



Agency for
Science, Technology
and Research



alphaBeta
strategy x economics

Roundtable Series on Future Foods: Alternative Proteins

Event Summary | December 2019

Contents



1. Background: Singapore Food Story
2. Context: Why alternative proteins?
3. Roundtable event: Programme summary
4. Feedback: Participants' responses
5. Highlights: Synthesis of discussions
6. Next steps: Moving the agenda forward

As part of Singapore's broader Agri-food Development Plan, opportunities in "future foods" are being explored

The Target

Singapore imports over 90% of its food supply, making it vulnerable to volatilities of the global food market. In a push to ensure sustainability and resource-resilience, it was announced that Singapore aims to develop the capability and capacity in its Agri-Food industry to produce 30% of the nation's nutritional needs locally by 2030

The Strategy

On 27 March 2019, the Singapore Research, Innovation and Enterprise Council (RIEC), chaired by Prime Minister Lee Hsien Loong, announced funding of up to S\$144 million into an integrated "Singapore Food Story" R&D programme. The programme seeks to turn Singapore's food challenges into opportunities by focusing on three R&D themes:

- Sustainable Urban Food Production;
- Future Foods: Advanced Biotech-based Protein Production; and
- Food Safety Science & Innovation

The Agencies

The Singapore Food Story R&D programme is jointly developed and led by the Singapore Food Agency (SFA) (previously Agri-food and Veterinary Authority, AVA), Enterprise Singapore (ESG) and the Agency for Science, Technology and Research (A*STAR), and extends involvement to the nationwide public sector research ecosystem

The Agenda

As part of this "Singapore Food Story", a series of events will be organised to bring together government agencies and industry players to understand opportunities, challenges and potential solutions in particular areas of "future foods". The first set of discussions in July-August 2019 focused on alternative proteins under the second theme i.e. Future Foods



■ This event

Roundtable Series on Future Foods: Alternative Proteins

Events related to alternative proteins in Singapore

1

Singapore Food Story programme commissioned

- Singapore Food Story R&D Programme commissioned by PM Lee Hsien Loong on **March 27, 2019** with S\$144 million in funding, to be developed by SFA, ESG and A*STAR
- **Focus topics** – three R&D themes:
 - Sustainable urban food production;
 - Future foods: Advanced biotech-based protein production; and
 - Food safety science and Innovation

2

Alternative Proteins Roundtable Series: Prelude Event

- Prelude event held on **July 1, 2019**
- **Focus topics** – Overview of plant-based and microbial proteins, Singapore’s positioning as a hub
- **Key outcome(s)** – Insights used to develop key hypotheses to test at Main Event, and feedback used to inform design of the event

3

Alternative Proteins Roundtable Series: Main Event

- Main event held on **August 19-20, 2019**
- **Focus topics** – Key “themes” related to Singapore’s positioning as an alternative proteins hub
- **Key outcome(s)** – Action plan for Singapore to capture the alternative proteins opportunity, including further research, assembling industry working groups, and policy agenda

4

Future events

- Roundtable series to continue in **2020** and beyond
- **Focus topics** – Cultured meat, consumer insights, regulatory barriers, startup ecosystem, etc.
- **Key outcome(s)** – Inform product development, detailed policy proposals, design of R&D and manufacturing facilities, etc.

Contents

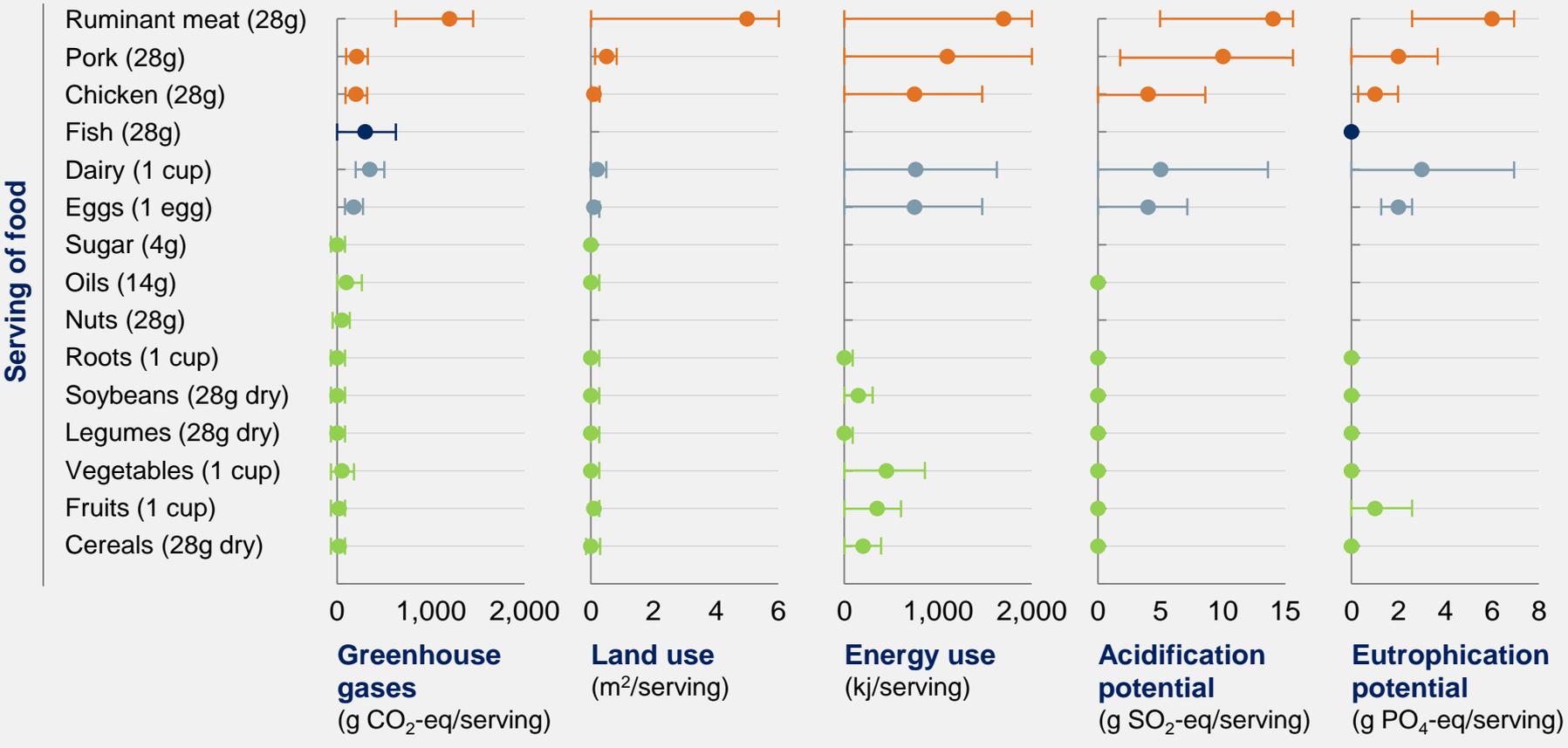


1. Background: Singapore Food Story
2. Context: Why alternative proteins?
3. Roundtable event: Programme summary
4. Feedback: Participants' responses
5. Highlights: Synthesis of discussions
6. Next steps: Moving the agenda forward

