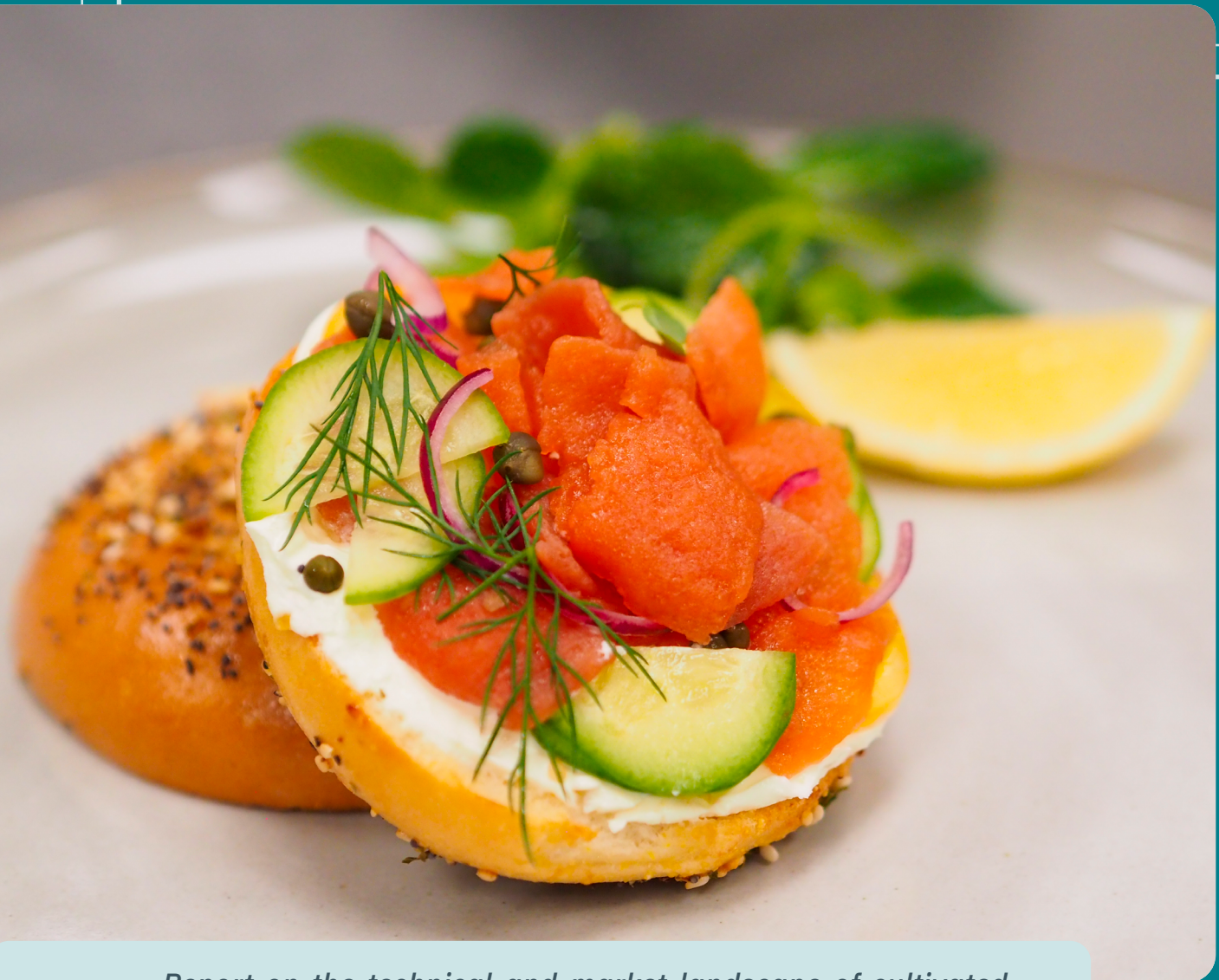


CULTIVATED MEAT: KEY OPPORTUNITIES AND RECOMMENDATIONS FOR INDIA



Report on the technical and market landscape of cultivated meat with key policy recommendations for India

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PREFACE

This report is a collaboration between Invest India and the Good Food Institute India with the objective of analysing the emerging trends and policies on cultivated meat across the globe. A study of the initiatives taken by countries like Singapore and Israel to incentivise the growth and innovations in cultivated meat have paved the way for giant economies like India to deliberate on and work towards the establishment of a regulatory framework for this sector. While writing the report, many stakeholders across private industry and government bodies were consulted. A roundtable was also convened at Invest India to share the major observations from this report and to seek inputs from senior officials from the Department of Animal Husbandry and Dairying (DAHD), the Ministry of Food Processing Industries (MOFPI), the Agricultural and Processed Food Products Export Development Authority (APEDA), the Office of Principal Scientific Advisor, a representative from the ICAR-National Research Centre on Meat, experts from the Good Food Institute India, and startups from the cultivated meat industry in India.

The roundtable underscored the fact that apart from regulatory support, the government can support through several other mechanisms to help this nascent sector grow to become globally competitive. For instance, the DAHD's infrastructure funds can be extended to the cultivated meat industry's infrastructure development projects. Similarly, the Ministry of Food Processing Industries' Production-Linked Incentives scheme could also have a separate category for disruptive and sustainable categories such as smart protein. To avoid companies redomiciling to other countries leading to a brain drain, it is imperative to support this growing industry through schemes and incentives. The representatives from DAHD had queries regarding the potential impact of this sector on the traditional livestock industry and recommended that once India comes up with well-defined regulations for cultivated meat, then a proposal may be sent to DAHD to consider including cultivated meat within the purview of the Animal Husbandry Infrastructure Development Fund, and then a decision will be taken by a higher level committee. The representative from ICAR-National Research Centre on Meat pointed out that to meet the current levels of consumption, we will need to triple our meat production. Given the growing emphasis on carbon neutrality, it is important for us to promote the cultivated meat technology.

The roundtable also witnessed participation by experts from organisations like Myoworks Pvt. Ltd., Laurus Bio Pvt. Ltd., Ferm Box Pvt. Ltd., and the Association of Biotechnology-Led Enterprises (ABLE), who emphasised the need for generating awareness to combat consumer stigma, and the need to streamline incentives and grants across ministries to support the growth of the alternative protein sector. 'The need of the hour is to address malnutrition and protein deficiency. Therefore, it is crucial to study the nutritional value and composition of conventional meat and cultivated meat, and to analyse the transition that is likely to occur in the future. It is particularly important to ensure that this transition does not have a negative impact on the livelihoods of livestock farmers.'

“

Invest India has always played a proactive role in assisting the government with policy analysis, facilitating inter-ministerial discussions on topical issues, and creating a roadmap for sunrise sectors. The collaboration between Invest India and the Good Food Institute India has culminated in the creation of a very insightful report on the opportunities, investment trends, and potential of the cultivated meat sector. Since India is yet to draft regulations for cultivated meat, this study will play an important role in creating awareness about this sector and to also quell misconceptions amongst consumers. Kudos to the Animal Husbandry desk at Invest India and the Good Food Institute for this wonderful report!”

Priya Rawat

Chief Operating Officer at Invest India, Ministry of Commerce & Industry, Government of India.

FOREWORD

The global demand for protein is likely to double by 2050, due to changing food consumption patterns as a result of rising income levels and growing urbanisation. Much of this demand is expected to come from emerging markets like India where the demand for poultry meat alone is projected to increase 850 percent by 2040 (from 1.05 to 9.92 million tonnes, annually), representing the steepest increase of any region in the world (FAO, 'Mapping of Supply and Demand for Animal-Source Foods', 2011).

Growing concern over the contribution of livestock to greenhouse gas emissions, natural resource degradation, and public health outbreaks – including endemic and re-emerging infectious animal diseases, met with the overuse of antibiotics accelerating the development and spread of antimicrobial resistance – has led to a growing discourse over the need for diversification of our existing protein supply chain.

This report presents an overview of one such alternative - cultivated meat, as part of the broader smart protein (also known globally as the alternative protein) industry which comprises plant-based, cultivated, and fermentation-derived protein with potential to supplement the livestock sector in meeting the increasing demand for protein in a sustainable and cost-effective manner. We intend to make the case that the cultivated meat industry does not pose a threat to the traditional livestock industry and that the two industries (traditional livestock and cultivated meat) can co-exist and thrive. The cultivated meat industry will offer consumers an addition to the menu and importantly, can become a strong source of foreign exchange through the promotion of exports in the sector. Further, this paper can serve as an important reference tool for government and regulatory bodies to formulate regulations for cultivated meat in the future.

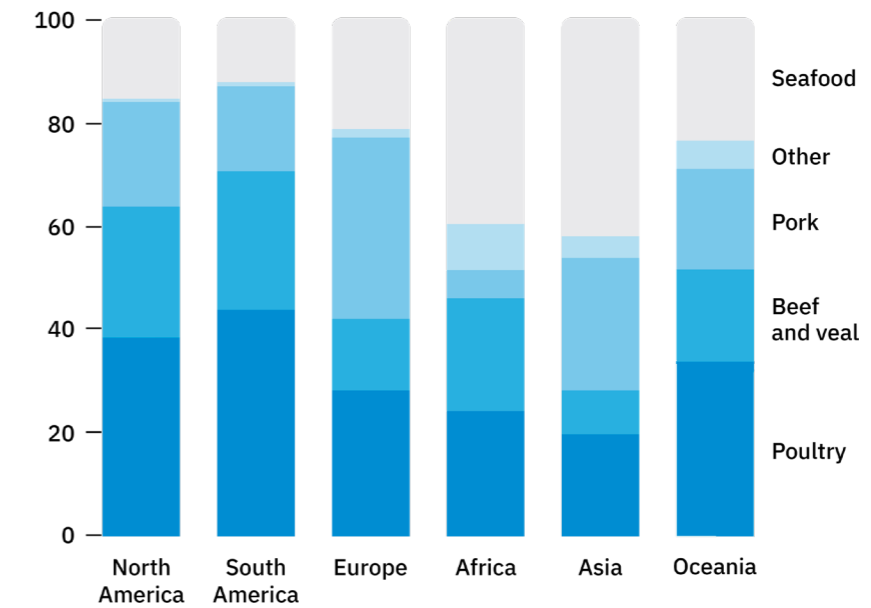
Through this report we discuss global market trends and the future prospects of the cultivated meat industry in line with the growing global meat sector. We also highlight specific challenges and opportunities in the Indian market, and effective interventions for this sunrise industry to grow. India with its large pool of consumers, biotechnology talent, and bio-manufacturing capabilities could reap the benefits of the emerging cultivated meat industry, by paving the way for the creation and regulation of cultivated meat facilities ahead of other emerging economies. India has an opportunity to leverage the first mover advantage and position the country as a leader and a prominent innovator, manufacturer, and exporter of cultivated meat.

