

The Rapidly Growing Cultured Proteins Market: Economic Development Opportunities and Challenges in Rural Ontario & Canada

November 29, 2021

Rural Ontario Institute

Brantford, Ontario - Best Western Hotel & Conference Centre

Mark Juhasz, PhD

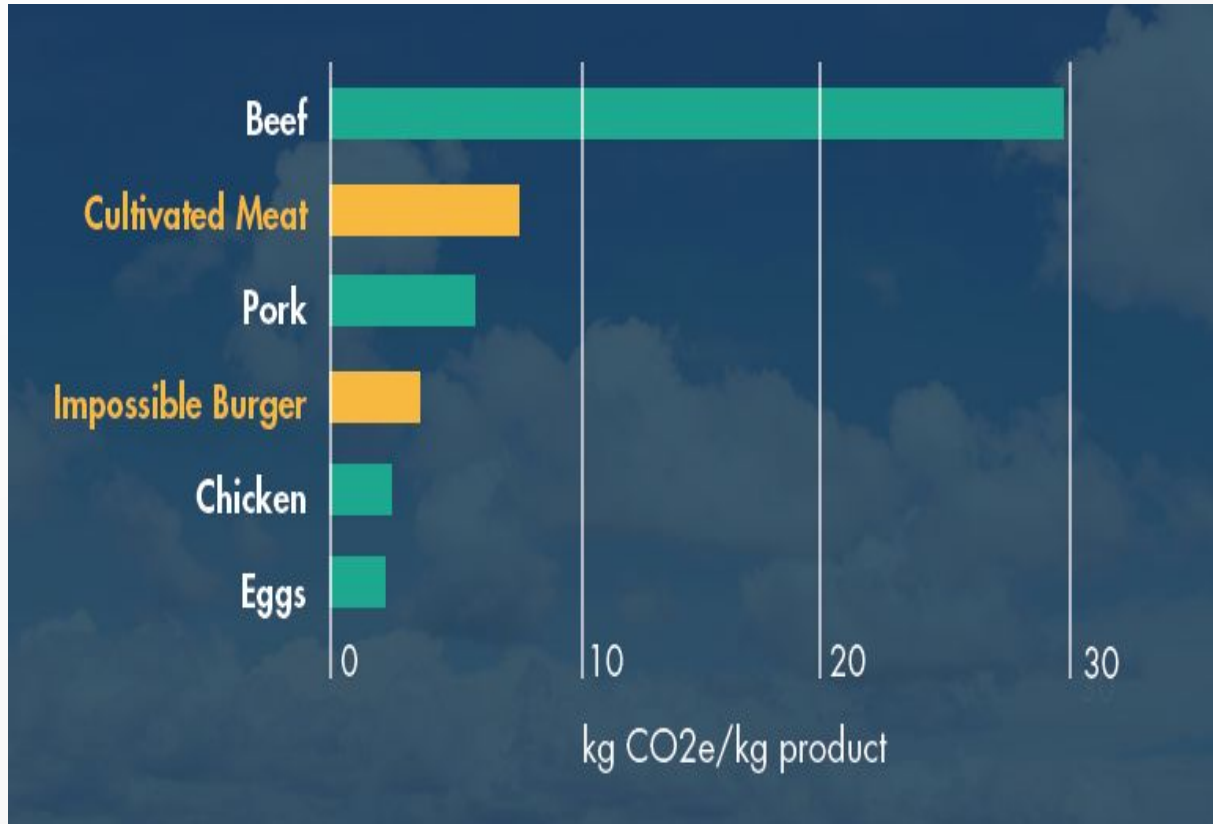
Principal and Founder, Harvest Insights

Proteins: *Contested - Why Now?*

- ▶ Personal health, Ethical perspectives, Planetary health
- ▶ Zoonotic Diseases
- ▶ UN-SDGs - Climate Targets - Biodiversity
- ▶ Earl's Restaurants (buy animal welfare or buy Canadian?)
- ▶ Which source: Beef, Pork, Poultry, Seafood, Fish, Dairy, Plant-based
- ▶ The future of proteins
 - ▶ *A very complex journey*

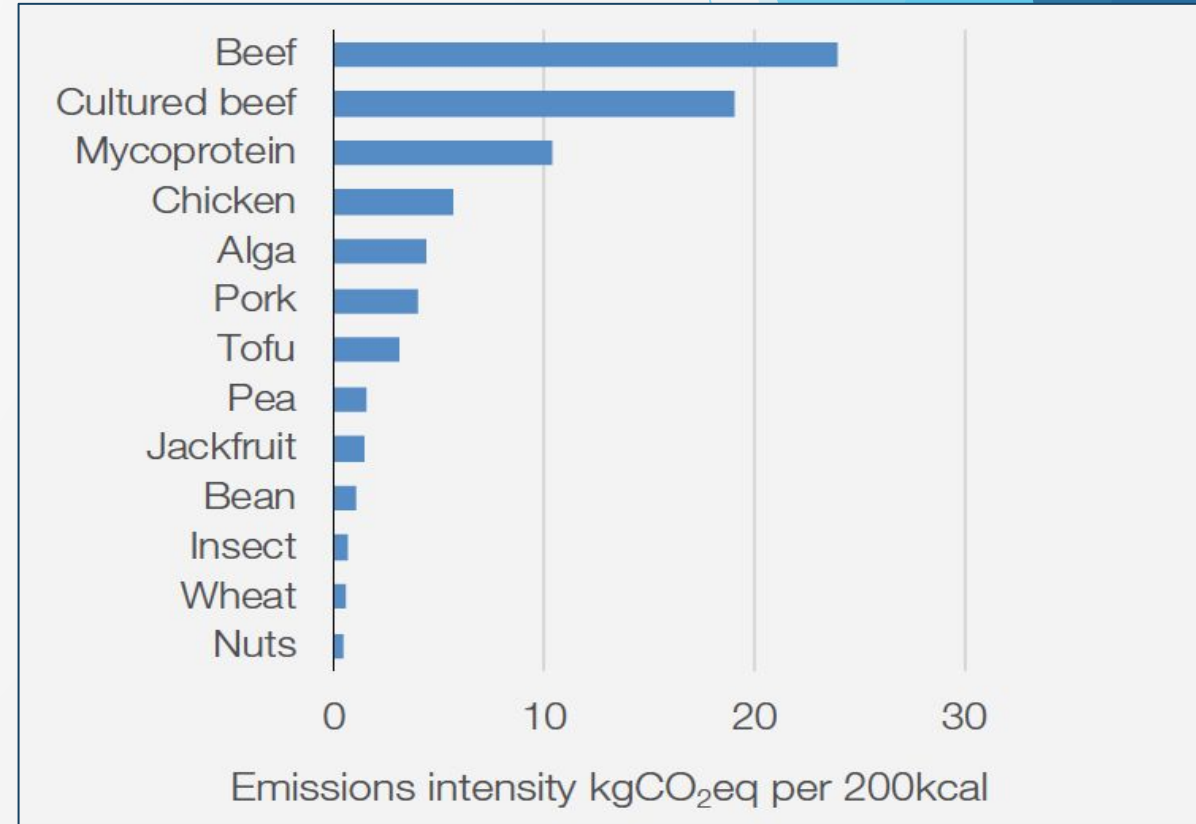
Proteins: *Contested*

Comparing meat sources: CO₂e/kg product



Source: Poore and Nemecek (2018), Rotz et al. (2019), Putnam et al (2017), Pelletier et al (2014), Impossible Foods (2019) - Breakthrough Institute 'The Case for Public Investment in Alternative Proteins Smith et al, 2021

Emission intensity - kgCO₂ eq per 200kcal

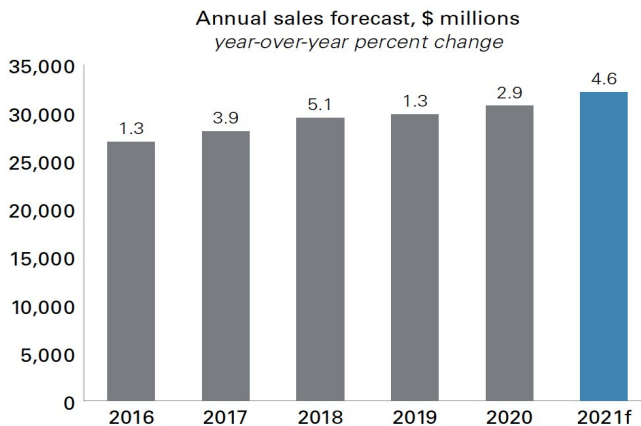


Source: Jan 2019, Meat: The future series: alternative Proteins, White paper, World Economic Forum

Canada's Proteins Landscape: *Beef, Pork, Dairy*

Beef - Meat

Figure E.1: Meat product sales are expected to increase 4.6% in 2021 YoY

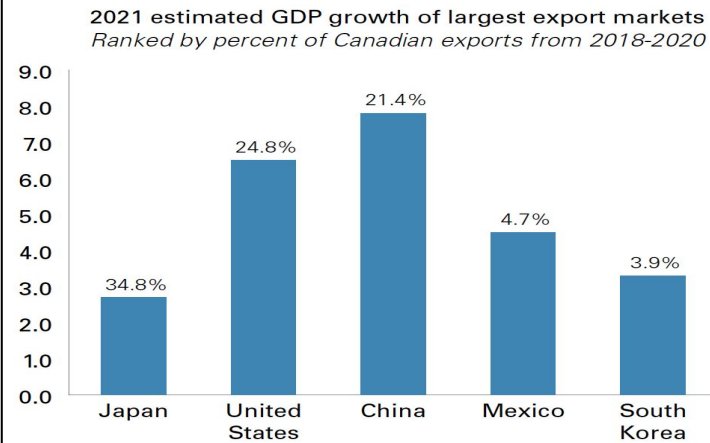


Source: Statistics Canada, Quandl and FCC calculations

- China, Hong Kong, Japan, Mexico strong export markets

Pork

Figure E.3: Asia provides an opportunity for pork exports growth in 2021

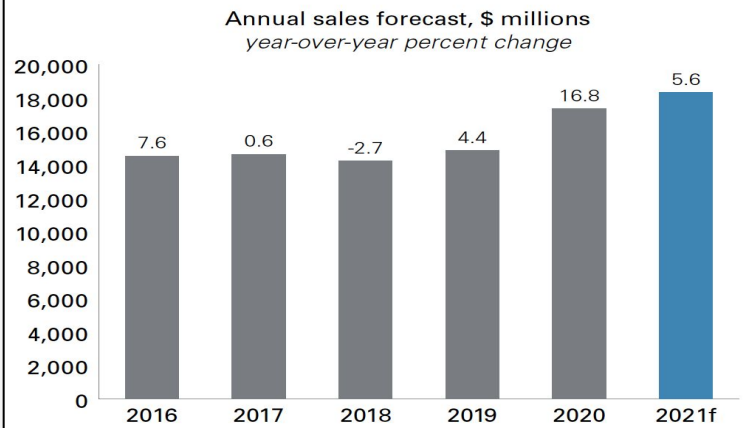


Source: World Bank, IMF, Statistics Canada, U.S. Census Bureau

- Bacon and Sausages selling well
- Asian and US export markets

Dairy

Figure D.1: Dairy product sales expected to increase 5.6% in 2021 YoY



Source: Statistics Canada, Quandl and FCC calculations

- Coffee creamers, ice cream, whipping cream sell well

- Global demand for meat is strong: rising to \$1,200B in sales by 2025, to \$1,800B by 2040.
- FCC: Meat exports up >9%, year-to-date.

Source: Farm Credit Canada, 2021 Market Report - Beef, Pork, Dairy Sales

Canada's Proteins Landscape: *Poultry (Eggs and Chicken meat)*

- ▶ 2020: 1,205 egg farms in Canada (432 in Ontario)
- ▶ 22,100 layer chickens - avg. per farm
- ▶ Fed. quota: # of eggs (2021) = 762 million (dozen) eggs

- ▶ 2,877 chicken farmers in Canada (1,244 in Ontario)
- ▶ 185 chicken meat processors
- ▶ 101,900 jobs - C\$8B to GDP

Source: *Egg Farmers of Canada, 2020 annual report; Chicken Farmers of Canada, 2021, website - Kevin Grier Marketing Analysis and Consulting Inc.; 2018 Economic Impact of the Poultry and Egg Industries, Nov. 2018; StatsCan, Input-Output Model Simulations, 2019-05-22*

Canada's Proteins Landscape: *Seafood and Aquaculture*

Canadian aquaculture

- ▶ Canada over \$2.5B in exports to USA, 2020
- ▶ 250+ Canadian aquaculture companies (16 in Ontario), 2020
- ▶ 90% farmed salmon
- ▶ \$5.2B in total economic activity
- ▶ 21,300 FT jobs

Canadian wild caught fish seafood - 2020-2021

- ▶ Online sales of fish and seafood in the USA tripled to US\$1.1B
- ▶ In 2020 export declines dragged down sales
- ▶ Over C\$5B (est.) in seafood product sales
- ▶ USA and China best for Cdn. export opps
- ▶ Strong demand for frozen and canned

Source: Cdn. Aquaculture Industry Alliance; Industry Canada; StatsCan, RIAS Consulting