Meat, poultry and aquaculture production have outside environmental impact in comparison with plant production

Food group | ● Plant-based foods ● Fish ● Dairy & Eggs ● Meat

Environmental effects per serving of food produced¹

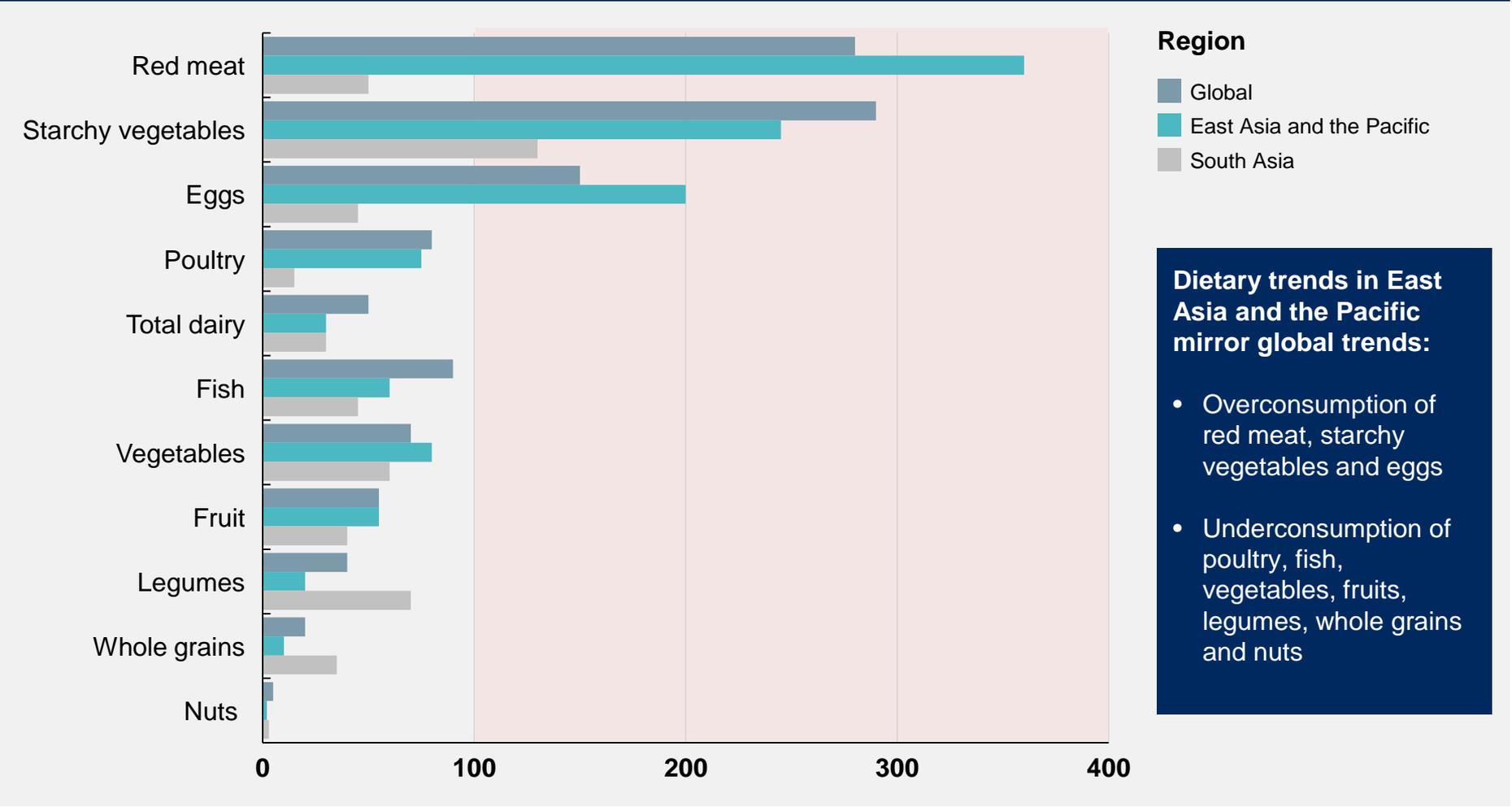


Singaporeans eat **3 to 5 times** more **meat** and eggs than is environmentally sustainable

¹ Bars represent standard deviation. Results for fish are incomplete due to lack of data; CO₂ = carbon dioxide; PO₄ = phosphate; SO₂ = sulphur dioxide

Together with outsized environmental consequences, red meats are also over-consumed relative to reference dietary intakes

Diet gap between actual dietary patterns in 2016 and reference diet intakes of food¹; Percentage, 2016



Dietary trends in East Asia and the Pacific mirror global trends:

- Overconsumption of red meat, starchy vegetables and eggs
- Underconsumption of poultry, fish, vegetables, fruits, legumes, whole grains and nuts

¹ Reference dietary intakes account for regional differences. Food group consumption score of less than 100% indicates underconsumption against reference intake amount (i.e. indexed to 100%), and a score of over 100% indicates overconsumption against reference intake amount.

Plant-based meats require significantly fewer natural resources than conventional meat

Reduction in resource usage by plant-based beef versus conventional beef; Percentage

		IMPOSSIBLE™	
Land usage 	93%	95%	97%
Water usage 	99%	75%	90%
GHG emissions 	90%	87%	96%

While population growth was the main driver of protein consumption historically, going forward it is likely to be driven by other factors

	Description	Projected annual trend from 2018 to 2025 ²	Future growth rate relative to historical
 Population growth	Population growth accounted for 80% of protein demand growth between 2000 and 2018	2000-18: +90 mil p.a. 2019-25: +79 mil p.a. (-12%)	
	 Change in per capita consumption	Consuming class¹ growth. Higher propensity to spend on food proteins as people enter the consuming class	2000-18: +108 mil p.a. 2019-25: +290 p.a. (+169%)
Urban population growth. Increased incomes lead to higher protein consumption		2000-18: +74 mil p.a. 2019-25: +79 mil p.a. (+7%)	
Share of global population over age 65. An older population is likely to consume less protein per person		2018: 8% 2025: 10% (+2%)	
Change in dietary preferences due to health and ethical reasons		Not available	Not available

1. Consuming class defined as people in the middle class, which is defined by Kharas (2017) from Brookings as households with per capita incomes between \$10 and \$100 per person per day (pppd) in 2005 PPP terms . This implies an annual income for a four-person middle-class household of \$14,600 to \$146,000.

2. The bar charts in this column reflect the historical (2000-18) and projected (2019-25) annual average increase in absolute terms for all drivers except “share of global population over age 65”. “p.a.” in each of the bar charts for these drivers refer to “per annum”. For the driver “share of global population over age 65”, the bar chart displays the absolute percentage shares of individuals aged over 65 of global population in 2018 and 2025.