CHAPTER 1

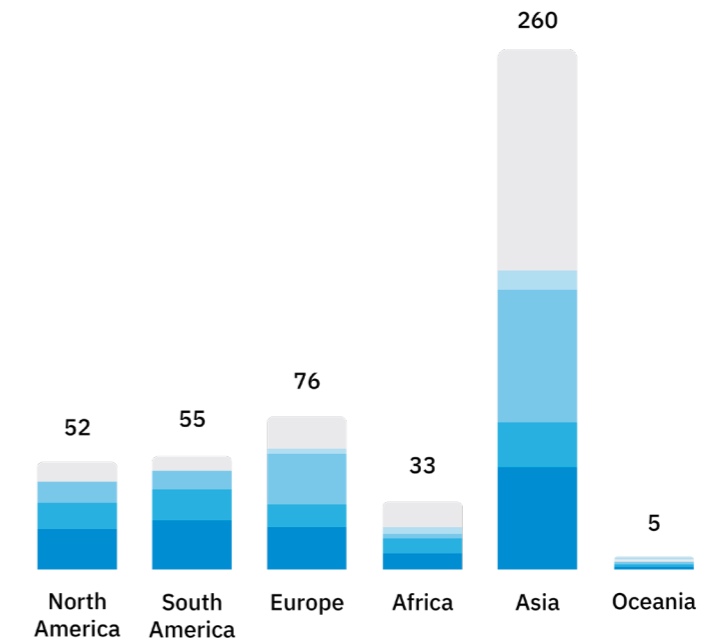
GROWING PROTEIN DEMAND

Over the last two decades, global protein consumption has grown by around 45 percent, rising from 166 million tonnes in 2000 to around 242 million tonnes in 2019.

2017-19 average consumption, %



2017-19 average consumption, millions of tonnes



Source: Euromonitor; OECD-FAO Agricultural Outlook 2020-29, taken from McKinsey & Company 'Cultivated Meat: Out of the lab, into the frying pan'



Image by Ivy Farm

Global Meat Consumption by Region

Five countries in Asia drove the majority of this growth, accounting for around 63 percent of the overall increase – with China (26 percent) and India (14 percent) displaying the largest growth among individual countries. Africa (15 percent) is another key source of the global increase in protein demand. As incomes continue to grow, we are likely to see a dietary transition towards higher consumption of meat, fruits, and vegetables relative to that of cereals (FAO 2011). By 2050, six of the seven largest economies in the world are projected to be emerging economies, with a majority of protein demand coming from these markets.

Although per capita meat consumption in India is amongst the lowest in the world, the demand for protein is growing (OECD 2021), with poultry accounting for 66 percent of total meat consumption. India is also grappling with the issue of malnutrition, with 38 percent undernutrition (46.6 million) in children under the age of five and 53 percent anaemia among adult women (National Family Health Survey 2015-16). For context, India's protein consumption is much lower than the 48 gm/day that is recommended by the Indian Council of Medical Research (ICMR). The recommended dietary allowance of protein for an average Indian adult is 0.8 to 1 gm per kg body weight. However, the average intake is about 0.6 gm per kg body weight.

With an expected doubling of the global demand for meat by 2050, there is an urgent need for the diversification of the protein supply chain. Feeding this demand through the intensification of our current protein supply system poses significant threats. The most recent extensive study, published in the journal *Science*, demonstrates meat and dairy uses 83 percent of farmland and is responsible for 60 percent of agriculture's greenhouse gas emissions - the latest in a long line of work demonstrating these impacts. Of course, India can scarcely afford these impacts - According to the *Global Climate Risk Index 2021*, India is poised to become one of the world's worst-affected countries by rising global temperatures. Crop yields in the country can fall by as much as 30 percent by 2050, while almost 40 percent of Indians will be potentially living in water scarcity by the mid-21st century.

Smart protein is protein ingredients derived from plants, microorganisms, cell cultures, that provide the same taste, texture, and nutrition as conventional animal-based sources. Smart protein can be classified into three buckets from a technology and infrastructure perspective: plant-based, cultivated, and fermentation-derived proteins.

- Plant-based meat, dairy and eggs closely resemble an animal-based meat product in their organoleptic properties, using one or a combination of plant or crop ingredients.
- Fermentation-derived protein entails the cultivation of any microbial species for either whole-cell biomass fermentation (to imitate conventional meat) or to produce valuable ingredients which could be transferable to the convergence of plant-based and cultivated meat.
- Cultivated meat (also referred to as clean meat, cultured meat, or cell-based meat) is genuine animal meat derived through the cultivation and expansion of animal-derived muscle, fat and other supporting cells. The starting material for cultivated meat is a biopsy from an animal, from which a starter culture of muscle cells is created. These cells are then grown and multiplied over several cycles to produce cultivated meat. Cultivated meat tastes, smells, sizzles, and cooks exactly like conventional meat.

Smart protein has the potential to offer significant environmental, social, and economic benefits and address 9 of the United Nations' 17 Sustainable Development Goals (SDGs). These proteins require substantially less land and can positively impact climate change, in addition to posing nearly zero public health risks because they eliminate animal rearing and slaughter from the process. Specifically, cultivating meat directly from cells, for example, uses anywhere from 64 to 90 percent less land than conventional meat production.

CHAPTER 2

INTRODUCTION TO SMART PROTEIN



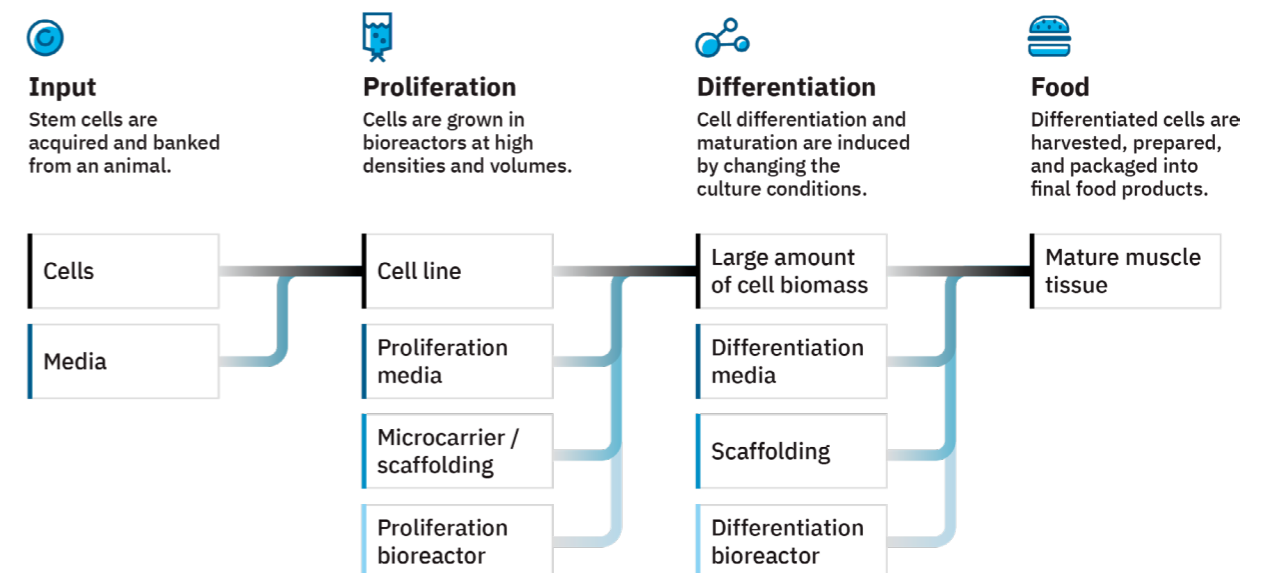
For the purpose of this report, we will focus on the opportunities presented by cultivated meat.

Cultivated Meat

Cultivated meat is identical to animal meat at the cellular level. It provides the same sensory and nutritional profile of conventionally produced meat because it comprises the same cell types and three-dimensional structure as meat from an animal. At scale, cultivated meat is produced in ‘cultivators’ (or bioreactors) which are seemingly similar to the existing fermentation bioreactors, but with advanced bioprocess design for growth of animal cells.

Fundamentally, the process of producing cultivated meat remains the same i.e., taking a biopsy from an animal and generating cell lines of various lineages such as muscle and fat, but there will be several variations for scaling this technology. For example, a company which produces structured meat will deploy edible scaffolds on which the muscle tissue will grow, giving the end meat product a whole-cut structure. But a company which produces ground meat products may simply deploy other technologies such as microcarriers for cells to adhere and multiply. The following table broadly highlights the steps involved in producing cultivated meat.

Cultivated meat process



Source: <https://gfi.org/resource/cultivated-meat-eggs-and-dairy-state-of-the-industry-report/>