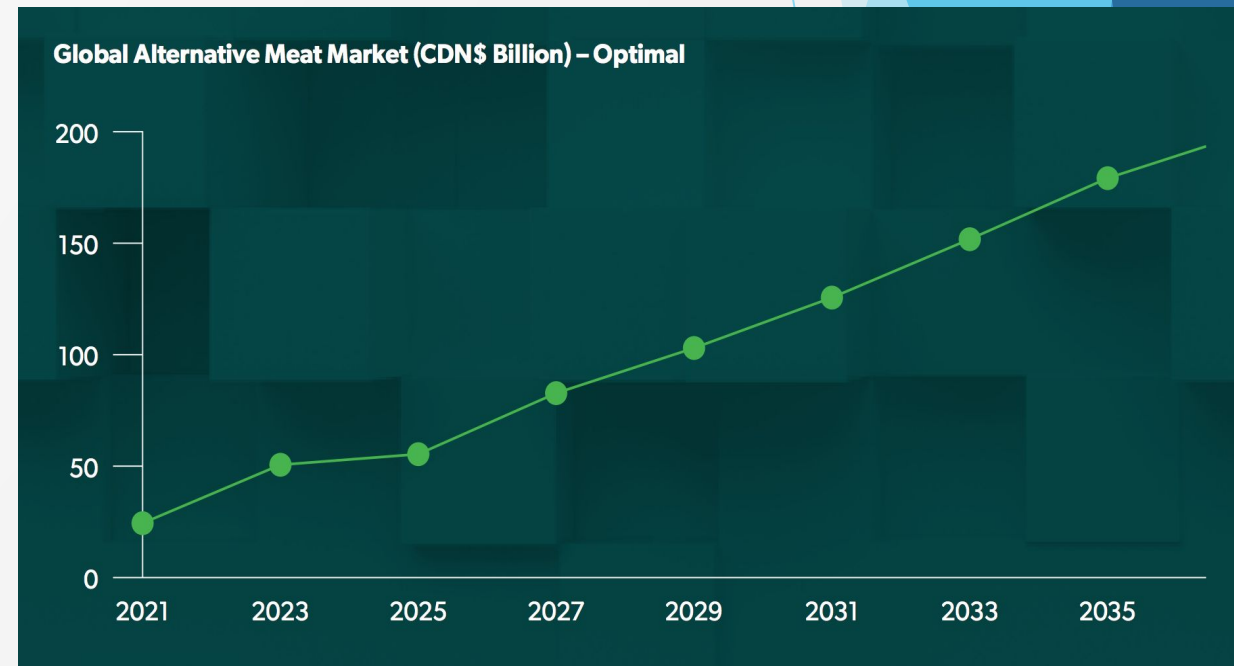
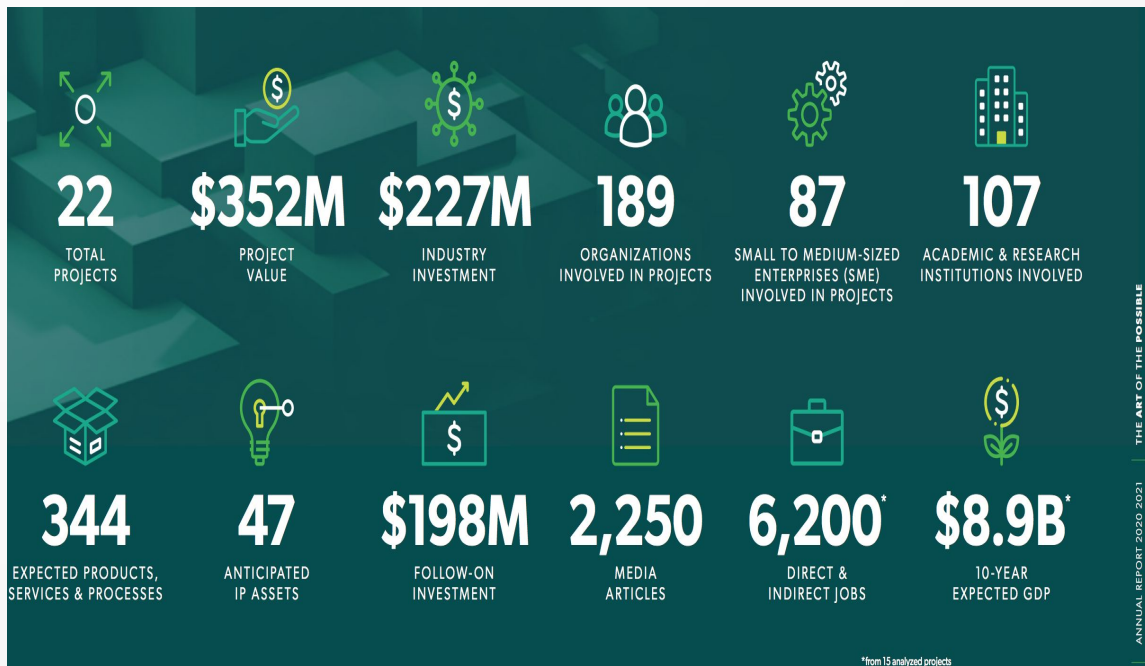
Source: IRI Worldwide, FoodInCanada 2021 Food Industry Report; StatsCan; Farm Credit Canada; Quandi; World Bank; IMF; US Census Bureau; Nielsen

Canada's Proteins Landscape: *Plant-based*

- ▶ Plant-based Foods of Canada (PBFC): plant-based food options will make up a greater portion of shopping choices, and at the close of 2019, worth \$500M, with CAGR 16% (FIC, 2021)

Leading and Emerging Brands

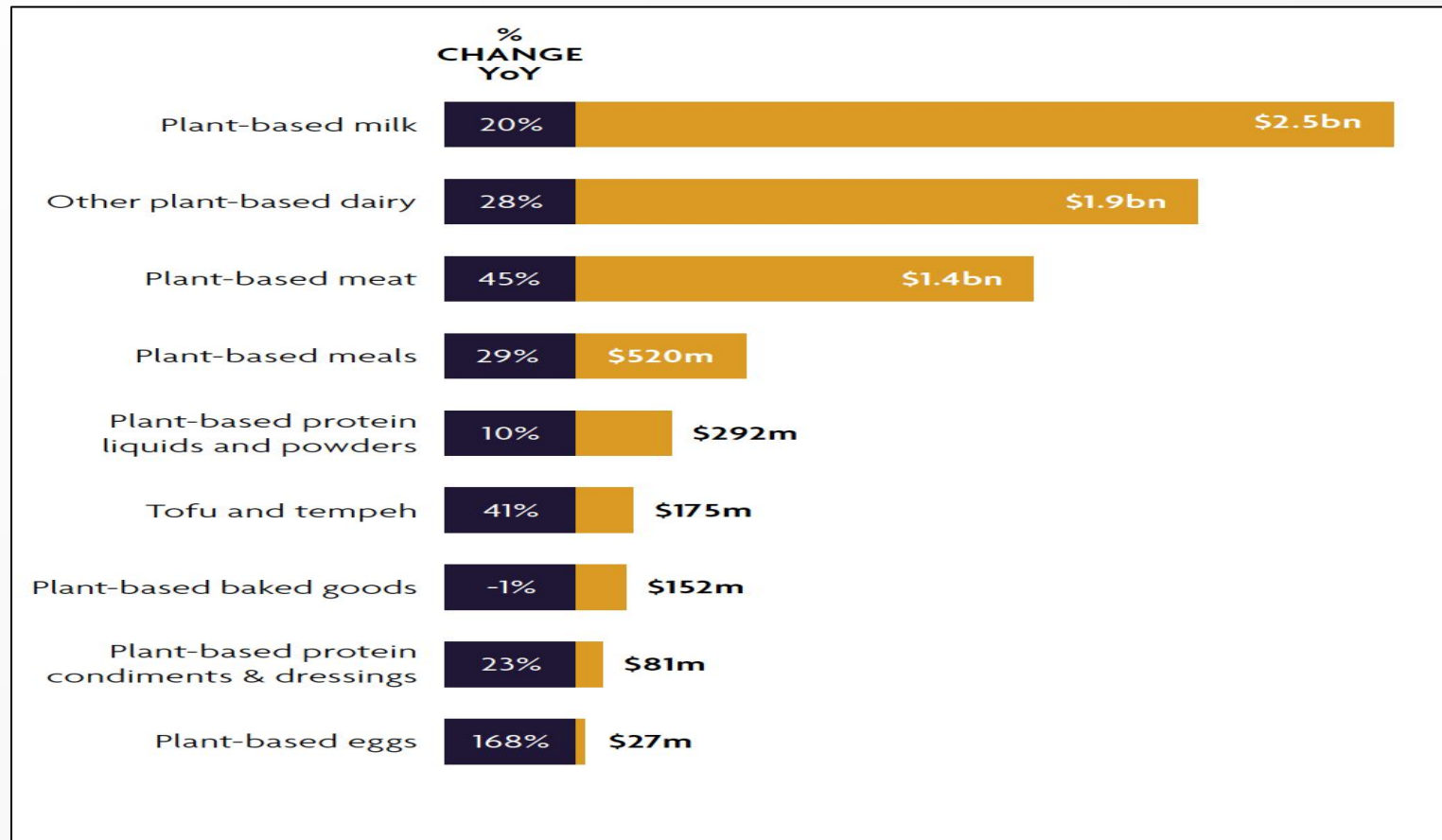
- ▶ *Roquette* | *Verdient Foods (Ingredion)* | *Phyto Organix Foods* | *More Than Protein Ingredients*



Source: Protein Industries Canada

Canada's Proteins Landscape:

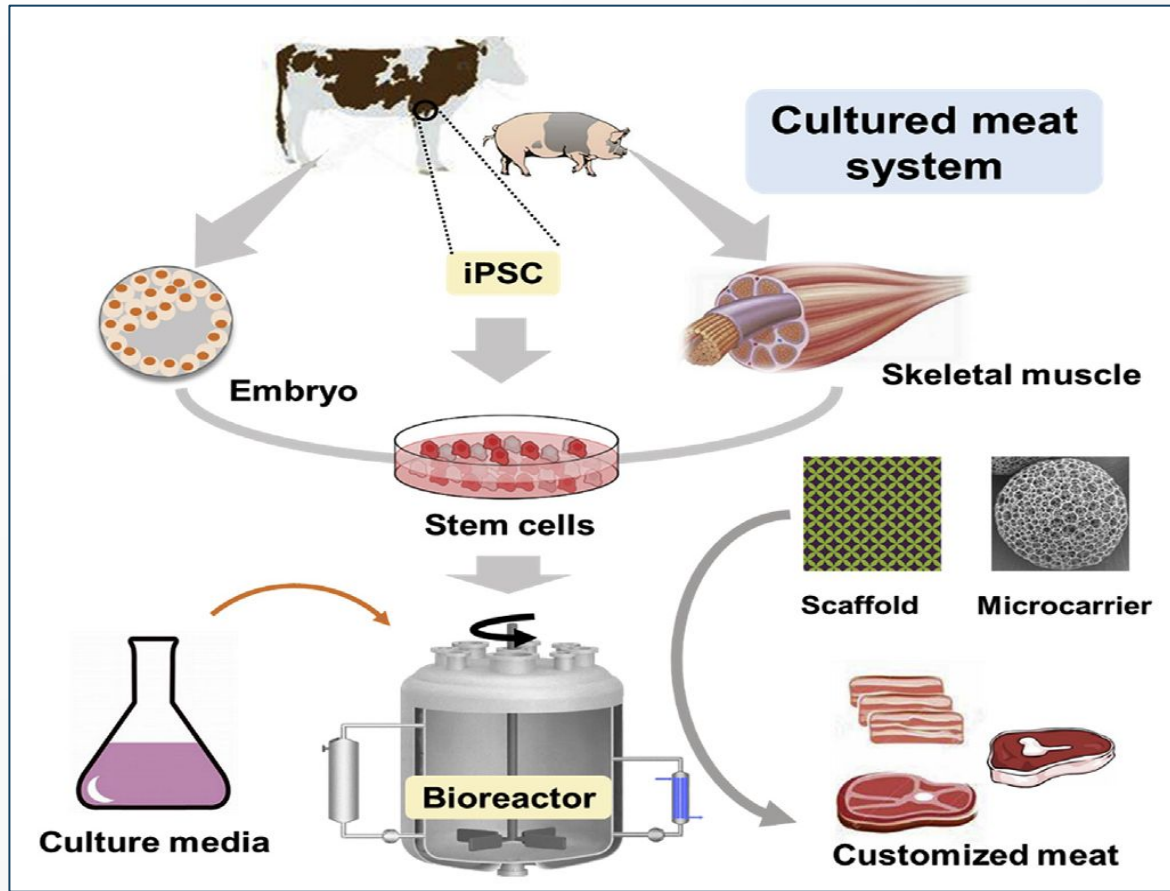
Total US plant-based sales and growth, category, 2020



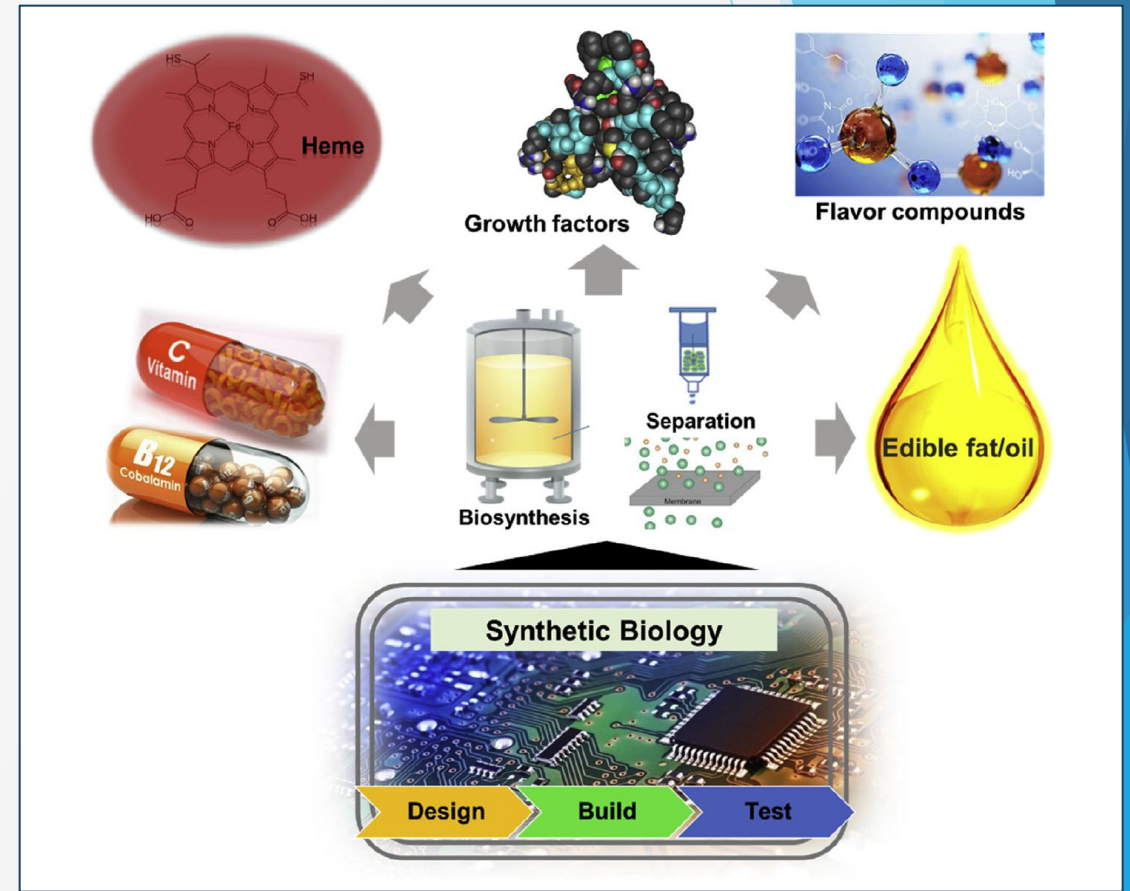
Source: SPINS Natural Enhances Channel, SPINS Conventional Multi Outlet Channel, 52 weeks ending 27-12-2020; The Good Food Institute, 2021; FAIRR: A Collier Initiative - Public Report: Appetite for Disruption: The Last Serving, Sept. 2021

What are Cultured Proteins?

