

STATE OF THE INDUSTRY REPORT

Smart Protein in India



Plant-based meat products: Shaka Harry

Editors' note

As the most populous country in the world today, we find ourselves revisiting a pressing question—how do we feed 10 billion people by 2050, one-sixth of whom will be Indian? There are several paradoxes within our food systems—they are productive but unsustainable, resource intensive yet malnourished, technologically advanced but inequitable, and globally relevant yet often disconnected. Navigating a food system transformation in the country therefore, calls for a region and people-specific evidence-based approach to build the pillars of social and ecological resilience while also improving economic productivity.

The need for immediate solutions is imperative. As torch bearers of the next generation, we must be laser-focused on creating a food secure India in which nutritional gaps can be bridged sustainably. Smart protein shines as a beacon of hope with its potential to bolster our food system's resilience in a sustainable, secure, ethical, and equitable manner.

Smart protein is more than a solution. It is a journey that represents a fundamental change in how we think about food. It is a celebration of innovation, science, and culinary artistry, aiming to discover exciting yet familiar ways of nourishment while treading lightly on our planet. It caters to a wide spectrum of dietary preferences and beliefs, offering solutions for vegans, vegetarians, flexitarians, and meat lovers alike. It serves as a unifying bridge, initiating conversations about our collective duty to safeguard the environment and advocate for equitable protein diversification.

Our exploration into the world of smart protein has led us to discover, nurture, and build an incredible community of passionate individuals who are shaping its future. Their dedication and relentless pursuit of creating accessible, nutritious, and delicious alternatives to food we all know and love, instills hope and optimism. The story of smart protein in India is still being written. The pace of technological advancement in the sector is proof that exponential growth is inevitable and together, we must show resilience and pioneer a path toward a more sustainable and just food system for all.

We hope this report serves as a valuable resource for policymakers, industry professionals, investors, innovators, and consumers seeking to understand the state of the smart protein industry in India and its transformative potential. We aim to provide a comprehensive and objective overview of this rapidly evolving sector—enabling informed decisions and fostering dialogue on the future of protein in India.

Thank you for embarking on this journey with us.

With gratitude and hope,



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About GFI India's State of the Industry Report

GFI India's first ever State of the Industry Report serves as a one-stop-shop comprehensive resource for all things smart protein (also known as alternative protein). This encompasses:

- *Plant-based meat, seafood, eggs, and dairy*
- *Cultivated meat and seafood*
- *Fermentation: Meat, seafood, eggs, and dairy*

This report compiles business developments, key technologies, policy updates, and scientific breakthroughs in India over the past five years, along with a deep dive into the major highlights from 2021 through April 2023.

A note on smart protein

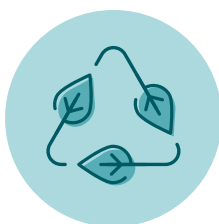
Smart protein is globally and commonly known as alternative protein. In India, the adoption of the term “smart” signifies the uniqueness of our people and market. India has often used “smart” as a prefix in the name of policies, plans, and projects to indicate renewal toward a future that is more efficient, sustainable, technologically advanced, and, thereby, smart. Smart protein is therefore positioned as a new category of innovative foods that have the potential to transform our food system, nourish our people, and renew the environment that gives us sustenance.

Symbols to look for

Throughout this report, look for symbols highlighting how developments in the past five years have advanced the smart protein sector in the areas of health and nutrition, sustainability, and path-to-market progress. Dig deeper and opportunity icons are calls to action for researchers, investors, and others seeking to learn more and advance the field.



Health



Sustainability



Opportunity



Path-to-market



Dig deeper

Please note that the Good Food Institute India is not a licensed investment or financial advisor, and nothing in this report is intended or should be construed as investment advice.

About the Good Food Institute India

As part of an international network of organizations powered by philanthropy, GFI India works alongside scientists, businesses, and policymakers to make smart protein as delicious, affordable, and accessible as conventional meat. In Asia Pacific, Brazil, Europe, India, Israel, and the United States, our teams are mobilizing the international community to use markets and technology to cultivate practices that are better for the climate and biodiversity, for food security, and for global health.

In India, we focus on three programmatic priorities:

Cultivating a strong scientific ecosystem

GFI India's science and technology teams map out the most neglected areas that will allow smart proteins to compete on taste and price. We develop open-access research and resources, educate and connect the next generation of scientists and entrepreneurs, and drive funding for research that benefits smart protein development across the sector.

Influencing policy and securing government investment

GFI India's policy team ensures that smart proteins are a part of the policy discussion around food and nutrition security, climate change mitigation, and public health. We advocate for government investment in smart proteins and regulatory approval of novel proteins such as cultivated meat.

Supporting industry to advance alternative proteins

GFI India's corporate team engages with the largest food corporations and startups innovating across the value chain. We facilitate partnerships, curate ecosystem activities, work with investors, and represent industry to the government to scale the supply chain faster than market forces alone.

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- **Newsletters** | GFI's suite of expertly curated newsletters puts timely news, insights, and opportunities right in your inbox. Check out gfi.org/newsletters to find the ones most suitable for your interests.
- **GFIdeas India community** | Through the [GFIdeas India Community](#), we host [online](#) webinars with leading experts from across India: The series focuses on topics related to starting and scaling a good food business as well as cutting-edge research developments that enable smart protein innovation. Community members also get access to a monthly newsletter that keeps them informed about any developments in the smart protein industry, upcoming events, hiring requests, community updates, and new resources.

This State of the Industry Report series, as well as all of GFI's work, is made possible by gifts and grants from our global family of donors. If you are interested in learning more about giving to GFI, please visit [here](#) or contact philanthropy@gfi.org

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Executive summary

Executive summary

The smart protein sector in India has seen immense development over the past five years. From a novel category that was unheard of, it has now struck discourse across businesses, consumers, investors, and the government. This report provides an in-depth look at key developments in the sector, summarized below.

Commercial landscape

- India now boasts over 113 startups across plant-based, fermentation, and cultivated proteins and a network of 100+ companies supporting its growth.
- This enabling ecosystem has seen prominent players plug in at every section of the value chain—from ingredient suppliers like **AAK and ADM**, and manufacturing companies like **Symega** to large conglomerates like **Tata** and **ITC** launching their own smart protein range of products.
- There are a total of 377 products, across 41 formats, and 73 smart protein brands across meat, eggs, and dairy available in retail and e-commerce channels.

Investment

- Globally, the alternative protein sector has attracted **\$14.2 billion**¹ over the last decade, with year-on-year investment nearly doubling on average.
- In India, between 2016 and April 2023, the sector has seen investment from 34 venture capital funds, 27 angel investors and family offices, two corporates, one investor syndicate, and three grant-provisioning organizations.
- In 2022, companies based in APAC saw 43 percent year-over-year funding growth to reach \$562 million. For the first time in the alternative protein sector's history, investments from outside of North America represented the majority share of the global total (58 percent vs. 42 percent). In India, smart protein startups recorded a modest **\$17Mn** in investments over 2021 and 2022 across all three categories.

Science and technology

- In the last five years, India's smart protein industry has embraced a significant number of technological interventions leading to the development of novel protein ingredients and a wide range of alternative protein products.
- Strategic public-private partnerships (PPP) and collaborations between the food industry and equipment manufacturers have accelerated ingredient and product innovations and manufacturing capacity (extrusion facility) in the plant-based smart protein sector.

- Indian contract development manufacturers have emerged as key suppliers of precision fermentation-derived cell culture media ingredients to leading cultivated meat companies across the globe, demonstrating India's advanced biomanufacturing capabilities that meet both cost and scale requirements of the industry.

Government and regulation

- The last two years have seen increasing interest from the Indian government in smart protein as a mechanism for different policy programs. In 2023, the **Department of Biotechnology (DBT)** instituted a sectoral committee on smart proteins, through which it will invest further in the smart protein sector to improve India's bioeconomy.
- Regional governments are realizing the potential of investing in the smart protein sector. In 2022, the Maharashtra government set a target of achieving a \$1 trillion economy by 2030 and has included smart protein as a pillar to help reach that target.
- **The Food Safety and Standards Authority of India (FSSAI)** has granted approvals to several plant-based companies and a few fermentation-derived companies to enter the market—marking significant progress for the smart protein industry.

A close-up photograph of a hand holding a piece of plant-based mutton curry. The hand is positioned at the top, with the thumb and index finger gripping a piece of the food. The food is a thick, brown, and slightly charred piece of meat, dripping with a rich, orange-red sauce. Below the hand is a black, shallow bowl filled with the same plant-based mutton curry. The bowl contains several pieces of the meat, all coated in the thick, orange-red sauce. A small sprig of fresh green cilantro is garnishing the top of the dish in the bowl. In the background, a blurred plate of food is visible, including what appears to be a lemon, some purple onions, and a green chili. The overall lighting is warm and focused on the food, creating a high-quality, appetizing look.

Section 1

Introduction

Introduction

Smart proteins are proteins produced from plants or animal cells, or by fermentation. These innovative foods are designed to taste the same as or better than conventional animal products while costing the same or less.

Smart protein is envisioned to become its own new category in the grocery aisle—one that would include protein alternatives that are plant-based, fermentation-derived, or cultivated from animal cells. Plant-based alternatives span the sub-categories of meat, dairy, eggs, and seafood. Cultivated meat and seafood refer to meat and seafood grown from animal cell lines cultured in nutrient-rich growth media. Fermentation is used as an enabling technology to produce specific functional ingredients such as flavors and fats that feed into making an end product such as a plant-based mutton keema or to produce animal-free dairy proteins like casein and whey, or to synthesize purified protein components required for manufacturing cultivated meat.

Globally, alternative protein has been adopted as a solution for a complex web of challenges all leading up to the biggest challenge of climate change that is prescribed to affect livelihoods, agricultural production, food security, and public health. Similarly, smart protein presents a compelling solution in India for several reasons:

Environmental sustainability: India faces significant environmental challenges stemming from the rice-wheat cropping system-led agriculture. These [challenges](#) include deforestation, water scarcity, deteriorating soil quality, and substantial greenhouse gas emissions from crops and livestock activities at the farm level, estimated to be 650 million metric tons (MMT) CO₂e annually. Smart protein technologies, such as plant-based and cultivated proteins are inherently more sustainable. They require fewer natural resources, emit fewer greenhouse gases, and have a smaller ecological footprint due to minimal land and water usage, making them a viable solution to address these sustainability challenges.

Agricultural resilience: Smart protein can help strengthen the existing agricultural value chain by diversifying the crops grown. Crop diversification supports improved biodiversity, enhanced soil health, and mitigates risks associated with crop failure, leading to more protected outcomes for farmers and a more reliable food supply.

Population growth and food security: India's population is steadily increasing, and with it, the demand for food. Smart protein offers a way to meet the growing demand for protein without exacerbating resource scarcity. These technologies can efficiently produce protein in controlled environments, reducing the pressure on land and water resources. Smart protein technologies can enhance food security by providing a reliable source of protein that is less vulnerable to climate-related disruptions, diseases, and other challenges that often affect traditional livestock farming. Further, they can be tailored to produce protein with minimal waste, reducing overall food loss in the supply chain.

Health and nutrition: Dietary patterns in India are changing, with an increasing prevalence of lifestyle-related diseases. Smart protein options provide essential nutrients while reducing the consumption of saturated fats and cholesterol, potentially improving health outcomes. Further, they reduce the risk of antimicrobial resistance and zoonotic diseases that pose a considerable threat to India's public health systems.

Cultural and dietary preferences: India has a diverse population with a wide range of dietary preferences, including a significant vegetarian population. Smart protein products offer culturally resonant protein alternatives and regionally adaptable protein sources, promoting inclusivity and culinary innovation.

Economic opportunities: The smart protein industry presents substantial economic opportunities for job creation, entrepreneurship, and investment. India can position itself as a hub for smart protein innovation, research, and production, which can contribute to economic growth and technological advancement.

Global export potential: As the global demand for sustainable and ethical protein sources grows, India can position itself as an exporter of smart protein products, contributing to its export revenue and strengthening its position in the international food market.

In summary, smart protein is a solution for India because it addresses critical issues of sustainability, health, culture, economics, and food security. By embracing and promoting smart protein technologies, India can chart a path toward a more sustainable, inclusive, and resilient food system that meets the evolving needs of its population and contributes to global efforts to combat climate change and resource depletion.

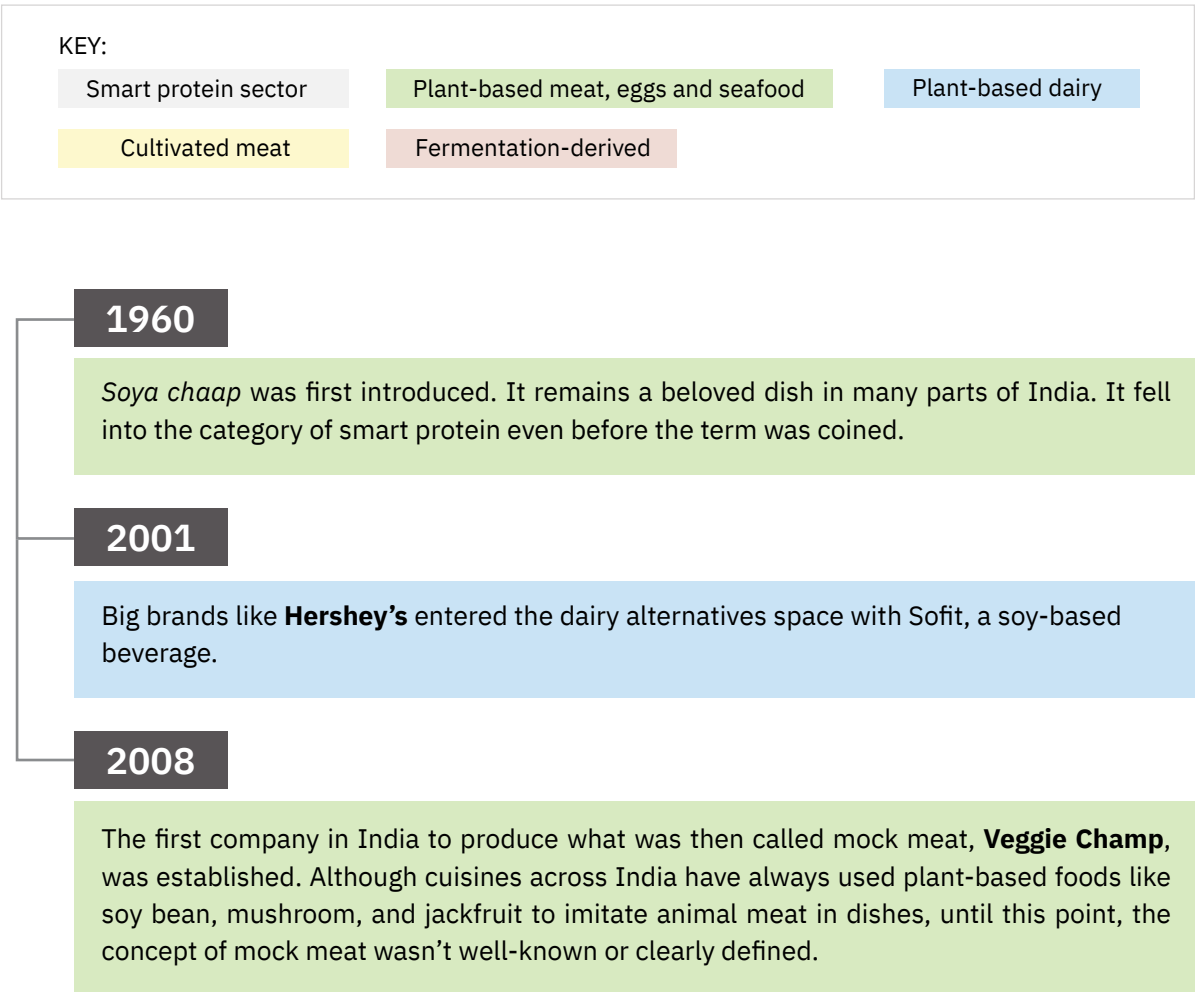
History

While meat-like products such as *soya chaap* have existed since the 1960s and have successfully established a new category of their own, it was only in 2018 that a widespread association of smart protein as an alternative to animal-derived protein began taking shape.

Indian cuisine has incorporated nut and plant-based milks for millennia. *Badam* milk is a beloved drink, often accompanying North Indian sweets, while coconut milk is integral to various Goan and South Indian curries. However, people did not begin using them as alternatives to animal-derived dairy until the late 2000s.

In comparison, cultivated meat is a more nascent yet rapidly evolving domain of protein production. Like other transformative innovations in their early years, cultivated meat faces challenges such as scaling, cost reduction, and a clear regulatory path to market. While it will take some time before cultivated meat products become commercially available in the Indian market, a handful of notable research institutes and companies are making significant headway in the space.

Key developments up to April 2023:



2010s

As the awareness and prevalence of plant-based diets, veganism, and lactose intolerance increased in India, the market for dairy alternatives diversified to include options such as almond and oat milk.

2008-2018

During this decade, a few other companies launched meat alternative products. These were typically categorized as mock meat or vegan meat and were made from textured vegetable protein (TVP).

2018

The **Good Food Institute** established an affiliate organization in India, and the alternative protein sector was contextualized to the Indian subcontinent, leading to the use of the term smart protein to represent the three types of alternatives to animal-derived protein.

More companies began to venture into this new category, and many began positioning their products as plant-based alternatives.

Popular brands like **Epigamia**, **Urban Platter**, and **Raw Pressery** entered the dairy alternatives space with unflavored milk substitutes that could be used flexibly in food preparation.

2019

The **Center for Cellular and Molecular Biology (CCMB)** in India received a substantial ₹4.5 crore grant (among the highest of any government funding for cultivated meat at the time) from the Department of Biotechnology for research on cultivated meat.

Brands began to innovate incorporating new technologies in extrusion, developing new flavor profiles, and contextualizing them for the Indian palate.

2020

The Covid-19 pandemic wreaked havoc across various aspects of life. Several nations' food systems were heavily affected by not being able to trade, transport, and, in some cases, even grow food. The nature of the highly infectious virus further highlighted the potential dangers of zoonotic diseases arising from animal agriculture. A deeper acknowledgment of the necessity of alternatives emerged across consumers, markets, and governments.

The plant-based dairy market diversified further to include ingredients like millets and other indigenous crops.

This period also saw a proliferation of alternative dairy end-products such as *curd* (yogurt), cheese, and even *ghee* and *paneer*.

The cultivated meat sector witnessed its genesis with the establishment of three startups.

2021

23 startups launched with over 300 products on the shelves. These spanned plant-based alternatives to meat, dairy, eggs, and seafood.

2022

Notable conglomerates like **Tata Consumer Products** and **ITC** entered the market with plant-based meat alternatives, showing that the smart protein category is here to stay. Revolutionary online retail platforms like **Amazon** and **Swiggy** began to list plant-based products.

There was a total investment of ~₹548.4 crore (\$6.6 million) in smart protein in India.