SOURCE: UN Population; Brookings Institute; AlphaBeta analysis

Growing protein demand, environmental concerns, and over-consumption of red meats has driven interest in alternative proteins



Growing protein demand

Plant-based proteins

Extraction and processing of protein isolate from plant sources such as soy, pea, etc.



IMPOSSIBLE™



Environmental concerns

Microbial proteins

Dried cells of micro-organisms (e.g. algae, fungi, insects)



CALYSTA.
Perfect Day



Unsustainable diets

Hybrids proteins

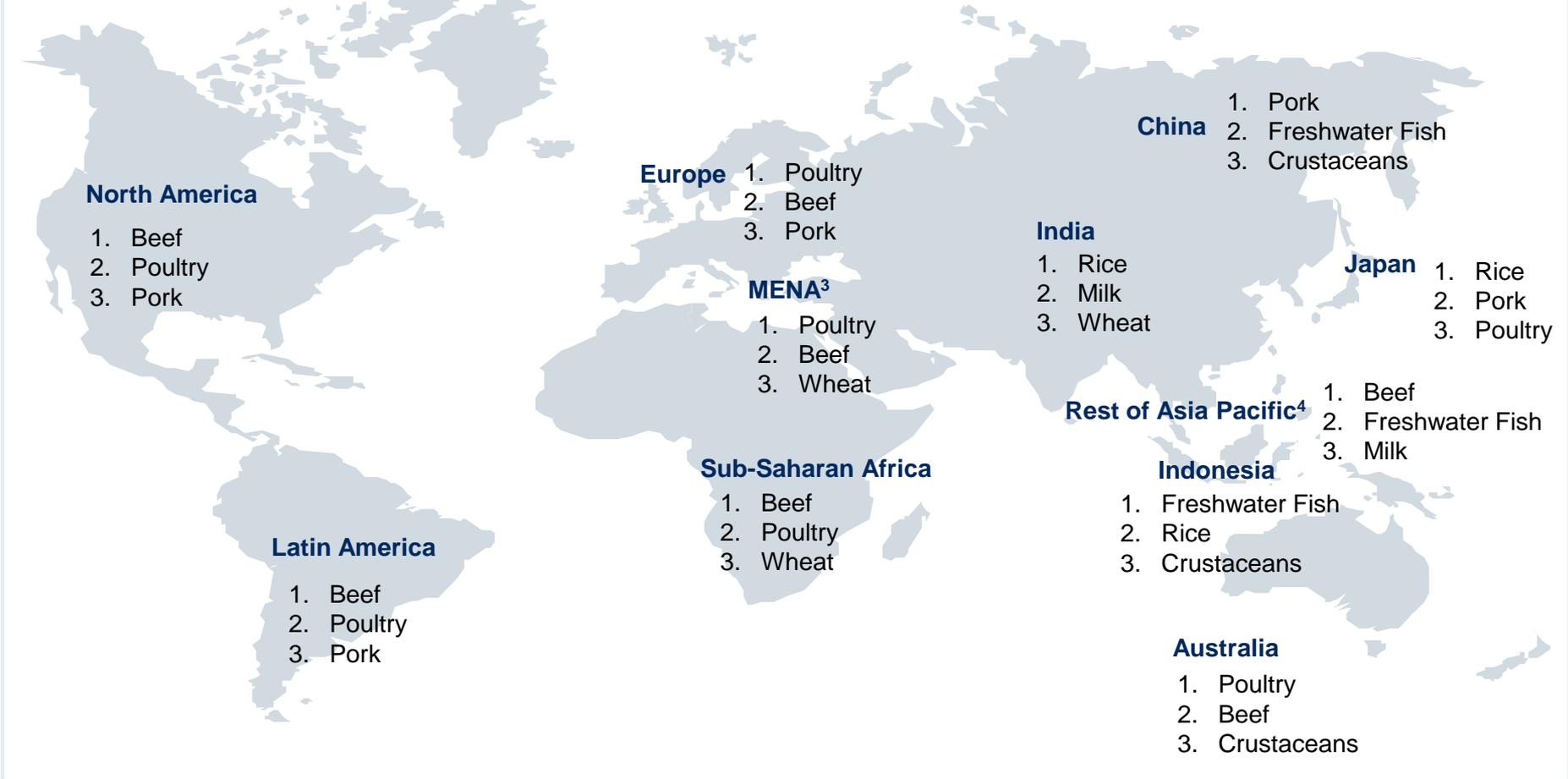
Hybrid meat products occupy a middle ground between conventional meat and their alternative counterparts, enabling a reduction of conventional meat consumption without a significant shift in consumer behaviour



essento®

The ranking of different protein demands globally

Top three protein types by market value¹ in 2025 across regions
 ('Business-as-usual' scenario²)



¹ Based on 2017 prices: FAO producer price data to proxy for plant-based, meat, eggs, and dairy prices; GlobeFish European Fish Report for aquaculture and wild catch fisheries; available market research for non-traditional proteins

² In this scenario, protein consumption was projected based on growth of population, historical per-capita consumption and consuming class

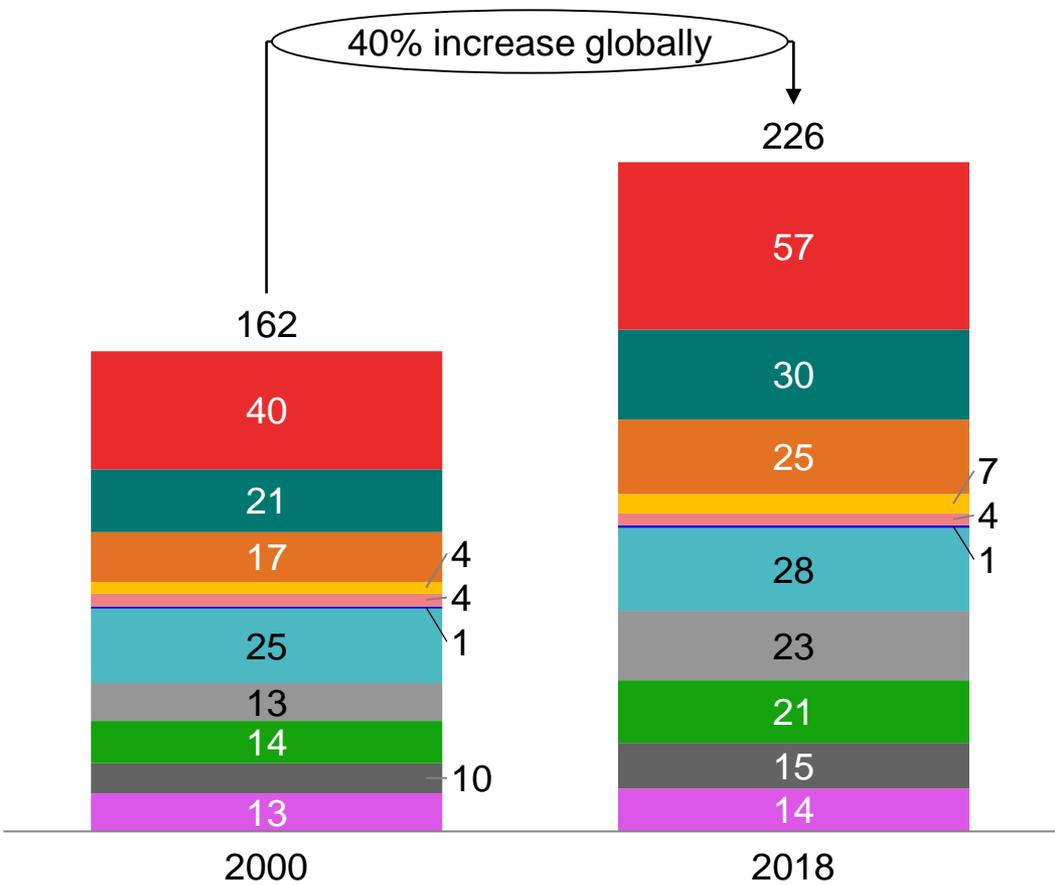
³ MENA consists of Middle East and North Africa.