Production flow chart of cultured meat

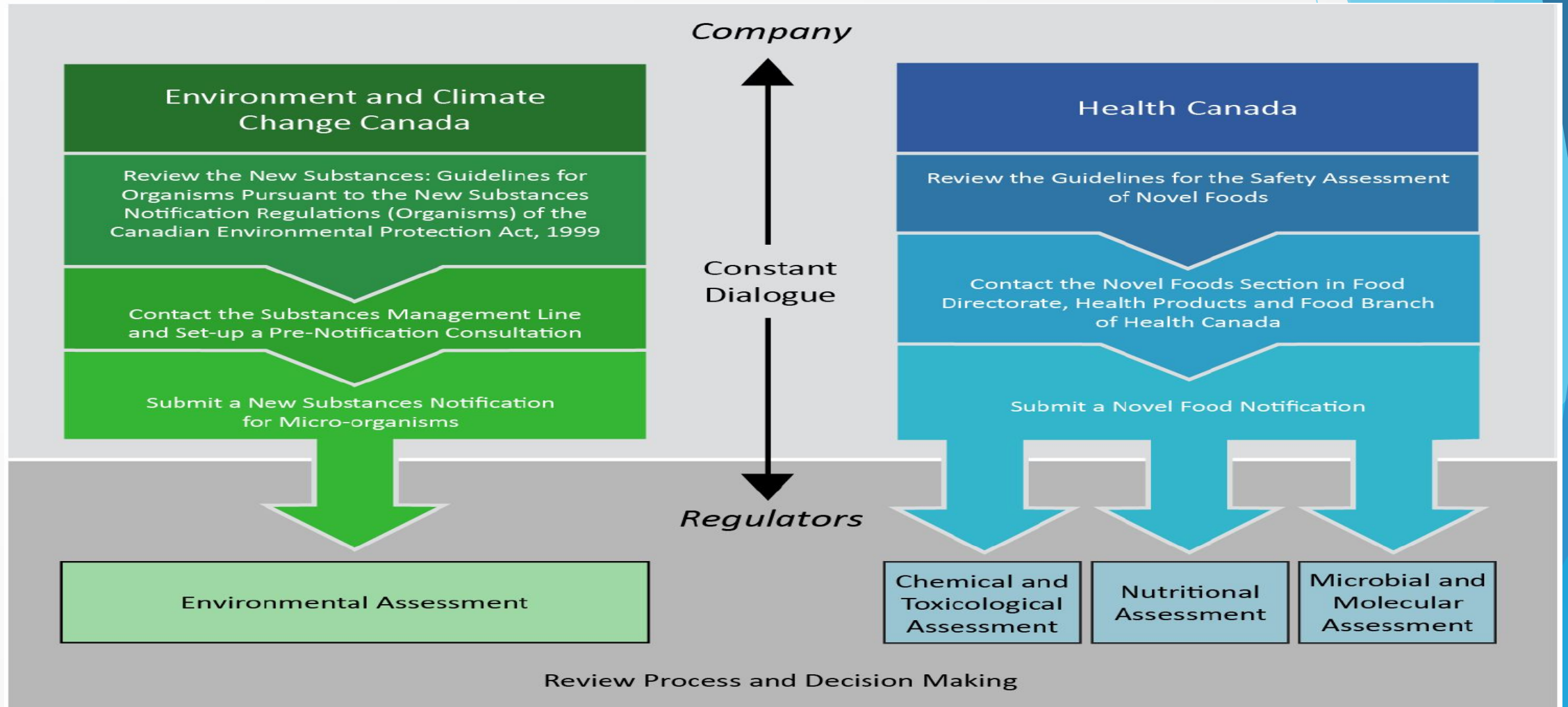


Synthetic biology-based bioengineering applied to cultured meat production and optimization



Source: G. Zhang, et al, Challenges and possibilities of bio-manufacturing cultured meat. *Trends in Food Science & Technology* 97 (2020) 443-450

Regulating Cell Cultured Proteins: *One scenario in advancing a Canadian process*



Source: Cellular Agriculture Canada, Sept 2020. First Steps Towards A Regulatory Framework for Cell Cultured Food Products in Canada - *For companies developing Novel Feeds, the approval process will require safety and environmental assessments conducted by the CFIA

Regulating Cell Cultured Proteins: *Issues for Consideration*

- ▶ Labeling
- ▶ Nomenclature (Cultivated-, cell cultured-, lab-grown, 'meat', 'dairy', 'fish') - EU issues
- ▶ Food safety (ingredients, allergens)
- ▶ USA: FDA (Generally Recognized As Safe) GRAS. Perfect Day's whey protein approval = 10 months
- ▶ USA: *Alliance for Meat, Poultry & Seafood Innovation*
- ▶ Singapore Food Agency - facilitated safety testing and a framework
- ▶ Canada: cell, cultured protein - 'Novel Food' by Health Canada. 'Heme' in Impossible burger was approved in Canada through this process
- ▶ Open Access Research - Public Funding vs. Venture Capital, IP, Patents

The Economics of Cultured Proteins: *How is Big Protein Responding?*

- ▶ Tyson Foods, Maple Leaf Foods, Nestle, Cargill, Kroger, Tesco, Unilever - all investing in alternative protein, and have teams dedicated to new conventional meat alternatives.
- ▶ November, 2021: Brazil's **JBS** - the world's largest meat processor is set to acquire a majority stake in Spanish cultivated meat company, **BioTech Foods** in \$100M investment.

The Economics of Cultured Proteins: *Comparing Proteins*

- ▶ **CanFax Research Services:** beef demand in Canada in 2020 highest (apart from 2016) in over 30 years.
- ▶ Food Business News Report - Nov. 17, 2021,
 - ▶ ‘We’ve seen a big deceleration [in plant-based meats]’ said C. DuBois, SVP of IRI’s protein practice.
 - ▶ ‘In the past 6 months, unexpectedly, there has been a deceleration in the category growth rates of plant-based protein. The more concerning set of facts are rooted in category performance, which has basically flatlined’ said Michael H McCain, president and CEO of Maple Leaf Foods
 - ▶ 2021 Q3: Greenleaf’s sales fell to C\$48M, from C\$51.4M during the same period of the year before.
 - ▶ Beyond Meat missed its Q3 guidance of between \$120-\$140M in sales, reporting \$106M in revenues during the period.
- ▶ CEO of Beyond Meat: fewer consumer trips, less openness to new products, less interest in healthy options, reduced scope due to Delta variant, labour issues, increased category competition.
- ▶ DuBois, IRI: ‘complicated ingredients in meat substitutes’; ‘have yet to see a carbon footprint’

The Economics of Cultured Proteins: *Disruptive Potential*

Both novel vegan meat replacement and cultured meat have disruptive potential

Criteria

Input materials¹

Conversion rate

Product features

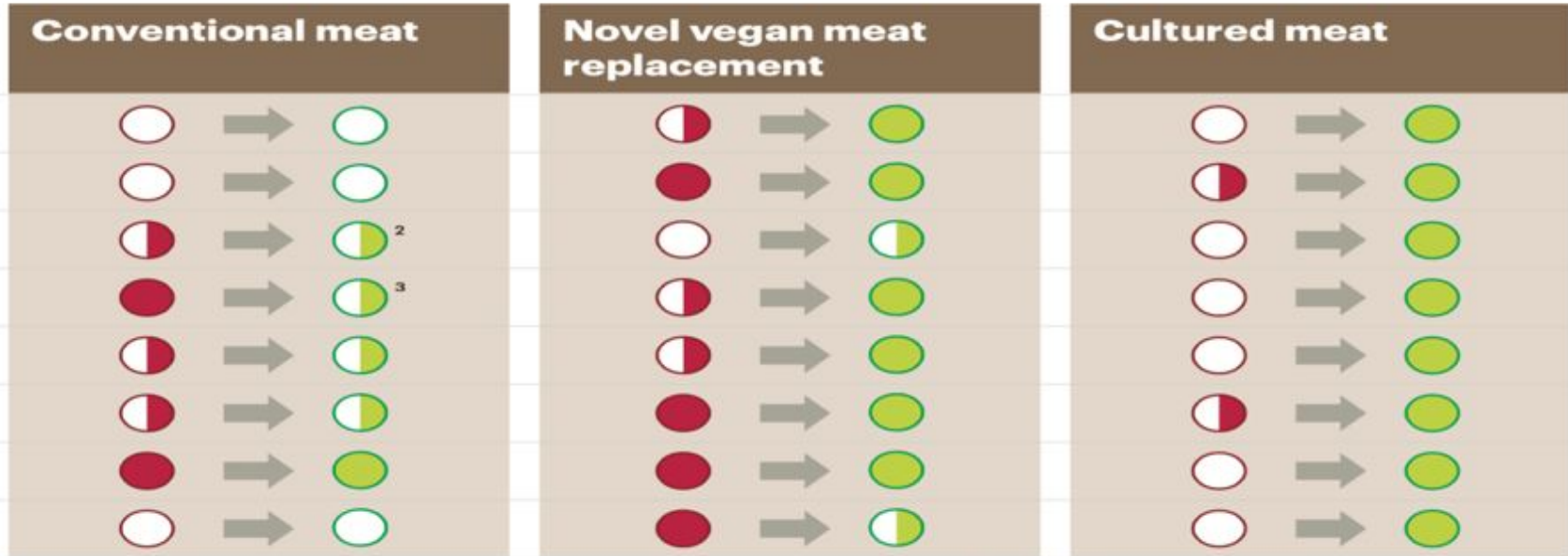
Scalability

Consumer acceptance

Ethics and sustainability

Regulatory approval

Venturing



"As-is" situation (2018): ○ Low ○ Medium ● High

"Estimated" situation (2030): ○ Low ○ Medium ● High

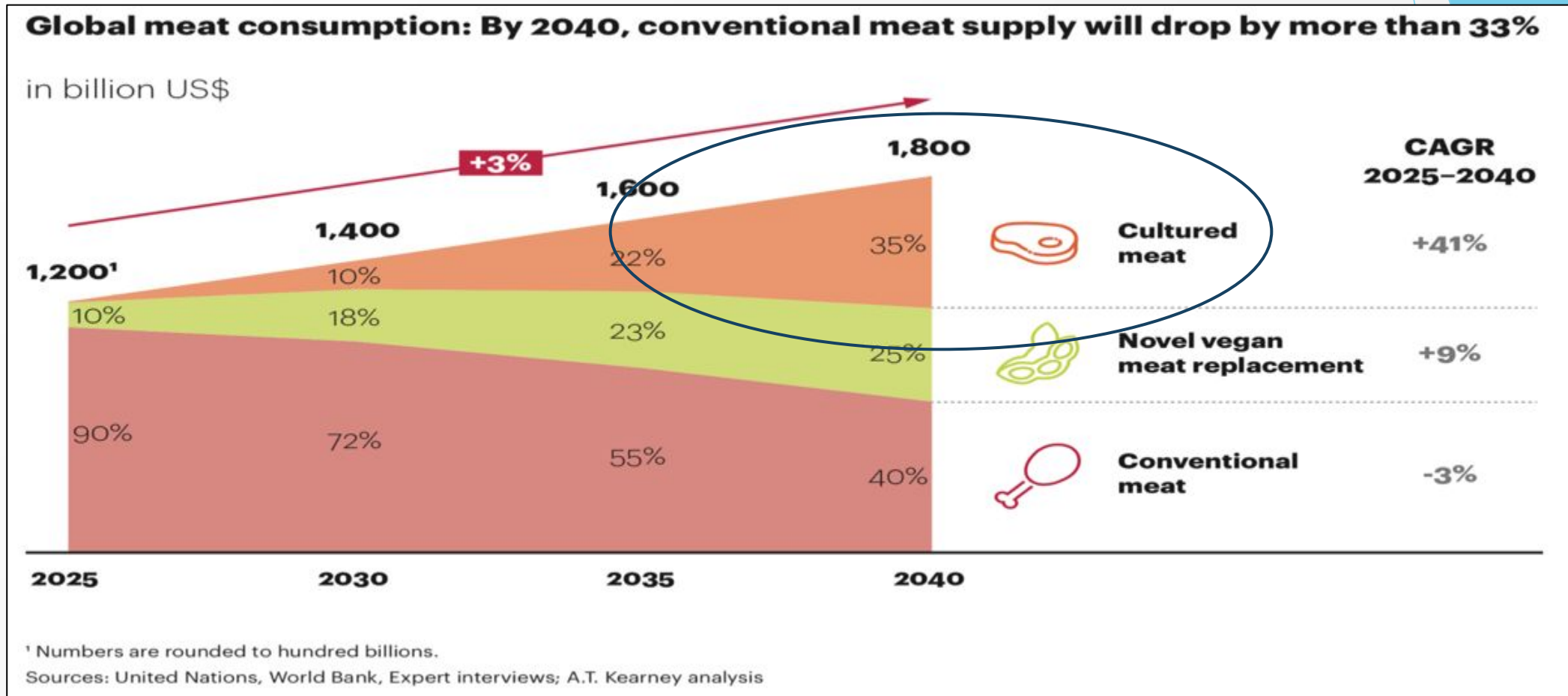
¹ Input materials in terms of "availability"

² In addition to taste, shelf life and customization (for example, muscle-fat-nutrient ratio) have been taken into account.

