme 2 - 'Future Foods: Alternative Proteins'³⁶ respectively.

3. Grow the industry and ecosystem

SFA, together with other agencies, is working on a few areas to promote an enabling regulatory and economic environment that will facilitate the development of local champions and grow the industry and ecosystem. These efforts include conducting food safety assessments for novel foods such as alternative proteins before they are allowed for sale in Singapore, as well as streamlining and adopting an outcome-based approach to regulations and to reduce compliance cost for farms. Through the Agriculture Productivity Fund (APF)'s Productivity Enhancement (PE) scheme, SFA supports farming systems that lead to higher productivity through capability upgrading, increased production capacity and land intensification.³⁷

There are also existing courses in Institutes of Higher Learning to build a talent pipeline for this growing industry. For example, Republic Polytechnic offers a part-time diploma course in urban agricultural technology. The course covers areas such as agricultural technologies for food production, farming processes and management as well as urban farming technologies and systems and sustainable farming. In 2019, 70 students enrolled in the course. At the same time, there is a need to continue growing the industry to attract talent. Attracting foreign businesses could provide another means to augment the talent pool.

4. Engage and mobilise the public

It is also critical to support domestic players by educating and promoting locally farmed produce to the public. SFA co-organises the SG Farmers' Markets with the Singapore Agro-Food Enterprises Federation (SAFEF) two to three times a year, and partners with supermarkets to organise local produce fairs.³⁸ Another initiative the SFA will be rolling out in 2020 is the development of a new brand logo to make local produce easier to identify for consumers. This new brand logo will replace the "Love Homegrown Produce" and "Love Singapore Farm Produce" labels currently found on the packaging of some local produce.

³⁵ <https://www.sfa.gov.sg/food-farming/singapore-food-story/singapore-food-story-r-d-grant-call>

³⁶ <https://www.a-star.edu.sg/Research/Funding-Opportunities/Overview>

³⁷ For more information, see: <https://www.sfa.gov.sg/food-farming/funding-schemes/agriculture-productivity-food>

³⁸ CNA (2019), "Singapore aims to produce 30% of its nutritional needs by 2030, up from less than 10%".

Available at: <https://www.channelnewsasia.com/news/singapore/singapore-produce-30-own-food-up-from-10-nutritional-needs-11320426>

There are large opportunities for businesses linked to the ‘30 by 30 goal’, but innovative approaches and partnerships will be required

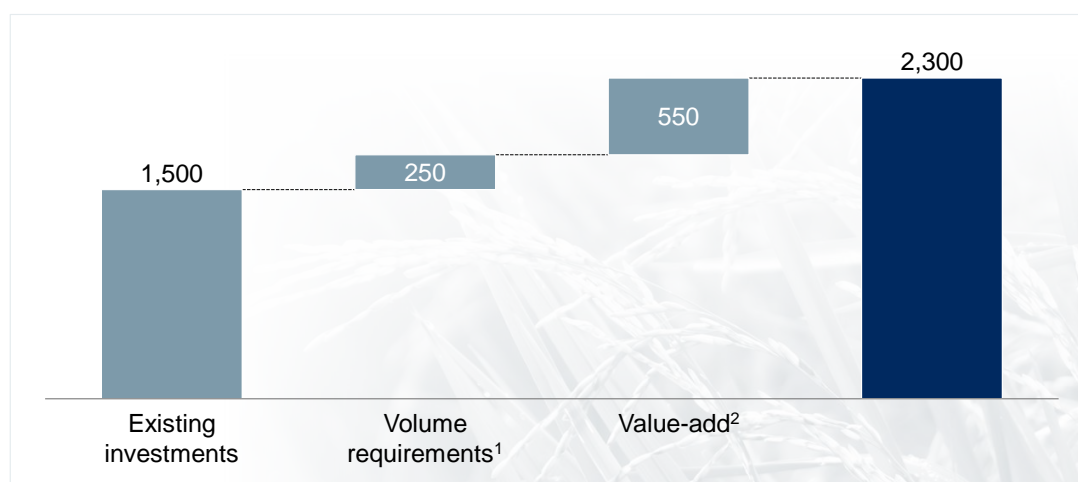
As highlighted earlier, there has been a lack of historical investment in the agri-food sector to support the uptake of new technologies globally. Recent research has suggested that US\$800 billion of additional investment will be needed over the next decade to address food security concerns (Exhibit 8). This investment would unlock market growth of around 7% per year, with the region more than doubling its total spending on food to over US\$8 trillion by 2030.³⁹

A critical component of capturing this market opportunity will be to form new partnerships between government, academia and the private sector. For example, as part of Singapore’s ‘30 by 30’ goal, A*STAR is working with relevant government agencies and the private sector to identify opportunities for Singapore to develop leading positions in different areas of the thriving alternative protein market.

EXHIBIT 8

Investment in the agri-food sector in Asia will need to increase significantly over the next 10 years to meet food security concerns

Agri-food investment requirements
USD billions; 2020-30



¹ Investment to support increased quantity of food demanded

² Investment to support demand for better-quality food (including safer food, healthier food and more sustainable food).

SOURCE: PWC, Rabobank, and Temasek (2019), *The Asia Food Challenge: Harvesting the future*.