2022 also saw the rise of two more startups working on cultivated meat and one focusing on cultivated seafood, the first of its kind in India.

2023

Smart protein was chosen as one of the six thematic sectors under the policy priorities for high-performance biomanufacturing by the Indian government.

As a first in precision fermentation, **Perfect Day**, an animal-free dairy startup received pre-market regulatory approval while homegrown startups like **Phyxx44** and **Zero Cow Factory** made significant headway.

A collection of plant-based meat products from Plantaway. In the center, a white bowl is filled with golden-brown, irregularly shaped fried nuggets. To the right, a sesame seed bun burger sits on a wooden board, featuring a thick plant-based patty, melted cheese, lettuce, tomato, and sauce, accompanied by french fries. In the foreground, several long, cylindrical fried items, possibly falafels or vegetable sticks, are garnished with fresh cilantro. Other dishes include a bowl of fried items in the top left, a small bowl of orange sauce at the top, a bowl of coleslaw on the right, and a bowl of dipping sauce at the bottom right.

Section 2

India as a unique geography

India as a unique geography

The Indian target market

India has reached the landmark of becoming the fifth-largest economy in the world and is on its way to becoming the third-largest by FY27–28. With a population exceeding 1.4 billion, of which more than half (52 percent) is below the age of 30, India's demography is younger than any major economy. It boasts a vibrant diversity of people, languages, cultural traditions, and eating habits.

Local tastes and cuisines

Indian food consists of various regional and traditional cuisines native to the Indian subcontinent. With variations in soil, climate, culture, ethnic groups, and occupations across regions, these cuisines vary substantially between different states and sometimes within a few miles of the same state. Along with many vegetarian options, Indian cuisine also has non-vegetarian² delicacies made with fish, lamb, goat, chicken, and other meats. Most tier-I and tier-II cities in India have specialty restaurants serving authentic local dishes from different states. Global cuisines like Italian (pizzas and pasta), Chinese (noodles and fried rice), and American (burgers) are also quite popular in India. More recently, there has been an increase in interest in other cuisines like Lebanese, Mexican, and Pan-Asian (non-Chinese), especially in metro cities. **However, most of the popular global cuisines are also served with an Indian touch, emphasizing the importance of localization of taste.**

The Indian food service industry has extensively altered Chinese food and spices over the last few decades, with Indo-Chinese becoming a cuisine in itself. Dishes like *gobi manchurian* (*manchurian* made with cauliflower), *Chinese bhel* (a localized version of American chop suey where crispy fried noodles and stir-fried vegetables are mixed with a combination of sweet/sour and tangy sauces), *schezwan dosa* (Indian pancakes topped with schezwan sauce and stir-fried vegetables), and vegetarian versions of momos and spring rolls are popular across restaurants and street hawkers in the country.

Menu localization has been a critical driver for growth for many western quick service restaurants (QSRs) as well. The *McAloo Tikki* burger (made with a potato patty) by **McDonalds**, Veg. *Makhani Burst* burgers (patties made with vegetables and lentils) by **Burger King** and **KFC's** *Biryani Bucket* (chicken legs with spiced gravy and flavored rice) are some classic examples of *Indianized* offerings by established multinational chains. Pizza chains have localized their menu with Indian versions of toppings like *tandoori* mushrooms and peppery *paneer* while **Subway** has offerings like *tandoori tofu* and *chatpata chana* (spicy roasted chickpea), among others.

Most meals in India are home-cooked and freshly made

Since most meals are home-cooked and served hot in India, the [frequency of eating out](#) is lower (1.1 times a week) compared to markets like the U.S. (3.6 times a week) or China (2.6 times a week). Nevertheless, with the increase in double-income families, more women in the workforce, urbanization, and increasing aspirations, out-of-home food consumption has steadily risen in urban areas. Covid-19 has accelerated the growth of the ready-to-cook segment and meal kits as consumers have broadened their culinary engagement and brought home the joy of dining out. This trend started with packaged non-vegetarian and potato products and has expanded into a range of Indian and global dishes like *parathas* (a type of Indian bread), *rajma masala* (a gravy made with kidney beans), *dal makhani* (a creamy curry made with lentils), nuggets, patties, *kebabs*, sausages, momos, and sweets.

Cultural and religious influences on meat consumption

While the typical Indian diet is predominantly vegetarian, [77 percent of Indians](#) consume meat daily, weekly or occasionally. 39 percent of women and 49 percent of men consume fish, chicken or meat at least once a week. With over a billion people eating non-vegetarian food, India is a massive market for meat and seafood. However, various cultural, religious, and social pressures in India also influence several consumers who eat meat or eggs.

- From a religious standpoint, different religions in India have restrictions on (including abstinence from) one or more types of meats. Where permitted, meat consumption can vary depending on days of the week or times of the year in line with religious observances.
- Beef is considered taboo by most and is consumed by only a handful of minorities. A majority of Indian states have regulations prohibiting the sale of cow meat.
- Some households do not accept non-vegetarian food for indoor consumption.

Meat in India is not the entire meal, it's a part of the meal

Indian staple foods include whole wheat flour, rice, millets, lentils, and pulses, which are cooked using locally available spices, herbs, vegetables, and fruits. On most occasions, meat is consumed as one component of a diverse plate (*thali*), rather than as a standalone entrée or the meal's centerpiece. It is consumed as an accompaniment along with rice or *rotis* (bread), typically made of wheat or other grains like millets. It is also cooked along with rice into *biryani* or *pulao*.

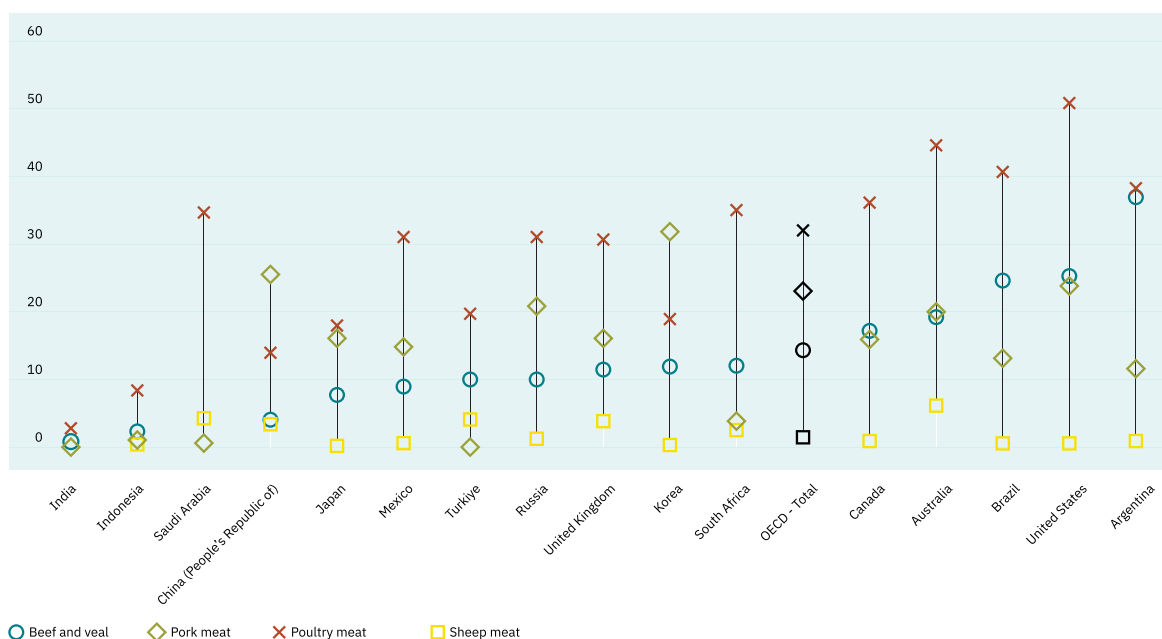
[American meat consumption patterns](#) highlight one hero category, the burger, which is consumed thrice a week, on average. Conversely, **India has multiple regional favorite dishes made with meat ranging from *biryanis* and fried rice (rice cooked with meat) to roasted chicken, *tandoori* chicken (chicken cooked on charcoal or firewood in a cylindrical oven), chicken/mutton stew/*korma*, *chicken 65* (diced and fried in batter), *kebabs* (cubes of meat marinated and cooked on a skewer), fried chicken, and home-style traditional gravies.**



Per-capita meat and seafood consumption

According to the [fifth edition](#) of the National Family Health Survey (NFHS-5), although 77 percent of Indians are non-vegetarians, only 7 percent of the population has meat and seafood daily, and about 44 percent have it once a week. India's annual per capita meat consumption is 3.8 kg, compared with 101 kg in the U.S. and 47 kg in China. Poultry takes most of the share of consumption with 2.7 kg, followed by beef and sheep meat. The [average per-capita fish consumption](#) in India is 9 kg per annum against the global per-capita fish consumption of 16 kg.

Fig 1: Per-capita meat consumption by country



Note: Sheep includes goat and sheep. In India, consumption is primarily of goat meat.

Source: Meat consumption per capita by country, OECD-FAO Agricultural Outlook (Edition 2021)

Indians are protein deficient

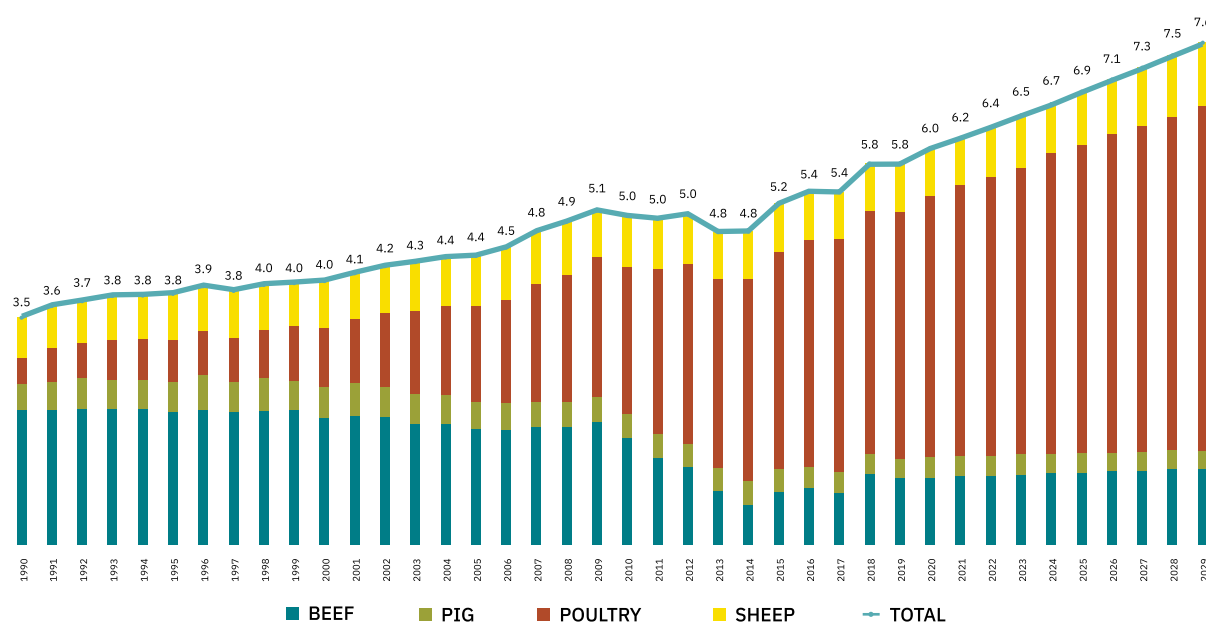
When we look at Indians' daily calorie intake, they consume more whole grains like wheat, rice, and other cereals and less protein than recommended. According to the [EAT-Lancet Commission report](#), **while the dietary recommendation for protein is about 30 percent of the total calorie intake, Indians consume only six to eight percent.**

This protein deficiency is driven by a low frequency of meat consumption along with a low quantity of protein consumption. Affordability and socio-cultural factors, mentioned in section 2.2.3, are the key reasons for lower meat consumption.

Meat consumption is on the rise

With increased incomes and aspirations, per-capita meat consumption in India is projected to increase in the coming years. India consumed six million metric tons (MMT) in 2020 and is expected to consume 7.6 MMT by 2029. Chicken dominates as the primary protein source, contributing to 66 percent of meat consumption. With better affordability, health benefits, and relatively lesser religious association, chicken consumption is experiencing rapid growth and is expected to reach 5.4 MMT by 2029. Though mutton (goat meat) is considered a delicacy, consumption is relatively low on account of higher price points, taste variability, and potential health implications, whereas buffalo and pork consumption remains limited. Meanwhile, India is the world's [second-largest fish-producing](#) country, accounting for 7.58 percent of global production. Notably, fish production in India reached an all-time high of 14.16 MMT during 2019–20.

Fig 2: Meat consumption in million metric tons (MMT)



Source: Meat consumption in million metric tons for India, OECD-FAO Agricultural Outlook (Edition 2021)

The dairy prevalence

India, the world's largest producer and consumer of milk, contributed to [24 percent of global milk](#) production in 2021–22. On average, [nearly half of India \(48.8 percent\)](#) consumes either milk or *curd* (or both) daily. A cup of milk tea in the morning is a ubiquitous daily ritual observed across households of diverse socio-economic backgrounds. In India, dairy transcends dietary and nutritional uses. Most Hindus also use dairy products for religious purposes. For example, *ghee*, or clarified butter, is used to light lamps for rituals. Milk is used to bathe Hindu idols on special occasions. Sweets made from milk or *ghee* are first offered to gods. The Indian dairy sector—employing almost 80 million rural households, contributes to about [five percent of the country's GDP](#). As the primary source of income for many small/marginal farmers and the landless, the dairy sector has significantly contributed to the growth of the rural economy in India.

The case for India's food system

Agriculture continues to be a critical sector for India, with at least 42 percent of the population dependent on it for their livelihoods, according to a [recent report](#) by NITI Aayog and FAO. The sector contributes to 16.5 percent of the GDP and has taken India from being a food-deficit country to one of the biggest exporters of a range of agricultural commodities over the last four decades. However, as the global population surpasses an overwhelming eight billion, agricultural productivity stagnates, and the threat of climate change accelerates, India's agricultural sector stands at a critical moment of ensuring viable and enduring livelihoods to the millions of smallholder farmers as well as food and nutritional security to a national population projected to reach 1.6 billion by 2050.

The eight-billion global population milestone underscores the increasing dependence on agricultural sustainability to produce 60 percent more food to feed the planet by 2050. Globally, over the past few decades, a shift toward unsustainable agricultural practices like increased usage of chemical inputs and increased pest threats has led to soil erosion, loss in soil nutrition, and depleting groundwater levels—eventually leading to a drastic loss in yields and frequent crop failures. According to the [Global Food Policy Report 2022](#) by the International Food Policy Research Institute (IFPRI), soil erosion in India will diminish up to 10 percent of crop yields by 2050. This is staggering and is equivalent to removing millions of hectares of land from crop production, significantly impacting food supply.

Moreover, regenerating this topsoil is an extremely gradual process, with only one centimeter forming in over 1000 years. Healthy groundwater levels are pivotal to food security and account for 60 percent of irrigation supplies in India—a country that is incidentally the world's largest consumer of underground water. Heavy dependence on water-intensive crops such as rice and wheat, coupled with increased groundwater consumption for domestic uses, is rapidly depleting this critical reserve. While the rice-wheat cropping system has been integral to India's food grain sufficiency, its excessive application across the country has [led to serious challenges](#) of declining productivity, groundwater depletion, soil deterioration, and high greenhouse gas (GHG) emissions.

Therefore, in India, where the agricultural sector employs almost half the country's population, the need to adopt sustainable practices is especially urgent—something that the Ministry of Agriculture and Farmers Welfare (MoAFW) also acknowledges. This fundamental shift would require a reimagining of not only how we produce but also what we produce.

Smart protein has the potential to emerge as a viable and essential strategy to mitigate many of these challenges. Integrating indigenous and sustainable agricultural produce into the value-added smart protein processing supply chain can enhance and diversify farmer incomes. Simultaneously, it will necessitate the adoption of efficient agricultural and post-harvesting practices for quality control at the farm level.


The potential of indigenous crops

Today, the primary ingredients for plant-based meat alternatives around the world are soy, peas, yellow peas, and fungi, as these are the most available commodity crops. India is a major producer of peas and soy with high productivity and large areas under cultivation. India also produces a large variety of legumes like chickpea, mung bean, and pigeon pea that hold great potential to enhance the nutritional value and functionality of plant-based smart protein products.

According to the MoAFW, India is the world's largest pulses producer, with approximately 28 million hectares of area under pulses cultivation in 2021. Over the last five years, government interventions have also played a pivotal role in improving India's productivity of pulses, bringing it up to nearly 885 kilogram/hectare. Ongoing crop improvement programs on improving yield and nutrient content, under the leadership of ICAR-Indian Institute of Pulses Research, further signify that India will keep improving the quality and production capacity of pulses. Millets, another cereal crop similar to rice and wheat, are more nutritious in terms of proteins, minerals, and vitamins. Their potential to be incorporated as ingredients into smart protein products is also being encouraged by the government. The International Year of Millets initiative has further bolstered global cooperation to promote millets in various ways, and smart protein ingredients' optimization is where India can take the lead.

- Pea is India's third most popular rabi pulse, with a production output of approximately 891 MMT in 2021.
- Soybean production in India has seen a major boost in the past decade not only because of a surge in demand for soybean oil but also for its high protein and fiber content, making processed soybean in various forms a common meat substitute. The oilseed has witnessed a large increase in area under cultivation with enhanced manufacturing and processing. The current production of soybean in India is ~12.72 MMT (2021–22), with Madhya Pradesh and Maharashtra as its largest growers.
- Nearly 99 lakh hectares of cultivable land in India is used for growing chickpea, with a majority coming from the states of Madhya Pradesh and Maharashtra. According to the MoAFW, the crop harvested a record production of 107 lakh tons in 2021–2022. The functionality and nutritional value of chickpea has immense potential for innovation in plant-based meat products and is increasingly becoming a sought-after crop for many smart protein ingredient manufacturers.
- The total cultivated area for mung beans has also seen a phenomenal increase in the past five years, with about 50 lakh tons of land growing the crop. The utilization of mung beans in plant-based meat and egg production is a great opportunity for India to carve itself as a leader in ingredient manufacturing.
- Over the past few decades, even as the area under millet cultivation dropped by 56% in India, production increased from 11.3 to 16.9 MMT. This was possible through developing and adopting improved varieties and hybrids, and better crop management practices. Despite a

consistent reduction in the area of cultivation since the 1960s, the estimated yield has more than doubled as a direct result of increased productivity and capacity-building initiatives by the government.



Incorporating various indigenous legumes, pulses, and millets into smart protein products can help India's agricultural sector improve soil health, reduce and reverse groundwater depletion, diversify crops, improve farmer welfare, and socialize sustainable farming practices.



Millets as ingredients of smart protein products is a step toward diversification and inclusion of protein sources from growing plant-based alternative food segments. Millet-based smart protein products will improve the functionality and nutritional value, and enhance the socio-economic opportunities for small and marginal millet farmers and local agro-processing value chains.