Technology Readiness

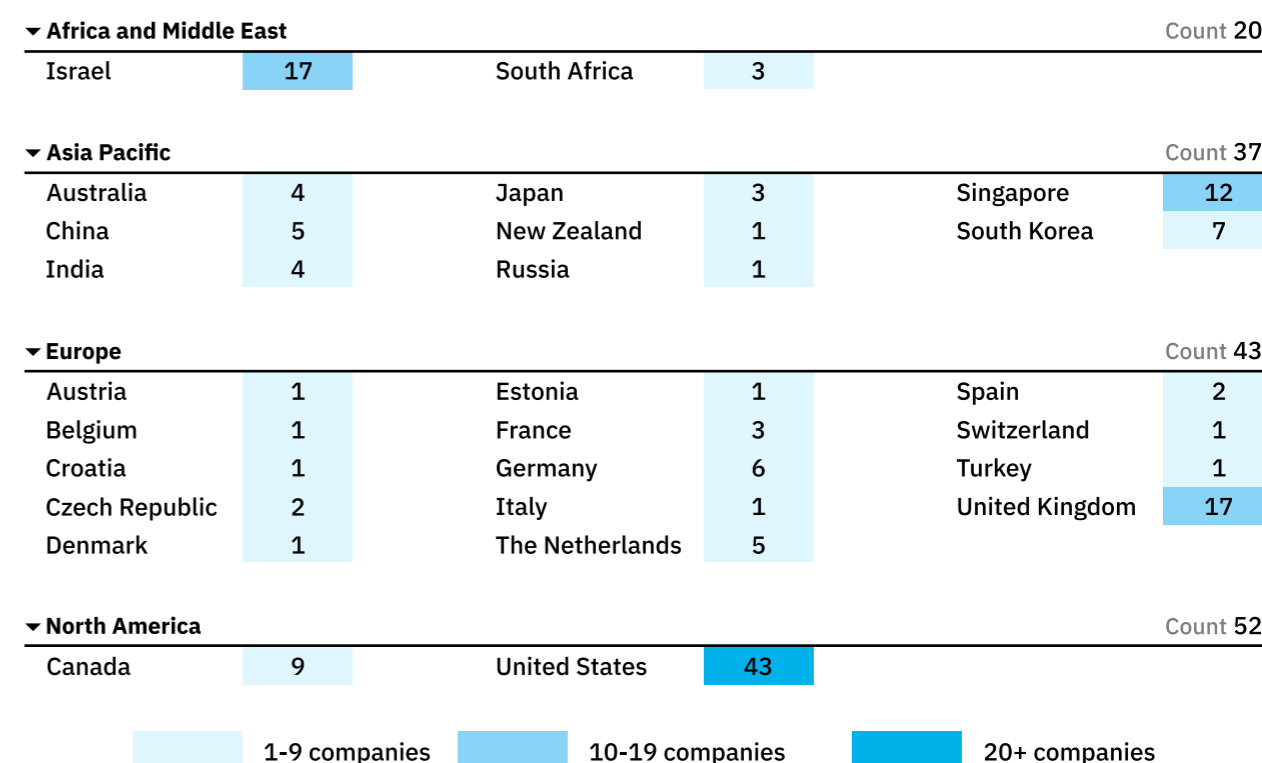
Economically viable production systems which can scale are fundamental to the success of the cultivated meat industry. Decades of knowledge accumulation in cell culture, stem cell biology, meat science, tissue engineering, and chemical and bioprocess engineering underpins the technology of cultivated meat. The field has had rapid cross-disciplinary innovations in the past decade, and future research will dissect the application of cell culture technology to egg and dairy proteins.

A growing number of companies and academic laboratories globally are racing to translate knowledge from biology, chemistry, physics, material, and computer sciences, to advance this sector to an industrial scale. Consortia, bringing together experts from several disciplines, to act as force multipliers for research at universities and in the industry for catalysing knowledge exchange, idea generation, and training will be essential. Additionally, the availability of open access resources will determine the industry's success. For example, the Cultivated Meat Modeling Consortium is deploying various computational and data mining tools to simulate large-scale cultivation of meat. Collaborative research is critical to advance this sector. The Good Food Institute (GFI) has created a database of researchers who are open to collaboration on smart protein projects to solve white space bottlenecks, while also creating a crowdsourced directory of species-specific resources to help researchers find the right tools or service providers for cultivated meat research. Additionally, GFI's Curriculum Repository hosts course materials to lower barriers for instructors to educate and train students on the science of cellular agriculture.

Commercialisation Of Cultivated Meat

Given the technical challenges, infrastructure construction needs, scale up and/or scale out considerations, and regulatory uncertainties, cultivated meat is estimated to be broadly available at upscale restaurants by the late 2020s and in mass market restaurants and grocery stores by the 2030s. Hybrid plant-based and cultivated products, which contain only a small constituent amount of cultivated meat, may be available in mass market restaurants by the mid-to-late 2020s.

Distribution of companies by country and region



Sources: GFI company database, PitchBook, Crunchbase, manufacturer websites.

This graphic includes all publicly announced cultivated meat companies, but it may not include all cultivated meat companies founded to date as many companies begin in stealth mode. We expect more companies founded in 2022 to announce their work in 2023.

Technological progress across the value chain

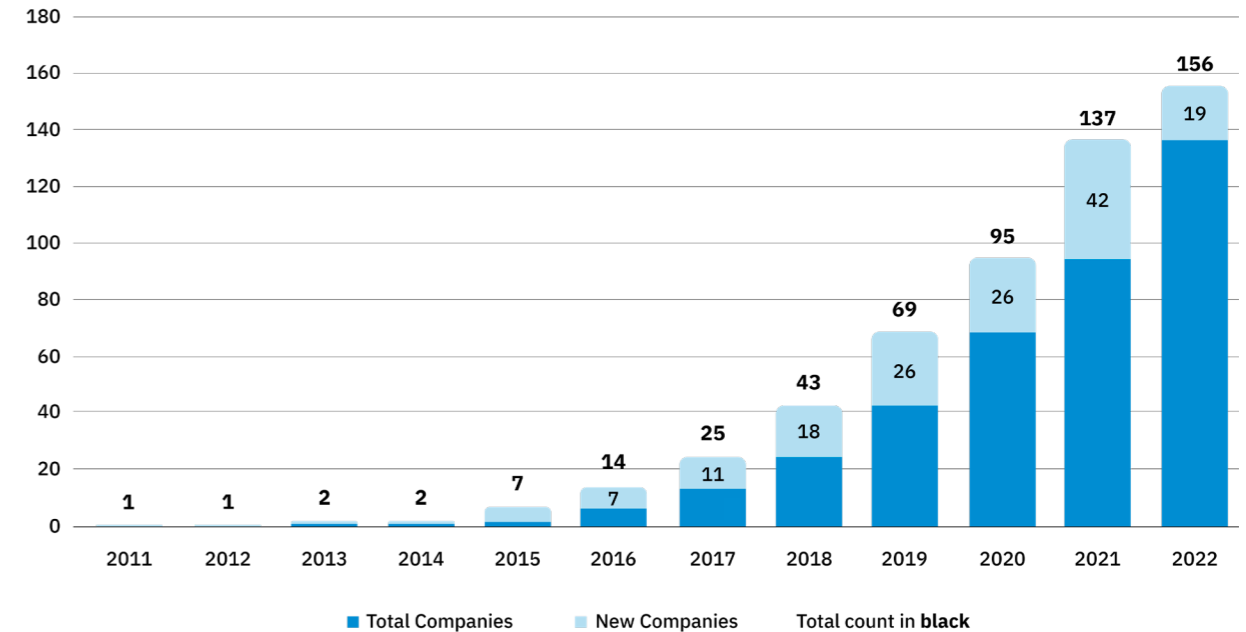
Four key technology areas underpin the progress of the cultivated meat sector:

- Cell lines are the basic and the most challenging areas within the cultivated meat production value chain. Startups and several research groups across the world are actively trying to establish a perpetual source of cells required to generate cultivated meat products. Several techniques are being deployed to create viable and commercially acceptable cell lines.
- Culture media provides the necessary microenvironment for cells to grow and is the biggest cost contributor in the cultivated meat value chain. Several companies are working on cost-effective serum-free media formulations to produce cultivated meat products by creating key protein mimics or replacements for key components such as albumin, transferrin, hormones, and growth factors.
- Scaffolding is deployed mainly for generating structured whole-cut meat products. Scaffolding gives the right skeletal framework and microenvironment for the growth of muscle, fat, and other support cells aiding the interspersal of a variety of cells that mimic whole-cut meat products. Significant progress has been made using various base materials such as bioengineered collagen, decellularized plants, alginate, chitin, and so on.
- The production process of cultivated meat needs to be cost-effective and move towards increasing price parity with conventional meat along with matching taste, mouthfeel, and nutritional quotients in order to be commercially successful. A financially viable and efficient bioprocess design underpins scale-up of this segment. Bioprocess engineers around the world are working on upstream and downstream process innovations to design the most efficient and inexpensive bioprocessing solutions.

Market Landscape

Over the last decade, \$14.2 billion has been invested into the global alternative protein category, with \$2.8 billion invested in cultivated meat and investments on average tripling every year. During this time the industry has expanded to include:

- 156 cultivated meat ventures focused exclusively on developing cultivated meat inputs or end products.
- 70 companies, largely in the life sciences, that have publicly announced business lines in cultivated meat.
- A global distribution of cultivated meat companies, with the highest numbers of companies in North America (52) followed by Europe (43) and Asia Pacific (37). There are currently 4 active cultivated meat startups in India.



Sources: GFI company database, PitchBook, Crunchbase, manufacturer websites.

In GFI’s 2021 Cultivated meat and seafood report, we reported that 21 new companies were founded in 2021, and that number has since increased to 40 as companies founded in 2021 launched out of stealth mode in 2022. We anticipate that the 18 companies founded and announced in 2022 are similarly an underestimate, and we expect more companies founded in 2022 to announce their work in 2023. Readers can refer to GFI’s company database for an up-to-date count of announced cultivated meat companies.

There is an emerging trend of industry incumbents entering into the cultivated meat industry, both through investments and strategic partnerships, with opportunities for collaboration on research, production, and distribution. The graph below is an overview of the top five U.S. meat companies as well as the top five U.S. consumer packaged goods (CPG) food companies are involved with cultivated meat:

Conventional companies with involvement in cultivated meat

	CPG companies					Meat companies				
	PEPSICO	NESTLÉ	KraftHeinz	ABInBev	General Mills	Tyson	JBS	Cargill	Smithfield	Hormel Foods
Investment						✓		✓		
Acquisition							✓			
Partnership		✓								
R&D and manufacturing		✓					✓			

We are seeing similar trends globally, with large food companies or institutions with existing R&D infrastructure serving as valuable partners to cultivated meat startups:

Major players in the cultivated meat industry

Believer Meats (formerly Future Meat Technologies) (Israel)

PROFILE:

Israel-based startup working on cultivated meat products such as chicken kebab, using muscle and fat production and media recycling.

RECENT DEVELOPMENTS:

Broke ground on a 200,000-square-foot facility in North Carolina that will have the capacity to produce at least 10,000 metric tons of cultivated meat per year. In 2021, Nestlé began a partnership with Believer Meats to develop products with plant-based ingredients and Believer’s cultivated meat.

GOOD Meat (United States)

PROFILE:

US-based company with a plant-based egg brand called JUST Egg and a cultivated meat subsidiary called GOOD Meat, with plant-based products including liquid egg, folded egg, and sous vide egg bites; and cultivated meat products including chicken.

RECENT DEVELOPMENTS:

Received regulatory approval and sale of cultivated chicken by Singapore

Food Agency, and gearing towards commercial-scale production with the largest cultivated meat factory in Asia with a launch slated for 2023. In early 2023, GOOD Meat also received a “no questions” letter from the U.S. Food and Drug Administration.

UPSIDE Foods (formerly Memphis Meats) (United States)

PROFILE:

US-based cultivated meat startup producing beef, duck, and chicken product prototypes.