⁴ Rest of Asia Pacific excludes Australia, China, India, Indonesia, and Japan.

SOURCE: FAO stats; AlphaBeta analysis

Global protein consumption has risen 40% since 2000, with more than half of the increase being driven by Asia

Breakdown of global protein consumption by region in 2000 and 2018¹; Million tonnes



Region	Contribution to global increase from 2000-2018, by region (%)
China	26%
India	14%
Rest of APAC ²	13%
Indonesia	4%
Japan	-1%
Australia	0%
Europe	4%
Sub-Saharan Africa	17%
Latin America	11%
MENA	8%
North America	3%
Total Asia (China, India, Rest of APAC, Indonesia)	57%

Total 57% of global increase coming from Asia

1. Latest FAO data point is 2013. 2018 estimated using historical growth rates (i.e. 5-year CAGR)
 2. Rest of Asia Pacific excludes Australia, China, India, Indonesia, and Japan; MENA consists of Middle East and North Africa.
 Note: Figures may not sum due to rounding
 SOURCE: FAO stats; AlphaBeta analysis

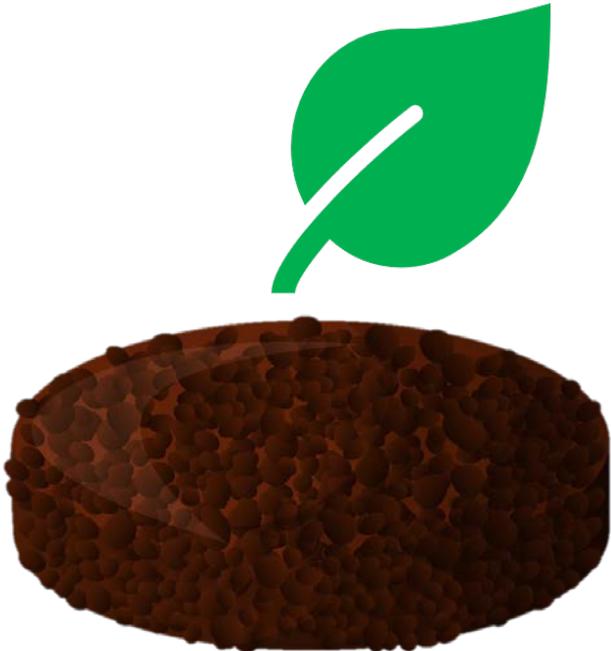
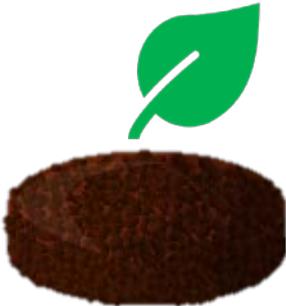
The market for alternative proteins is growing rapidly; nascent Asian market to register strongest growth through 2025

Global meat substitutes market

2017

2025

2035



US\$4.2 billion

US\$7.6 billion

Potential to reach
US\$100 billion

Growth rate (CAGR, 2018-25)

- Global: 7.7%
- Asia-Pacific: 9.4%

There is growing traction in Singapore for alternative proteins

Opportunity to develop alternative proteins industry in Singapore

Favourable consumer sentiment

Singapore ranked as Asia's 2nd most vegan friendly city (behind Taipei), driven by strong consumer demand

Over 50% of Singaporean consumers believe companies should ensure sustainable supply chains



Increasing alternative meat options

Impossible Foods launched its plant-based meat in March 2019 at 8 eateries

Beyond Meat now selling at multiple outlets, including NTUC FairPrice Finest, Redmart, and Little Farms



Vibrant startup sector

Shiok Meats secured US\$4.6m in seed funding; launched the first tasting of a shrimp dumpling prototype in April 2019

US\$50m (S\$68m) Big Idea Ventures fund backed by Temasek and Tyson Foods for future proteins in Singapore



Contents



1. Background: Singapore Food Story
2. Context: Why alternative proteins?
3. Roundtable event: Programme summary
4. Feedback: Participants' responses
5. Highlights: Synthesis of discussions
6. Next steps: Moving the agenda forward

The Prelude Event on Alternative Proteins in Singapore was conducted on July 1, 2019, ahead of the Main Event in August

PRELUDE EVENT Jul 1, 2019



Purpose



Solicit initial feedback on key issues to explore, ahead of the Main Event in August which will go deeper on the issues identified

Participants



60 participants from government, academia, investment community, FMCGs, ingredients houses, F&F houses, commodity suppliers, not-for-profits, equipment manufacturers, etc.

Structure



- Full-day programme
- Keynote addresses on (i) improving flavour of pea/pulse proteins; and (ii) applications of microalgae proteins
- Gallery walk on (i) changing protein demand, (ii) overview of alternative proteins, (iii) production and startup value chains, and (iv) emerging hubs in Asia Pacific
- Group discussion on strengths and opportunities for Singapore in alternative proteins R&D and manufacturing
- Four breakout group discussions, exploring questions on product development, and supply chain and feedstocks

Outputs



- **Ideas exchange between a range of interested parties**
- **Identification of key hypotheses** to be tested at the Alternative Proteins Main Event in August



The Main Event on Alternative Proteins in Singapore was conducted over 2 days on August 19-20, 2019