Dr. Rashmi Sharma, Department of Science and Technology,
during the millets-based alternative protein roundtable.

As the ingredient supply chain for smart proteins continues to be localized, innovation and growth in the smart protein sector can incentivize a shift toward crop diversification at the farm-level and optimization of the crop quality for smart protein ingredients and manufacturing. This would also contribute toward the government's push for sustainable agriculture through the National Mission for Sustainable Agriculture (NMSA). Diversity in crops grown, judicious use of natural resources, improved nutritional profiles of food crops at harvest, and value addition at the farm level to improve farmer incomes are all achievable through the indigenization of the smart protein supply chain.

The development of smart proteins as a mainstream choice also has the potential to address the concerns of nutritional security. While India is food secure in terms of cereals, our nutritional needs remain unmet. According to the [Global Food Security Index 2022](#), 16.3 percent of India's population is undernourished. [Some estimates](#) of protein deficiency in the Indian population peg it as high as 80 percent. The [Protein Paradox](#) study by the Right to Protein initiative highlighted the misconceptions and the lack of awareness about adequate protein consumption in the country. **Alternative protein products, made from domestically grown agricultural produce, are comparable in taste and price to those from animal sources. Produced at scale without the risks of industrial livestock farming, both vegetarians and meat-eaters could enjoy these products equally, potentially revolutionizing nutrition levels in India.**

India as an export hub

India has close to 60 percent of agricultural land and a similar percentage of the population involved in agriculture. With diverse climatic agro-zones, India is a gateway to multiple global ports. India is the largest producer of pulses, with a sizable institutionalized system of pulses processing and manufacturing. Combined, these factors position India well for strengthening its agro-economy with plant-based foods. **Indian agriculture is primed to provide inputs, raw materials, and end-products for the global plant-based foods market, which is estimated to be anywhere between \$85 billion (as per UBS) to \$240 billion (as per Credit Suisse) globally by 2030.**

Table 1: Export market potential for India

	Low growth	Medium growth	High growth
Export potential (₹ Cr)	Total	Total	Total
Plant-based meat	2,194	4,722	6,824
Plant-based dairy	459	1,208	1,889
Plant-based egg	266	432	631
Fermentation-derived	351	604	819
Cultivated meat	1,312	2,415	4,158

Source: Smart Protein Economic Analysis by GFI India and Deloitte, 2022

The table above shows the export potential for smart protein alternatives under three demand scenarios. To keep up with this projected demand, the plant-based supply chain will need to scale rapidly to produce inputs of optimum quality that adhere to globally accepted and recognized standards. Based on publicly available forecasts of plant-based meat demand and production needs, GFI's [report](#) explores a production scenario set in 2030, where plant-based meat has captured 6 percent of the global meat and seafood market, necessitating the production of 25 MMT of plant-based meat annually. Such a scenario would require a 3–10x increase in ingredients supply to be pumped into the current supply chain. This presents a lucrative opportunity and incentive for Indian ingredients manufacturers to create robust R&D and value chains for native and novel crops to be viable raw materials and inputs for plant-based foods globally.



To tap into this opportunity, there is a need for enhanced, cost-effective, value-added processing and manufacturing capacity, and more research and development in crop optimization for plant-based ingredients' end-use applications and functionality.

India's excellent infrastructure and talent from the biotechnology and bioprocessing industries can be leveraged to produce food-grade inputs for smart protein products, which are manufactured using precision or biomass fermentation. Some companies that are ahead of the curve have started working on scaled up production of precision fermentation-derived functional ingredients such as animal-free culture media supplements necessary for cultivated meat production, with a select few already building pathways for export.



There is a growing popularity and demand of plant-based foods, including plant-based smart proteins, in developed countries. This is an excellent opportunity for India, with its abundant cultivable land and a significant population engaged in agriculture, to alleviate its crop biodiversity to diversify the global protein supply chain. We see this as having substantial potential to boost export numbers and benefit Indian farmers in the process. APEDA has been looking at the plant-based alternative category very positively and working to streamline the production and certification process to boost Indian plant-based alternative exports through its National Programme on Vegan Products (NPVP). The program aims to position India as an export leader in this category by producing and exporting high-quality "vegan" and plant-based products that adhere to domestic and international standards. India is the first country to have started working on specific export standards for plant-based foods.

V. K. Vidyarthi, General Manager, APEDA

Case studies

Some Indian companies producing key ingredients and end products have identified the export market as a key opportunity for growth while the Indian market develops over the next decade. Many are actively conducting R&D to utilize indigenous crops in smart protein products.

The post-pandemic diversification of the global supply chain has positively impacted the growth of India's exports. For instance, in the chemical industry, Indian manufacturers consistently leverage India's cost advantage, strong supplier base, and strengths in research and development. Similarly,

the smart protein sector has the potential to boost India's push for export-oriented manufacturing and the government's aim of growing India's exports to \$2 trillion by 2030 while also creating high-skill and well-paying jobs.

- **Laurus Bio** develops animal-origin-free recombinant proteins, growth factors, and cell-culture media supplements to cater to culture media requirements of leading cultivated meat companies across the globe, meeting both the cost and scale requirements of these industries.
- **Greenest Foods** [shipped](#) India's first plant-based meat export consignment of 5,000 kg to the U.S. from Gujarat in 2022.
- **Wakao Foods** [shipped](#) one of the largest-ever shipments (13 tons) of jackfruit-based products to the U.S. in 2023.
- **Shaka Harry** announced its [expansion](#) into Singapore in 2023, where it will introduce 15 innovative products at the Mustafa Centre.
- In 2022, **Blue Tribe Foods** rolled out its signature line of products in Singapore across supermarkets, stores, and online platforms such as **Waangoo**.
- **BVeg Foods** [supported](#) **Haldiram's International** in the production and launch of their Plant Perfect range of plant-based meat and protein products for the U.S., EU, UK, and Australia markets. BVeg also shipped 22 tons of frozen plant-based beef chunks to the UK in July 2023.
- As of 2021, **GoodDot** [exports](#) its products to Singapore, Canada, Nepal, the UAE, South Africa, Oman, and Mauritius, with plans to enter the U.S., UK, and other European markets.
- **Evolved Foods** is exporting its plant-based meat products to Singapore and Nepal.



While most smart protein brands are based in the top three metros of the country, **Oatmlk**, a Kanpur-based oat milk brand, became one of the first plant-based dairy brands in India to export its products to the UAE and Singapore, showcasing that it's possible to build a brand with global reach from anywhere in India. New brands from tier-II and tier-III cities will play an important role in India's export story in the coming decades.

A note on GFI India's mission for smart protein

The focus on smart protein stems from the unique circumstances of India's political economy, which necessitate bold and visionary leadership more than in other geographies. As an agrarian economy, food systems are integral to India's social, economic, and cultural fabric. Any shocks to these systems can have a monumental impact on our ecology, livelihoods, food security, resilience, and public health. This was increasingly evident after the Covid-19 pandemic, the effects of which we are still experiencing. The status quo is untenable—we need to build a food system that is sustainable, inclusive, and secure. As the central expert and convening body, GFI India's work on the transition toward smart protein is powered by four major initiatives:

- **Smart Protein Innovation Hubs Initiative:** The Smart Protein Innovation Hubs serve as focal points where researchers, innovators, and creators nurture ideas into game-changing scientific breakthroughs. The Hubs help stimulate scientific advancement while fostering talent development for the next-generation of quality workforce. Based at India's top universities and research centers, the Hubs are launching course curriculum specific to the science of smart protein and are filling critical research gaps through incubation and supporting startups from inception to growth stages in partnership with investors and the industry at large.
- **Smart Protein Manufacturing Futures Initiative:** The Smart Protein Manufacturing Futures Initiative seeks to build critical infrastructure in India to feed the growing global demand for protein, and aspires to expand manufacturing at scale for a future market. The focus of the Initiative is toward building dashboard-level data of the infrastructure needed across various technologies and working closely with the government to align smart protein with national efforts to invest in biomanufacturing. The Initiative also aims to ensure that we leverage India's advanced expertise in biopharma, industrial fermentation, food processing, and agri-value addition to drive local end-to-end processing to deliver high-quality, made-in-India, affordable ingredients and end-consumer products.
- **Indigenous Agriculture Initiative:** The Indigenous Agriculture Initiative seeks to advance value addition and farmer welfare by building fast-growing end markets for agricultural produce. This is facilitated by creating robust R&D and value chains for crops such as pulses, legumes, millets, and hemp to be viable raw materials for smart protein foods, thereby diversifying global input for the sector. This allows smart protein companies worldwide to leverage underutilized, highly diversified, and high-protein sources to deliver superior functionality, more nutritious, and cleaner labels of smart protein offerings. With support from crop researchers and food scientists, research from this initiative translates to crop diversification opportunities and new income streams for farmers.
- **Smart Protein Corridors Initiative:** The Smart Protein Corridors Initiative looks to leverage and deepen bilateral relationships for mutual gain with markets such as Israel, Singapore, the United States, Japan, Canada, and Australia. The aim is to foster technology transfers, trade, bilateral investments, business, and talent development that will help advance the

global alternative protein market. The Corridors Initiative involves direct collaboration on mutually beneficial initiatives with stakeholders ranging from policy-makers, regulators, academics, universities, industry bodies, investors, and governments. A cross-country collaborative approach helps facilitate knowledge exchanges, set standards, and promote international cooperation for the growth of this new industry.

Fig 3: Initiatives under the mission for smart protein



**Smart Protein
Innovation Hubs
Initiative**



**Smart Protein
Manufacturing
Initiative**



**Indigenous
Agriculture
Initiative**



**Smart Protein
Corridors
Initiative**



Section 3

Commercial landscape

Commercial landscape

The smart protein sector is still in its early stages, actively working to develop tasty, healthier, cost-effective, and environmentally friendly alternatives to traditional animal-based products. Targeting the early adopters in the urban cities in India, the category is estimated to be around ₹350 crore with a split of ₹100 crore and ₹250 crore between plant-based meat and dairy, respectively. Growth from here depends on how soon the category can achieve key milestones like taste and price parity with traditional animal-derived products and reach consumers beyond the key metros and income groups.

GFI India and Deloitte India worked on a [Smart Protein Economic Analysis](#) to gauge what smart protein could mean for India's economic future in terms of market size, export potential, job creation, and more. Domestic market size models for plant-based and fermentation-derived protein across scenarios were built after considering various factors such as penetration of the various products/categories across different socio-economic classifications (SECs), adoption rates, and replacement potential for smart protein and prices of both conventional and plant-based products by 2030. Other key assumptions which underpin the path to taste and price parity for categories across the three scenarios are different levels of supply chain localization, investments in R&D, and local talent development.

We calculated projections across three scenarios—low-growth, medium-growth, and high-growth. Based on these, **the domestic market potential for plant-based and fermentation-derived categories is estimated to be anywhere between ₹7,475 crore to ₹18,963 crore by 2030**. Cultivated meat price points will be too high for significant domestic market penetration in India even in 2030, although they will present an export opportunity. Detailed projections by category and scenarios are given in the table below.

Table 2: Smart protein domestic market size by 2030

Domestic market size by 2030 (in ₹ CR)					
Scenario	Plant-based meat	Plant-based dairy	Plant-based eggs	Fermentation-derived meat	Overall
Current Market Size (2022)	100	250	1	-	351
Low Growth	1,803	4,827	527	318	7,475
Medium Growth	3,525	7,643	989	622	12,779
High Growth	5,884	10,625	1,416	1,038	18,963

Source: Smart Protein Economic Analysis by GFI India and Deloitte, 2022

As of April 2023:

- The total number of companies working on plant-based meat, dairy, eggs, and seafood rose to 75.
- Companies launched new product formats to retail like shelf-stable ready-to-cook and ready-to-eat meals.
- Food service providers took an interest in smart protein with more brands beginning to include menu launches in their go-to-market strategies.

Startups and company launches

The first wave of India's smart protein startup ecosystem occurred around 2020 when popular brands like GoodDot, Blue Tribe Foods, and Shaka Harry rose to success. The second wave was between 2021 and 2023 with currently about 113 startups active across plant-based, fermented, and cultivated proteins and a network of 100+ companies supporting its growth.

From 2021 to April 2023:

- **Continental Coffee Ltd:** CCL, a homegrown coffee brand, launched Continental Greenbird, a plant-based meat brand offering a range of frozen, ready-to-cook products. Product offerings include plant-based chicken nuggets, *seekh kebab*, sausage, and *keema*.
- **Licious:** Licious, the D2C chicken and seafood brand, launched a range of plant-based meat products under the brand name, UnCrave, in tandem with the company's strategy of portfolio diversification, providing an alternative to their meat-eating consumers on non-meat eating days.
- **Plantaway:** A plant-based startup owned by the Graviss Group offers consumers and HoReCa (hotels, restaurants, and café) partners plant-based meat and dairy alternatives ranging from cheese and butter to ready-to-cook plant-based meats.
- **Evolved Foods:** A plant-based meat company that focuses on providing highly versatile plant-based protein products that can be used in a variety of cuisines and formats, catering specifically to the Indian consumer and HoReCa partners.
- **Sudo Foods:** A plant-based meat brand created to offer a range of plant-based chicken *samosas*, chicken *seekh kebabs*, chicken popcorn, and mutton *galouti kebabs* with an ethos to 'unjunk' packaged food, and offer alternatives to India's vast non-vegetarian population.
- **Dancing Cow:** A plant-based dairy brand set up to provide dairy-free alternatives, including milk alternatives in different flavors.
- **Another Foods:** A services-focused plant-based meat startup founded to co-create customized plant-based chicken offerings for HoReCa partners based on the different needs and applications in food service.
- **Fermbox Bio:** A synthetic biology company in India that provides contract development and manufacturing (CDMO) services with improved scalability of cultivated meat production, and precision fermentation-derived animal lipids, colors, flavors, and proteins for food applications.
- **Klever Meat:** A cultivated seafood company set up to develop scaffolds and cell lines using indigenous fish species. The company was founded out of the India Smart Protein Innovation Challenge (ISPIC) 2021.

- **ITC:** ITC Ltd. launched a plant-based meat product range under its ITC Masterchef brand called Incredible! The product range included plant-based burger patties and nuggets that mimic the taste of chicken. Products were made available in e-commerce and large retail chains in the top eight cities and to institutional customers such as hotels and restaurants.
- **Tata:** Tata Consumer Products (TCP) launched their plant-based meat products category under a new brand, Tata Simply Better. The product range includes plant-based nuggets, burger patties, *Awadhi seekh kebabs*, and spicy fingers. The products are shelf-stable, do not require refrigeration, and are available at select retail outlets and on e-commerce platforms.
- **Epigamia:** Epigamia, a well-known, new-age, Indian dairy brand that made greek yogurt a household category in a market that has carried traditional *curd* for centuries, launched plant-based milk and yogurt in 2021.
- **Hershey's:** Hershey's has had plant-based drinks in its portfolio since introducing their beloved Sofit soy drink. In 2021, they expanded their suite of consumer options with a range of almond drinks.
- **Nestlé:** In 2023, Nestlé India began trials of its plant-based burger patties and nuggets at trade shows.

Data collection methodology

GFI India maintains a public-facing database of companies working on plant-based, cultivated, and fermentation-derived proteins. The database is populated by information provided by companies working in the smart protein sector, including details about their product formats, geographic focus, founders, business model, technology area, and funding status. Companies that use plant-based or cultivated ingredients to manufacture end-products that do not fall within the category of alternative eggs, meat, dairy, and seafood products are not included in this database.

Fig 4: Distribution of smart protein startups, 2004–2022

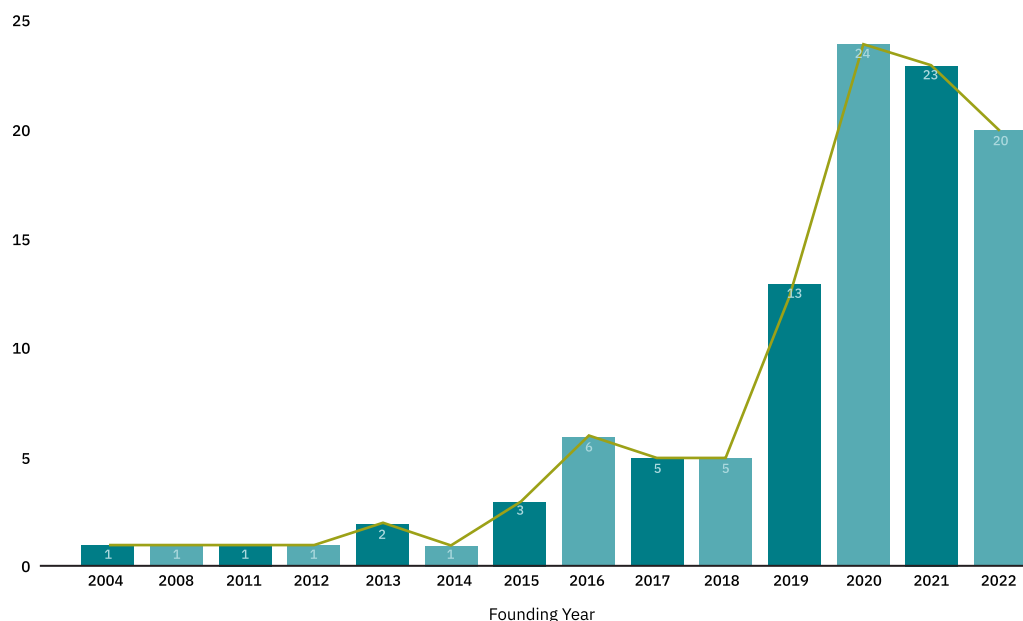


Fig 5: Map of smart protein startups in India (geographic distribution across cities)

Agra (1)

Off Meat (Bibhab
Foodworks Pvt. Ltd.)

Ahemdabad (2)

Grabenord (Dronify
Global Inc)
TruuSOME

Bangalore (22)

LETZ VEZ (Agromatic
Nutrifoods Pvt.Ltd.)
Oatey (Plant Essentials
Pvt. Ltd.)
Shaka Harry (Liber8 Foods
Pvt. Ltd.)
Demolish Foods (formerly
Brew51)
Innovative Nutrition
Solutions Pvt. Ltd.
Devigere Biosolutions Pvt.
Ltd.
Vegandukan.com (M/s
Vegan Ventures)
Evolved Foods (Bizchef
Ventures Pvt. Ltd.)
Made From Plants
Not Foods
MealTech
PHYX44 LABS Pvt. Ltd.
String Bio (String Bio Pvt.
Ltd.)
Sudo Foods (Plantly
Delight Pvt. Ltd.)
ALTCO (White Lotus Food
Labs Pvt. Ltd.)
Made from Plants (Alt
Basket Pvt. Ltd.)
OneGood, formerly
GoodMylk (Veganarke
Enterprises Pvt. Ltd.)
Imposter Meat
Algrow Biosciences

Bhubaneshwar (2)

FemtoFarad Pvt. Ltd.
Just Dig In! (Novolutions
Food & Beverage Pvt Ltd)

Chennai (3)

The Greener Good Foods
Only Earth
Zero Meat

Coimbatore (2)

Base'P sustainable foods
Progo Foods (Progo Foods
Pvt. Ltd.)