RECENT DEVELOPMENTS:

Built a 53,000 sq.ft plant, known as the Engineering, Production, and Innovation Center (EPIC), the world’s most advanced cultivated meat production facility, designed to bring products ‘out of the lab’ into industrial scale. In November 2022, the U.S. FDA completed its first premarket consultation for a cultivated meat product, giving UPSIDE Foods the green-light for their cultivated chicken.

Mosa Meat (Netherlands)

PROFILE:

Netherlands-based startup working on cultivated beef in collaboration with Prof. Mark Post at Maastricht University

RECENT DEVELOPMENTS:

Received a EUR 2 million grant for research into lowering the cost of cell culture media. They announced an expansion of their Maastricht-based pilot and R&D facility.

Shiok Meats (Singapore)

PROFILE:

Singapore-based company producing cultivated seafood, including crustaceans like shrimp, crab, and lobster

RECENT DEVELOPMENTS:

Launching a commercial pilot plant for its minced shrimp product is expected in 2022. Shiok Meats signed a partnership with Minh Phu Seafood, Vietnam’s largest conventional shrimp producer, to develop a combined R&D facility focused on cultivated shrimp.

Aleph Farms (Israel)

PROFILE:

Israel-based company producing cultivated beef steak.

RECENT DEVELOPMENTS:

Raised a USD 105 million Series B funding round towards large-scale global commercialisation by 2022 and portfolio expansion into new types of animal protein.

BlueNalu (United States)

PROFILE:

US-based startup producing cultivated seafood products.

RECENT DEVELOPMENTS:

Launched the world’s first commercial pilot facility for cultivated seafood. The 40,000 sq. ft facility will support BlueNalu in its plans for market launch pending regulatory approval.

Wildtype (United States)

PROFILE:

US-based startup working on cultivated salmon.

RECENT DEVELOPMENTS:

Raised a USD 100 million Series B. In 2021, Wildtype launched a pilot plant that can make up to 200,000 pounds of cultivated sushi-grade salmon a year once fully operational.

Avant Meats (Hong Kong)

PROFILE:

Hong Kong-based company uses a proprietary biotechnology platform to producing cultivated fish products, including food, skincare, and other functional applications.

RECENT DEVELOPMENTS:

Built a production facility for cultivated fish cells, set to be launched in Singapore by 2022.

Steakholder Foods (formerly MeaTech 3D) (Israel)

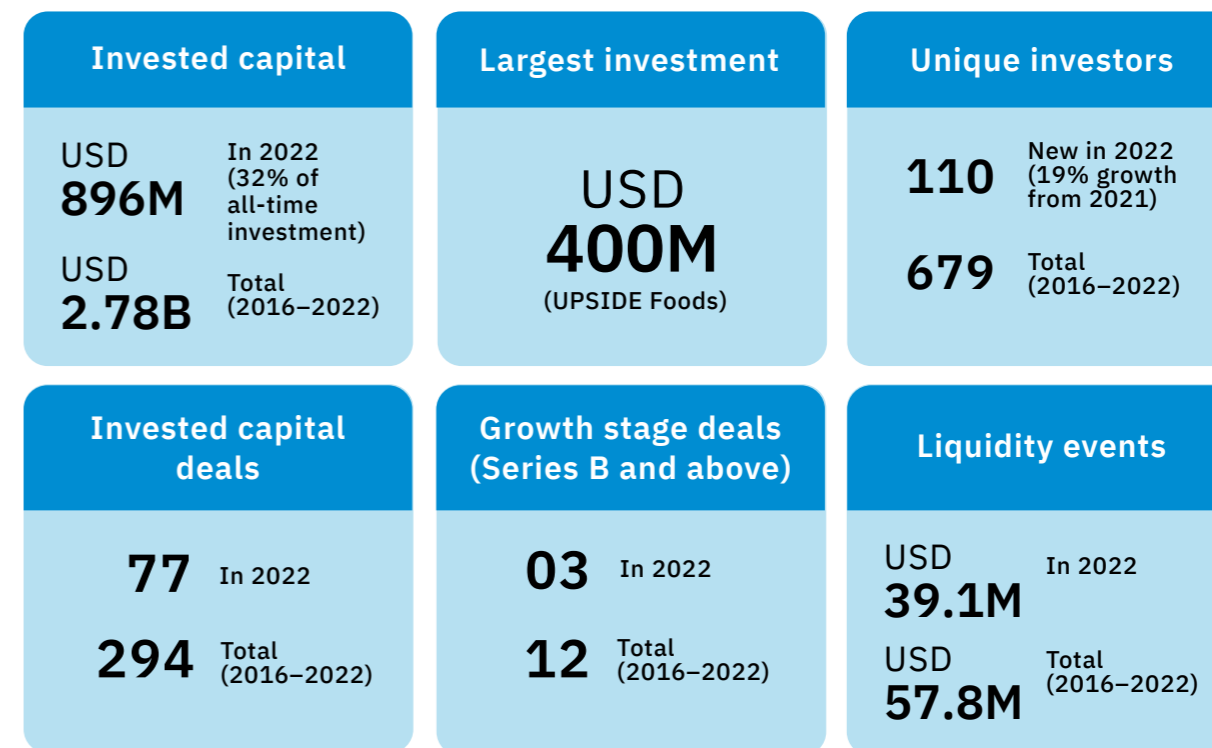
PROFILE:

Israel-based company producing 3D-printed cultivated meat.

RECENT DEVELOPMENTS:

Announced plans for opening a pilot facility in Europe to produce cultivated chicken fat to enhance meat alternatives. In 2022, MeaTech tasting event for investors featuring chicken nuggets made from cultivated and plant protein ingredients.

Investment Highlights In Cultivated Meat



Source: GFI analysis of data from PitchBook Data, Inc.
 Note: Data has not been reviewed by PitchBook analysts. See the Methodology of investment calculations section for GFI’s data collection methodology and definitions of “invested capital.” The total deal count includes deals with undisclosed amounts.

CHAPTER 3

FUTURE PROSPECTS

Making cultivated meat a USD 25 billion global industry by 2030 presents opportunities within and beyond today's food industry. By 2030, cultivated meat could provide as much as a half of one percent — billions of pounds — of the world's meat supply, with implications for multiple sectors. The future pace of adoption and market size will depend on the following factors:

1. Transformative innovation

A global life cycle assessment (LCA) and techno-economic analysis (TEA) of a hypothetical commercial scale cultivated meat production facility operating in the year 2030 has been conducted by the research firm CE Delft. This is a first-of-their-kind analyses highlighting the critical technical bottlenecks. It identifies areas of focus for cultivated meat manufacturers to implement in their production processes to achieve desired economic and environmental impact outcomes and together serve as a foundation for refined future models. The studies highlight the need for further open access research on the species and cell types used in cultivated meat production, development of new or improved core technologies, and global shifts in the energy sector for cultivated meat technology to

deliver on potential sustainability gains. The report incorporates data from industrial partners including cultivated meat companies and bioprocess, media, and scaffold providers and concludes that meat directly cultivated from cells could cut emissions by 92 percent compared to conventional meat, when produced with renewable energy. Additionally, cultivated meat requires 64 to 90 percent less land and 66 percent less water compared to conventional meat and results in lower environmental impacts in a variety of categories such as air pollution, acidification of soils, and marine eutrophication compared to conventional meat. With this massive decrease in land use, additional opportunities arise for carbon sequestration, renewable energy production, and biodiversity protection.

2. Achieving price-parity with conventional meat

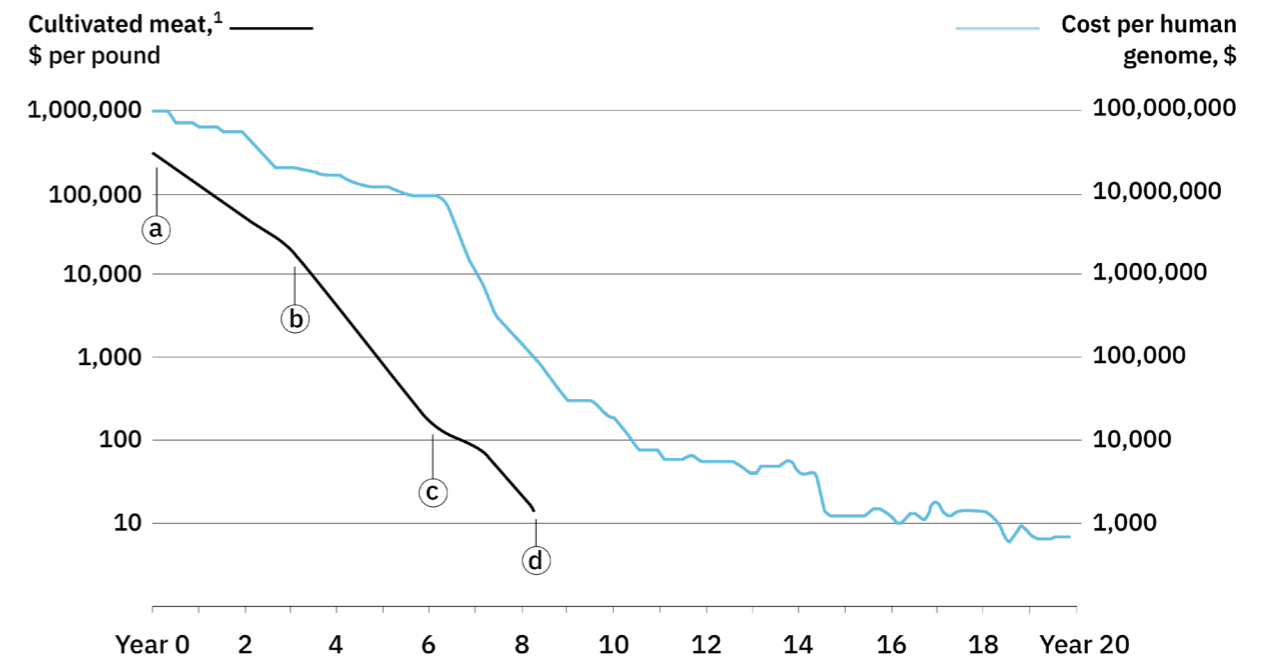
In less than a decade, companies have been able to reduce the production costs of cultivated meat by 99 percent. If costs follow the same trajectory as that of human genome sequencing (for which costs, on average, dropped by 45 percent annually between 2001 and 2021), cultivated meat can potentially achieve cost parity with conventional meat by 2030. Based on a McKinsey analysis, about 75 percent of costs can be eliminated through increased scale and best-in-class manufacturing processes, while roughly 25 percent of additional costs can be eliminated by fine-tuning R&D, bringing the total cost down 99.5 percent, from the low thousands of dollars to under USD 5 per pound. GFI's Techno-Economic Analysis modelled costs as low as USD 6.43 per kg.