MAIN EVENT Aug 19-20, 2019

Purpose		Build on input from Prelude Event and test potential for Singapore to lead industry development in alternative proteins in Asia across six key “themes”
Participants		~100 participants from government, academia, investment community, FMCGs, ingredients houses, F&F houses, commodity suppliers, not-for-profits, equipment manufacturers, etc.
Structure		<ul style="list-style-type: none">Two-day programmeKeynote addresses on (i) Flavour aspects protein functionalisation; (ii) Landscape of microbial proteins; and (iii) Resources optimisation in production and processing stages of the value chain and waste reduction at sourceGallery walk on six “themes” related to alternative proteins in Singapore: (i) Sustainability, (ii) Nutritional leadership, (iii) Protein identification, (iv) Protein functionality and stability, (v) Food safety, and (vi) Asian phenotypeBreakout group discussions to develop action plans on four prioritised themes: (i) Nutritional leadership (with aspects of Asian phenotypes); (ii) Protein identification (with aspects of sustainability); (iii) Protein functionality and stability; (iv) Food safety
Outputs		<ul style="list-style-type: none">Potential next steps developed to capture the alternative proteins opportunity for A*STAR’s consideration, specific to each prioritised themeExtensive networking to catalyse action



Contents



1. Background: Singapore Food Story
2. Context: Why alternative proteins?
3. Roundtable event: Programme summary
4. Feedback: Participants' responses
5. Highlights: Synthesis of discussions
6. Next steps: Moving the agenda forward

Participants indicated that while Singapore faces several constraints, it could pursue a “centre of excellence” strategy as an APAC hub

What is the **biggest implementation challenge** to Singapore becoming an alternative proteins hub?



Participants feedback¹

- Maintaining sustained interest, and in particular progressing on food safety issues
- Low investor risk appetite and the nascent startup ecosystem
- Identifying appropriate protein sources for mass processing in Singapore
- High costs of production i.e. land, labour, raw materials, etc. and challenges in product design and space/capacity for mass processing
- Addressing legal challenges in IP protection (e.g. nutritional R&D) to enable collaboration between companies and countries
- Consumer perceptions, both at home and overseas

What advice/suggestions do you have for how **Singapore could best become an alternative proteins hub for APAC?**



- Follow-through on alternative proteins plan as R&D will take time; could establish a committee to lead
- Aspire to be “centre of excellence” for APAC – Specifically focusing on R&D gaps first (e.g. cultured proteins, single-cell proteins, nutritional leadership, food safety; microbial proteins and microalgae)
- Build on existing expertise and capacity from other sectors (e.g. biopharma)
- Integrate across entire value chain – including R&D and commercialisation – but focus on technology and collaborate with regional hubs such as Thailand for manufacturing
- Aggregate siloed research and non-competitive information, and build common R&D facilities for MNCs and start-ups
- Mentor/assist early stage start-ups and SMEs through a specific programme

¹ Responses were provided by 34 out of 48 external participants (i.e. excluding A*STAR and AlphaBeta representatives) at the Prelude Event, and 54 out of 83 external participants at the Main Event.

Singapore's strengths in R&D make it an attractive market for a "pilot test"



STRENGTHS

- **R&D hub:** Ranked first in Asia and 7th globally on Global Innovation Index; regional R&D hub for top companies including P&G, GSK, DSM, Mondelez etc.
- **Strong government support and IP protection:** Alternative proteins is key pillar under Singapore Food Story R&D Programme; Singapore ranked 3rd globally and 1st in Asia for IP protection by World Economic Forum
- **Global food tech investment hub:** Availability of both public and private funding e.g. US\$50m Big Idea Ventures fund backed by Temasek for alternative proteins

OPPORTUNITIES

- **"Pilot test" market:** Develop a pilot test for alternative proteins, manufacturing end-products at a smaller scale to test product viability before expanding in other markets
- **Hub for Southeast Asia:** Identify unique proteins in (Southeast) Asia for trials; create products specifically for the regional consumer leveraging local insights in nutrition and cuisine
- **Export supply chain to APAC:** Develop alternative protein production model for distribution across APAC by integrating with feedstock producers and demand centers

A lack of skills, high costs, and competition from other APAC hubs are impediments to alternative protein manufacturing



Manufacturing

STRENGTHS

- **Strong government commitment and IP protection:** EDB, A*STAR, ESG developing high-value manufacturing; Food Manufacturing Industry Transformation Map developed to transform local food production; Singapore ranked 3rd globally and 1st in Asia for IP protection by World Economic Forum
- **Food safety standards:** Singapore renowned for stringent safety standards in food import, production and retail
- **Potential talent pipeline:** Efforts to increase bio-engineering talent through SkillsFuture and programmes at tertiary institutions

OPPORTUNITIES

- **Regional alternative proteins trade hub:** Companies can build regional manufacturing hubs with supply lines from producing countries in the region and distribution of across Southeast Asia, China, India, Japan, the US and Oceania
- **Manufacturing for the Asian consumer:** Manufacture alternative proteins products suitable for consumption by Asian consumers and aligned to local tastes
- **Automation leverage:** Comprehensive industry 4.0 strategy for automation in high-value manufacturing; current applications in biopharmaceuticals, refined oil etc.

Four key themes for Alternative Proteins in Singapore were prioritised by participants

Theme	Description
1 Nutrition leadership	 <ul style="list-style-type: none">▪ Singapore could become a hub for insights into the nutritional benefits of alternative proteins, where there is currently a lack of rigorous insights▪ These insights in R&D could then inform new product development and reference dietary intakes, specifically for Asians
2 Food safety	 <ul style="list-style-type: none">▪ Concerns about safety issues with many alternative proteins (e.g. toxins from microalgae) and currently limited research▪ Singapore could establish Asia equivalent of GRAS in the US (Generally Recognised As Safe)
3 Protein identification	 <ul style="list-style-type: none">▪ Less than 2% of current plant species used in agriculture production are commercially used for alternative proteins; a further 250,000 species are not used in agriculture at all▪ Singapore could leverage its big data capabilities, plus understanding of ASEAN byproducts (such as palm husks) to identify Asia-produced feedstocks
4 Protein functionality & stability	 <ul style="list-style-type: none">▪ Little is still known about protein stability issues which can influence taste, texture, and shelf life▪ While other hubs are exploring this, Singapore could lead this in Asia, and understand how Asian conditions (e.g. lack of cold chain logistics, humidity) influence stability