Dewas (1)

Vippy Industries Ltd.

Faridabad (1)

Mister Veg Food
Corporation

Gurgaon (4)

Bevry (AP BREW PVT. LTD.)
Piperleaf (Piperleaf India
Pvt. Ltd.)
Rewild Bio Pvt. Ltd.
WhiteCub (Compassionate
Choices Pvt. Ltd)

Hyderabad (3)

Nutrivative Foods Pvt.
Ltd. (Nourish You)
Continental Greenbird
(Continental Coffee Ltd)
Urban Tiller

Jaipur (2)

Freshwoof (Urban Tails
Pvt. Ltd.)
GoodDot

Kanpur (1)

OatMlk (WG Corp)

Kochi (1)

The Green Meat
(Greenovative Foods Pvt.
Ltd.)

Kolkata (1)

Tata Simply Better

Mumbai (29)

Another Foods
Katharos Foods (Mad
Parsee Foods LLP)
Mylkmond (Enceladus
Foods Pvt. Ltd.)
Mighty Foods (Freshezy
Foodtech Pvt. Ltd.)
ProMeat (ProPlant Foods
Pvt. Ltd.)
SeaSpire (SeaSpire Pvt.
Ltd.)
Funny Nani (Nayamylk
Products Pvt. Ltd.)
Imagine Meats
Evo Foods India Pvt. Ltd.
Blue Tribe Foods
(Shivanika Foods Pvt. Ltd.)
1Ness | 1Ness Foods Pvt.
Ltd.
Soft Spot (WestBay Foods)
Epigamia (Drums Food
Pvt. Ltd.)
Urban Platter (iStore Direct
Trading LLP)
Slicc

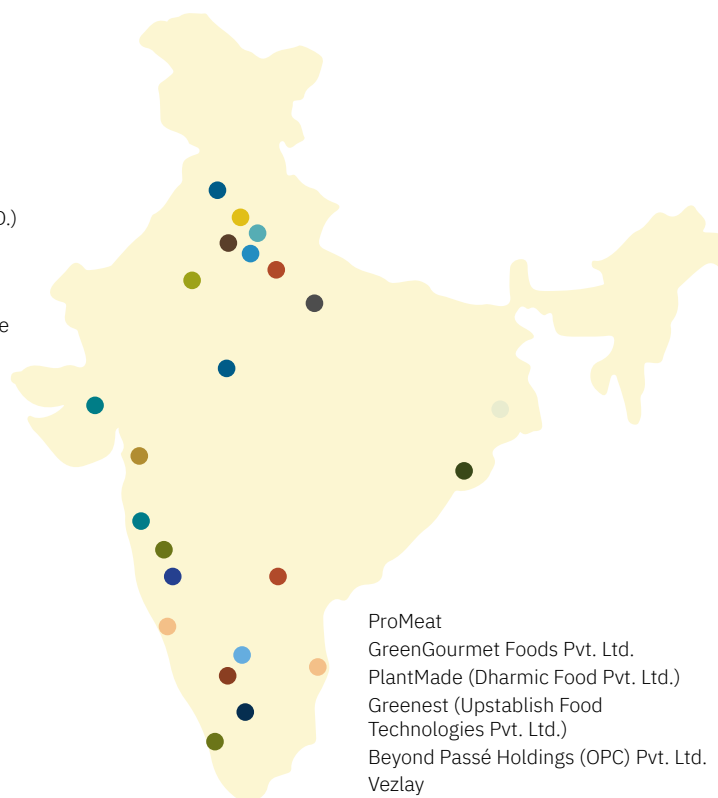
Nomou
Bombay Cheese Company
Big Sam's
SOFIT (Hershey India Pvt.
Ltd.)
Nurrish
Foodease
RAW Pressery
Pilk
Go Zero
Homcraft
Plantaway
NOTO
Myoworks
Incredible by ITC
Masterchef
Terramatter Climate
Technologies Pvt. Ltd.
FlavingredProducts and
Services Pvt. Ltd.
HiMedia Laboratories Pvt.
Ltd.

Mysore (1)

Naka Foods Pvt. Ltd.

New Delhi (16)

MilkinOats (Snoozing Cattle
Pvt. Ltd.)
BVeg Foods Pvt. Ltd.
Minus30
goCore Superfoods
What A Momo
Vegan Foods LLP



ProMeat
GreenGourmet Foods Pvt. Ltd.
PlantMade (Dharmic Food Pvt. Ltd.)
Greenest (Upstablish Food
Technologies Pvt. Ltd.)
Beyond Passé Holdings (OPC) Pvt. Ltd.
Vezlay
Veggie Champ (Ahimsa Food)
Sain
NeatMeatt
Clear Meat
Moofft (Kindible Foods Pvt. Ltd.)

Noida (3)

alt foods (SAP Agrotech Pvt. Ltd.)
Oatish by Dancing Cow (Dancing Cow
Foods Pvt. Ltd.)
Drupe Foods

Panjim (1)

Wakao Foods

Pune (5)

Eat With Better
Klevermeat (Metamorphic Foods
Pvt. Ltd.)
Proeon (Sattvaponics Solutions Pvt.
Ltd.)
Rethink Bio
Supplant Foods

Satara (1)

Oatmax

Sonapat (1)

Plantish

Surat (1)

Zero Cow Factory (HENI
INNOVATION Pvt. Ltd.)

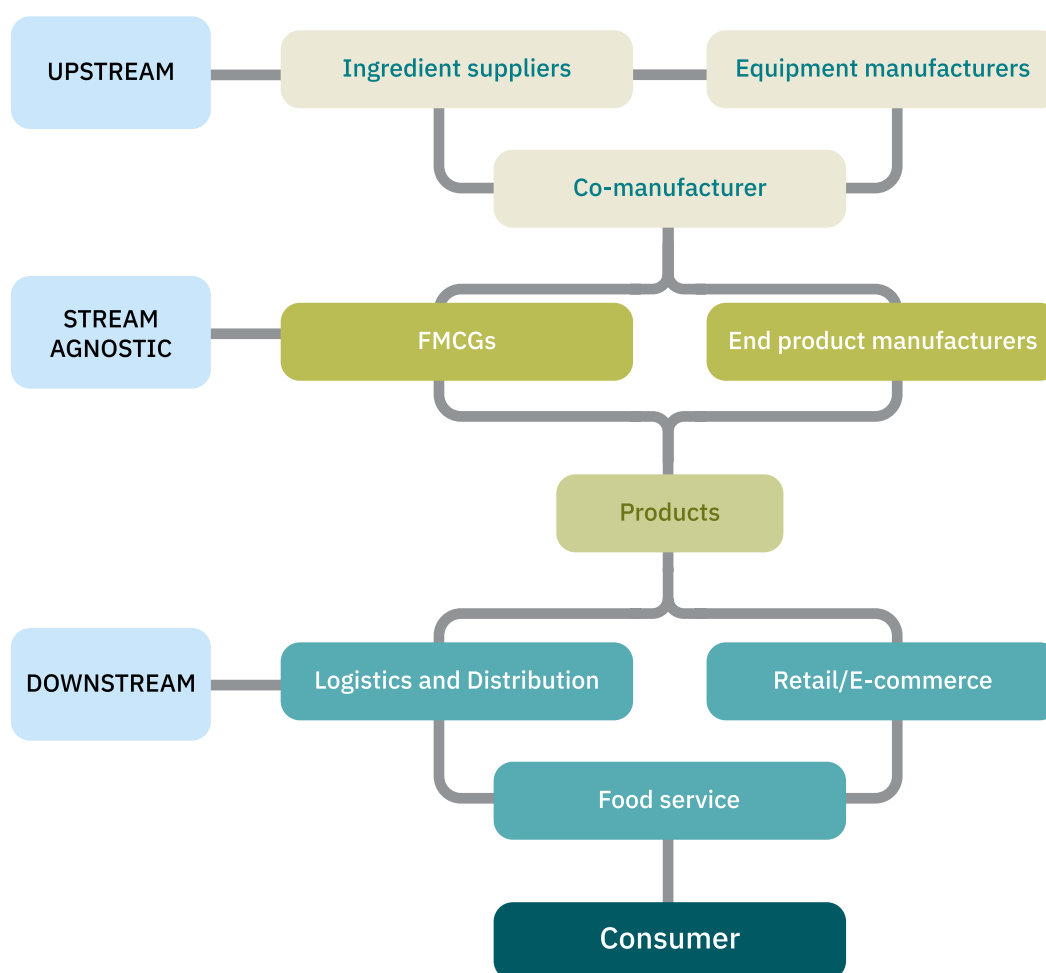
As shown in the graphs above, the industry has recently entered a crucial stage of market activity. This proliferation is a result of years of foundational work to build the ecosystem. Now, multiple brands have launched products that are available in restaurants, retail stores, and for home use. In fact, more than half of the brands in the space have been launched in the past four years, indicating the massive strides the sector has made since 2019, when the Indian smart protein sector started taking off. With ecosystem-building initiatives (like ISPIC, see below) inspiring and supporting innovators across the value chain, the sector continues to see a steady stream of launches taking up space in the market.

GFI India's flagship initiative, [The India Smart Protein Innovation Challenge \(ISPIC\)](#) aims to address the talent bottleneck, solve for white spaces, and build the early stage startup ecosystem for the smart protein sector. Over its past two iterations, ISPIC has trained hundreds of new innovators and accelerated go-to-market and scale-up processes for dozens of entrepreneurs through its one-of-its-kind, comprehensive program. ISPIC is on track to achieve even [greater impact](#) with its 2023 iteration launched earlier this year.

Smart protein ecosystem

For brands to make high-fidelity smart protein products available to customers, there is a clear need for a robust enabling ecosystem that supports their go-to market. Over the past few years, players like large corporations in allied sectors and incumbent agri-businesses have explored how best to plug into the smart protein sector in ways that leverage their existing strengths, expertise, assets, and access to markets. The protein value chain has scope for partnerships and interventions right from the bean to the biryani—involving ingredient suppliers, equipment manufacturers, co-manufacturers, R&D or business consultants, logistics and distribution partners, branding and design agencies, regulatory advisors, and so much more. The visual below depicts this interdependent ecosystem that is essential for this sector to become mainstream.

Fig 6: The smart protein ecosystem




Over years of ecosystem building, GFI India has developed a comprehensive [Ecosystem Database](#) to help facilitate partnerships across the value chain. It lists stakeholders like ingredient suppliers, equipment manufacturers, co-manufacturers, and technical R&D and business consultants. Entrepreneurs can explore this list and connect with trusted partners tailored to their specific needs.

Manufacturing

Manufacturing capacity remains one of the most significant barriers to achieving price parity for plant-based proteins. GFI's report, [Plant-based meat: Anticipating 2030 production requirements](#), provides preliminary insight into the need for manufacturing capacity, estimating a potential need for more than 800 extrusion facilities, to reach a high-end target production of 25 MMT of plant-based meat in 2030. **India, known for its low-cost manufacturing scale-up, could house a significant portion of this production capacity, thereby attracting global interest and investment.**

Leading players in the Indian ecosystem are cognizant of this opportunity and have invested significantly to enter this segment or retrofit their existing manufacturing previously utilized for animal-meat processing or dry snacks to align with the space:

- In 2022, **Symega Food Ingredients** announced plans to expand its presence in the plant-based sector with a [₹100 crore \(\\$10.29 million\) investment](#) over the coming years, to strengthen its manufacturing and development capabilities across the value chain. Located in Kerala, the current plant features machinery for various modern plant-based manufacturing technologies with an installed capacity to produce 150 metric tons (MT) of plant-based meat per month, along with an on-site purpose-built R&D laboratory, SYMEGA Protein Innovation Centre (SPIC).
- In 2022, **BVeg Foods**, in partnership with world-class technology provider **Buhler Group**, set up a [specialized plant-based meat co-manufacturing facility](#) housing India's first commercial high-moisture extruder, allowing entrepreneurs to launch high-fidelity plant-based whole-muscle meat products for the Indian and global markets.
- **Chatha Foods**, a leading ready-to-eat poultry and meat manufacturer, wanted to keep pace with the sector and [ventured into the plant-based meat category](#) in 2021. Since then, they have worked with 10+ brands from product formulation to development to produce formats ranging from *kebabs* and patties to cheeses and spreads.
- In 2022, **Zippy Edibles**, a leading pasta and extruded snacks manufacturer supplying to industry stalwarts such as **Reliance** and **Jubilant Foodworks**, recently added [high-moisture extrusion capabilities](#) to address the gap of high-moisture meat analog substrates in the Indian market.
- In 2023, **Pall Corporation**, a leader in filtration, launched an 'Alternative Proteins' segment, which is expanding globally by building on their past successes in processing high-quality proteins with optimal functionality. Pall has also begun manufacturing its crossflow systems in India, strengthening its team in Pune and initially supplying to the Asian market.




A key consideration for players investing in infrastructure set-up is that smart protein production requires specific equipment in addition to equipment that is commonly used across the food processing industry. **To produce specific outputs like protein isolates, protein concentrates, hydrolyzed concentrates, binders, fats, and flavors, specialized equipment and infrastructure protein fractionation facilities, twin-screw high and low-moisture extruders, shear-cell technology equipment, and 3D printers are needed.**

Government incentivization is key to offsetting the risk of setting up dedicated infrastructure in the sector at scale. More corporate buy-ins, strategic partnerships, and significant private and public investment into R&D, manufacturing, and scale-up will enable the industry to reach taste and price parity, a crucial driver for large-scale adoption of smart protein products in India.

Ingredients

Functional ingredients form the building blocks of plant-based meat, eggs, and dairy products. Over the last few years, several collaborations between multinational ingredient companies and Indian startups have helped jump-start the sector and tailor products to the Indian palate. However, a few critical challenges can slow momentum in the market. Many Indian plant-based brands continue to import bulk ingredients since indigenously sourced ingredients do not match functional specifications and suffer from quality issues due to batch-to-batch variability. Import duties for key ingredients like isolates and concentrates are anywhere between 30 to 60 percent, significantly increasing the end-products' base costs. Import duties are also prone to fluctuations, which create further uncertainty for manufacturers, compelling them to price their products even higher. Given these factors, innovation in supply chain localization is critical.



Following are some examples of partnerships between ingredient suppliers and manufacturers and co-manufacturers that propelled the Indian smart protein sector in the last five years:

- **Archer Daniels Midland** (ADM), a global leader in plant-based ingredients, partnered with the founders of **Imagine Meats** in 2020 to provide end-to-end product offerings made from soy and pea proteins.
- Radicle™ by **Kerry** is a unique portfolio of plant-based ingredients and solutions that help food brands and manufacturers create meat and dairy alternatives that are delicious, nutritious, and sustainable.
- In 2021, **AAK Kamani**, India's leading manufacturer of specialty oils and fats, announced a new co-development partnership with **Vista Processed Foods Pvt. Ltd.**, part of the OSI group, to meet the country's growing demand for plant-based meat alternatives.

Logistics and distribution

The biggest challenge for smart proteins in India compared to other developed countries is getting the distribution right. In the developed markets, most smart protein brands collaborated with food service providers, giving them visibility, access to the consumer, and retail penetration. However, India as a market stands low on eating out frequency compared to the developed markets and is also highly unorganized and fragmented when it comes to the distribution of food products. More than 80 percent of FMCG sales in India still come through traditional *kirana* and general stores.

Selling frozen or chilled products in India is a tougher challenge due to the poor infrastructure in transport and warehousing beyond the key metros. Some of the key challenges faced by the brands in the smart protein space in India are:

- **Cold chains for products in smaller quantities pushes up the cost of distribution.** This is a crucial barrier for most brands to move beyond the key metros.
- **Lower interest from distributors, retailers, and e-commerce platforms owing to low consumer demand.** As a result, distributors demand higher margins along with high credit periods. E-commerce platforms are demanding higher listing fees for smart protein products.
- **D2C as a channel is more popular among the startups in India.** The costs of servicing consumers are high through this channel, leading to increased pressure on profitability.
- **Vegetarian and meat products are always segregated in India due to religious and cultural sensitivities.** There is confusion at the ground level about moving plant-based meat as they are typically positioned and marketed for meat-eating consumers.

To address some of these challenges, brands and service providers in the ecosystem are coming up with innovative solutions:

- **Big logistics firms like Radha Krishna Food Land are coming up with solutions where multiple smaller brands can share truck loads and also other infrastructure like warehouses/dark stores to save costs.** Prominent companies like **Imagine Meats** and **Blue Tribe Foods** have partnered with them.
- Emergence of intra-city logistics partners like **Just Deliveries**, which runs a network of delivery vans in top Indian metro cities for daily replenishment of stocks.
- Establishment of dark stores/cold storage and shared infrastructure beyond metros by brands and upcoming startups like **Zippee** are increasing the reach of smart protein products.

- Brands are partnering with established distributors in the food space to take advantage of their existing networks. **TJUK Trade Networks**, one of India's leading food service and retail distributors, representing 100+ brands and 5,000+ SKUs in over 42 cities in India, has partnered with several leading plant-based meat companies to help them deepen their product penetration in metros.
- **Some plant-based meat brands, such as GoodDot, have developed shelf-stable products to reach a broader market.** Developing shelf-stable products without sacrificing product taste and quality could be a significant step toward growing the plant-based meat category in tier-II towns and cities in the long term.

Food service

The food and beverage industry has an enormous influence on the way we consume. Further, it significantly contributes to India's economy. The Indian HoReCa industry is poised to reach a market potential of ~₹23.31 trillion ([\\$280 billion](#)) by 2025. While the smart protein category is new, over 500 standalone restaurants and hotels in the top eight Indian cities have launched plant-based menus or dishes over the last few years across various food service platforms.

- **GoodDot** has significantly penetrated the food service industry with almost 50 HoReCa partners across a diverse portfolio with luxury brands like the Leela, Novotel, Marriott, Radisson, and Taj, to chains like Barbeque Nation, Applebee's, Biggies Burger and even roadside *dhabas* and eateries.
- In 2022, **Tata Starbucks** partnered with **Imagine Meats** in 10 cities all over India.
- In January 2022, **Blue Tokai**, a specialty coffee brand, announced its Veganuary month by serving **Better Bet's** (previously known as Alt Foods) millet-based milk at their Delhi NCR outlets. They now serve it across all outlets in India.
- In October 2021, **Burgrill**, a popular Indian fast-casual chain specializing in gourmet burgers, announced the launch of The Green Meat Pounder made with a plant-based chicken patty developed by **Greenest**. In April 2023, Greenest announced a brand collaboration with Greenit, a plant-based kitchen based in Delhi NCR.
- **Blue Tribe Foods** is now present across 200+ hotels and restaurants ranging widely from luxury brands like **ITC Hotels, The Oberoi Group, Four Seasons Hotels, Fairmont Hotels, Hyatt Hotels, Taj Land's End** to chains like **Impresario Restaurants (Social & Smoke House Deli)** and **Travel Food Services** (across airports in Mumbai & Bangalore) along with several other standalone restaurants. Their current HoReCa favorites include the plant-based chicken mince and chicken nuggets and they will soon launch plant-based chicken chunks to enable more flexibility for chefs.
- **Evolved Foods** has established partnerships with over 20 popular name brands like **Shangri-La, Toscano, Go Pizza, HRX by Eatfit, Curefoods, Nomad Pizza, Go Native,**

and many more, across six cities. Their best-selling dishes include *Donne Briyani*, *Tandoori Tikka*, *Chettinad Dry Ghee Roast*.