Cost of production is very difficult to predict because the production technique is not stabilised, startups' private costs are largely hidden, and

it is difficult to anticipate the effect of high scale production. The biggest challenge for startups is to lower significant costs stemming mainly from culture media. Cell culture media constitutes more than 90 percent of the overall product development costs in cultivated meat. Albumin (a transport protein) and proteins such as insulin and growth factors form the bulk of the cost of culture media. Scaleup facilities, efficient ingredient sourcing and finding ways to recycle or upcycle spent media (the most significant waste product in terms of volume) could reduce culture media prices.

Manufacturers are also looking at using cultivated meat as an ingredient in plant-based or cultivated blends as a way to more thoroughly biomimic the conventional animal meat experience. Blended or 'hybrid' products are anticipated to have reduced costs.

Comparative Cost of Changing Technologies



- (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 \$200/lb
- (d) 2021: Future Meat Technologies reduced it produced a 4 oz chicken breast at \$4 (with mixed plant protein)

Source: McKinsey & Company 'Cultivated Meat: Out of the lab, into the frying pan'

3. Industrial-scale manufacturing

By 2030, McKinsey estimates that cultivated meat could account for up to 2.1 million metric tons (MMT) of volume; a USD 25 billion market. Reaching a USD 25 billion cultivated-meat market by 2030 will require the annual production of 1.5 million tonnes of cultivated meat. The existing infrastructure that is technologically suitable for cultivated meat production has been designed for biopharma, a price-insensitive application at a much smaller scale than what will be

needed to produce millions of metric tons of meat.

At current levels of cell-culture productivity, the industry would need anywhere from 220 million to 440 million litres of bioreactor capacity. Considering that the pharma industry's current cell-culture capacity is estimated to be between 10 million and 20 million litres, it will take a massive capital build-out just to reach 1 percent of the protein market. To meet just 0.3 percent of global meat production, 100 similarly-sized facilities would need to be constructed.

This underscores the need for a lot of new infrastructure (including an assessment for refurbishing potential) and mechanisms for financing those projects.

A number of startups in the sector will be looking to partner with key research, production, and distribution partners as an essential step toward scaling cultivated meat production. Companies active in the life sciences industry can provide critical inputs, infrastructure, and expertise to cultivated meat startups.

4. Consumer acceptance

Researchers from the University of Bath, the Good Food Institute, and the Center for Long Term Priorities collaborated on the first quantitative comparison of consumer attitudes towards plant-based and cultivated meat across China, India, and the U.S. 3,000 participants were surveyed, as an exploration into the market demand across key markets (Bryant et al, *Frontiers in Sustainable Food Systems*, 2019). About 30 percent of US consumers, 59 percent of Chinese consumers, and 56 percent of Indian consumers were “very or extremely likely to purchase cultivated meat regularly,” with interest in cultivated meat expected to grow once there is a

product on the market and consumers are more familiar with it. In every country, the more familiar participants were with cultivated meat, the higher their acceptance. Continuing to normalise and get the word out about plant-based and cultivated meat will likely lead to greater acceptance over time.

5. Food safety and regulation for cultivated meat products

Prior to wide-scale commercialisation of cultivated meat, food produced through cellular agriculture will require regulatory authorization before entering the Indian market. Given the pace of technological development in the field to prepare for market entry of these products, it will be imperative for India to have the necessary regulatory frameworks, bodies and infrastructure in place for assessing the safety of cultivated food products and production processes, as well as legislation developed for accepted terminologies and labelling requirements for marketing these products. In later sections of the report, we detail out key regulatory recommendations for India.



Image by Bluu Seafood

CHAPTER 4

GLOBAL POLICY, R&D AND REGULATORY LANDSCAPE OF CULTIVATED MEAT

Assembling consortia and expert groups for scientific and regulatory advancement

If the government funds open access research, it provides a foundation for the industry to build upon, thereby facilitating innovation. Further support through assembling consortia and funding of R&D infrastructure will help in accelerating the growth of the sector

Japan

The **Japan Association for Cellular Agriculture (JACA)** is a collaboration between industry, government, and academia to create rules for cultivated meat, egg, and dairy products in order to contribute to their commercialisation in Japan. JACA is led by the Center for Rulemaking Strategy (CRS) at Tama University, a Japanese think tank, and comprises 30 companies, including some of the major food companies in Japan. CRS' focus is to design rules (law, industrial standards, self-regulation guidelines, and more) for emerging technologies and important concepts to be implemented into Japanese society.

The **Food Tech Research Group**, which includes over 100 companies, was launched by the Ministry of Agriculture, Forestry and Fisheries (MAFF) in April 2020.⁶ It aims to foster the food industry and strengthen Japan's food security through utilising different cutting-edge technology.⁷ Six meetings have been held so far to share the latest developments of startups and large companies, as well as to understand structural challenges that these companies are facing in the food technology field so that they can come up with future policies. As the theme is food tech in general, it is not limited to cultivated meat – but includes a wide range of topics such as genetically modified food, plant factories, 3D food printers, cooking robots, and delivery robots. More discussions will continue and dive deeper into each of the fields within various areas of food technology. Identifying priority issues to be resolved and forming an appropriate market for cultivated meat are likely to be at the top of the agenda.

⁶<https://www.gfi-apac.org/blog/japan-regulatory-updates-on-shaping-the-cultivated-meat-market/>

⁷<https://www.maff.go.jp/j/kanbo/foodtech/kenkyukai.html>

The Japanese Ministry of Health, Labour and Welfare convened a team of experts to study the safety of cultivated meat as part of its efforts to review cultivated meat regulations and determine if additional regulations are necessary. The expert panel will rely on cultivated meat regulations overseas as part of its research, with the aim to release a report on food safety for cultivated meat, including health impacts. on food safety for cultivated meat, including health impacts.



Israel

Israel granted final approval for the USD 18 million cultivated meat consortium of 14 companies and 10 universities and research institutions. In addition, the **Israeli Ministry of Innovation and the Ministry of Agriculture, in collaboration with GFI Israel**, have also launched a USD 1.2 million Alternative Protein Research Grant programme.



South Korea

In 2022, a cultivated food company, **Space F**, received **support** from the Ministry of Trade, Industry and Energy, South Korean universities, and industry partners to conduct R&D on cultivated meat technologies.



People's Republic of China

The Chinese government has indicated a strong interest in the smart protein sector and shows signs of accelerating involvement. **In December 2021, China's Ministry of Agriculture and Rural Affairs included cultivated meat in its five-year plan.** It provides a blueprint for strengthening innovation in "frontier and

cross-disciplinary technologies" and clear guidelines for developing the protein industry and related technologies. **China's Ministry of Science and Technology is funding a Green Biological Manufacturing R&D programme** to provide an estimated USD 3.1 million for smart protein.

Research funding



Japan

Japan's Ministry of Economy, Trade, and Industry has funded several cultivated meat research projects, though funding amounts are unknown. Also in 2020, the Japanese government **granted USD 2.2 million to IntegriCulture**, a startup supplying growth media and other technical solutions to cultivated meat makers to build a production facility.



Israel

Research funding under **Israel's Agricultural Research Organisation (ARO), a research institute (Volcani Institute)**, under the Ministry of Agriculture and Rural Development, is studying cultivated meat and has dedicated a lab for the same.



Singapore

The Centre of Innovation for Sustainable Banking and Production of Cultivated Meats (CRISP Meats) is a Singapore government-funded research programme to facilitate the development and production of cultivated meat through public-private partnerships.

The Singapore Food Agency (SFA) and the Agency for Science, Technology and Research (A*STAR) have **launched grant calls for R&D** in 'Sustainable Urban Food Production' and 'Future Foods: Alternative Proteins'.



United States

A consortium of researchers at the University of California, Davis, aims to explore the long-term sustainability of cultivated meat, supported by a new grant of up to USD 3.55 million from the National Science Foundation Growing Convergence programme, in addition to previous support from the Good Food Institute and New Harvest.

A team led by Tufts University has received a five-year, USD 10 million grant from the U.S. Department of Agriculture to develop cultivated meat.



United Kingdom

The UK government has backed cultivated meat innovation through funding as Edinburgh biotech firm Roslin Technologies received a major grant from the UK government to develop its cultivated meat technology.



European Union

Spain: Cultivated meat company **BioTech Foods** has revealed that it is heading a **EUR 5.2 million cultivated meat project** – majoritively funded by the Spanish government – that will investigate the potential health benefits of cellular agriculture. The project aims to investigate meat produced from cellular agriculture that, together with the development of healthy fats and functional ingredients, will enable the manufacture of healthier meat products than traditional red meat.

Iceland: **Biotechnology company ORF Genetics has been awarded a EUR 2.5 million grant from the Grant Management Services of the European Commission.** The grant is intended for the research, development, and marketing of animal-like growth factors to produce cultivated meat.

Netherlands: The Dutch government has announced a record EUR 60 million of funding for cultivated meat.

The European Union is also set to invest EUR 2 million in a scientific project that is developing cultivated meat for commercial markets. Under a Covid recovery plan that

was set up by the European Commission last year, known as React-EU, funding has been granted to two Dutch food firms – Nutreco and Mosa Meat – which are attempting to lower the costs of growing meat in vitro.



Qatar

Qatar's sovereign wealth fund, the **Qatar Investment Authority**, led a **USD 200 million investment round for a leading plant-based egg and cultivated meat company Eat JUST**. Doha Venture Capital, a state-backed investment fund, and the Qatar Free Zones Authority, an independent authority that oversees and regulates the country's free zones,⁸ are also involved in the construction of the USD 200 million Eat JUST cultivated meat production facility in Doha.

Government support and endorsement for cultivated meat:

Progressive statements from governments and their support in the form of focused initiatives to promote cultivated meat have been instrumental in building consumer trust, and accelerating enterprise value creation.



Japan

In 2020, Japan declared smart proteins an “important sector” and formed the Japan Association for Cellular Agriculture (JACA), an official working group on cultivated meat. JACA provides an opportunity for industry, government, and academia to collaborate on guidelines and recommendations for laws applicable to cultivated meat, egg, and dairy products to contribute to their commercialisation in Japan.

⁸ Free zones generally refer to areas in which corporate taxes and duties are minimal or nonexistent to encourage economic activity.