Contents



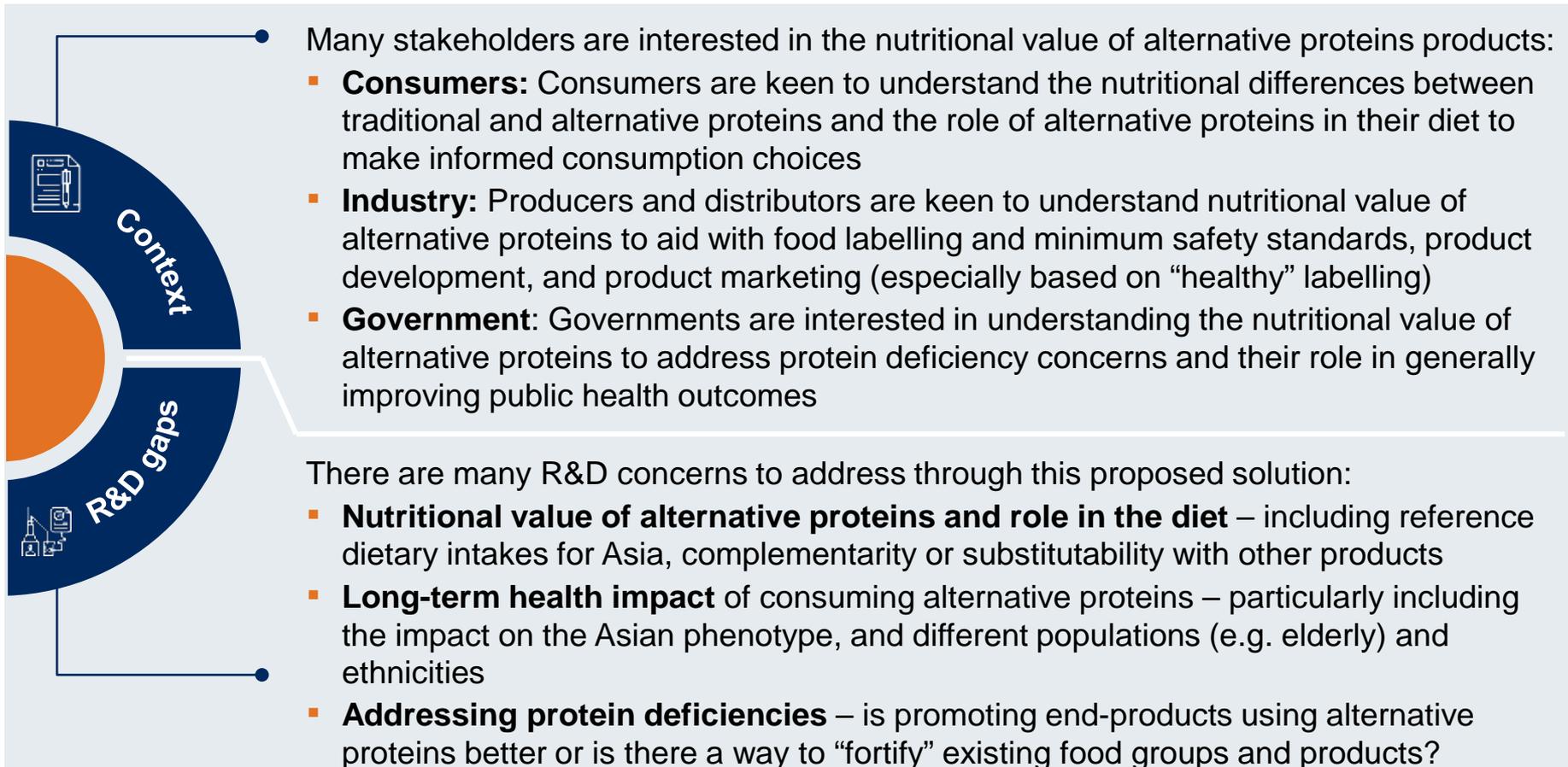
1. Background: Singapore Food Story
2. Context: Why alternative proteins?
3. Roundtable event: Programme summary
4. Feedback: Participants' responses
5. Highlights: Synthesis of discussions
6. Next steps: Moving the agenda forward



1. Nutrition leadership: Collaboration is needed to address key R&D gaps

PROPOSITION

Singapore should become a **R&D hub for nutritional leadership in alternative proteins**, leveraging existing R&D capabilities, diverse market base, and large network of relevant stakeholders. A tripartite research body (government, industry, academia) could be established to pursue this objective and plug existing gaps in R&D.





Singapore has a range of strengths and opportunities to enable nutritional leadership in alternative proteins for Asia

STRENGTHS

- **R&D facilities:** Singapore has state-of-the-art R&D facilities – A*STAR’s several labs can house research on nutritional profiling of alternative proteins and their products
- **Availability of funding:** A mix of government grants and private sector funding available for research
- **Strong stakeholder network:** Singapore has a strong stakeholder network to champion nutritional leadership, including a supportive public sector, range of FMCGs and ingredients houses and academia

OPPORTUNITIES

- **Pilot test with Asian consumers:** Singapore and neighbouring countries are viable pilot test markets with a diverse consumer base to test (long-term) nutritional impact of alternative proteins products from an Asian perspective; additionally could look at impact on the elderly and other unique/vulnerable population segments
- **Nutrition labeling:** Nutritional labeling is a key component of product development – deep knowledge base could be leveraged by companies and foodservice sector to promote alternative proteins products

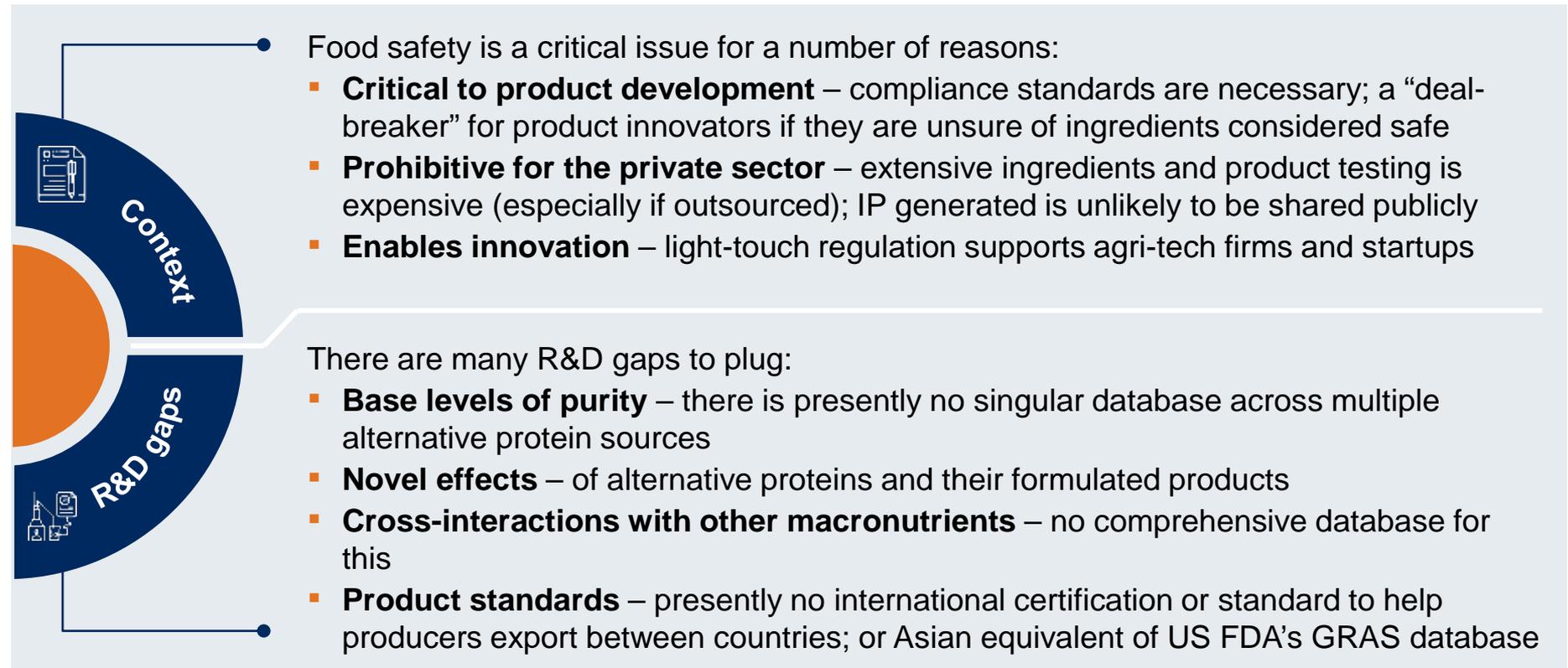


2. Food safety: Singapore well-placed to lead Asia in alternative proteins safety

PROPOSITION

The Singapore Food Agency (SFA) and A*STAR should together:

- **Create a systematic database on food safety of alternative proteins**, leveraging its reputation for stringent food safety regulations, status as a “neutral” country (i.e. low production interests), and existing infrastructure in the biopharmaceutical industry
- **Coordinate with other national food agencies** to create an internationally accepted safety standard for alternative proteins products
- **Pursue a regulatory sandbox** approach and provide financial support to promote product innovation based on this research



Singapore is well-placed to lead on food safety standards in alternative proteins across Asia Pacific



STRENGTHS

- **Strenuous existing food safety regime:** Current capabilities exist to assess the presence of heavy metals and pathogens in food as well as to determine safe dosages of ingredients
- **Independent perspective:** Singapore is not a producer country, and is less susceptible to lobbying from potentially threatened industries (e.g. meat producers)
- **Innovation-friendly government:** Singapore government is open to regulatory sandboxes to explore innovative product development; past success across a range of sectors including clean energy and healthcare

OPPORTUNITIES

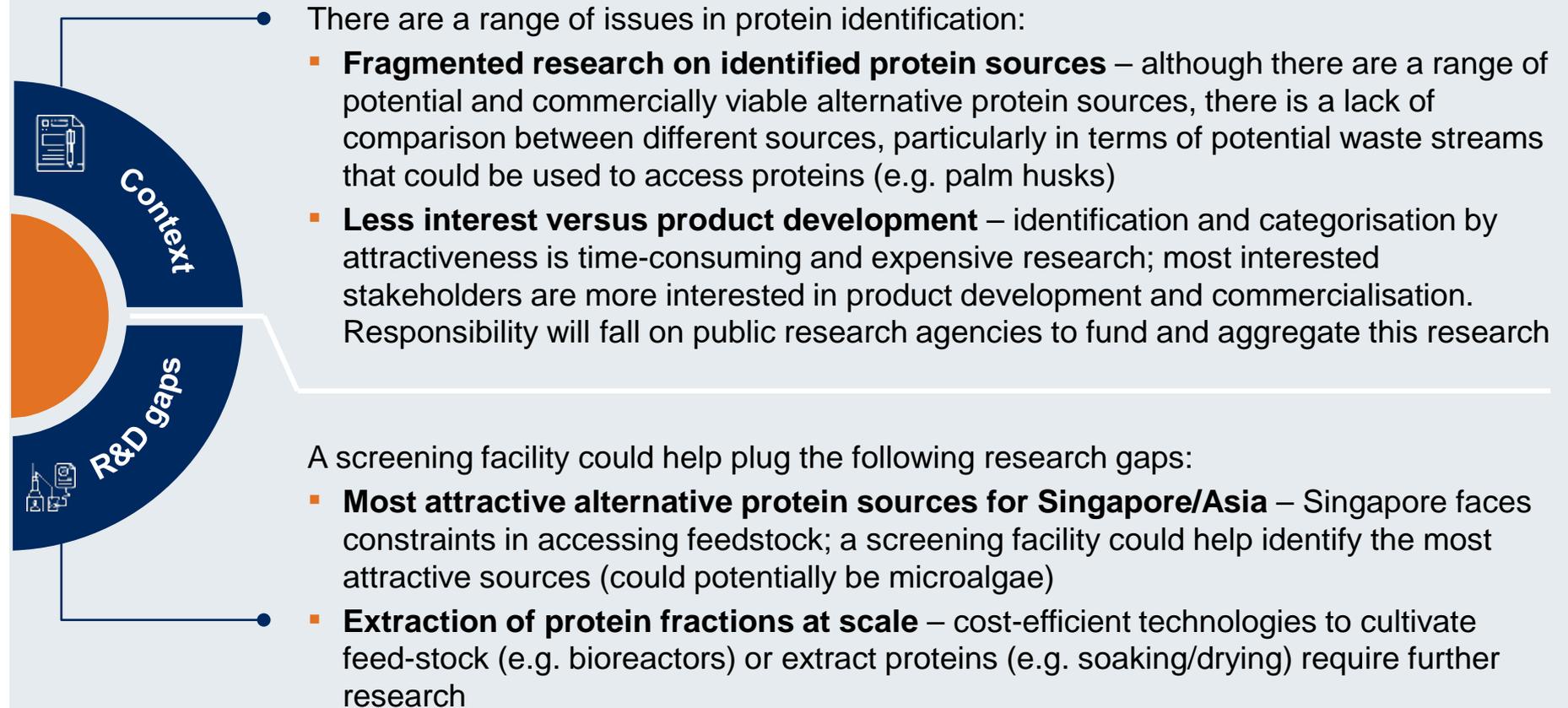
- **Safety testing from an Asian perspective:** CODEX is not exhaustive and does not cover all potential Asian ingredients – opportunity for Singapore to lead development of an Asian standard; also strong opportunity to test impact of such novel foods on the Asian phenotype
- **Align standards internationally:** Singapore's strong trade and political ties with many countries around the world place it in a good position to develop internationally accepted safety standards for novel alternative proteins product (where there is currently none)

3. Protein identification: Systematic evaluation of alternative proteins is needed



PROPOSITION

Singapore should focus on developing a **screening facility for the alternative proteins** identified by the National Product Library (NPL) and those with emerging interest in Singapore/Asia. This screening facility should develop a **database ranking alternative proteins on “attractiveness”** in terms of supply chain accessibility (at scale), sustainability (e.g. carbon emissions or water usage), protein content, basic functional properties, valorisation opportunities after fractionation, etc.