- In December 2022, **Another Foods** announced an [exciting partnership](#) with **Indigo Hospitality**, which runs the Indigo Deli Colaba and the cloud kitchen Indigo Burger Project. Since then, Another Foods has partnered with multiple food service groups like the **St. Regis, Impresario (Socials, Smoke House Deli, Boss Burgers)** and currently supply to many restaurants pan-india including the famous **Black Sheep Bistro** in Goa.
- **Wakao Foods** supplies its products to many hotels and restaurants, including **Ibis, Hilton, Burma Burma**, and **London Taxi**.
- In 2021, **Domino's Pizza**, a giant in the Indian QSR space, launched the *Unthinkable Pizza* with plant-based meat toppings across all its outlets in Delhi NCR, Mumbai, and Bangalore.
- In 2022, the Royal Challengers Bangalore cricket team introduced plant-based meat at the RCB Café and Bar in Bangalore.

While the success of brands within food service is notable, buy-in from the larger community is essential. The entry of pioneer QSRs, like **McDonalds, KFC, Burger King**, and **Subway**, to name a few, will be game-changing for the sector and help bring smart protein to the mass market. Corporate and large-scale food service such as airlines, schools, theaters, and hospitals is another considerable opportunity that is relatively untapped. As brands continue to innovate in product development, engaging with the chefs' perspectives and developing base products that can be used flexibly across various dishes and cuisines in a commercial kitchen will be useful.

Retail and e-commerce

Retailers and e-commerce players are an important mechanism for products to reach consumers. Physical retail stores present opportunities for brands to stock and market their products innovatively. They can conduct tastings, hand out samples, position their branding collateral, and conduct surveys to learn more about their consumers. E-commerce is a widely favored avenue for smart protein businesses to enter the market as it tends to draw in younger customers who are more inclined toward smart protein options.

In 2021:

- **Nature's Basket**, a leading retail destination for fine foods, launched a separate category for plant-based meats across 25 outlets, listing products from top brands. They also list a variety of plant-based dairy products.
- **Amazon Fresh** entered the sector by listing products from **Blue Tribe Foods**. They now have more than 8 top brands in plant-based meat and 12 in plant-based dairy, available for purchase.

- **Urban Platter**, a popular online marketplace, lists various smart protein brands, including their private label range and **Beyond Meat** from the U.S.

In 2022:

- Indian delivery giant **Swiggy** listed plant-based products from **Good Dot**, **Blue Tribe Foods**, **Shaka Harry** on its grocery platform, Instamart.

Other prominent physical and online retailers include **Food Hall**, **Vegan Dukaan**, **Vvegano**, **Vegan Mall**, and **Pink Harvest Farms**.

While several prominent retailers have entered the category, the number of products listed is not proportional to the number of products launched in the market. Since consumer interest in the sector is slowly and steadily growing and category creation takes many years, at this stage of the ecosystem, retailers, and manufacturers must forge novel strategic partnerships to enable more startup brands to be listed and marketed.

Product mix

The Indian consumer market boasts 370+ SKUs across plant-based³ meat, eggs, and dairy, with new products entering the market every few months.

From a handful of companies in 2016, the smart protein sector has grown by leaps and bounds in the last two years to include various options, recreating some of India's most popular meat dishes.

- There are 377 products, across 41 formats, and 73 smart protein brands across meat, eggs, and dairy available in retail and on e-commerce channels. Some brands have also exclusively taken the food service route, with their products only available at select restaurants, hotels, and QSRs.
- There are 143 plant-based meat products, 223 dairy products, and 11 egg products in the market.
- The top five animal products replicated are chicken, milk, ice cream, cheese, and mutton.
- The top 10 product formats are almond milk, burger patties, oat milk, cheese, *kebabs/tikka*, *keema/mince*, nuggets, icecream, sausage, and soy milk.

Data collection methodology

GFI India maintains a database of plant-based meat, eggs, seafood, and dairy products that are currently available in the Indian market with details about the product, including product category, ingredient composition, product format, price per kg, shelf life, and storage condition. The data collected in the database is open-source information extracted from e-commerce marketplaces, company websites, and media articles. Plant-based products that are globally manufactured but are available in the Indian market are also included in this database. As smart protein companies launch their products through multiple channels, the database only accounts for end products that are available for direct consumers on the market and does not account for products or dishes that are available in food service or QSR outlets. Additionally, with companies launching and discontinuing products at irregular intervals, the database presents a conservative estimate of the number of plant-based products in the Indian market.

Fig 7: Distribution of products in the market by segment

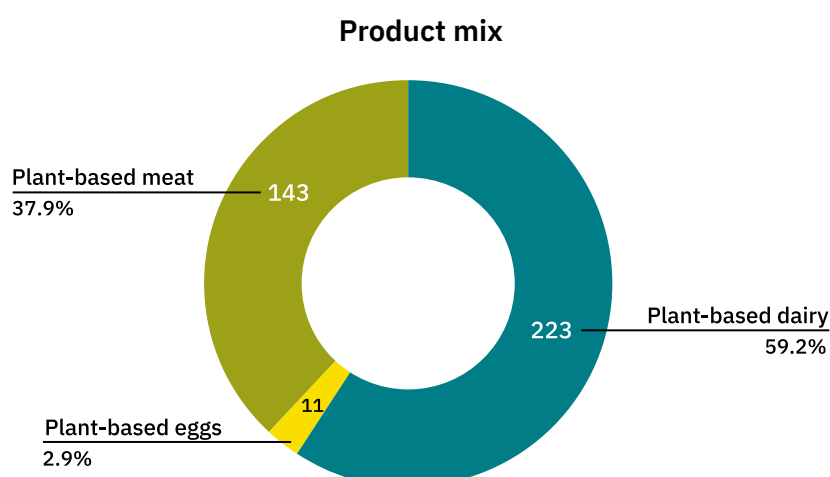


Fig 8: Distribution of brands in the market by segment

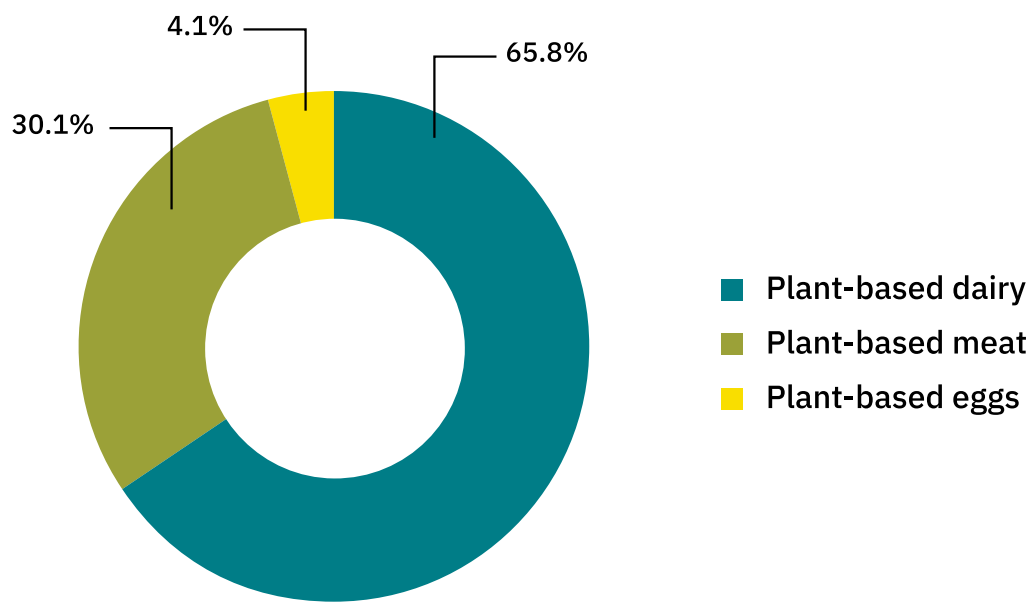


Fig 9: Top 10 product formats by brand quantity in the market

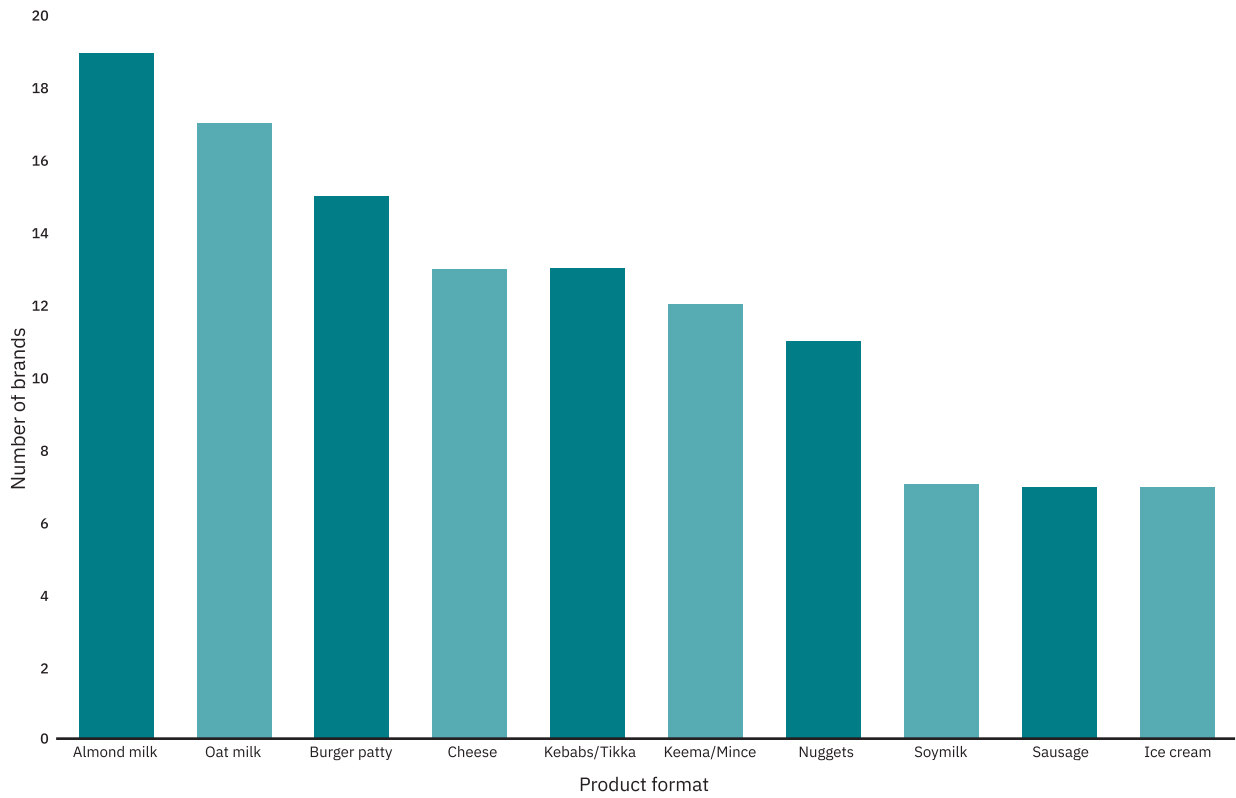


Fig 10: Top 10 formats replicated by product quantity in the market

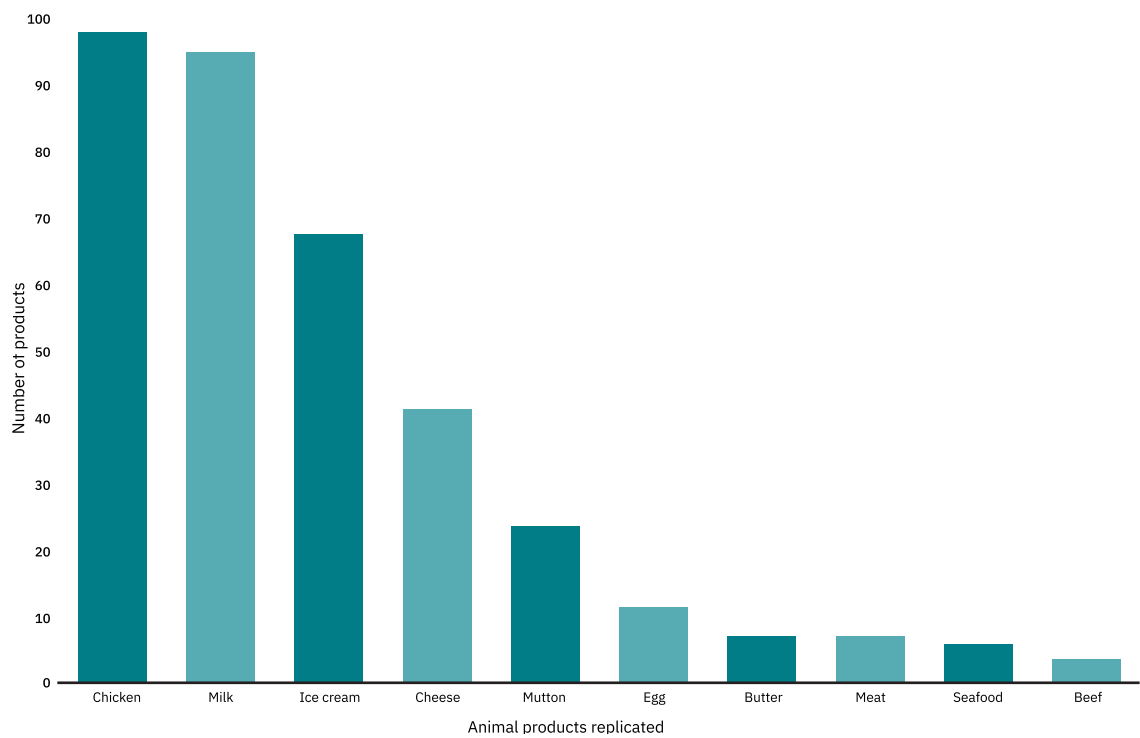
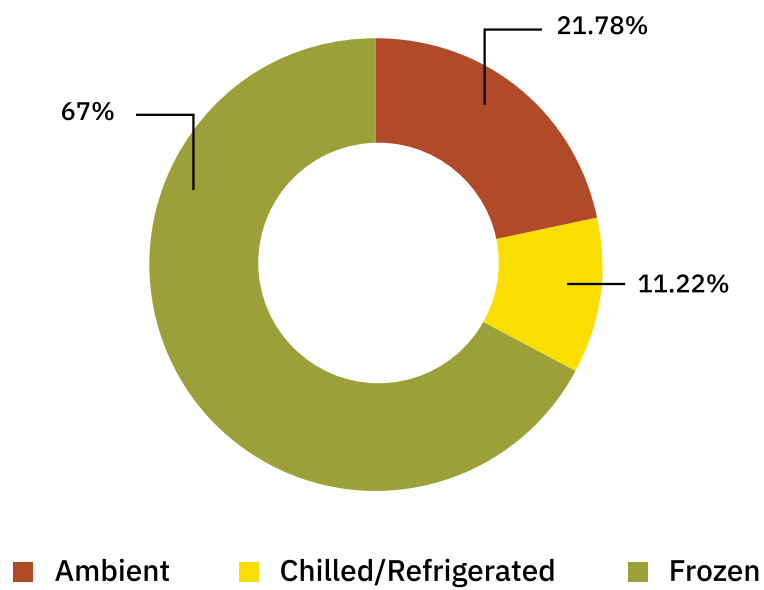


Fig 11: Product mix by storage condition



Product format innovation

Startups in India are not only looking to create products that can reliably and predictably substitute the consumption of animal-derived meat, eggs, and dairy but also replicate the sensory and cultural experience of traditional dishes and cuisines for consumers. **A growing trend toward localization has been a big win for the category. Catering to the vast diversity in Indian cuisines, products in formats and flavors that resonate with different consumers are now being launched. However, there is still room for growth in replicating the entire sensorial journey for consumers—the aroma, juiciness, and fat profiles while expanding to newer categories like fish, mutton, and shellfish.**

These products range from snacks to main meal dishes, and there are numerous untapped innovation opportunities for developing product formats that will allow consumers to integrate and experiment with them in different dishes across all parts of their day. In nascent sectors like smart protein, consumers are more likely to try plant-based alternatives via variations of conventional dishes that are popular in the local cuisine. The following graphs illustrate the current product mix in the market to give an indication of what is popular and the gaps that can be filled through product innovation.

More information on product format innovation and consumer demand can be found in GFI India's [Product Rollout Guides](#).