Israel

Former Prime Minister of Israel, Benjamin Netanyahu, was the first head of government to participate in a cultivated meat tasting hosted by cultivated meat company Aleph Farms and smart protein nonprofit organisation, Good Food Institute Israel. The Prime Minister was presented with a National Policy Plan to position Israel as a global smart protein leader, after which he recommended appointing a coordinator to oversee the growth of the sector.⁹ Subsequently, President Isaac Herzog announced that the Israel government has ‘officially’¹⁰ embraced smart protein as part of their National Climate Strategy.¹¹ The Ministry of Foreign Affairs in Israel created a video on cultivated meat featuring the Israeli startup Aleph Farms.



Singapore

Inclusion of smart protein in Singapore’s ‘30 by 30 vision’. Smart protein has been divided into “traditional foods” and “novel foods” for differentiating assessment criteria.



United Kingdom

The UK government has backed cultivated meat innovation and underscored that “Developing cultivated meat is one of the most significant advances we can make, as a country and as a planet, to tackle the scourge of food shortages and climate change.”¹²

⁹<https://gfi.org/blog/cultivated-meat-tasting-israel/>

¹⁰ <https://plantbasednews.org/culture/politics/israeli-government-cell-cultured-meat-climate-crisis/>

¹¹ <https://www.gov.il/en/departments/news/press-251021>

¹² <https://www.foodnavigator.com/Article/2021/11/05/UK-government-backs-cellular-meat-innovator-Developing-cultivated-meat-is-one-of-the-most-significant-advances-we-can-make>

Overview Of Regulations Enacted By Countries

Food production accounts for 35 percent of total global greenhouse gas emissions, of which 57 percent is attributed to the production of animal-based food, including livestock feed. Against this backdrop, many experts believe that cultivated meat might be a viable solution to the issue. Therefore, having an efficient and comprehensive regulatory framework is critical for the introduction of cultivated meat products, as it is critical for consumer safety. It will also promote innovation and reduce uncertainty for entrepreneurs interested in working in this industry. This section will cover the measures that certain nations have made to establish a regulatory environment that administers this industry.

Regulations & Labelling

We have taken into account the scenario of major economies like the US, EU, Singapore, and India. You can also read more about the regulatory environment for cultivated meat with a set of recommendations for developing regulatory guidelines here.



United States

In 2018,¹³ the US Department of Agriculture (USDA) and the US Food and Drug Administration (FDA) announced their intent to implement a joint regulatory framework for cultivated meat¹⁴ and subsequently released a formal agreement¹⁵ describing their respective oversight roles and responsibilities under this framework. FDA will oversee cell collection, cell banks, and all cultivation inputs and processes including cell growth and differentiation, up through the moment of “harvest” from the bioreactors. USDA will then oversee the further processing and labelling of food products derived from the cells of livestock and poultry. The agreement is a significant step forward in

¹³<https://www.fda.gov/food/workshops-meetings-webinars-food-and-dietary-supplements/public-meeting-foods-produced-using-animal-cell-culture-technology>

¹⁴<https://www.fda.gov/food/food-ingredients-packaging/food-made-cultured-animal-cells>

¹⁵US FDA, Formal Agreement Between FDA and USDA Regarding Oversight of Human Food Produced Using Animal Cell Technology Derived from Cell Lines of USDA-amenable Species <<https://www.fda.gov/food/domestic-interagency-agreements-food/formal-agreement-between-fda-and-usda-regarding-oversight-human-food-produced-using-animal-cell>>

providing a clear and predictable regulatory framework for cultivated meat. Since then, USDA and FDA have formed three interagency working groups on cultivated meat, and have confirmed the framework of the formal agreement. Although there have been a few challenges to labelling¹⁶ FDA as part of its initiative to involve the industry in the rulemaking process, has invited public comments on labelling of cultivated seafood products.¹⁷

FDA completed its first pre-market approval for cultivated meat company UPSIDE Foods in November 2022. In March of 2023, GOOD Meat became the second company to receive a no-questions letter from the FDA.



European Union

The EU supports and promotes smart protein in its regulatory framework and says, “New technologies and innovations in food production should be encouraged as they could reduce the environmental impact of food production, enhance food security and bring benefits to consumers as long as the high level of consumer protection is ensured.”¹⁸ Cultivated meat in the EU will be categorised under the Regulation (EU) 2015/2283¹⁹ on novel foods regulations that explicitly refers to food produced from “cell culture or tissue culture derived from animals”. If the product is deemed safe after a scientific assessment by the European Food Safety Authority (EFSA), the Commission approves the pre-market authorisation. Pre-market authorisation is handled centrally, meaning that once the European Commission and representatives from the EU member states approve a product, the approval applies across all 27 member states.

¹⁶<https://www.fsis.usda.gov/inspection/compliance-guidance/labeling/labeling-policies/foods-made-cultured-animal-cells>

¹⁷FDA Seeks Input on Labeling of Food Made with Cultured Seafood Cells <<https://www.fda.gov/food/cfsan-constituent-updates/fda-seeks-input-labeling-food-made-cultured-seafood-cells>>

¹⁸ S 29, of 2015/2283 EU Regulation

¹⁹ https://eur-lex.europa.eu/legal-content/EN/TXT/?uri%3DOJ%3AJOL_2015_327_R_0001&sa=D&source=docs&ust=1640020753366000&usg=AOvVaw1V3umA-qOpIzXuYkWWYndI



Singapore

“The Requirements for Safety Assessment of Novel Foods”²⁰ is the current regulatory framework in Singapore that would cover the scope of the manufacture and sale of cultivated meat products. This regulation is expected to be revised and updated periodically as the industry develops (the SFA has refined/ reviewed the regulatory framework four times currently based on industry and expert feedback). Food business operators that intend to manufacture, import or sell “novel foods” are required to conduct and submit the safety assessment of the products to the Singapore Food Agency (SFA) for review and approval. The regulatory framework defines cultivated meat as “meat developed from animal cell culture. The process to produce cultured meat involves growing the selected cell lines (or stem cells) in a bioreactor. The cells are grown in a suitable growth media, and subsequently onto a ‘scaffold’ to produce products resembling meat muscle.” SFA focuses on regulating the product, more than the process, but still recognises its significance in establishing overall product safety.

In November 2020, Singapore became the first nation to green-light the sale of a cultivated meat product.²¹ The approval of Eat JUST’s cultivated chicken, for use as an ingredient in the company’s chicken bites, was the culmination of a regulatory process developed over more than two years. Companies hoping to sell cultivated meat or seafood in Singapore must still submit regulatory filings for their specific formulations.

In early 2023, Singapore approved GOOD Meat to produce cultivated meat through a serum-free formulation.



Canada

In Canada, cultivated meat and seafood are characterised as “novel foods” and require the submission of detailed information in an application for pre-market approval. A three-part approval is required: (i) a letter of no objection

for human food use through the novel food assessment process, (ii) a pre-market assessment for new animal feed (due to the possibility of supply chain crossover and regardless of whether the product is intended for use as animal feed), and (iii) an environmental assessment under the New Substances Notification Regulations. Companies may not market their products in Canada until they have all three approvals.

Authority of India (the FSSAI), lays down the pre-market authorisation for novel food products/ingredients; food or food ingredients processed with the use of novel technology; any new additives or new processing aids including enzymes not previously laid down in other standards or regulations; food and food ingredients consisting of or isolated from microorganisms, bacteria, yeast, fungi or algae; and any other non-specified food which is not covered elsewhere. Although the definition does not make references to foods derived from animal-cell culture like in Singapore’s or EU’s regulatory framework, there is a section of the Indian framework that requires information around whether the food product is from an animal source and asks that “the genus and species of the organisms must be mentioned”, which could cover the scope of cultivated meat products.



Israel

Israel’s National Food Service under the Ministry of Health has maintained that cultivated meat and fermentation-derived foods would come under the regulatory definition of novel foods. Accordingly, foods will be considered for regulatory approval on a case-by-case basis.



Australia & New Zealand

Cultivated meat is likely to require pre-market approval as a novel food. Additional pre-market approvals, such as food additive or nutritive substance approvals, may be required. The Australian and New Zealand food regulatory body - Food Standards Australia New Zealand (FSANZ) stated that they have received its first application from Vow for approval of its cultivated quail which has now been accepted and the timeline for the stakeholder consultation process has been notified by the authority.



India

Currently, the regulatory framework for novel and non-specified foods in India, namely the Food Safety and Standards (Approval of Non-specified Foods and Food Ingredients) Regulation 2017, regulated by the Food Safety and Standards

It may be useful for the FSSAI to confirm if cultivated meat falls under the novel food category under the regulation. It is suggested that the definition of ‘Novel Food’ under the current regulatory framework should include “food from cell culture or tissue culture derived from animals”, in addition to categories of foods derived from microorganisms, fungi, algae, and bacteria. This specificity will be helpful for entrepreneurs and signal receptiveness towards regulating emerging categories. Indian regulators may refer to regulatory frameworks on definitions, nomenclature, and regulatory processes laid down by the regulators in Singapore, the US, Australia & New Zealand, Canada, and Israel.

²²F. No. 12/PA Regulation/Dir (PA)/FSSAI-2016 available [here](#)

²³Under the Draft Notification of Food Safety and Standards (Approval for Non-Specified Food and Food Ingredients) Amendment Regulation 2021#, novel food is defined as “food that may not have a history of human consumption; or may have any ingredient used in it which or the source from which it is derived, may not have a history of human consumption; or a food or ingredient obtained by new technology with innovative engineering process, where the process may give rise to significant change in the composition or structure or size of the food or food ingredients which may alter the nutritional value, metabolism or level of undesirable substances.”[here](#)

India: Key Policy Recommendations

Sunrise industries like smart protein can form a pillar of India's bioeconomy with the right support for a '**National Mission for Smart Protein**'. Convening a multi-agency working group or task force with participation from various relevant ministries which actively collaborates to move these areas forward is essential to establishing the industry. Below are essential recommendations that would help build domestic strength for the development and growth of the cultivated meat industry in India.

1. Investments and government support to encourage smart protein talent development for a future-ready ecosystem:

Like any other emerging sector, it is essential to have support from the government of India with clear funding programs for R&D, hands-on training modules and curriculum development in research institutions. Government intervention in promoting academia-industry collaboration through technology transfer schemes will also turbo-drive this sector. Relevant agencies such as The Council of Scientific and Industrial Research (CSIR), Department of Biotechnology (DBT), Department of Science and Technology (DST), Indian Council for Agricultural Research (ICAR), should come up with smart protein funding calls to advance this sector in India.

I. Advancing research funding for emerging technologies such as cultivated proteins, research and technology advancement through open access and licensable R&D can unlock many opportunities and lead to entrepreneurial stimulation. Supporting this R&D through specialized grants will help advance the industry on critical dimensions and make India globally competitive. Examples include the DBT-funded cultivated meat mutton project in collaboration with AIC-CCMB and the National Research Centre on Meat (NRCMeat), Hyderabad on a proposal on cultivated mutton meat. Dr. Mukunda Goswami, CIFE, and Shubhankar Takle, Myoworks, have received funding support from GFI's Competitive Research Grant Programs in the past two years.