³⁹ PWC, Rabobank, and Temasek (2019), *The Asia Food Challenge: Harvesting the future*. Available at: <https://www.asiafoodchallenge.com/documents/afc-report-112019.pdf>

For businesses in Singapore, there are two broad categories of opportunities:

- **Opportunities linked to existing production.** This will require more high-tech production of vegetables, fish, eggs, and other primary produce, which could lead to significant increases in productivity (Exhibit 9). By building a controlled environment, crops can be grown much quicker, with less water wastage and a lower carbon footprint. In highly urbanised Singapore, challenges include limited land allocated for farming (less than 1 percent), high production costs (e.g. energy), low consumer awareness and general resistance to purchasing pricier local produce due to the availability of other relatively cheap import food sources.⁴⁰ Government-driven policy strategies and partnerships between the public and private sector will be increasingly important across stakeholders and adjacent industries (e.g. utilities, retail).

EXHIBIT 9

New technologies can transform the productivity of food systems

Multi-storey/multi-tier to maximise land productivity, with automation that reduces reliance on labour, and environmental controls to produce independent of extreme weather

	Vegetable farms		Sea-based fish farm		Land-based fish farm		Alternate protein
	Median existing local farm	Model farm using ideal technology	Median existing local farm	Model farm using ideal technology	Median existing local farm	Model farm using ideal technology	Lab-culture meat
Technology	Conventional soil-based vegetable farm with basic netting green house	Indoor lighting farm, 4 storeys, 4 tiers per storey (overseas high-tech veg farm)	Farming in coastal sea space with small, shallow net-cages, rely on tidal movement for dilution of waste	Farming in deep sea with large deep net-cages, stronger currents to flush away waste (local high-tech aqua farm)	Pond or concrete tanks; minimal water treatment; paddle wheel for pond aeration	Recirculating Aquaculture Systems (RAS), oxygen generator or super saturation of dissolved oxygen (local high-tech aqua land farm)	Growth of meat cells in culture media within bio-reactors (AP company)
Productivity Tonnes/ha/yr	140	2,500	40	245	34	500	20,000

SOURCE: Singapore Food Agency

⁴⁰ Stella Liu (2017), *Lessons Learned from Growing Food in 100% Urbanised Singapore*. Available at: https://d2oc0i9d6a5bt.cloudfront.net/wp-content/uploads/sites/837/2017/06/1_StellaLiu_Lessons-Learned-from-Growing-Food-in-100-Urbanized-Singapore.pdf

Some examples of partnership opportunities include sustainable food sourcing such as switching menus to local produce, offering commercial spaces for urban farming and taking part in the master planning of new infrastructure in the Agri-Food Innovation Park and broader Lim Chu Kang area. Another opportunity could be positioning Singapore as a food processing hub for long shelf life food products.

- **Opportunities linked to future foods.** Singapore could potentially become a global hub for novel foods and alternative proteins, leading research into areas such as protein identification, food safety, nutrition profiles (particularly for the Asia phenotype), protein functionalisation (i.e. developing desirable texture interactions with carbohydrates, fats, etc), protein extraction (i.e. at scale without damage and undesirable bound compounds that can hamper taste). The growth of alternative protein firms such as Beyond and Impossible Foods points to tremendous growth opportunities in this space. Focusing on nutrient dense food (as opposed to weight or volume) could be key to unlocking this opportunity for Singapore. Local companies are also increasingly active in this space. For example, SATS is aiming to establish itself as a one-stop go-to-market platform in Asia for marketing, distribution and potentially even co-manufacturing of alternative proteins, which would enable food tech start-ups to leverage SATS' deep Asia expertise.⁴¹

How fast these business opportunities grow will depend on several factors. *First*, consumer eating habits and speed of the transition to eating more plant-based diets. For example, there is a negative consumer perception of microalgal protein products, particularly given the aroma and “fishy” flavour. Ensuring consumer safety will also be important. *Second*, whether technological innovations can produce solutions which are sustainable and scalable. This will require tackling a range of challenges, including the supply of feedstock, reducing the environmental footprint of food,⁴² managing space requirements, and progressing on the key R&D challenges (e.g. protein identification, functionalisation, and extraction). *Third*, the regulatory support structures will need to be put in place, including food safety standards, regulations related to feedstock imports, land availability, etc).

⁴¹ SATS (2019), “SATS Develops Market for Sustainable Food Products in Asia”.

Available at: <https://www.sats.com.sg/Media/NewsContent/21Nov19-SATS%20develops%20market%20for%20sustainable%20food%20products%20in%20Asia.pdf>

⁴² Deloitte and A*STAR (2019), *Environmental Impact of Food Consumption in Singapore*.

Available at: <https://www.ecosperity.sg/en/events/ecoconvo-environmental-impact-food-singapore-2019.html>

Conclusion

Food security will become an increasingly pressing concern given the range of global and regional trends. While Singapore has limited resources, it is well placed to turn these challenges into growth opportunities. The '30 by 30' goal will not only enhance Singapore's food security but also enhance regional collaboration and contribute towards developing sustainable agri-food solutions for a rapidly urbanising Asia.