Fig 12: Distribution of product formats by brand quantity, plant-based meat

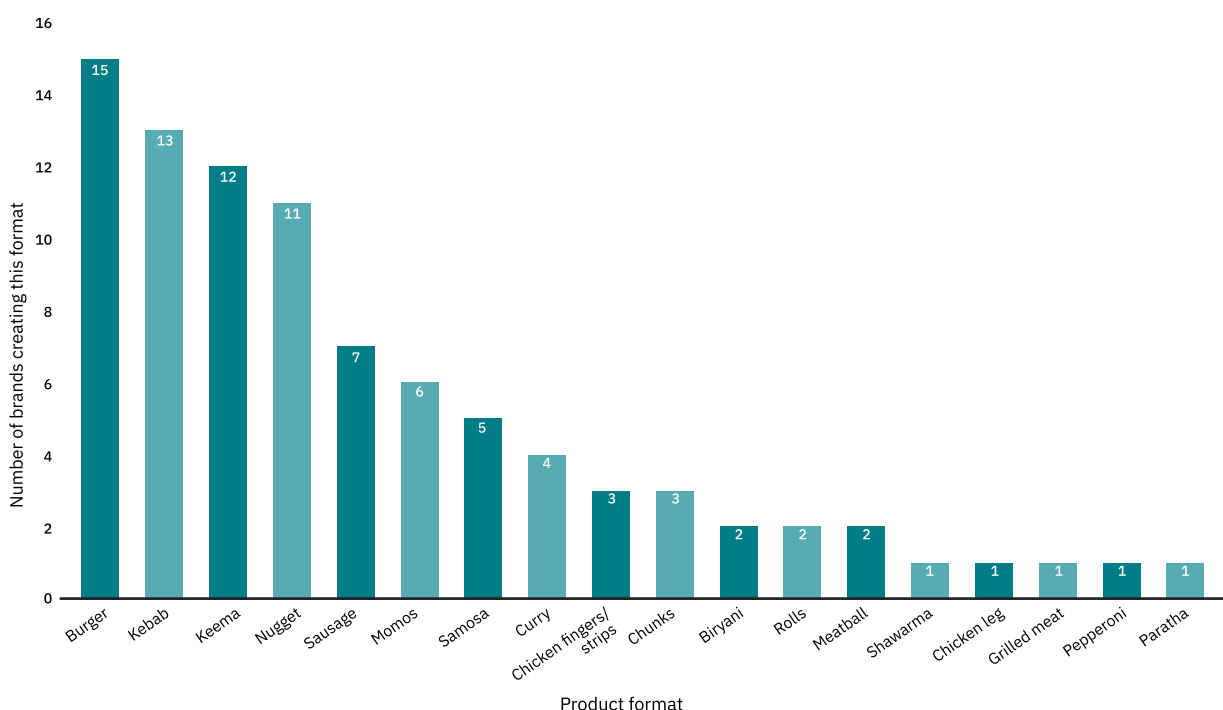


Fig 13: Distribution of product formats by brand quantity, plant-based seafood and egg

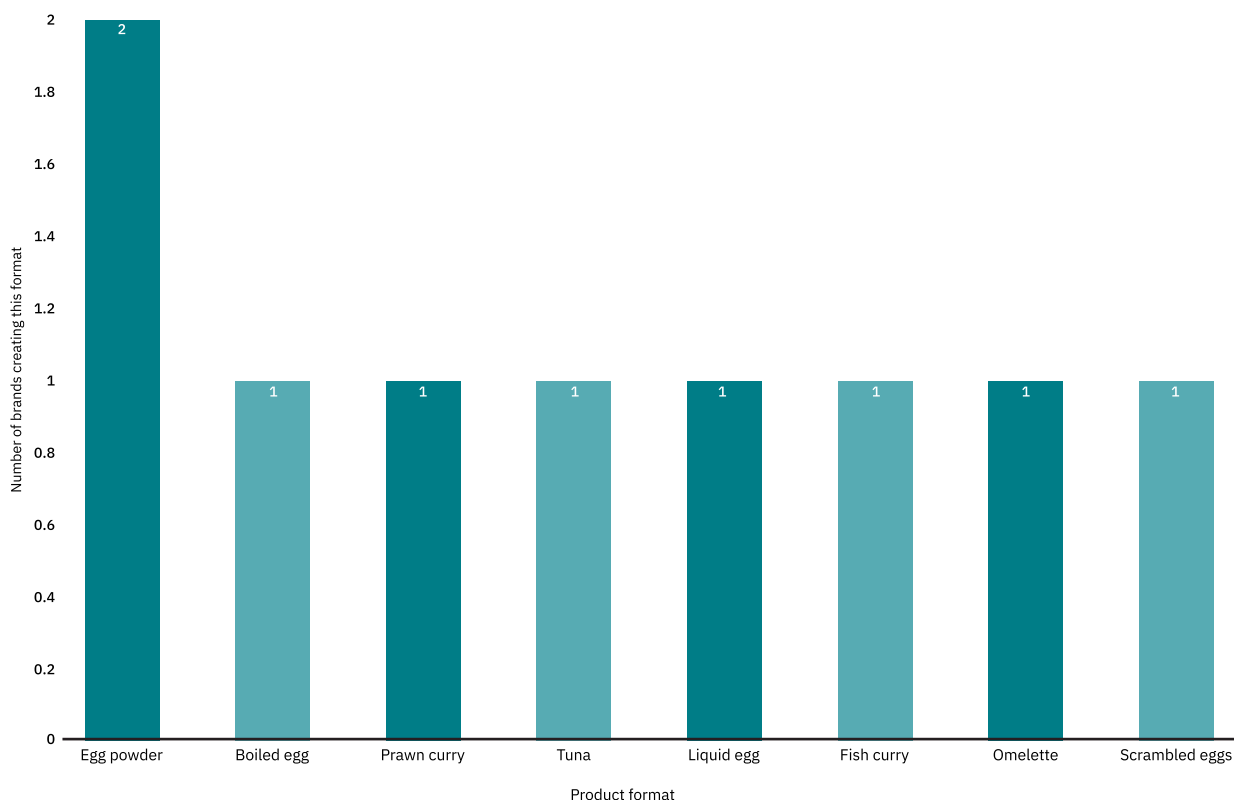
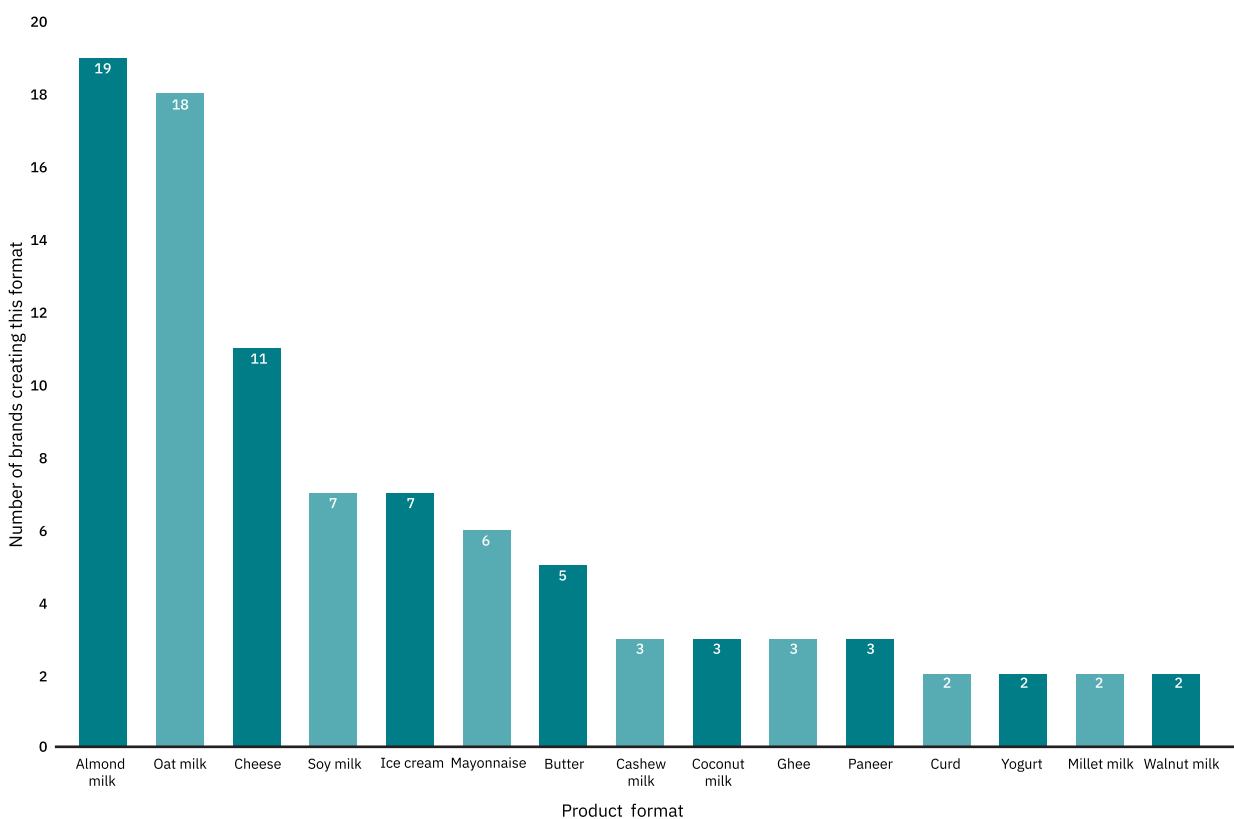


Fig 14: Distribution of product formats by brand quantity, plant-based dairy



Note: In all three figures above, there is an overlap between the startups working across different product formats, as startups often have a diversified product portfolio. For example: Plantmade is a smart protein startup that has both plant-based egg and plant-based meat products in the market.

GoodDot:

40–50

40–50 HoReCa
partners

All

Present in all
major Indian
cities

50+

Product used in
50+ Indian meat
recipes



GoodDot, an early-mover in the plant-based meat space, continues to sell their products all across India, from villages to metro cities. With a focus on bringing affordable texturized protein that consumers can cook as per their recipes, the brand recently launched its most affordable product—Pro Chaap. This unflavored textured plant protein is nearly half the cost of chicken in India. To allow consumers to try their product in traditional Indian dishes, the brand has partnered with a variety of HoReCa partners, from roadside eateries to premium luxury properties like The Leela, Novotel, Pullman Hotels and Resorts, Marriott International, Radisson Hotels, and The Taj Group of Hotels. Beyond the Indian market, GoodDot has launched its plant-based protein in Indian product formats in the United States and Singapore, and is finalizing similar collaborations in Canada, Middle East, United Kingdom, and Australia.



Through years of experience, we have learnt that the consumer in India is very value-conscious. Whether it's taste, price or nutrition, a plant-based meat product needs to bring really good value to the consumer. Simultaneously, Indians also love cooking their own dishes. Using these insights, our team worked hard to develop Pro Chaap, a raw plant protein that is almost half the cost of chicken, the most affordable animal meat. GoodDot is now supplying to outlets like Barbecue Nation, Domino's, Applebee's, Biggies Burger, Samosa Party, and Taj Qmin, among others. We have been witnessing an increasing interest in plant-based proteins in India with the cultural tailwinds being significant here.

Abhishek Sinha, GoodDot

Evolved Foods:

20+

20+ HoReCa
partners

6

Present across 6
Indian cities

50+

Product used in
50+ Indian meat
recipes



EVOLVED
GALOUTI KEBAB

Evolved Foods, a B2B plant-based meat brand, has collaborated with clients and chefs across India to integrate their plant protein in traditional Indian meat recipes like *Hyderabadi Dum Biryani*, *Rajasthani Laal Maas*, *Mangalorean Ghee Roast*, *Tamil Chettinad*, *Bengali Kosha Mangsho*, *Kashmiri Rogan Josh*, *Haleem*, *Bihari Champaran Curry*, and *Lucknowi Galouti Kebab*. Evolved Food's team has focused on customizing their product to regional cuisines to highlight culinary innovation and cultural relevance to increase customer acceptance and market potential.



From the onset, the Evolved Foods team decided to create a product that would celebrate the rich culinary heritage of the Indian cuisine. Offering plant-based versions of regional dishes would enable us to cater to the diverse dietary preferences of the large Indian population looking to adopt a plant-based diet while still enjoying familiar flavors.

Roma Roy, Evolved Foods

Innovation in product formulation

To improve the functionality and differentiation of products on the market, innovators have begun diversifying plant-based protein sources and have undertaken product development with novel ingredients like mung bean, pea protein, chickpea, lentils, millets, oats, almonds, walnuts, and even watermelon seeds.

Millet

Having a rich micronutrient profile and a low glycemic index, millets present a lucrative opportunity as a substitute for soy and wheat gluten to produce plant-based alternatives. Recognising this potential, four plant-based dairy companies (**Alt Foods, Oatey, OneGood, and Nourish You**) have cumulatively launched 13 millet-based milk products in the Indian market.

Soy

From mock meats to texturized vegetable protein, soy has traditionally played a key role in developing plant-based meat alternatives. With significant advancements in extrusion technology and innovative product development, 90+ plant-based meat products, 33 plant-based dairy products, four plant-based egg products, and three plant-based seafood products currently use soy as a key ingredient.

Mung bean

With strong coagulation capability, mung beans possess various properties to achieve the desired taste and texture profile for many plant-based applications—especially for egg alternatives. Ingredient companies like **Devigere BioSolutions** and **Proeon** have set up research labs and partnered with startups to formulate smart protein products that use mung bean as a key ingredient.

Oats

Oats have played a crucial role in the boom of plant-based milk in the Indian market. Over 19 companies have developed 35+ SKUs using different blends (oat-almond, oat-millet-almond, cashew-almond-oat, cowpea-moong-oat) and varieties of oats.

Packaging and labeling

A study conducted by [GFI India and Ipsos on plant-based dairy](#) showed that consumers pay more attention to the packaging and labeling of products when the category is relatively new. Plant-based dairy consumers pay attention to nutrition facts, protein content, and the ingredient list of plant-based products. While shopping for animal-derived dairy, the same consumers pay more attention to details like price/promotions/discounts and manufacturer details.

GFI India recently carried out consumer research to assess market perceptions of plant-based dairy and meat products. The study aimed to determine whether consumers could distinguish these plant-based options from conventional animal-derived products. Specifically, the research focused on identifying the features and cues that consumers noticed on the packaging to make this differentiation. As per the study, there is a clear gap in comprehension of the category and various terms/nomenclature used by the manufacturers. This is more pronounced for plant-based dairy, where the conventional terminology is restricted. Consumers were confused about the category and the product in the absence of descriptors like milk, cheese, and butter on the packs. They tried to comprehend the category through cues like visual symbols, text, colors, and shapes of the packaging. Some key insights from the study, aimed at aiding manufacturers of plant-based meat and dairy in optimizing their packaging and labeling, are outlined below. A detailed report on the study is slated for release by the end of 2023.

- **Consumers noticed vegetarian or non-vegetarian logos and used them to differentiate products.**
 - Majority of the consumers were aware of the vegetarian and non-vegetarian logos (green and red dots, respectively) and used them to differentiate between products, especially in cases where they were not too familiar with the product or category.
 - While the vegetarian and non-vegetarians logos have existed for many years, the vegan symbol was only introduced recently in the Indian market. Owing to this, not many consumers were familiar with or could identify the newly launched vegan symbol in the consumer research.
 - Once the vegan symbol was explained, many consumers appreciated its presence and elements such as the color of the symbol (green) and depiction of leaves to indicate the absence of animal products.
- **Bright and bold block colors capture the attention of the consumer.** Most packs preferred by consumers used elements of green either in specific text or on the packaging. Images of leaves or some representation of plants were used as cues by consumers to differentiate plant-based packaging from others. Quirky, offbeat packaging earned good reviews.
- **The shape of the packaging also served as a cue for the product category.** For example, consumers intuitively expected cheese to come in block-shaped packaging, milk in tetra paks, and ice cream in tubs. Since the category is considered modern and premium, consumers expected the packaging also to look modern and premium.

- **Product images on the packaging played a crucial role in helping consumers identify both the nature and the expected taste of the product.** For example, an image of a block of cheese or a bottle of milk on the packaging helped consumers identify the contents, especially in cases where conventional dairy terminology was absent on the packaging. Images also helped consumers deduce the appearance, taste, and texture of meat products.
- **“Plant-based” as a term worked better as a qualifier for the category.** Consumers differentiated plant-based products from animal-derived ones through qualifiers like plant-based and vegan. Most consumers preferred the term “plant-based” over “vegan”.
- **Mentioning the type of protein being mimicked helped in building the association with the product.** For plant-based meat products, consumers preferred if the name of the protein like “plant-based chicken” or “mutton” was clearly defined. In cases where the protein type was not specified, consumers were uncertain about what to expect from the product.
- **Health-related claims were particularly important for consumers of plant-based milk, while taste claims resonated more with those interested in plant-based meat.** On plant-based dairy packaging, claims such as “no added sugar,” “rich in nutrients,” “healthy,” and “no preservatives” were appreciated by consumers. For taste-driven products like plant-based meat and cheese, cues related to taste were crucial. Taste claims such as “just like chicken,” “just like mutton,” “tastes like meat”, and “0 percent meat, 100 percent taste” effectively conveyed the taste profiles. Claims like “zero cholesterol,” “no preservatives,” and “trans-fat free” conveyed the health aspect. **“High protein” was an important claim observed by most consumers.**
- **Familiarity with ingredients played a key role in consumer choices.** For example, the use of the words like soya/almond helped them set their expectations with respect to the product’s taste and texture.
- **Clarity of labels and nutritional information helps.** Early adopters preferred packs that offered clarity in terms of ingredients, preservatives, additives, and nutritional information. This preference stems from a desire to make informed choices or transitions.
- **Claims on animal cruelty did not significantly motivate consumers to replace conventional animal-derived products with plant-based alternatives.** In fact, these plant-based options were primarily considered as substitutes for animal-derived meat during festivals and religious observances when meat consumption is prohibited.
- **Consumers resonated well with the formats and flavors that are familiar to them.** Given that the category is still emerging, these familiar formats and flavors helped consumers in identifying and relating to the products. For example, the plant-based versions of different *kebabs* were more easily understood by consumers, who had clear expectations about their taste, texture, and preparation methods. Most consumers either have tried or are inclined to explore the category through these familiar formats.


Adoption and consumer interest

Young, urban flexitarians with better incomes are the early adopters of plant-based meat, dairy, and eggs

The smart protein industry in India is new and niche, targeting early adopters. Early adopters are people who are comfortable with innovations and are cognizant that change is often inevitable. Early adopters are more likely to consume and purchase new categories sooner than other consumer segments. They are also likely to pay more for the category in the initial stages.

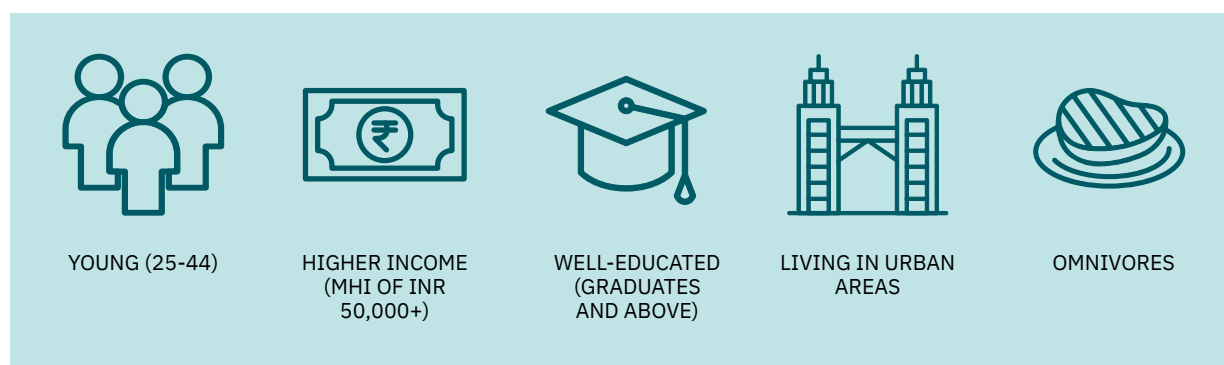
GFI India has identified the profile of the early adopter using two parameters:

- Consumers who are **“very or extremely likely” to pay more** for plant-based meat, dairy, and eggs than they would for conventional animal-derived products.
- Consumers who reported being **“very or extremely likely” to regularly purchase** plant-based meat, dairy, and eggs.



Young (aged 25–44), higher income (MHI of ₹50,000+), well-educated (college graduates and above), living in urban areas, and flexitarians are the early adopters of plant-based meat in India. Consumers in the age group of 18–24 are also keen on trying the category, however, due to the price premium on the category at this stage, they might not have the financial means to regularly adopt it. The demographic profile remains the same for plant-based dairy and eggs as well, with the exception of **both vegetarians and non-vegetarians being the target audience for plant-based dairy and eggs.**

Fig 15: Profile of the early adopters of plant-based meat, dairy, and eggs



Early adopters and their shifting consumption patterns

Early adopters exhibit high consumption of animal-derived products compared to the rest of the population. Dairy and eggs have the highest penetration among the early adopters, followed by poultry, fish, and mutton. Early adopters consume conventional meat almost on a daily basis, frequently incorporating it into their weekday meals. Chicken and fish are mostly consumed on

weekdays, while mutton and shellfish are consumed on weekends or at gatherings with friends and family. Dairy and eggs are typically consumed around 4–5 times a week.