II. Additionally, investments in research advancement and technology development in areas of food technology and manufacturing,

CHAPTER 5

INDIA: KEY POLICY RECOMMENDATIONS

bioreactor design, scaffold development, bioprocessing and scale-up units, etc., will support in scaling these technologies and infrastructure and can provide workable solutions to broader issues such as food security in India.

III. Global research and development partnerships: Creating talent development programs such as training fellowships and promoting education and translational research by launching specialized curricula and coursework in premier institutes in collaboration with international universities will help build a talent pool to support the industry in India.

2. Building R&D and manufacturing capacity in India through Central and State level interventions

(relevant agencies: Ministry of Food Processing Industries, Ministry of Fisheries, Ministry of Animal Husbandry and Dairying (and their individual departments), Department of Biotechnology, Department of Science and Technology, CSIR, Office of the Principal Scientific Advisor, BIRAC, NITI Aayog-Atal Innovation Mission): The Central and State government can support startups and companies working in cultivated meat R&D with policy support such as providing infrastructural support for setting up pilot, lab and industrial scale facilities based on industry requirements, providing financial support for procuring equipment. Incentivising the production of cultivated meat machinery and equipment similar to government support provided for equipment that is produced for biotech and pharma industries can help Indian companies drive down production costs and can attract global investors.

I. Open access cell line repository and research: One of the biggest bottlenecks is an open-access repository of cell lines with the potential to establish their entire genetic lineage toward creating non-GM cell lines. Several attempts have been made to generate such cell lines, but the bottleneck has been the source and the protocol deployed toward creating these immortalised or viable cell lines. The Good Food Institute has developed a repository of existing cell lines containing those that are established, planned, or in progress. Cell-line repository for seafood species is also a big bottleneck. Additionally, central cell-line repositories such as the National Repository for Fish Cell Lines (NRFC), which has 50 cell lines from fish species currently available to researchers for their programs, could be made accessible to the wider smart protein ecosystem

players to accelerate product development and commercialization. The government can support critical research in this area and ensure that the results of such studies are open-access for companies innovating in this area (including chicken cells, mutton cells, and seafood species, etc.)

II. Capacity building for Smart Protein: Building infrastructure through dedicated ‘*Smart Protein Innovation Hubs*’ at existing bio-incubators and Atal incubation centres with access to lab, pilot, and manufacturing-scale infrastructure will support research and entrepreneurship in these areas. Key institutions such as the Biotechnology Industry Research Assistance Council (BIRAC), Department of Science and Technology (DST), and Council of Scientific & Industrial Research (CSIR) have shown interest in advancing grant opportunities and building capacity in the R&D ecosystem. Several of the 9 DBT-supported biotech parks and 60 BIRAC-supported bio incubators, 41 CSIR-supported institutions, and 17 DST-supported institutions in India have the necessary talent and infrastructure to support and encourage cultivated meat R&D and translate it into commercial products.

III. Inclusion of CM within existing Central and State level policies: Relevant Ministries like the Ministry of Fisheries, Animal Husbandry and Dairying (MFAHD), the Ministry of Commerce, the Ministry of Science and Technology and the Ministry of Food Processing (MoFPI) can consider creating incentives in cultivated meat R&D and production. Schemes like the Production Linked Incentive Scheme by MoFPI, Mega Food Park Scheme, and the Animal Husbandry Infrastructure Development Fund (AHIDF) by MFAHD can be extended to cultivated meat.

i. Central level policies: Apart from forming regulatory frameworks and achieving procedural clarity, government support plays a key role in advancing the sector through supportive policies. Recognition of alternative proteins like cultivated meat in national policy plans similar to Israel or China would encourage further innovation and stimulate research and development in these categories. Additionally, government support through public funding would be critical to advance the growth in science and technology and bring these products towards price parity.

- a. Incentivising the production of cultivated meat by providing access to machinery and equipment could be a welcome push for the Indian ecosystem.
- b. Inclusion of Cultivated Meat under AHIDF: The Animal Husbandry Infrastructure Development (AHIDF) has been approved with an outlay of 15000 crores (approximately USD 2 billion) for incentivising investments by individual entrepreneurs, private companies, MSME, Farmers Producers Organisations (FPOs) and Section 8 companies to establish (i) the dairy processing and value addition infrastructure, (ii) meat processing and value addition infrastructure and (iii) animal feed plant. Once the country comes up with well-defined regulations on cultivated meat, then schemes like AHDF should cover cultivated meat as well.

ii. State-specific policies: The Ministry of Animal Husbandry and Dairying and other relevant Ministries can support state level Ministries and departments to develop state-specific policies to promote infrastructure capabilities, cluster production centres, generate employment, build attractive regional hotspots for FDI, manufacturing, and so on. Adding the scope of cultivated meat production within state-level policies, such as the following examples:

- a. Andhra Pradesh Biotechnology Policy 2015-2020: Development of several infrastructure projects and industrial parks
- b. Karnataka Biotechnology Policy 2017–2022: Strengthening the ecosystem required for boosting start-ups, accessing funds for R&D and product development, developing attractive incentives for investors and providing mentorship for growth
- c. Telangana Life Sciences Policy 2015-2020: Development of suitable infrastructure to attract life science companies and become a leading investment destination in the sector.
- d. Uttarakhand Biotechnology Policy 2018-2023: Aims to attract new investments worth USD 709 million in the sector; generate employment opportunities for 5000 people by 2023
- e. Himachal Pradesh Biotechnology Policy 2014: Aims to make

Himachal a globally competitive destination for development of biotechnology products, processes and services

- f. Rajasthan Biotechnology Policy 2015: Aims to establish world-class research institutes and biomanufacturing infrastructure
- g. Gujarat Biotechnology Policy 2016-2021: Aims to develop a robust biotechnology ecosystem in the state
- h. Assam Biotechnology Policy 2018-2022: Development of the biotechnology industry in Assam, following the growth of bio-agri segment in the state
- i. Odisha Biotechnology Policy 2018: Aims to make Odisha one of the top biotech investment and innovation destinations in the country
- j. Atal Jai Anusandhan Biotech Mission: Launched by the Department of Biotechnology, the Mission seeks to transform ‘Health, Agriculture and Energy’ sectors by 2025 under ‘Nationally Relevant Technology Innovation’ (UNaTI). DBT may consider adding cultivated meat research within the core areas under the Mission

3. Building partnerships for knowledge and tech transfer (*relevant agencies: Ministry of Foreign Affairs, Department of Biotechnology, Department of Science & Technology, Office of the Principal Scientific Advisor, Invest India*)

I. Industry - academia partnerships for research translation: In April 2021, Singapore announced that it would set up the Future Ready Food Safety Hub (FRESH), a joint initiative by Nanyang Technological University (NTU), SFA, and A*STAR, to create a pro-business food regulatory ecosystem that supports innovation and allows the launch of safe novel foods. The key objectives of FRESH are threefold: i) to close the gap between older regulatory frameworks and novel food production methods (such as cell cultivation and microbial fermentation), ii) to strengthen food safety in Singapore by increasing collaboration between regulators and industry, iii) and to “enable regulatory responsiveness” by exposing regulators to novel food production methods.

i. Consortia building: Collaborative research centres could incentivise and facilitate consortia building between academia and the industry for joint research proposals that allow benefit-sharing among its participants. Israel, for example, has established a consortium which will focus on integrating artificial intelligence and genome editing, which will enable the industry to be at the forefront of such technology internationally. For example the USD 3.5 million grant from the US National Science Foundation to the university UC Davis for research and commercialisation of cultivated meat (produced directly from cells rather than by raising and slaughtering animals), which has demonstrated the efficacy of such coalitions and has resulted in the development of promising technologies and value creation for its members.

II. Cross-country collaboration: Food technology could benefit from information sharing partnerships with global partners, policy frameworks to support emerging technologies and infrastructural incentives, and regional cooperation through common frameworks which can help promote regional development to reach sustainable development goals (SDGs). Support towards smart protein would positively impact action towards attaining sustainable development goals that are top priority areas for India, such as food security, climate resilience, and nutrition, and can increase India's economic development by improving domestic production facilities and infrastructure that will reduce reliance on imports, and further expand export capabilities.

III. Protection of intellectual property rights of the innovators (researchers and companies)

i. The government may need to balance the promotion of innovation in the industry while also protecting the intellectual property rights of entrepreneurs, especially the ones that claim the first-mover advantage in a nascent industry, similar to the Singapore food regulator's (SFA) efforts towards protection of trade secrets. To promote innovation, the government can also incentivise and motivate researchers and companies alike to deposit cell lines in public repositories to lower the burden of entry throughout the

industry.

a. Production of cultivated meat requires the development and use of innovative technology such as the cell lines which ultimately determine many of the downstream variables to consider. Companies in the United States usually obtain patents for the cell lines developed by them. As a result, currently, there exist few publicly available cell lines for cell-based meat production. This results in slowing the innovation and ultimately the speed at which these products reach the market. To promote the growth of cultivated meat research and development as well as to protect and safeguard the intellectual property of the companies and researchers developing novel technology for cultivated meat, it will be crucial to find a balance between innovation and the protection of intellectual property rights. Patents usually take time to be granted and are jurisdictional in nature (geographically confined), which makes innovators susceptible to IP violations in their absence. To prevent this, the government can have a policy in place to protect innovations such as cell lines, etc. made for cultivated meat as a trade secret.