³ The scalability of meat will decrease due to stronger hygiene regulations and higher quality standards on the part of consumers.

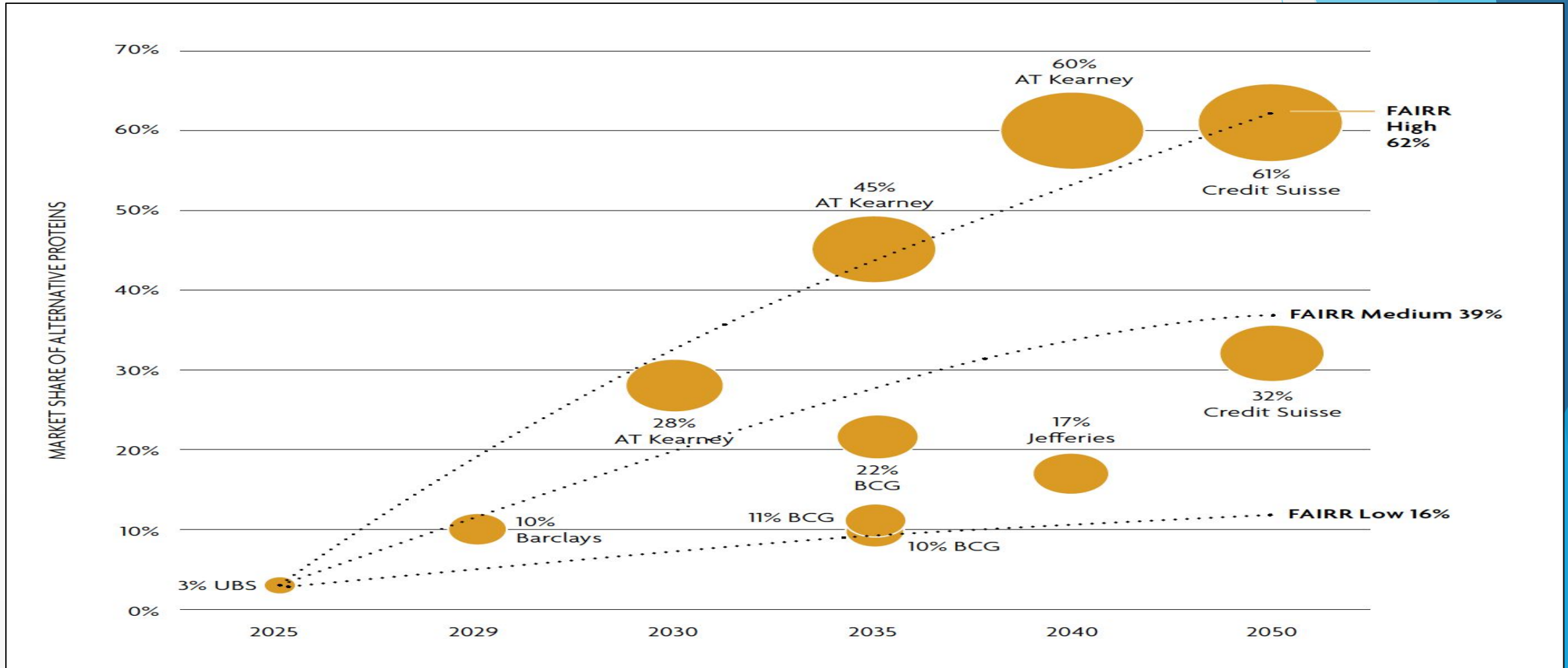
Source: A.T. Kearney analysis

The Economics of Cultured Proteins: Comparing protein sources - 2025, 2030, 2035, 2040



Source: AT Kearney, 2019

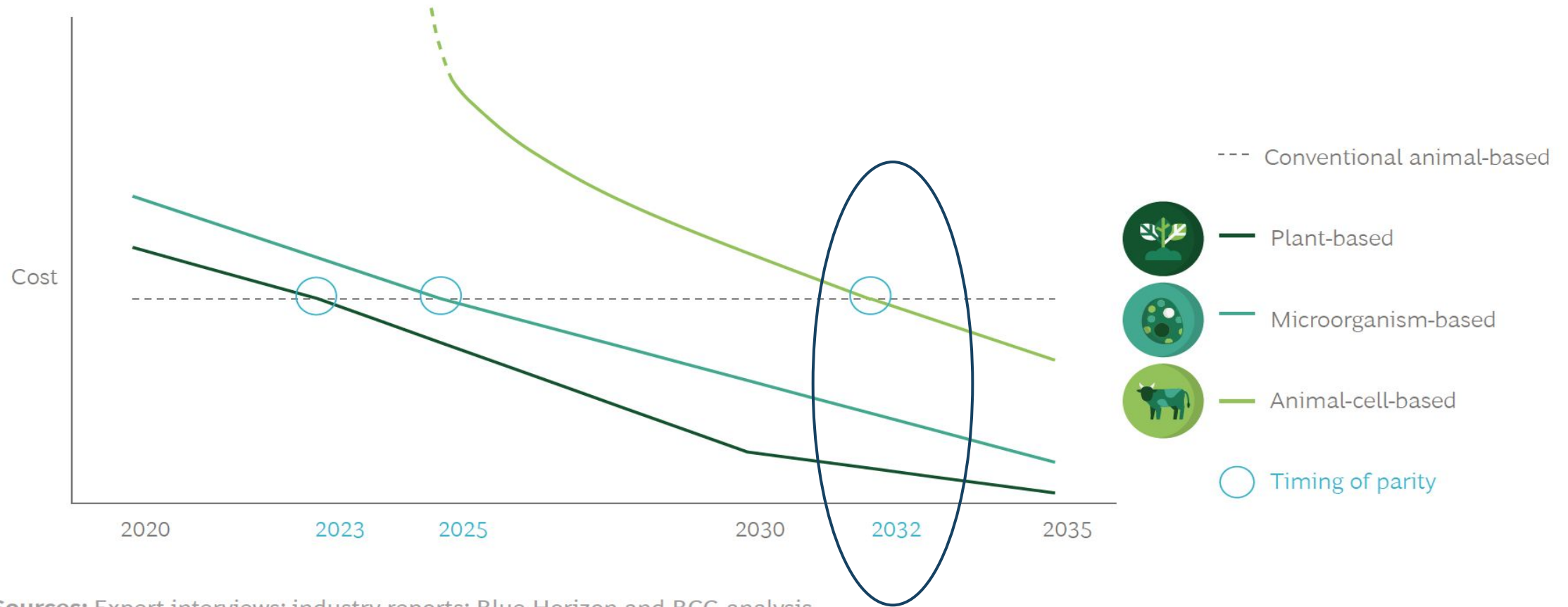
The Economic Growth of Alternative Proteins: *Global growth scenarios - % of protein market 2025-2050*



Source: FAIRR, 2021

The Economics of Cultured Proteins: *Price Parity in the Next Decade?*

Relative timing of cost parity for alternative proteins with realistic taste and texture¹

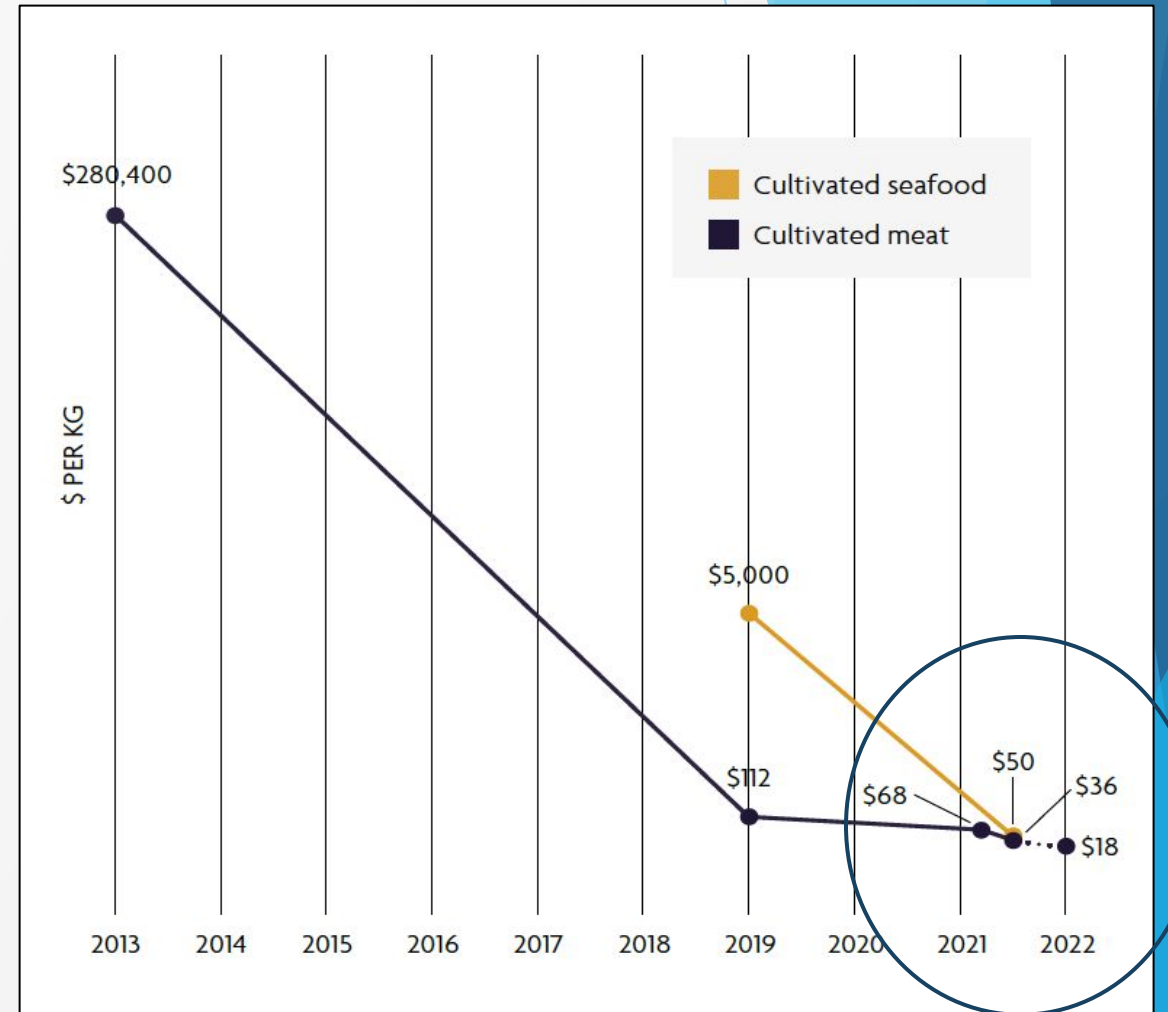


Sources: Expert interviews; industry reports; Blue Horizon and BCG analysis.

¹Illustrative data for US and EU; variations by product group and geographic area are omitted for clarity.

The Economics of Cultured Proteins: *Price Parity*

- (continuous) Actual production costs of cultivated meat & cultivated seafood from 2013 -Q2 2021
- (dotted) Forecast of cultivated meat cost in 2022 (\$/kg)

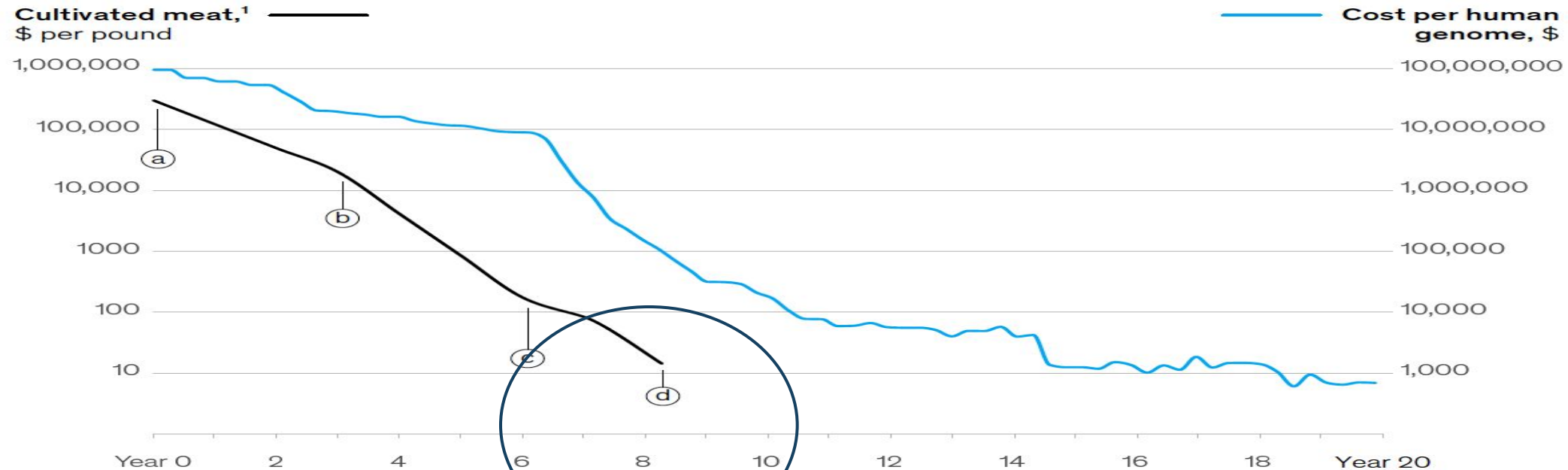


Source: FAIRR, 2021

The Economics of Cultured Proteins (CP): *Cost evolution: CP + Genome Sequencing*

The cost of cultivated meat has come down at an even faster rate than another well-known biotechnology—genome sequencing.