One in four early adopters claims that they would consider not consuming animal-based products like chicken, fish, mutton, and dairy/eggs in the future. Some of the key reasons for reducing conventional meat consumption in the future are:

- **Product-related barriers:** Concerns about the hygiene of the meat procured, smell, ease of cooking, and heaviness on the stomach post consumption
- **Increasing consciousness about animal cruelty**
- **Impact on the planet**

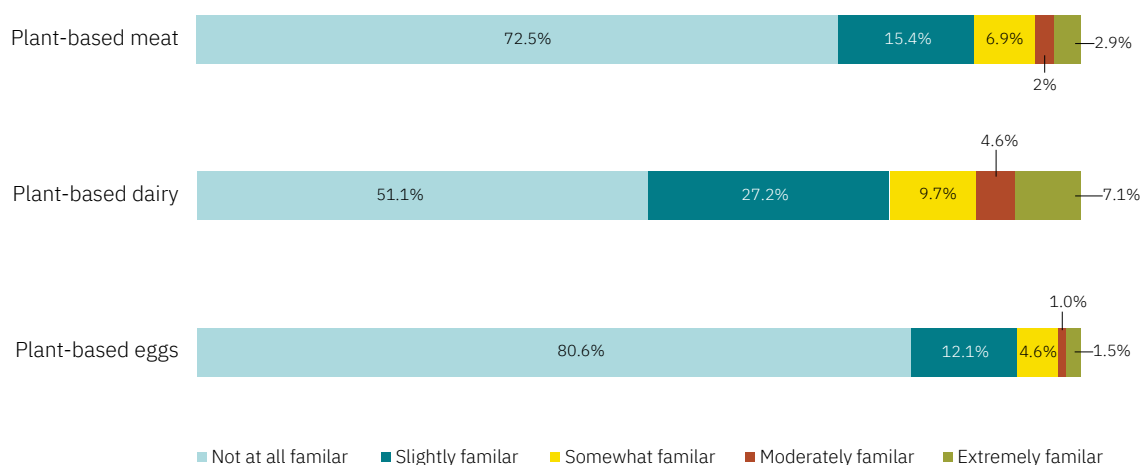
For an in-depth understanding on the consumption patterns of early adopters, please read GFI India's [study](#), A Deep-Dive into the Early Adopters of Plant-Based Meat.

Category awareness among early adopters

As per a [study](#) undertaken by GFI India and Kantar World Panel,

- Close to 30% of the early adopters are familiar with plant-based meat, and 50% with plant-based dairy. For plant-based eggs, the number stands at 20%.
- **Only 5% of the early adopters are “moderately or extremely familiar” with plant-based meat and 12% with plant-based dairy.**
- Internet, word of mouth, and in-store displays are the key sources of category awareness for early adopters across meat, dairy, and eggs. E-commerce websites are also a key source of awareness for non-vegetarians living in metros for both meat and dairy products.

Fig 16: Familiarity with the category



Source: Study by GFI India and Kantar World Panel on Trial, Awareness and Repeat Purchase of plant-based protein in India

Celebrity endorsements are helping boost the popularity of India's plant-based protein industry. Cricketer Virat Kohli and actor Anushka Sharma are investors and brand ambassadors for **Blue Tribe Foods**. MS Dhoni, former captain of the Indian men's cricket team, has invested in **Shaka Harry**, a plant-based protein startup. Another plant-based meat startup, **Imagine Meats**, is founded by Bollywood actor couple Riteish Deshmukh and Genelia Deshmukh. Udaipur-based plant-based meat company, **GoodDot**, has signed Olympic gold medalist Neeraj Chopra as their brand ambassador. Cricketer Ajinkya Rahane has invested in and is a brand ambassador for the plant-based milk startup **Oatey**.

Trials and intent to repurchase

- Of the households that are familiar with plant-based alternatives, 10% have tried plant-based meat, and 23% have tried plant-based dairy.
- 72% of the households who have bought plant-based meat in the last six months will consider buying it again in the future, indicating a healthy repeat purchase intent. For plant-based dairy, this number stands at 82%.**
- The same study indicates that 33% of the households who are familiar with plant-based meat would probably/definitely consider buying the category in the future. The same number for plant-based dairy stands at 43%.

Table 3: Awareness, trial, and repeat purchase intent

	Plant-based meat	Plant-based dairy
Number of households who are aware of the category (somewhat, slightly, moderately or extremely familiar)	27.5%	48.9%
Number of households who have tried the category (ever)	11%	23%
Number of households who are willing to purchase again in the future	72%	82%

Source: Study by GFI India and Kantar World Panel



Considering the healthy repeat purchase intent for the category among the early adopters, it is clear that the category can benefit from building consumer awareness. GFI India is currently working with key stakeholders in the industry to assess gaps and scope a roadmap for a category awareness campaign for the sector. In the past, similar campaigns were undertaken by The National Dairy Development Board (NDDB), the National Egg Coordination Committee (NECC), and the Association of Mutual Funds (AMFI). There is evidence that such campaigns play a key role in educating consumers and myth-busting, which could be promising for an upcoming sector like smart protein.

The coexistence of animal-derived and plant-based products

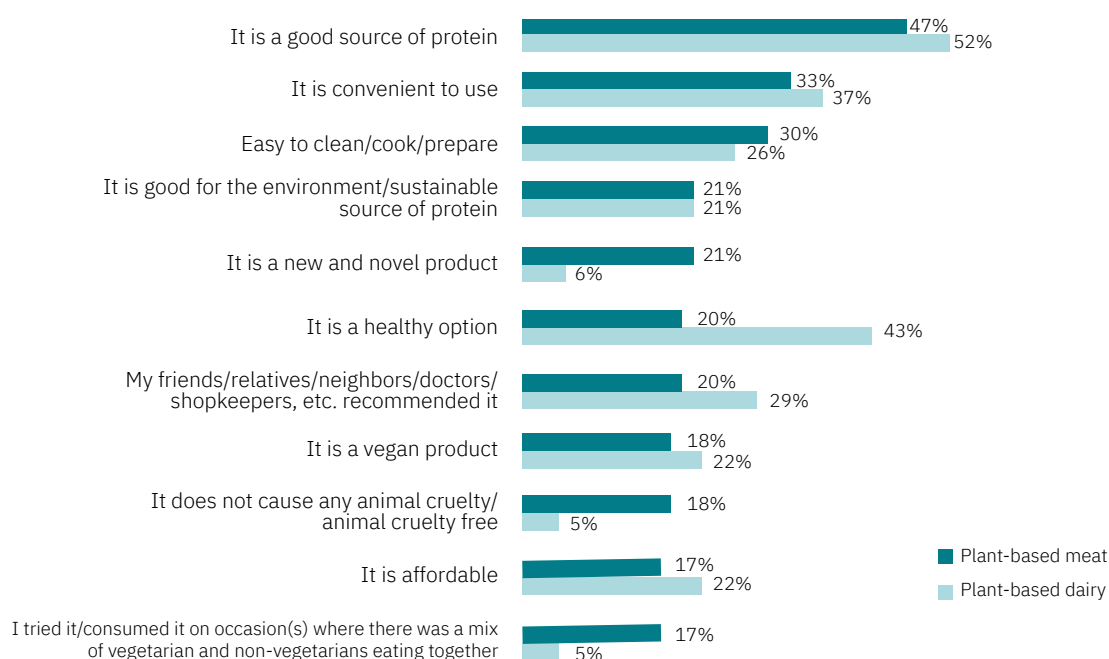
As per the study done by GFI India with Kantar World Panel with the early adopter population,

- 72% of the consumers who have purchased plant-based meat have also purchased animal-derived meat products.
- 89% of the consumers of plant-based dairy have also purchased animal-derived dairy products.

Currently, plant-based categories are supplementing the existing consumption of animal-derived meat and dairy rather than replacing them. Both plant-based meat and dairy are currently consumed in similar ways as conventional meat and dairy with the distinction that plant-based options are used more for special occasions rather than for everyday use.

Motivation for consumer adoption

Fig 17: Reasons for trial



Source: Study by GFI India and Kantar World Panel on Trial, Awareness and Repeat Purchase of plant-based protein in India



- **A key reason for consumers to try both plant-based meat and dairy is its protein content.** Convenience, especially the ease of cleaning and cooking compared to traditional meat products, is another key driver for consumers to try plant-based meat. This emerges as an important driver considering that most of the traditional meat products in India are still procured from the neighborhood butcher which requires extensive cleaning. The novelty of the category, along with other benefits like sustainability and health, also serve as key reasons for consumers to try plant-based meat.
- Much like plant-based meat, the key reasons consumers try plant-based dairy are its protein content, health benefits, and convenience.
- Awareness through word of mouth is also playing a key role in driving the trials for the category.

Of the consumers who have tried plant-based meat and dairy,

- 72% would consider buying plant-based meat again, and 82% would consider repurchasing plant-based dairy.
- The main factors influencing these repeat purchases are similar to those for initial trials—nutrition, health, and protein content.
- Taste, which is the top driver for conventional meat, appears after health and nutrition for the repeat purchase of plant-based meat, indicating the improvement required on the taste front for plant-based meat.

Barriers to trial

Even among the consumers who are familiar with plant-based meat, only 10 percent have tried it. Leading reasons for not trying the category are:


- Resistance from family, lack of relevance or clarity on health benefits, and perceptions of the product not being natural.
- In non-metro areas, more consumers feel these products are unnatural and are uncertain about where to purchase them, compared to consumers in metro areas.
- Among consumers aged 45 and above, there's a stronger belief that these products are not relevant to them and that they contain a synthetic taste and preservatives, compared to the younger audience.
- In the Monthly Household Income (MHI) group of ₹50K–100K, a relatively higher proportion feels that plant-based meat is not relevant to them and is too expensive, especially when compared to respondents in higher income groups (MHI of ₹100K+).

The relevance of plant-based dairy


Plant-based dairy has a higher share of trials compared to plant-based meat, with 23 percent of the aware consumers trying the category. Barriers to trials of plant-based dairy include:

- Value for money and availability (limited to e-commerce sites) are the primary reasons stated by the consumers under accessibility for not trying plant-based dairy. Lower value for money was more pronounced among the consumers in non-metros, lower-income groups (MHI of ₹50K–100K), and vegetarians.
- Versatility compared to animal-derived milk, especially for cooking, baking, making *curd* (yogurt), and compatibility with hot beverages, etc. is also a barrier to trial for plant-based dairy.

The drivers of consumer change



Consumers who have discontinued the usage of plant-based meat have cited taste and price as the predominant reasons. In terms of taste, many consumers do not like the product's texture and its lack of juiciness. Consumers are also concerned about the products being too expensive, having artificial flavors, added preservatives, etc.



The main reasons for not continuing the usage of plant-based dairy after trying are “did not like the taste” and “not convenient and natural.” **Consumers also noted “milk not being compatible with coffee/tea” and “product only being available on e-commerce sites” as barriers.**

25 percent of plant-based milk consumers make milk at home due to the expensive nature of the product. Consumers claim that they switch brands based on affordability.

Are we missing something from the Commercial landscape section? Did we get something wrong? We'd appreciate your feedback via [this form](#).



Section 4

Investments

Investments

India's per capita meat, egg, and dairy consumption is growing, and capturing a fraction of that could be a billion-dollar opportunity for the smart protein sector. The category has significant growth potential, with the total economic contribution ranging between **₹6,435 to ₹18,909 crore** (\$781 million to \$2.3 billion) by 2030. Beyond a growing consumer market, the smart protein sector has opportunities to develop food-tech solutions that can mitigate the impact of climate change on our current food systems, drive technology adoption and income diversification in agriculture, and address health and nutritional concerns for a growing population.

Over the last decade, **\$14.2 billion** has been invested across technology categories into the global alternative protein category, and although there's been a high variance over this period, investment has nearly doubled on average year-on-year. 2021 was a banner year for investments, with \$5.1 billion invested into the category, registering an almost 60 percent increase from 2020 and a 400 percent increase from 2019 (the year Beyond Meat experienced its [record-setting IPO](#)). Total investments in 2022, however, fell to \$2.9 billion, amid challenging macroeconomic and market conditions worldwide.

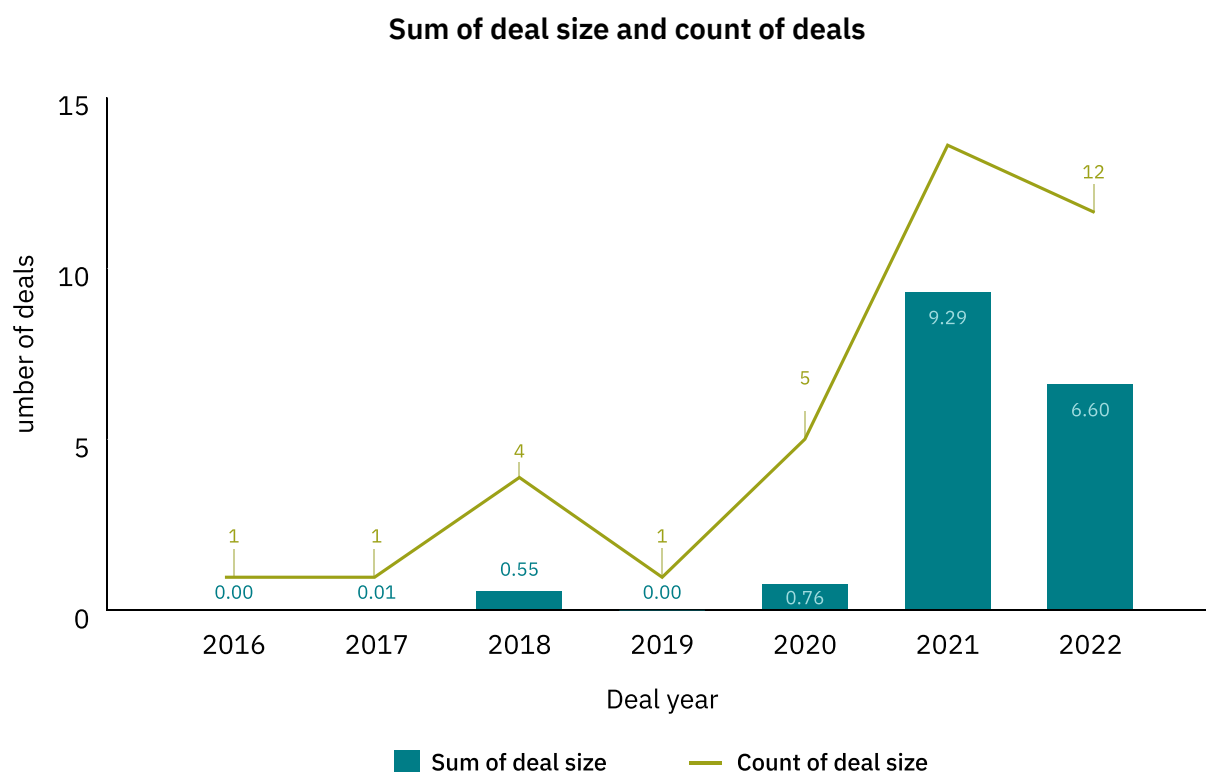
Bolstered by the shifting global economic climate, investors have shown a growing interest in alternative proteins in emerging markets. India, particularly, has an important role to play and can channel its manufacturing prowess, agricultural biodiversity, and ample human resources and talent to support global market development. In 2022, companies based in APAC saw 43 percent year-over-year funding growth to reach \$562 million. In fact, for the first time in the alternative protein sector's history, investments from outside of North America represented the majority share of the global total (58 percent vs. 42 percent), showing that the center of gravity in future food production is slowly but steadily shifting eastward. Despite this growing investor interest in Asia, virtually none of this funding trickled down to India—with smart protein startups recording **\$17 million** investments over 2021 and 2022, across all three categories of plant-based, fermentation-derived, and cultivated meat.

The success of early-day products demonstrated strong consumer interest, but investment is needed to enable alternative protein supply chain companies to build the necessary infrastructure to capitalize on this opportunity. India is uniquely positioned to build globally competitive B2B companies providing ingredients and equipment required for the sector to reach crucial inflection points on scale and price. Beyond plant-based products, India can also take the lead in the production and scaling of fermentation-derived and cultivated meat products through pre-existing infrastructure and expertise in bio-manufacturing.

A [survey](#) of investors currently active in or entering into the alternative protein sector conducted by the Good Food Institute shows that **99 percent** of respondents are optimistic about the industry's long-term potential. These developments and trends indicate that growth within this sector, like with other transformative categories, will not follow a linear trajectory and will continue to vary across regions and geographies.

Smart protein investment in India

Fig 18: Annual smart protein investment trend in India (2016–2022)



Data collection methodology

GFI India conducted a regional analysis of smart protein companies using data from PitchBook. PitchBook catalogs companies that focus primarily on the three verticals of smart protein products (plant-based, fermented, and cultivated) or provide ingredients to those who produce them. Companies involved in creating smart protein products in a limited capacity, or those that use plant-based or cultivated ingredients to manufacture end-products that do not fall within the category of alternative eggs, meat, dairy, and seafood products, are excluded from this analysis. For example, String Bio, a synthetic biotechnology company that manufactures proteins for animal feed along with human nutrition, which raised ~₹156 crore (\$20 million) in 2022, is not included in our investment analysis. Between 2016 and 2022, PitchBook profiled 75 smart protein companies, of which 19 have disclosed deals. While these companies have disclosed 40 unique rounds, only 27 deals have publicly disclosed amounts. Therefore, as these aggregate calculations account only for companies with deals and deal sizes disclosed to PitchBook, they are conservative estimates. For the purpose of this report, invested capital/investment refers to accelerator and incubator funding, angel funding, seed funding, equity and product crowdfunding, early-stage venture capital, late-stage venture capital, private equity growth/expansion, capitalization, corporate venture, joint venture, and general debt completed deals. Please note that GFI India and PitchBook continually improve the datasets, and the figures published in this report may, therefore, differ from prior figures published by us.

Top high-impact private deals in India

While companies in the global smart protein industry have raised billions of dollars in investment, the sector is still nascent, and only a handful of raises determine annual investment figures. Globally, in 2022, the top 10 deals (of 311 total deals) accounted for 47 percent of the total deal value. Similarly, some private deals account for a large share of the total deal value in India.