Singapore has the right mix of technology & opportunities to be a regional leader in creating a comprehensive alternative proteins database



STRENGTHS

- **Existing database of proteins:** The National Product Library (NPL) forms a strong knowledge base for Singapore to develop a comprehensive library of alternative proteins
- **Strong trade links:** Singapore has access to a range of potential feedstock through strong and diversified trade ties with many producer countries
- **Industry 4.0 capabilities:** Singapore's capabilities in automation and advanced data processing critical to exploring new technologies to identify novel proteins (e.g. digital phenotyping)

OPPORTUNITIES

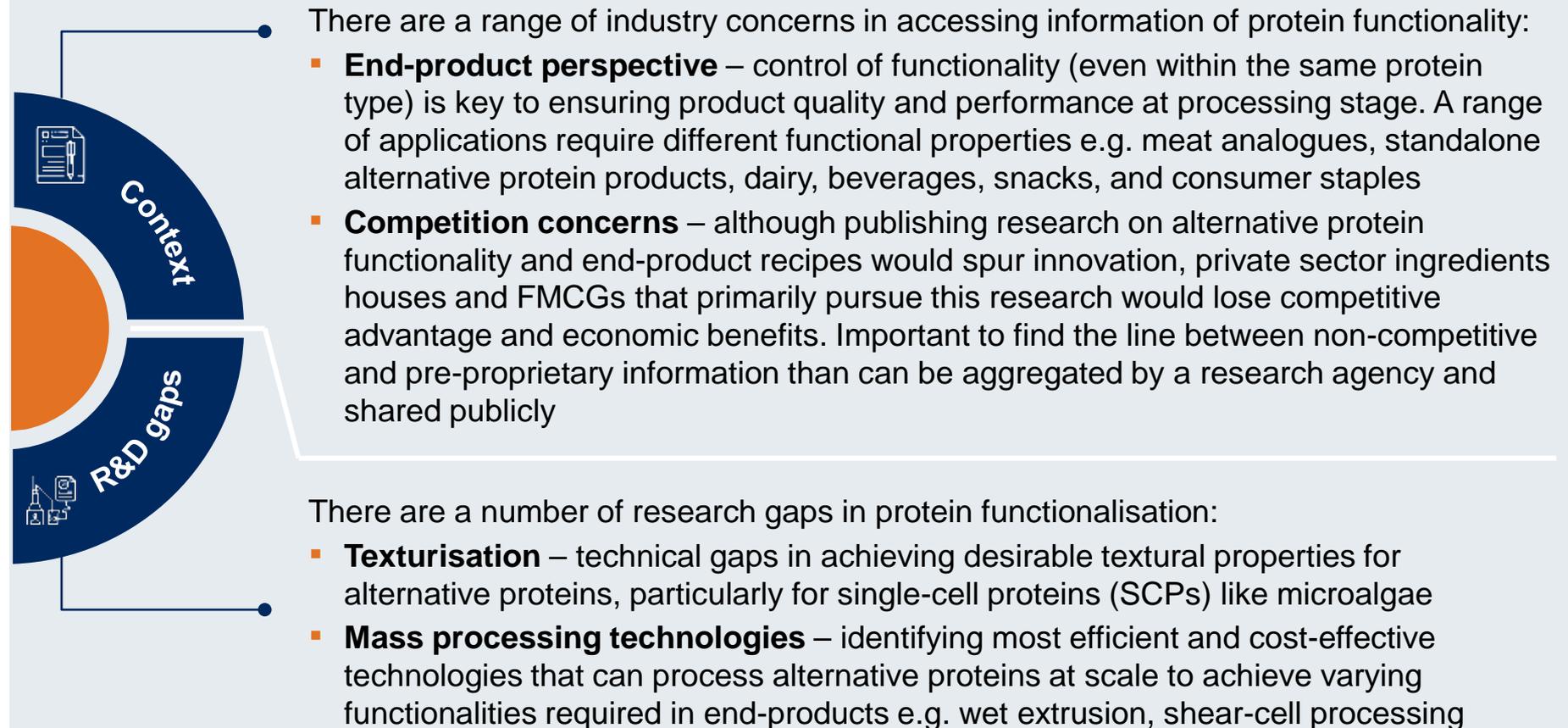
- **Leverage regional biodiversity:** Southeast Asia has rich biodiversity – opens doors for identification of novel protein-rich feedstock
- **Explore circular economy models:** Singapore could take leadership in plugging this key R&D gap – particularly for Asia-specific waste streams (e.g. palm husks)
- **Creation of shared facilities:** Shared research facilities would help reduce costs of equipment and operation across a range of companies/research agencies, also facilitate collaborative efforts



4. Protein functionalisation: A pre-competitive “toolkit” could be developed

PROPOSITION

A*STAR should take the lead in **developing a pre-competitive “toolkit” on functional properties of major alternative proteins** and their application across a range of end-products (with links to nutritional and food safety aspects) to engage with individual companies pursuing alternative protein products. This toolkit can also be developed in collaboration with other countries’ food research agencies.





Singapore must leverage its key strengths to gain a first-mover advantage in developing a knowledge base in protein functionalisation

STRENGTHS

- **R&D facilities:** Singapore has state-of-the-art R&D facilities – A*STAR’s labs can house research on efficient functionalisation and identifying the most efficient processing technologies for production in Singapore
- **Availability of funding:** A mix of government grants and private sector funding available to spur innovation
- **Company network in Singapore:** A strong mix of relevant companies (e.g. ingredients houses, FMCGs, etc.)
- **IP protection framework:** Strong IP laws can help clearly demarcate pre-competitive research

OPPORTUNITIES

- **Develop common knowledge base:** Basic understanding of functional properties and processing technologies for major alternative proteins can be used to support individual companies with product development
- **Pilot test market:** Singapore is a viable pilot test market with a mature consumer base that in which companies can test products for the Asian consumer
- **Collaboration across alternative protein value chain:** Opportunities exist to partner with food manufacturing hubs (e.g. Thailand, which has three wet extrusion facilities)

Contents

1. Background: Singapore Food Story
2. Context: Why alternative proteins?
3. Roundtable event: Programme summary
4. Feedback: Participants' responses
5. Highlights: Synthesis of discussions
6. Next steps: Moving the agenda forward

There are a range of next steps on the alternative proteins action agenda for Singapore

1 Develop industry white paper

- Industry white paper to be developed by A*STAR and partners to deep-dive into R&D gaps identified by theme
- To be released in Q1, 2020 together with industry roadmap

2 Award grants

- A*STAR has announced grant calls for seed funding in research for plant-based proteins, microbial proteins, waste valorisation opportunities, and high-throughput screening platforms together with additional funding for shared infrastructure to be awarded beginning Q1/Q2, 2020

3 Establish alternative proteins committee

- Participants have suggested setting up a research body to pursue common objectives and develop product development toolkits
- A tripartite body is recommended, comprising relevant government institutions and top experts from industry and academia

4 Future roundtable events

- Future events to be held in 2020 – focuses will move on to regulatory concerns and consumer insights
- Heavier focus on VCs, SMEs, and technical experts
- Open to a wider audience of industry players

For more information, please contact:



Agency for
Science, Technology
and Research

Food & Nutrition Cluster

A*STAR

 A-STAR_FNCC@hq.a-star.edu.sg

αlphaβeta
strategy x economics

Shivin Kohli

Consultant, AlphaBeta Singapore

 shivin.kohli@alphabeta.com