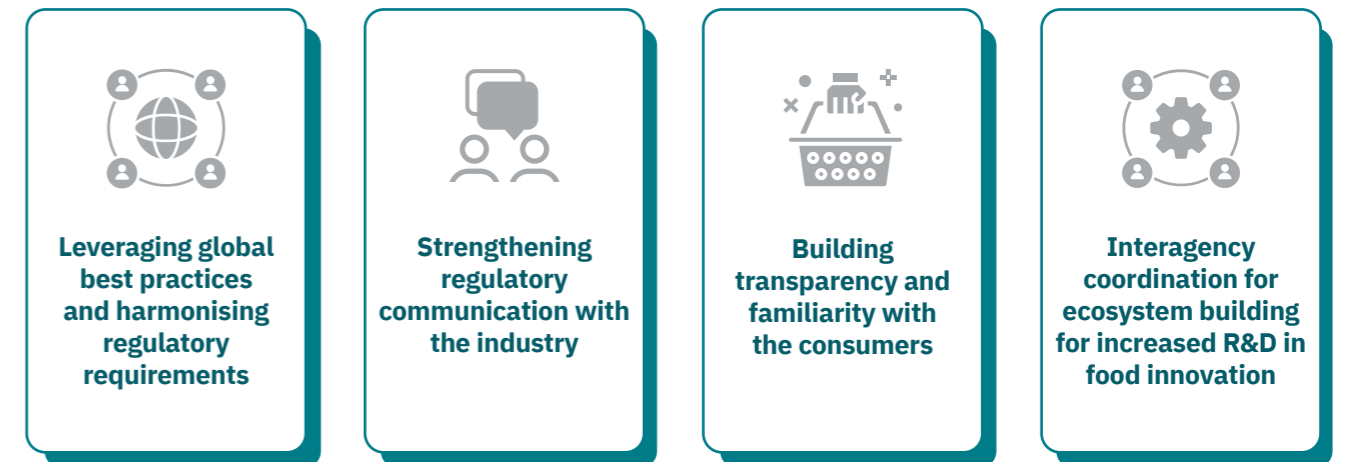
4. Building regulatory clarity and regulatory preparedness (*relevant agencies: Food Safety and Standards Authority of India*) To lay the groundwork for ushering in large scale investments in cultivated meat within the country - the relevant ministries and regulatory bodies like the Food Safety and Standards Authority of India (FSSAI) can establish regulatory clarity within existing regulation or notify a new regulation for cultivated meat regulatory approval.

²⁴FAO & WHO. 2023. Food safety aspects of cell-based food. Rome. <https://doi.org/10.4060/cc4855en>

The FSSAI can refer to reports such as the UN FAO report titled “Food Safety Aspects of Cell-Based Foods”²⁴ which brought expertise from 15 countries on regulating cultivated protein.



- I. Enabling regulatory data sharing:** Governments, regulatory authorities, and cultivated meat manufacturers should openly release any comprehensive regulatory frameworks, requirements, or datasets (when applicable) they have established or generated, e.g. data on risk and food safety assessment could be shared amongst the regulatory bodies and relied upon to reduce the duration of scrutiny of applications for market approvals.
- II. Establishing a framework for regulatory communication between the regulator and industry:** Governments could engage food businesses early in the application process to discuss requirements and gaps in their application to provide timely feedback that could potentially reduce approval timelines and provide more transparency on the development process to the regulator. Regulatory bodies such as Singapore Food Agency and Food Standards Australia New Zealand (FSANZ) have implemented this.
- III. Building a globally harmonised regulatory ecosystem:** Clear guidance and regulatory framework detailing how smart proteins are made, approved for marketing, and labelled - is essential in ensuring they have a fair path to market. At present, while the global regulatory environment is still vague and fragmented, it is developing rapidly.



As this industry is currently driven by small-scale entrepreneurs, it would help the industry players to have regulatory support from the government through enabling regulations and a supportive policy ecosystem to guide the development of the industry across the value chain. Furthermore, as the production of cultivated meat might involve the usage of recombinant proteins in culture media in which the cells grow, a clear roadmap to regulate the end product will be needed to assess the safety and nutritional profile of cultivated meat products. Visionary steps by the FSSAI to ensure that the new industry has several safety and regulatory checks in place with components of consumer awareness building can go a long way in advancing the category. Regulators of governments like Singapore, the USA, Japan, and Israel are moving ahead in this area and also building ecosystem capacity to support their efforts with academic, nonprofit, and industry inputs.

- IV. Building consumer awareness:** If smart proteins such as cultivated meat are to reach their full potential, consumers must trust them, knowing that these foods are safe to eat and that their ingredients are clearly and accurately labelled. The FSSAI’s role towards consumer education will go a long way in establishing category awareness and greater transparency about its safety and production process. Through its Social and Behavioural Change department, materials educating consumers about this category can be disseminated to create familiarity with the technology and address concerns.

V. Increasing the overall ease of doing business in India to increase domestic production capacity and help India become an export hub

(relevant agencies: Invest India, Directorate General of Foreign Trade, Department of Animal Husbandry and Dairying, Ministry of Food Processing Industries, Agricultural and Processed Foods Export Development Authority and the Marine Products Export Development Authority)

- i. Ease of Doing Business:** To allow for multilateral partnerships such as Aleph Farm and BRF in Brazil and Aleph Farm and Mitsubishi in Japan, the government can play an important role to ensure the ease of doing business by defining the available subsidies that can be extended to cultivated meat, in addition to regulatory clarity and easing the trade processes and foreign investments.
- ii. Domestic manufacturing promotion:** As part of the larger bioeconomy, smart protein can be a major win for India's Atmanirbhar Bharat and export ambitions. Easing access to capital through tax incentives for investors and for research-led innovation, and manufacturing infrastructure development are crucial areas for the development of a manufacturing industry.
- iii. Infrastructure capacity building:** Building domestic manufacturing capabilities and capacity for cultivated meat production through policy support and incentives through GOI policies such as the Production Linked Incentive Scheme (PLI) under MoFPI. Adding language such as *"food products created through emerging technologies"* in addition to RTE/RTC, poultry, and marine segments that can avail benefits.
 - a. India allows 100 percent FDI under the automatic route (a non-resident or Indian company will not require any approval from the government) for greenfield pharmaceuticals and manufacturing medical devices - it is recommended to provide a similar extension to industries manufacturing raw inputs and ingredients for cultivated meat.
 - b. While 74 percent FDI is permitted under the automatic route for brownfield projects, 100 percent under the government route is permitted for brownfield investments for cultivated meat as well.
 - c. Obtaining access and recognition within the Ministry of Food

Processing Industries' Pradhan Mantri Kisan Sampada Yojana to avail the benefits of sub-schemes such as the Integrated Cold Chain and Value Addition Infrastructure, Food Safety and Quality Assurance Infrastructure and more.

iv. Trade and export promotion: Via Make in India, Make for the World,

- a. Additional incentives for private R&D including tax incentives from bench-scale to market journey are also needed.
- b. Cultivated protein technology can be entwined with the Make In India story. This will go a long way towards positioning India as a leader in cultivated protein technology and generating interest amongst everyday consumers.
- c. Biomanufacturing facilities for cultivated meat may be located within Special Economic Zones including SEZ tax holiday benefits and priority sector lending, to aid in exports of value-added raw materials and end-product.

Conclusion

The cultivated meat industry has witnessed significant developments over the past three years globally, with key milestones such as regulatory approvals, commercial restaurant launches, increased public and private investments, tasting events, and advanced product developments from several entrepreneurs. Cellular agriculture technology has the potential to enable the production of high-quality cultivated meat and seafood but requires extensive government support through public funding, consortia building, regulatory frameworks, regulatory approvals, and consumer awareness. In India, cultivated meat presents unique opportunities to utilise its vast resources and manufacturing capabilities to employ strategically towards this emerging category and become a production powerhouse. As highlighted in the report, several nations now recognise alternative proteins, including cultivated meat, as one of the key elements required for achieving national food security and climate goals. Additionally, recent resources such as the UN FAO's report on 'Food Safety Aspects of Cell-Based Foods', emphasises the need for an evidence-based approach to determining the safety of cultivated protein products through regulations. Resources like these can help bodies such as the FSSAI to develop a comprehensive regulatory framework that covers food safety, hazard analysis, regulation and terminology of cultivated meat. There is no better time for India to showcase its technology and manufacturing capabilities and commitment towards climate-friendly innovation.

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The cultivated meat industry is an extension of the traditional meat industry's core business. Majority of Aleph Farms global strategic partnerships are with meat brand manufacturers. There is a rising population that wants to consume cultivated meat for ethical reasons, and meat processing firms are aware of this and wish to work with cultivated meat organisations. For several years, the Israel Innovation Authority has fostered R&D in critical areas like biotechnology, agriculture, and so on. The first financial assistance for stem cell research was also provided. Because this topic is well-known in Israel, the transition from stem cells to cultivated meat was not difficult. The Ministry of Health is also engaged in the implementation of obtaining regulatory approvals for cultivated meat, and three companies including Aleph Farms have agreed to participate in a pilot study to evaluate cellular agriculture cultivated meat. After Capex, the major expenditure in the cultivated meat business is the growth media itself. Now we are approaching the point when suppliers will provide growth media in food grade and at food-grade prices, and we believe that the cost will drop drastically in a few years. Once post-scale manufacturing is accomplished and massive bioreactors with high production capacity are established, cultivated meat will be price competitive. Globally, venture capitalists are exhibiting a strong interest in the cultivated meat business. At this point, venture capital investment is sufficient; nevertheless, a large-scale commercial setup is only achievable with government financial assistance to encourage this innovative industry. It will generate a considerable number of new jobs in the economy. Thus it is in the government's best interests to give substantial incentives for the growth of the cultured meat industry.”

Aleph Farms (Israel)

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Shubhankar Takle, Cofounder, Myoworks: “Cultivated meat is no longer science fiction. Its viability is rooted in technology, engineering, innovation, and ingenuity. Now is the time to figure out how to make it happen to ensure food security for the nation.

MyoWorks (India)

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Dr. Mukunda Goswami, Scientist, Central Institute of Fisheries Education, Mumbai: “Cultivated seafood/fish meat is the answer to a sustainable and environment-friendly source of alternative animal protein to achieve the sustainable goals of UNO in the future and particularly in India and particularly in India.”

Central Institute of Fisheries Education Mumbai (India)

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Subramani Ramachandrappa, Founder, Fermbox & Co-Founder Richcore Lifesciences (currently Laurus Bio)

“Cultivating cells is now a known art, the global cultivated meat industry players are now fixated on achieving price parity. Over the next few years, we will see unprecedented progress in the areas of media ingredients, bioreactor design and process engineering. We will witness cross border collaborations, like we are used to seeing in space exploration. With increasing adoption, we will see the industry evolve from being private owned, to one dominated by public-private enterprises. India’s English speaking technical workforce, natural resources, cost advantage and addressable domestic market (>71 % non-vegetarians), will make it a very attractive destination, both as a market and manufacturing destination.”

Fermbox (India)

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Authors

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About Invest India

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About GFI India

The Good Food Institute India is a nonprofit think tank working to make the global food system better for the planet and its people. Alongside scientists, businesses, and policymakers, GFI’s teams focus on making plant-based and cultivated meat delicious, affordable, and accessible. Powered by philanthropy, GFI is an international network of organizations advancing alternative proteins as an essential solution needed to meet the world’s climate, global health, food security, and biodiversity goals. To learn more, please visit www.gfi-india.org

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