Comparative cost of changing technologies (logarithmic scale)



a 2013: Dutch scientist developed and produced first cultivated meat at ~\$300,000 a burger²

b 2016: Memphis Meats produced a “cultivated meatball” for ~\$20,000/lb

c 2019: Future Meat Technologies reduced production costs of chicken to \$150/lb and beef to \$200/lb

d 2021: Future Meat Technologies announced it produced a 4 oz chicken breast at \$4 (with mixed plant protein)

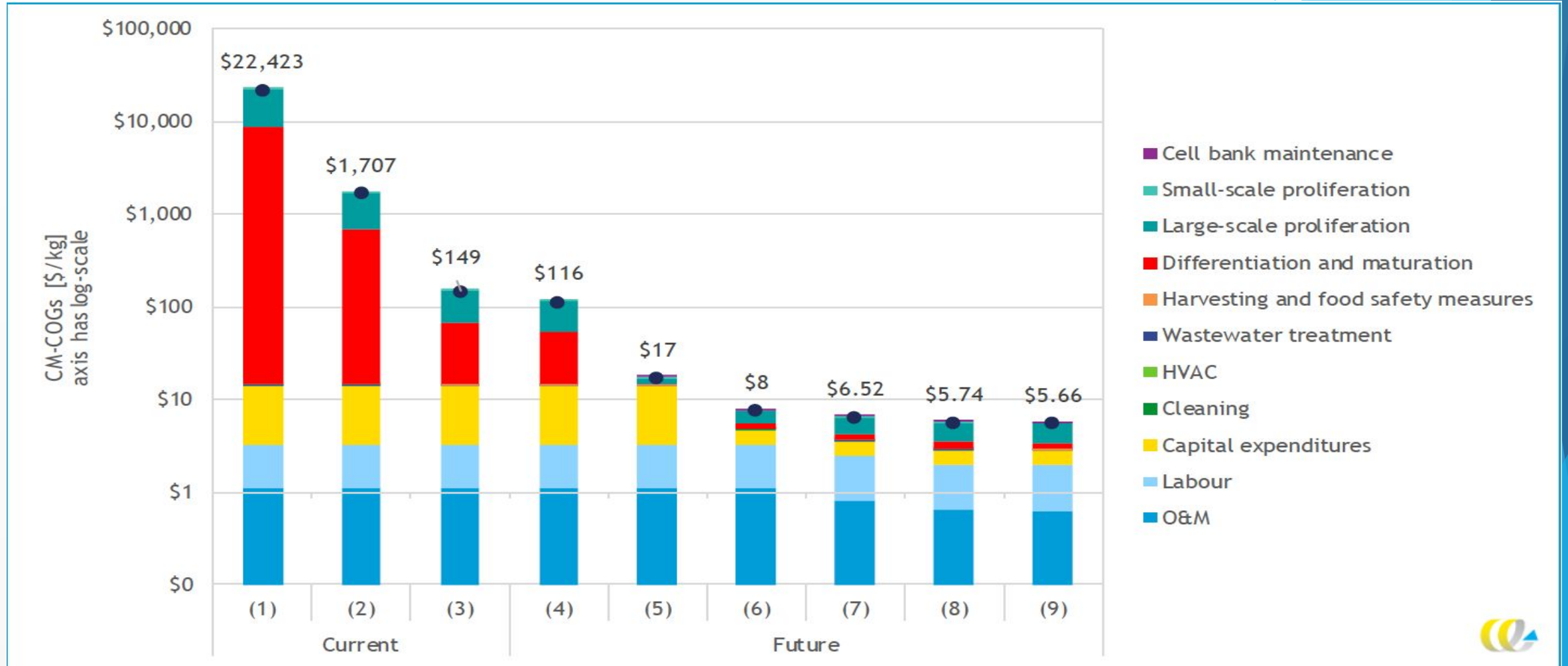
¹Cultivated-meat curve smoothed out to show straight line between key data points. Cultivated meat year 0 = 2013; Human genome year 0 = 2001.

²Based on €250,000 cost; however, Mosa Meat CEO Maarten Bosch has shared in an interview that the real number is “a bit higher.”

Source: National Human Genome Research Institute; press search

The Economics of Cultured Proteins:

Cost of Goods Sold modeling (\$/kg of cultured meat)



Source: Vergeer, R., P, Sinke, I. Odegard. 2021. Techno-economic assessment (TEA) of cultivated meat. Future Projections of different scenarios, CE Delft, Netherlands

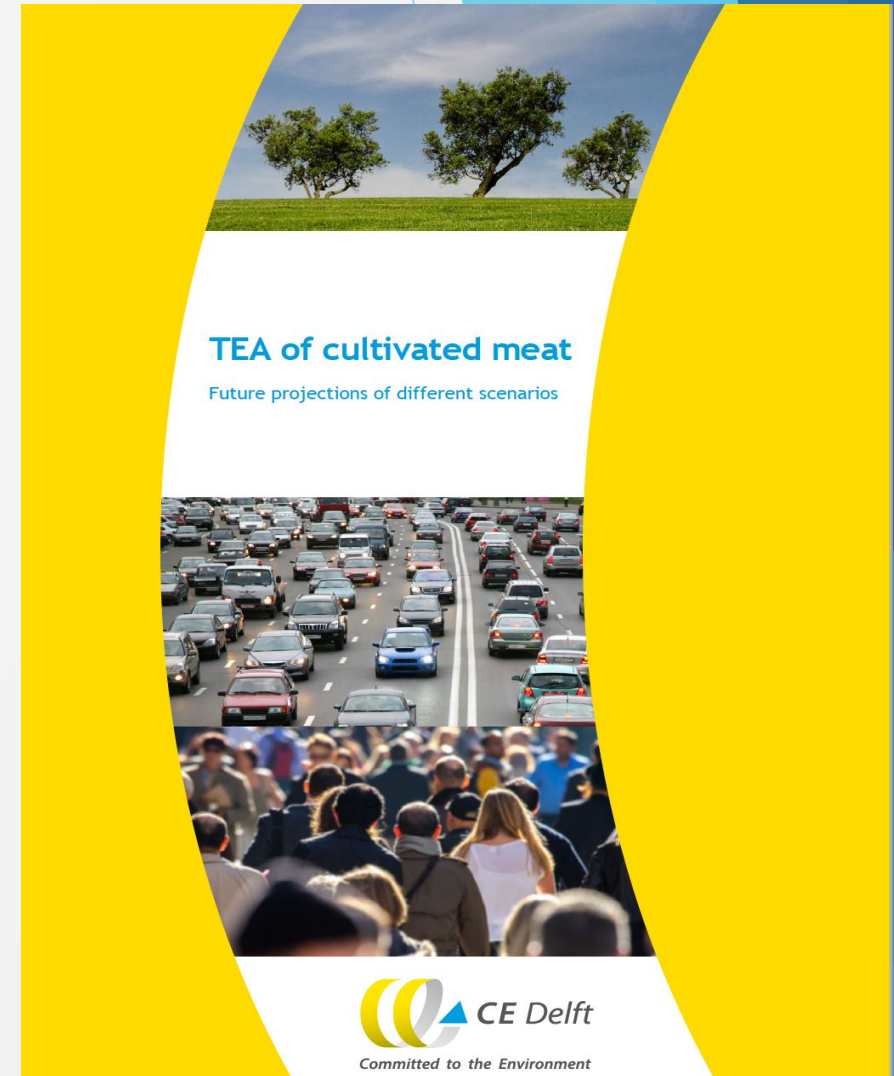
The Economics of Cultured Proteins: *TEA + LCA - CE Delft*

Aspects that stand out:

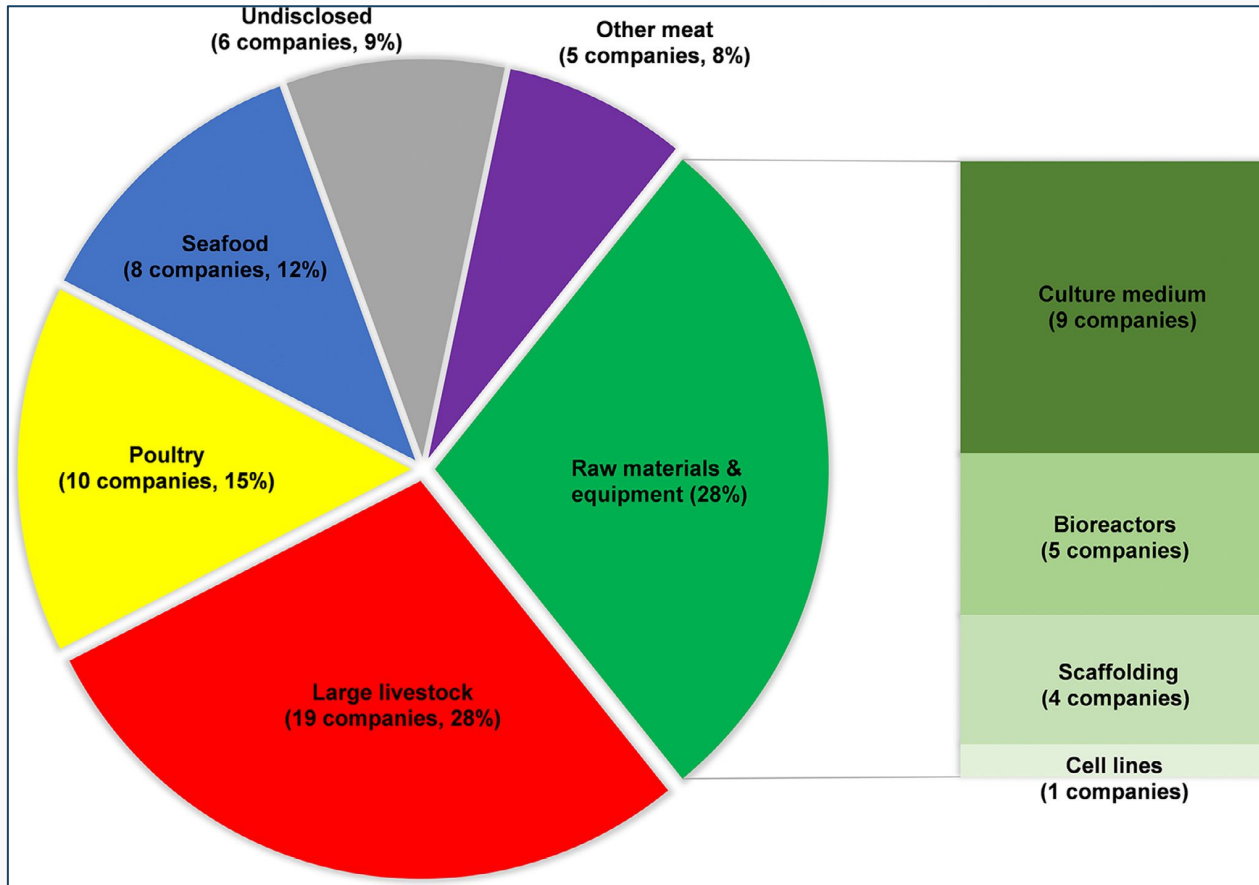
- ▶ Energy efficiency
- ▶ Energy sources
- ▶ Medium Use
- ▶ Supply chain collaboration

Considerations:

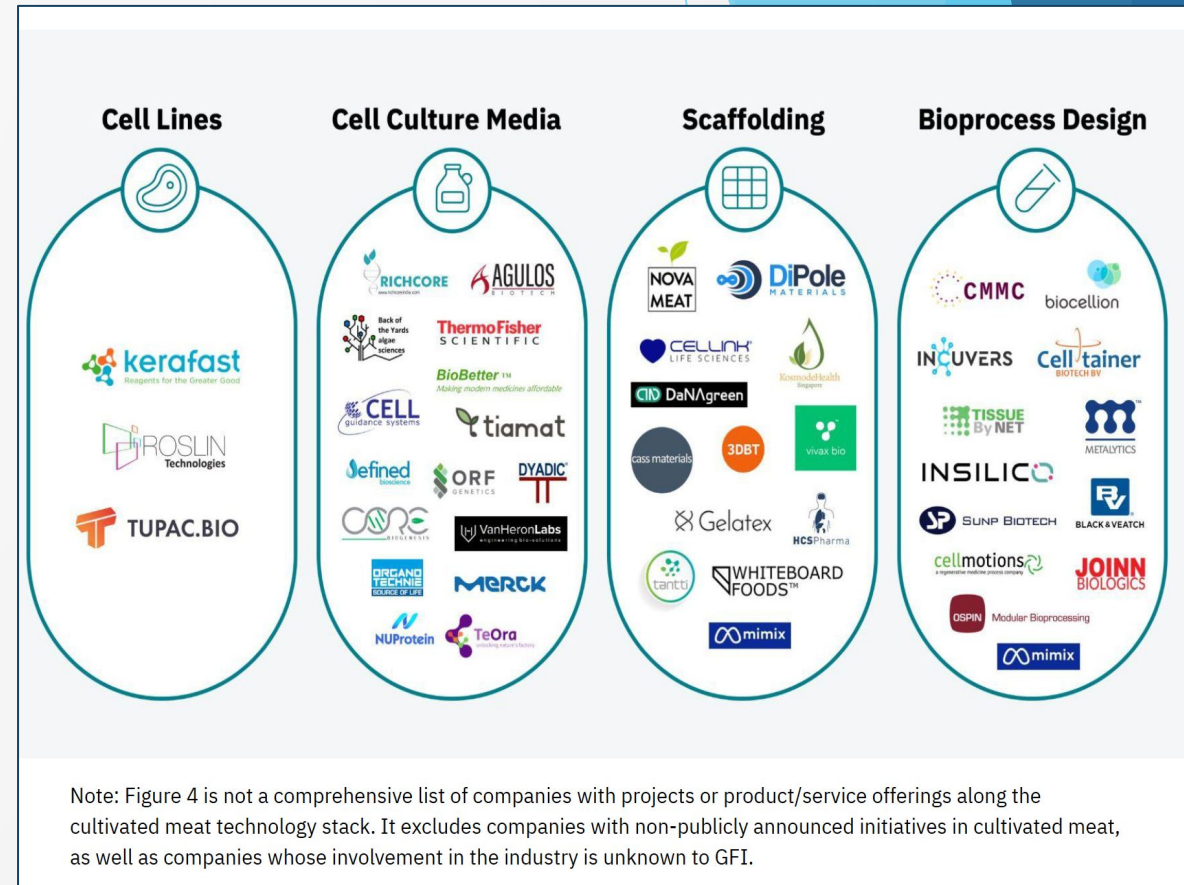
- ▶ Future culture media production costs
- ▶ Major steps to reduce production costs
- ▶ Improve the production process and favourable choices in cell types
- ▶ Generate or invest in renewable electricity



The Economics of Cultured Proteins: *Specialization and primary product/service*























Source: GFI, 2021; X. Guan, Q. Lei, Q. Yan et al, Trends and ideas in technology, regulation and public acceptance of cultured meat, *Future Foods* 3 (2021) 100032



Source: Good Food Institute, 2021

Category Innovations in Cultured Proteins: *Chicken*

Company	Amount Raised (USD million)	Plant-Based / Cultivated	Chicken Product Offered?
Impossible Foods	1,500		
LIVEKINDLY	535		
NotCo*	350		
Beyond Meat**	122		
Green Monday	70		
GOOD Meat***	170		
Upside Foods	211		
Aleph Farms	118		
Mosa Meat	95		
Meatable	60		

Of the top funded plant-based and cell cultured meat companies, *half offer chicken products.*

NotCo* announced the launch of a plant-based chicken product by the end of 2021.

Source: FAIRR, 2021. ** this only includes Beyond Meat’s private funding prior it. Its public listing on NASDAQ, ***Good Meat is the cultivated Meat subsidiary of Eat Just. This Figure only reflects the funding For Good Meat.

Category Innovations in Cultured Proteins: *Seafood*

BlueNalu Mission:

to develop great-tasting, healthy, safe and trusted cell-cultured seafood products that support the sustainability and diversity of our ocean.



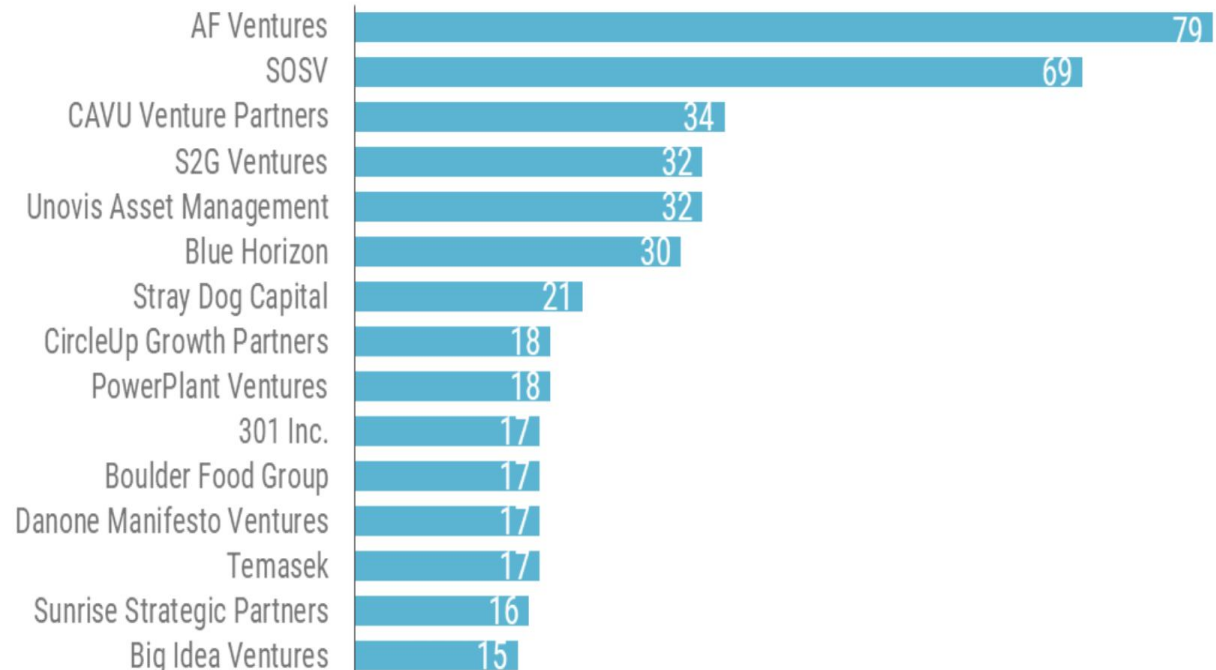
BlueNalu's whole-muscle, cell-cultured yellowtail prepared in a poke bowl

Financing Cultured Proteins: *Venture Capital and Private Equity*

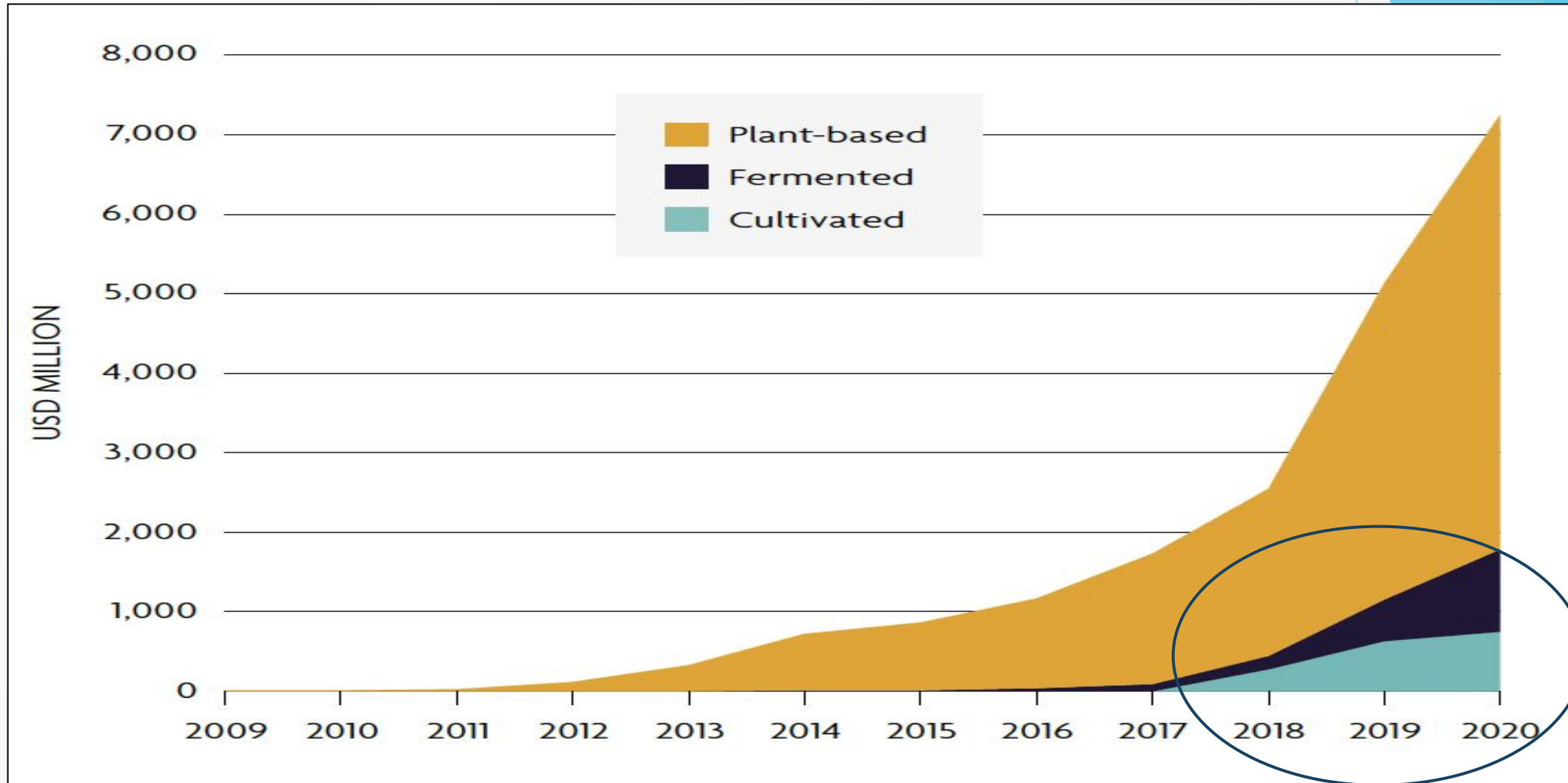
- ▶ Venture capital leading investments in cultured proteins.
- ▶ Celebrities investors: Leonardo DiCaprio, Ashton Kutcher, Bill Gates, and Richard Branson
- ▶ CPPIB, and OTPP are investors
- ▶ In 2019, US-based Big Idea Ventures launched its New Protein Fund
- ▶ Cdn. Investor firm, *Eat Beyond Global* focused on conventional protein alternatives

Top investors in food & beverage

By unique deals, 2016 - 2020



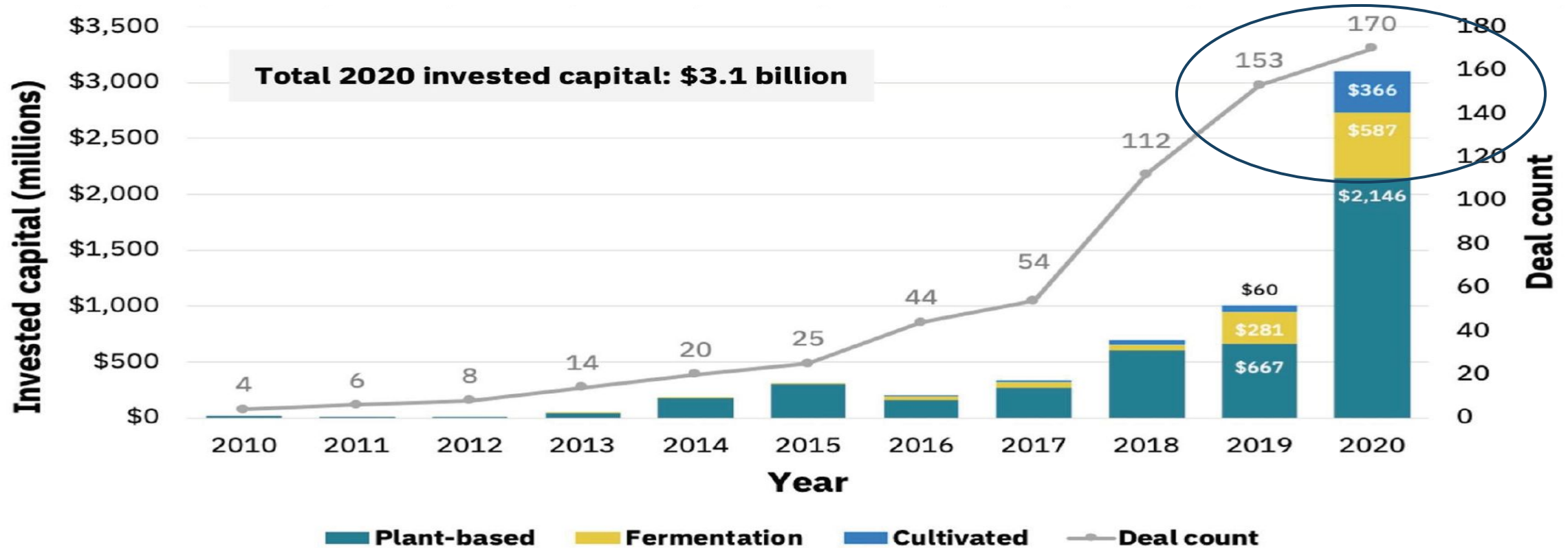
Financing Cultured Proteins 2010-2020: *Growth in private investment in alternative proteins*



Source: FAIRR, 2021

Financing Cultured Proteins:

The rapid rise of cultivated meat investments - 2019-2020



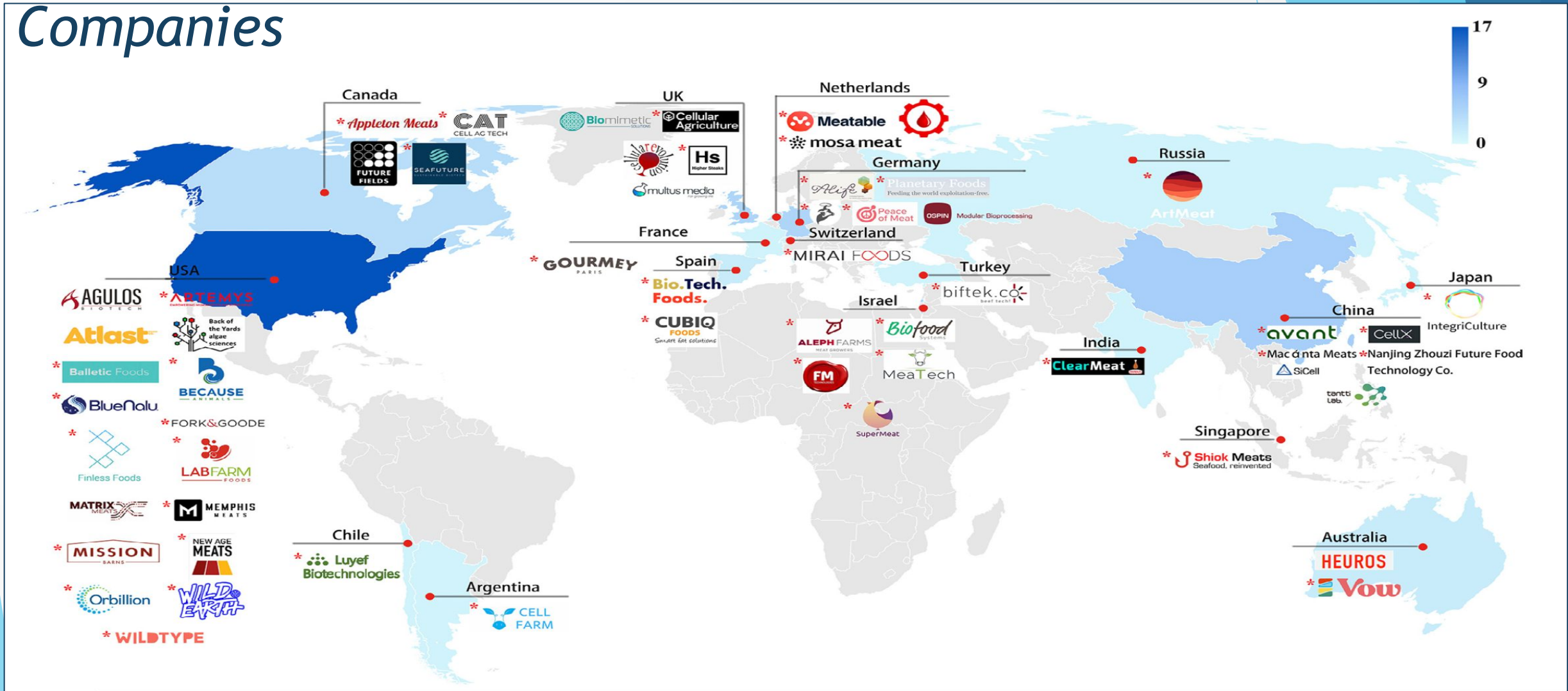
Source: GFI analysis of Pitchbook data. Note: Data has not been reviewed by PitchBook analysts

Cultured Protein Start-ups and Accelerators: *Recent Financing by Canadian Investors*

Company	Country	Year	Investment (million USD)	Notes
Perfect Day	US	2020	300	Series C round, Canada Pension Plan Investment Board (CPPIB) was lead investor with \$50M
	US	2021	350	Series D round, co-led by Temasek and CPPIB.
Upside Foods	US	2021	161	Series B round, previous investments included Builders VC, who have offices in Calgary
Mosa Meat	NLD	2021	85	Series B round, which included Toronto-based venture capital firm ArcTern Ventures
Motif FoodWorks	US	2021	226	Series B round led by Ontario Teachers' Pension Plan Board and including Wittington Ventures, based in Toronto
Eat Just, Turtle Tree Labs, Sing Cell	US, Singapore		Not available	Eat Beyond, a Vancouver-based venture capital firm, is focused on alternative proteins
Avant Meats	Hong Kong	2020	3.1	Seed round, Loyal VC, who have offices in Toronto
Eat Just, Biftek, Mogale Meats, Novel Farms Inc., MeliBio, Inc., CELL AG TECH	US, South Africa, Turkey, Canada	2021	Not available	CULT Food Science, an investment platform based in Vancouver, is focused on "lab-grown food" and has invested in Canadian cultivated seafood company CELL AG TECH

Source: Ontario Genomics, 2021. 'Cellular Agriculture: Canada's \$12.5 Billion Opportunity in Food Innovation

Innovation and Economic Development: Geographic Distribution of Cell cultured Proteins Companies



Innovation and Economic Development: Switzerland's FoodTech & Cell Cultured Protein Ecosystem

Ecosystem of Partners*

- Highly competitive FoodTech Hub with strong ecosystem partners
- Home to global leading food & nutrition companies
- Dedicated R&D landscape and world leading universities
- Great platforms and foundations for growth

*The report includes all active FoodTech players over the last 18 months. Please note that for governmental organizations and associations, players on national level were included and also represent their respective sections on a cantonal level.

**ETH Zurich includes two different research centers

7 Governmental Organizations



19 Corporates



26 Investors



11 Academia



17 Incubators & Accelerators



18 Food Associations



6 Research Center*



& more...



Innovation and Economic Development: Israel's FoodTech & Cell Cultured Protein

Ecosystem

ISRAELI FOODTECH INNOVATION - 2021

200 ISRAELI FOOD START-UPS ARE COOKING UP SOLUTIONS FOR HIGHER QUALITY, HEALTHIER AND MORE SUSTAINABLE FOOD, AND OTHER CULINARY INNOVATIONS

ALTERNATIVE PROTEIN
FERMENTATION & CELL CULTIVATION

PLANT-BASED

HEALTHY INGREDIENTS

PROTEIN-MASS

SAFETY & QUALITY

PACKAGING SOLUTIONS



The Kitchen
FoodTech Hub
by Shavei

The Kitchen FoodTech Hub is a technological incubator providing seed funding, mentorship, industry connections, and a full set of operational services to early-stage ventures operating in all areas of the food and beverage value chain.

GREENSOIL INVESTMENTS

With offices in Raanana and Toronto, and \$100m under management, GreenSoil Investments funds companies in the agro & food technologies and building innovation sectors. Founded in 2011, GreenSoil's agro & food technologies fund has a portfolio of 6 promising companies and is the largest dedicated fund in this space in Israel.

HEALTH & WELLNESS

PRODUCTS

TECHNOLOGY

RETAIL & RESTAURANT TECH

ADVANCED MANUFACTURING & LOGISTICS

START-UP NATION CENTRAL

Start-Up Nation Central is an Israel-based non-profit that serves as a gateway to Israeli innovation. The organization leverages its in-depth knowledge of Israel's innovation sector to introduce business leaders, governments, and NGOs from across the globe to the most relevant people and technologies that address their critical needs.

Innovation and Economic Development: *'The Chicken'* - Israeli test restaurant/plant



SuperMeat's **The Chicken**, a hybrid restaurant concept and pilot plant. | Image credit: SuperMeat.

Economic Opportunity: Cell cultured start-ups and companies in Canada



Future Fields, Edmonton, AB, making growth factors for the cellular agriculture market.

NOBLEGEN

Noblegen, Peterborough, ON, building ingredients and meat/dairy/egg products.



Canadian-founded Because Animals focusing on integrating cultivated ingredients into pet foods for dogs and cats.



Whiteboard Food (Spiderwort), Ottawa, ON, focusing on scaffolding for plant-based meat, cultivated meat or alternative proteins.



Biofect Innovations, Toronto, ON, designing microorganisms and using fermentation to create valuable animal ingredient products.



Ardra, Toronto, ON, using precision fermentation to sustainability create ingredients such as flavours and fragrances.



CELL AG TECH, Toronto, ON, focusing on seafood and a recent semi-finalist in XPRIZE Feed the Next Billion.



Caro Meats, Hamilton, ON, making cultivated meat using bioengineering techniques.



Another Fish, Montreal, QC aiming to produce a whitefish fillet and another semi-finalist in XPRIZE Feed the Next Billion.



Liven Proteins (ingredients) and New School Foods (plant-based seafood), Toronto, ON, are working together to create new food products.



Mara Renewables, Dartmouth, NS, creating omega-3 fatty acids from algae for human nutrition and related industries.



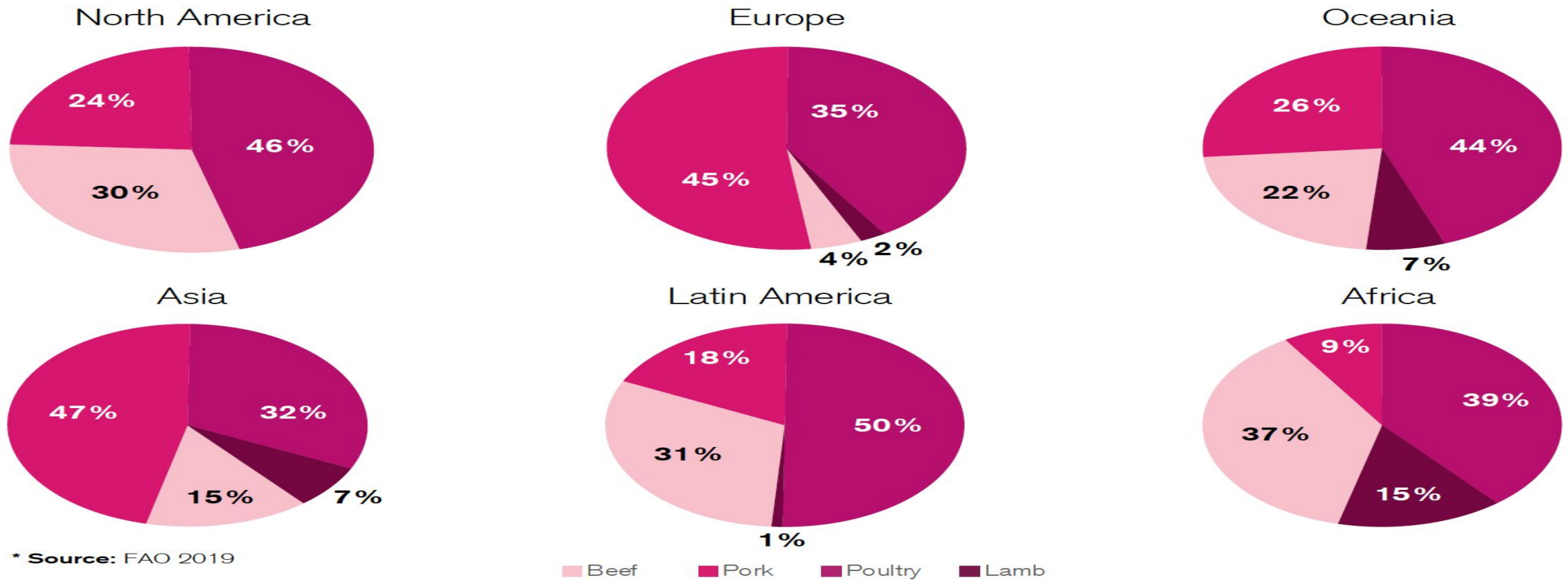
Appleton Meats, Vancouver, BC, working on a range of cultivated meat products, including beef and mouse meat for cats.



Better Milk, Montreal, QC, intending to make cow milk with mammary cells.

Economic Opportunity: Meat Consumption by Continent - 2018

Snapshot of meat consumption by type of meat per continent in 2018*

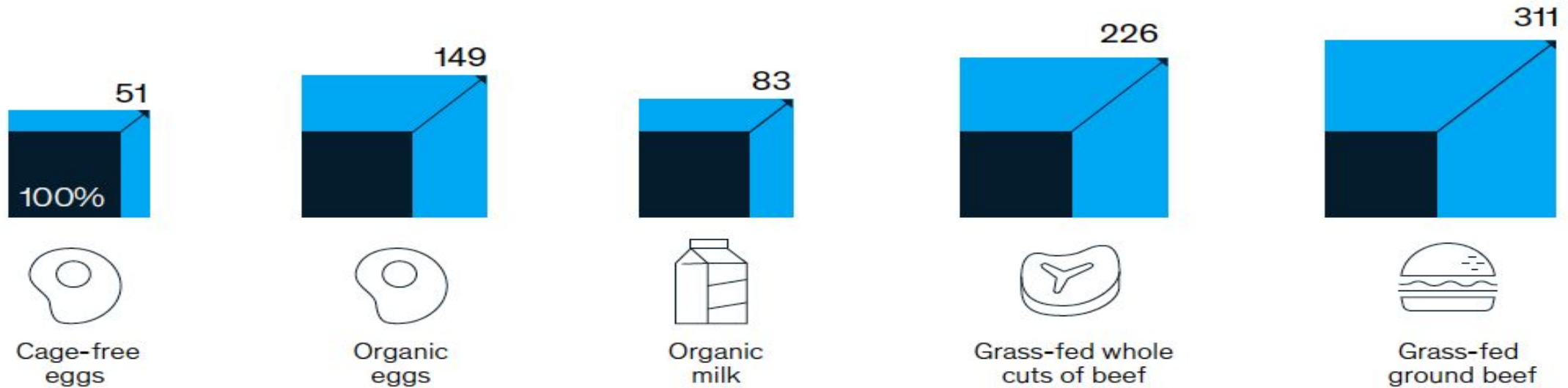


Source: Credit Suisse, 2020 - Alternative Proteins: Exploring the Asian appetite and conservation potential. NB: graph does not include prominence of seafood, esp. in Asian diets

Economic Opportunity: *Consumer Willingness-to-Pay for Premium Alt. Proteins*

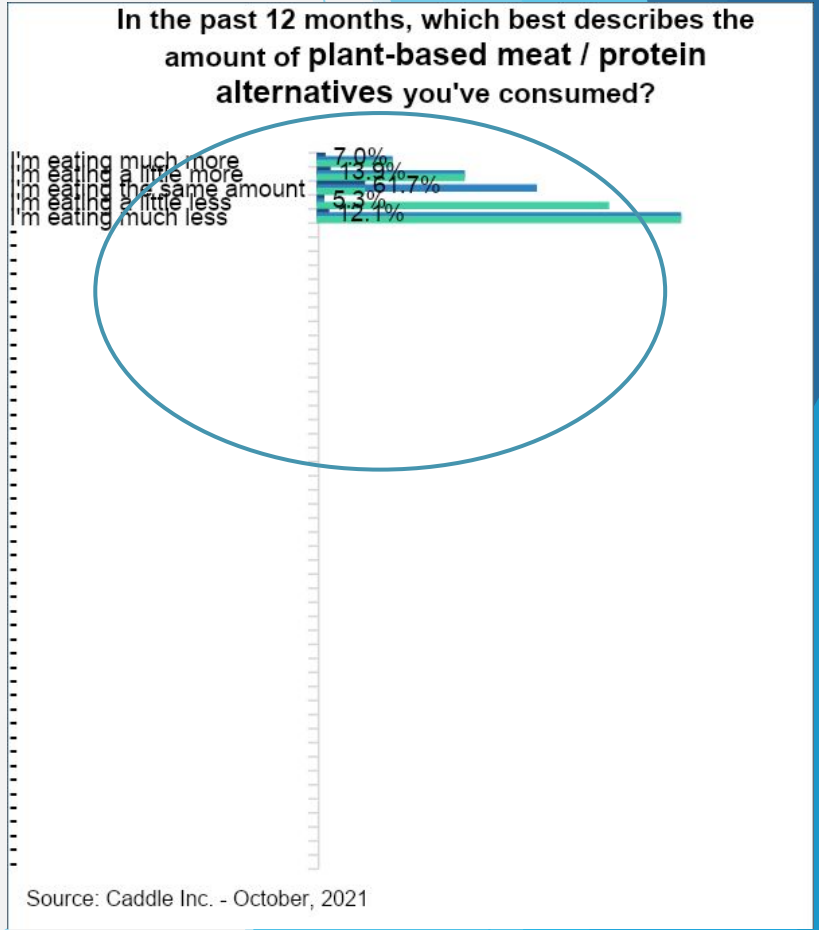
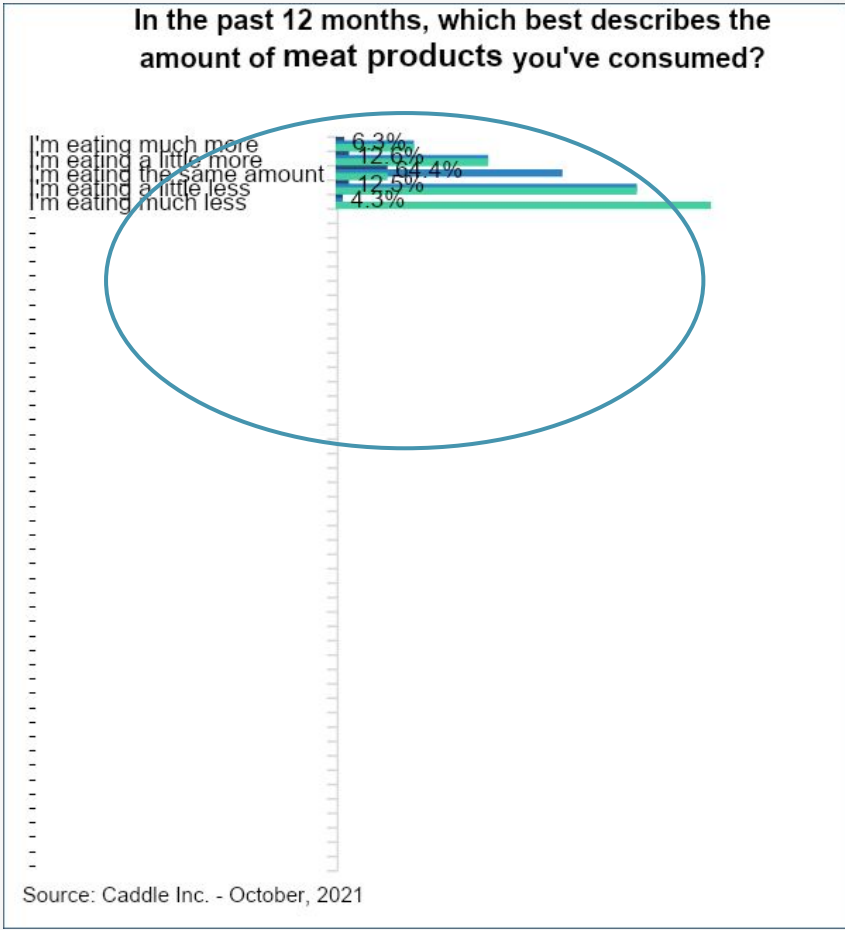
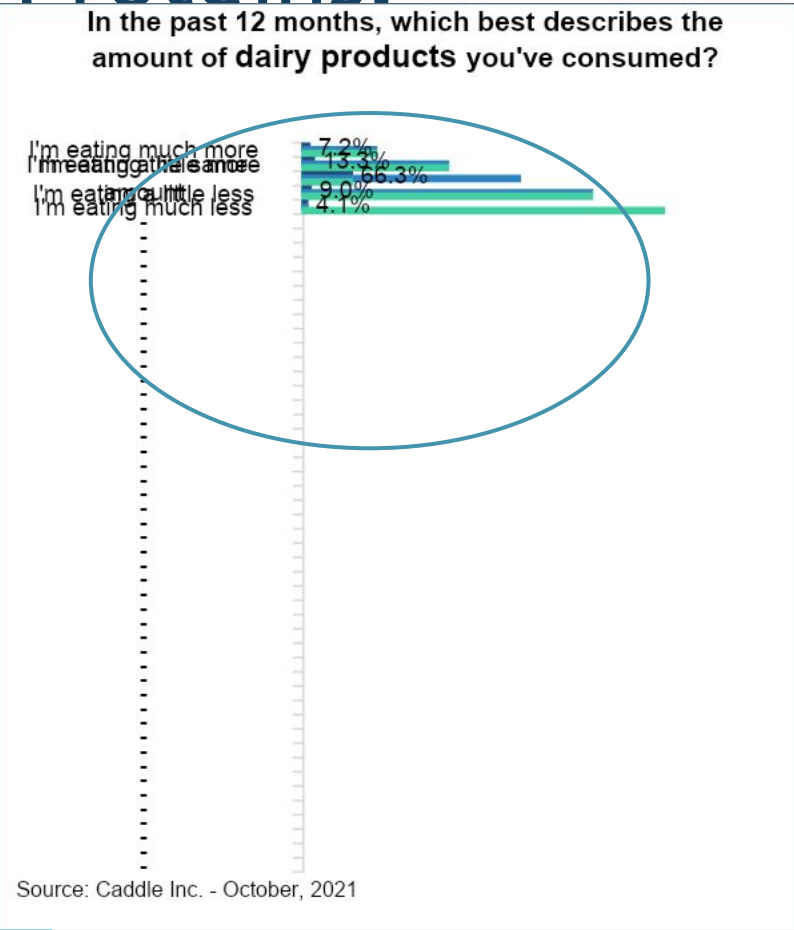
Consumers currently pay a premium for protein alternatives that are important to them.

Willing to pay for premium food, % over regular costs¹



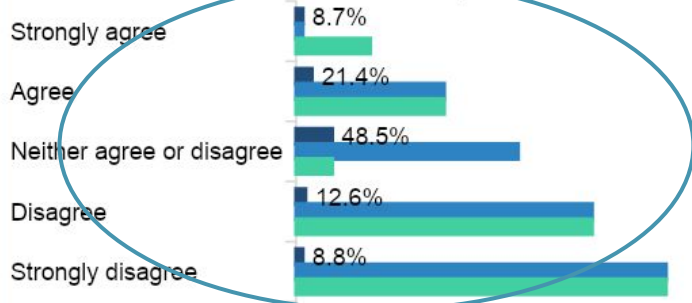
¹Based on US pricing data. Cage-free egg premium and organic-egg premium is based on the premium for Grade A eggs using the average price from January 2018 to October 2020 from the US Department of Agriculture (USDA). Organic-milk premium is calculated based on the comparison of pricing for nonorganic milk based on the 2020 average pricing per half gallon from USDA. Grass-fed, whole-cut, and ground beef is based on the 2019 to 2020 average pricing from USDA. Grass-fed beef is compared with the average pricing from all beef cuts (prime, choice, select, ungraded). Grass-fed 90 percent-plus lean ground beef is compared with non-grass-fed 90 percent-plus lean beef.

Where are Canadian consumers w. Cultured Proteins?



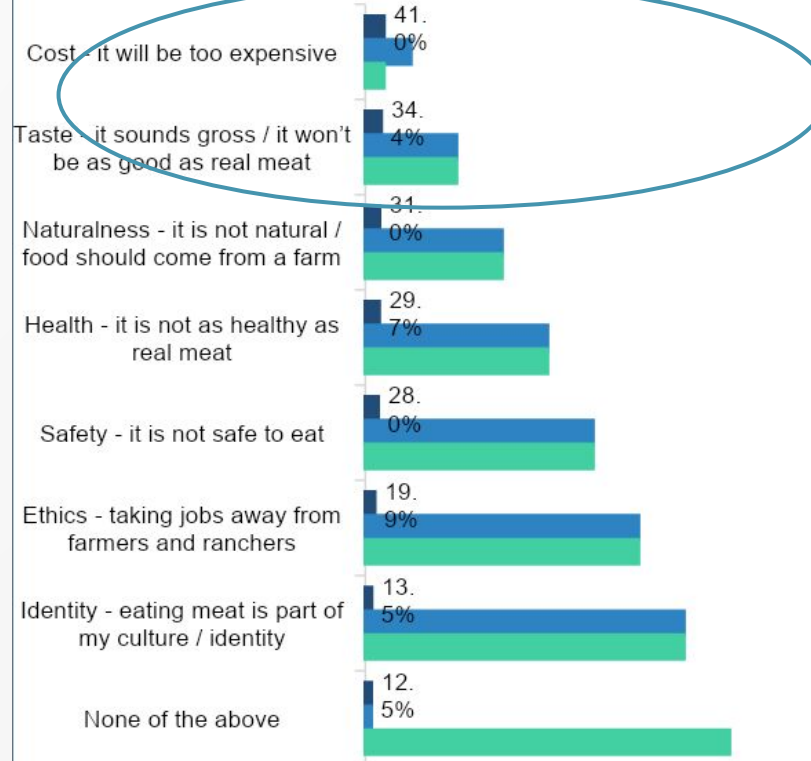
Where are Canadian consumers w. Cultured Proteins?

Please indicate your level of agreement with this statement: "I am supportive of the development of cultured, cell-based, or lab-grown protein alternative products in Canada".



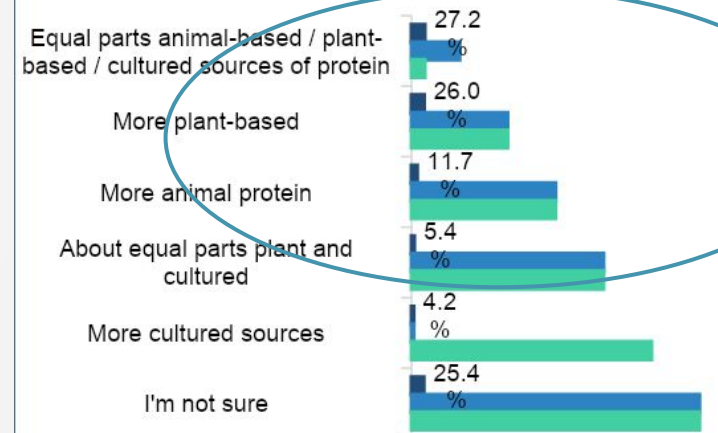
Source: Caddle Inc. - October, 2021

Which, if any, of these concerns would you most have about consuming cultured proteins? (Please select as many that apply)



Source: Caddle Inc. - October, 2021

By 2030, where do you think most people will obtain their protein from?



The Rural Economic Development Opportunity: *Cultured Proteins will need a business ecosystem*

The cultivated-meat industry will require an ecosystem of businesses to provide cell lines, growth media, bioreactors, sensors, extrusion equipment, and more.

Cultivated-meat opportunities

Inputs			Production			Distribution
Cell growth media	Media formula optimization	Bioreactors and scaffolding	Cell lines	Production	Downstream processing	Delivery and retail
<ul style="list-style-type: none"> • Growth-factor supply • Glucose supply 	<ul style="list-style-type: none"> • Media formulation optimization for individual cell line and cell type • Growth media mixing facilities 	<ul style="list-style-type: none"> • Bioreactor design (seed train, at-scale stir tank, perfusion) • Production • Supporting infrastructure (eg, sensors, controls) and software systems 	<ul style="list-style-type: none"> • Selection/development of cell lines 	<ul style="list-style-type: none"> • Engineering and construction of at-scale facilities, including bioreactor installation • Production as a service (eg, contract manufacturing) • Training workforce 	<ul style="list-style-type: none"> • Centrifugation equipment • Forming equipment (eg, extrusion, 3-D printing) • Contract manufacturing 	<ul style="list-style-type: none"> • Product delivery • Food-service and retail selling product



PrimaColl™

High-purity, bioactive collagen for food and beverage made without animals.



'The Canadian cellular agriculture industry could reach \$7.5B per year, and create up to 86,000 jobs by 2030'

- 2021 Ontario Genomics: Cell. Ag. study

Thank you! Questions?

Mark Juhasz, PhD

Principal and Founder, Harvest Insights

e. mvjuhasz@harvestinsights.com

Research Associate,

Agri-food Analytics Lab, Dalhousie University