Table 4: Top private deals by deal count recorded by startups/companies, 2016–April 2023

Year of investment	Company	Deal size	Funding round	Investors	Company logo
2023	Zero Cow Factory	\$4 million (~₹33.1 crore)	Seed	Green Frontier Capital, Pi Ventures, GVFL, Pascual Innoventures, Artesian VC, Brinc	
2023	Nourish You	\$2 million (~₹16.5 crore)	Seed	Y Janardhana Rao, Rohit Chennamaneni, Nikhil Kamath, Abhijeet Pai, Abhinay Bollineni	
2022	String Bio	\$20 million (~₹165.6 crore)	Series B	Woodside Energy Group, Ankur Capital, Dare Ventures, Redstart, Zenfold Ventures, Srinivasa Farms, Seventure Partners, Oil and Natural Gas Corporation, Karnataka Information Technology Venture Capital Fund	
2022	Shaka Harry	\$2 million (~₹16.5 crore)	Seed	Better Bite Ventures, Blue Horizon Corporation, Dexler Holdings, Mahendra Singh Dhoni, Manu Chandra, Panthera Peak Capital	
2021	GoodDot	\$4.56 million (~₹37.7 crore)	Series A	Sixth Sense Ventures	
2021	Proeon	\$2.37 million (~₹19.6 crore)	Seed	Flowstate Ventures, Peak Venture Partners, Sanjaya Mariwala, Scrum Ventures, Shaival Desai, Waa Partners	

Note: Conversions (₹) are based on the exchange rate at the time of writing the report

As the market matures and corporates operating in traditional industries look to navigate the sector, they are likely to enter into strategic partnerships or provide corporate venture capital to startups that have scalable technologies and manufacturing processes. In February 2021, **MisterVeg**, a plant-based meat brand, raised \$0.5 million (~₹4.1 crore) and entered into a shareholder agreement with **Jubilant Ingrevia**, a sister company of **Jubilant Foodworks**, the parent company of Domino's Pizza. Similarly, in April 2023, Zero Cow Factory, a precision fermentation dairy startup, secured \$4 million (~₹33.1 crore) in their seed round with participation from **Pascual Innoventures**, the investment arm of **Calidad Pascual**, a Spanish dairy company.



Join GFI India's [Investor Directory](#) to get inbound deal flow from smart protein startups and see which companies are raising rounds in India via our [Fundraising Database](#).

Simultaneously, we expect that with the investment tightening in the sector, smart protein startups who struggle to maintain their runway might get acquired by other companies looking to expand their product portfolio or merge with similar sized startups to reduce operational costs, enter new markets, and enhance the financial health of both entities. As of April 2023, the only example in India is **One Good**, a plant-based dairy company that acquired plant-based nutrition brand **Pro2Fit** in one of the first M&As in India's growing plant-based sector in 2021. The company also acquired plant-based cheese company **Angelo Vegan Cheese** in 2022 and merged with **Katharos** in 2023 to broaden its existing product range of alternative protein products which includes plant-based milk, butter, *ghee*, cheese, and yogurt.

Investor landscape

In India, with the smart protein ecosystem continuously expanding, there is an increasing need for several financial instruments that can support the growing requirements of startups in different stages of their life cycles. While early-stage financing can support startups to commercialize their technology, later-stage financing is critical for startups to scale their operations and expand their product portfolio. This has necessitated the entry of investors who can drive different stages of capital—from angel investors and accelerators to venture capital funds and development finance institutions. While the sector has yet to witness a steady flow of patient capital, private investors are beginning to incorporate smart protein in their portfolios, demonstrating their growing confidence in the sector.

Between 2016 and April 2023, 34 venture capital funds, 27 angel investors and family offices, two corporates, one investor syndicate, and three grant-provisioning organizations have invested in the sector. These are only conservative estimates of investor activity in the sector as they only account for companies with deals and investor names disclosed to PitchBook. As companies continue to innovate and fill existing white spaces (such as whole-cut meat alternatives), and scale and optimize production to improve the taste and affordability of products, the market will continue to grow and invite more investor interest.



Through Better Bite, we have invested in several startups in India that are planning to expand internationally with their products. In fact, some have already started. I believe, with its world-class talent and proven track record of cost-efficient scale-up, India is uniquely positioned to be a smart protein innovation and manufacturing hub. This is especially relevant for technologies like precision fermentation that can benefit from talent and equipment currently used for biomedical research and production.

Michal Klar, Better Bite Ventures

Table 5: Most active investors in India by deal count

Investor	Logo	Investor Type	Headquarters	Number of Deal Counts	Portfolio Companies
ProVeg		Incubator	Berlin, Germany	10	Fattastic Technologies, Algrow Biosciences, Mister Veg, Naka Foods, Pro Meat, Rewild Bio, Seaspire, Clear Meat, Alt Foods, and Altein Ingredients
Better Bite Ventures		Venture Capital	Christchurch, New Zealand	4	Shaka Harry, Greenest, Phyx44, and Klever Meat (through their First Bite program)
Big Idea Ventures		Venture Capital	Singapore	3	Evo Foods, Phyx44, and Green Gourmet Foods
Ahimsa VC		Venture Capital	Mumbai, India	3	Demolish Foods, Phyx44, and Alt Foods
Brinc		Accelerator	Hong Kong	3	Clear Meat, Zero Cow Factory, and Naka Foods
Ankur Capital		Venture Capital	Mumbai, India	2	String Bio and Myoworks
Unovis Asset Management		Venture Capital	San Francisco, USA	2	GoodDot and White Cub
Huddle		Venture Capital	Gurugram, India	2	Wakao Foods and Milkin Oats
Sandhya Sriram	-	Angel Investor	Singapore	2	Evo Foods and Phyx44



Having been a founder and investor in the global alternative protein industry since 2014 and subsequently shifting focus to India through AltX Ventures and Ahimsa VC, I've directly witnessed the remarkable progress of the Indian smart protein industry. In the last five years, there has been a significant increase in investments, partnerships, and research in plant-based, cultivated, and precision fermentation verticals. With numerous startups exporting plant-based products, India's potential to become a leading global alternative protein player is becoming a reality because of its cost-efficient innovation and manufacturing especially as China gets politically further isolated.

*This growth is bolstered by diversified funding along with endorsements from A-list celebrities and athletes like Anushka Sharma and MS Dhoni. Large corporations like **TATA**, **ITC** and **Haldirams** entering the alt-meat arena is another notable milestone. Indian smart protein entrepreneurs have a golden opportunity to learn from both the successes and struggles of West's past mistakes, which have led to consolidations, corrections, and closures. By prioritizing business fundamentals, building defendable moats, and avoiding pursuing excessive valuations, they can navigate the funding winter and create sustainable, long-term growth.*

Jinesh Shah, Ahimsa VC



Our collaboration with nonprofit and industry players has catalyzed India's first food-tech park. The partnership is a testament to our belief that India has a critical role to play in the global smart protein ecosystem. Bolstered by the appropriate regulatory framework and government incentives, India can serve as a model for other countries in channelizing its potential manufacturing prowess, farmers, and ample STEM talent to feed itself and the world in a safe, responsible, and sustainable manner.

Ayan Dutta, EFF Ventures

Accelerators and incubators

Early-stage startups require a clear pathway between grant funding, which can support prototype development and idea testing, and equity funding, which can help them commercialize the prototype and bring it to the market. However, funding alone is not enough. Entrepreneurs require technical mentorship, infrastructure access, and entrepreneurial support to bring new innovations to the market. Here, accelerators and incubators play a vital role as ecosystem enablers and help entrepreneurs navigate the legal, financial, technical, and commercial processes of setting up a company.

With the smart protein sector in India still in its infancy, entrepreneurs face unique industry challenges like navigating complex regulatory pathways, shortages of skilled talent, and lack of market access points. Yet, the biggest bottleneck is the lack of R&D infrastructure required at the lab, pilot, and large manufacturing scale to convert experimental solutions into market-ready products. Recognizing the need to address these gaps and the enormous potential of the sector, some incubator and accelerator programs have come to the forefront and are laying the groundwork for incorporating smart protein in their mandate.

- **Huddle**, a venture capital fund and accelerator, supported **Altein Ingredients**, **Milkin Oats**, and **Wakao Foods** on their go-to-market strategy, business development, and capital structuring through their sector-agnostic accelerator program.
- **Krystal Ventures Studio** [launched](#) its first plant-based cohort to support five startups in the areas of plant-based meat, dairy, protein ingredients, and nutraceuticals with an initial investment of \$100,000 (~₹82 lakh) and an additional fund of up to \$200,000 (~₹1.65 crore) as needed to achieve agreed upon milestones.
- Society for Innovation and Entrepreneurship (SINE) incubated **Myoworks**, **Plantish Foods** and **ProMeat** in its business incubator at the Indian Institute of Technology (IIT), Bombay to provide three years of incubation support, including access to infrastructure, grant funding, mentorship, retainer services, events, and ecosystem access.
- CSIR-Central Food Technological Research Institute (CFTRI) [incubated](#) **Plantish Foods** and **Mycovation** at their nutra-phyto incubation centre and common instrumentation facility.
- [CIIE.Co](#), an entrepreneurship center at the Indian Institute of Management (IIM), Ahmedabad, supported **Proeon**, **FemtoFarad**, and **Naka Foods** through their technology business incubator.
- [Atal Innovation Centre – Centre for Cellular and Molecular Biology](#) (AIC-CCMB), an incubator set up under the Atal Innovation Mission in Hyderabad, incubated **Phyx44** and **Neat Meatt** to provide them access to 10,000 sq.ft of dedicated facilities, customizable plug and play wet lab space, specialized equipment and a wide network of mentors and investors.
- BioNEST incubators, established under **BIRAC's** [Bioincubators](#) [Nurturing Entrepreneurship for Scaling Technologies](#) scheme, like **IKP Eden** and **ASPIRE BioNEST** have supported smart protein companies in their early-stage journey and are looking to scale their incubation facilities in the next few years.



From an investment perspective, the alternative protein sector is experiencing significant growth and is considered an emerging market with substantial potential for investment returns. By launching a plant-based fund, Krystal Ventures Studio aims to seize this market opportunity and provide support to companies in the sector. Traditional investors may have limited familiarity with the specific nuances and unique challenges faced by companies in the alternative protein space. To fill these gaps in the industry, through our cohort-based funding approach, we aim to create an ecosystem that fosters mutual benefits among startups.

Manjula Naidu, Krystal Venture Studio



GFI India signed a Memorandum of Understanding with research and business incubators, including the IIT Bombay-Wadhwani Research Centre for Bioengineering, the University of Trans-Disciplinary Health Sciences and Technology, IKP Knowledge Park, Guwahati Biotech Park, and AIC Nalanda Institute of Technology Foundation to advance the innovation ecosystem for smart protein entrepreneurs and researchers.

Building a thesis for smart protein

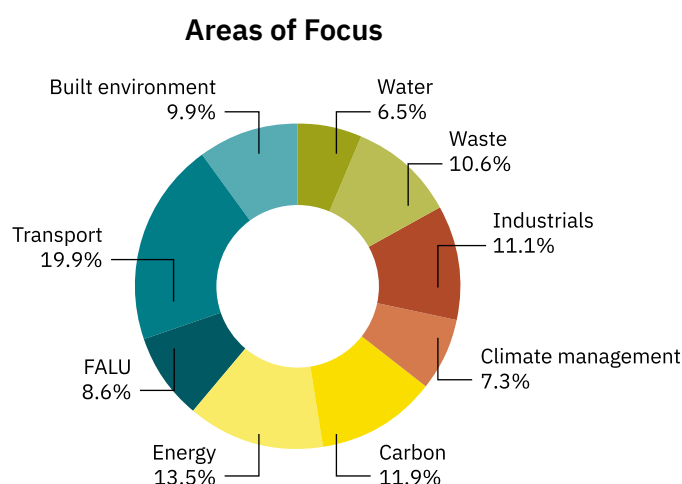
The venture capital funding landscape in India is poised to take on monumental challenges across climate, public health, and livelihoods. Smart protein sits squarely across these domains and investors have begun to develop varied investment approaches to the opportunities presented by smart protein companies to tackle these threats.

Smart proteins from an ESG lens—the next big opportunity for climate investment

India is predicted to become one of the world's worst-affected countries because of rising global temperatures putting additional stress on the food systems in the country. By diversifying protein sources and removing calorific wastage caused by animal agriculture, we can build a more robust agricultural system that is resilient to supply chain disruptions caused by natural disasters. It is well-documented that [plant-based](#) and [cultivated meat](#) can reduce direct emissions and require much less water to produce, which is especially pertinent to India as more regions become water-stressed.

In India, climate technology has seen approximately ~₹24,855 crore (\$3 billion) in private equity investments since 2016, with more than half of this amount invested in 2021 and 2022 (up to November 2022). As per the [India Climate Finance Report](#) published by the Climate Capital Network, one out of three impact investments in India in 2022 was in a climate-tech startup. While mainstream sectors like clean energy and sustainable mobility have received the largest share of these climate investments in India, there has been an increase in investor interest in smart protein as a high-impact climate solution. While food and land use solutions are only expected to attract [8.6 percent](#) of the total climate investments in the current year, a fair share of these investments are predicted to be directed into the smart protein sector.

Fig 19: Expected distribution of investment (in %) between the sub-sectors comprising the climate space in India in 2023



Note: FALU stands for 'Food and Land Use' category which comprises smart protein, regenerative agriculture, and nature restoration

Source: India Climate Finance Report 2022

In addition to being a climate solution, alternative proteins are increasingly being recognized for their role in contributing to the environmental, social, and corporate governance (ESG) mandate of global investors. As per [GFI's Investor Survey](#), ESG is important for 94 percent of the global investors surveyed, with 72 percent deeming ESG “critical or very important.” Accordingly, global investors are investing significantly in alternative proteins with ESG impact as the primary driver for 42 percent of the investors surveyed. Moving forward, as global ESG interest remains high and private impact funds have [\\$113 billion in dry powder](#) (funds that have yet to be invested), it is bound to create a tailwind for alternative proteins.



The food industry is crucial for feeding over eight billion people globally and has a significant climate impact. Smart protein can play a major role in providing required nutrition and reducing resource intensity. Smart protein technologies and processes that can maintain the taste, texture, and feel of animal protein and reduce climate impact by a factor of 5–10 times are increasingly gaining traction. While the market is still nascent in India, we see tremendous growth possibilities in this space and attractive investment opportunities in the next five years. The trend has accelerated in Europe and the U.S. and should gain momentum in India. Having invested in one company, we continue to look for other opportunities in this space.

Samir Shah, Peak Ventures



GFI & FAIRR collaborated to create [Alternative Protein ESG Reporting Frameworks](#) to enable both diversified and specialized companies to assess and monitor the ESG impacts and considerations related to alternative protein products. Companies can download the relevant framework and accompanying technical guide to better understand, track, and report ESG characteristics of their portfolios.

Smart protein's role in agri-tech's future

To create highly functional and nutritional smart protein products, startups are likely to expand their focus beyond traditional ingredients like soy and wheat. This will lead to the diversification of crops and adoption of indigenous varieties like millets that are climate resilient—a critical step toward building a more sustainable and integrated agri-food value chain.

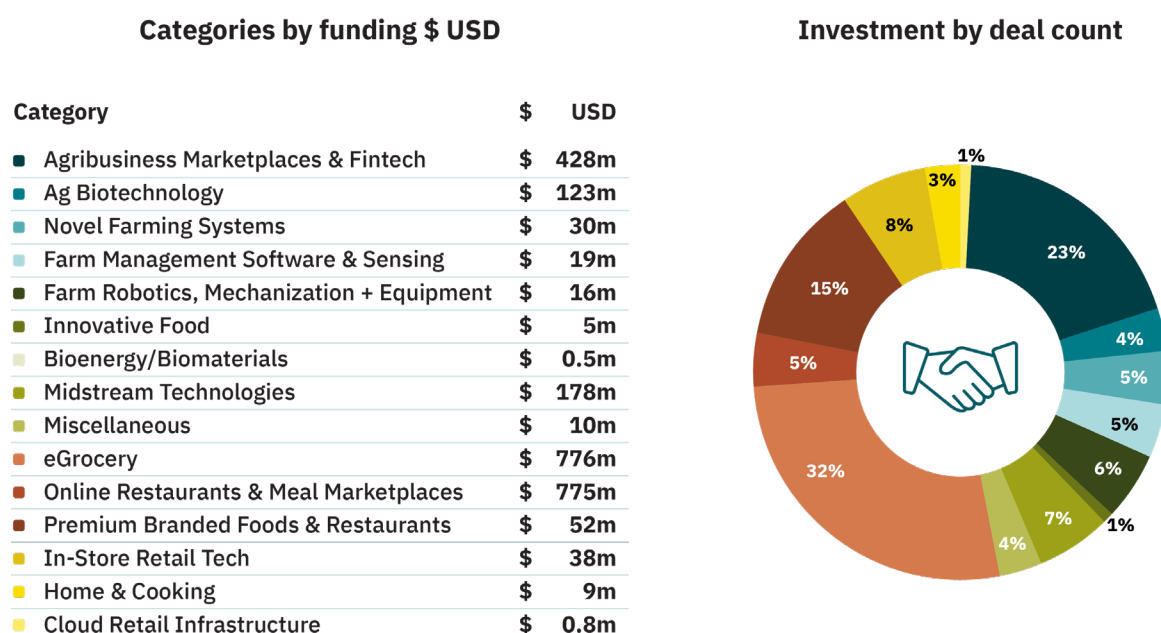
Capitalizing on this opportunity, as plant-based ingredient companies make strides toward backward integration into agri-value chains to support agri-biodiversity, there is a clear opportunity for investors looking to transform food systems in India to expand their portfolio beyond agri-tech startups. For example, in 2021, **Omnivore**, a venture capital firm that has

backed over 40 startups working on agrifood tech, launched OmniX Bio, an initiative to accelerate early-stage startups working in fields like smart protein, agriculture biotechnology, novel farming systems, and biomaterials.

In the last few years, with startups developing new technologies to transform our food system and the government providing positive regulatory support, India's agrifood-tech⁵ startup ecosystem has received substantial funding from private investors. As per the [AgriFoodTech Investment Report](#) published by AgFunder in 2023, startups in this space raised approximately ₹94,539 crore (\$11.4 billion) through 920 unique deals between 2018 and 2022.

However, mirroring the global macroeconomic trends and slowdown of venture capital funding in 2022, funding in the agrifood-tech sector dropped 33 percent to ~₹19,884 crore (\$2.4 billion) in 2022 from ~₹29,826 crore (\$3.6 billion) in 2021. A large proportion of these investments in 2022 were raised by startups working on upstream agriculture technologies and downstream services like eGrocery. Startups working on innovative food, including smart protein, only accounted for [six percent](#) of the investments raised through the 131 total deals. Moving forward, as the agricultural system in India bears the pressure of climate change, agri-tech investors will have to look beyond upstream technologies to sustain the existing agricultural value chains. Smart proteins will likely emerge as a pivotal solution for diversifying market demand and creating efficient, carbon-neutral food production systems.

Fig 20: Distribution of investments in sub-sectors of the agrifood-tech sector by deal size and deal counts in 2022



Note: The category of innovative food comprises cultivated meat, novel ingredients, and plant-based protein solutions.

Source: Agrifood-tech Investment Report 2023, AgFunder.

Smart protein with a consumer-centered focus


India is a growing, addressable market for consumer goods with increasing disposable incomes and upward social mobility. However, traditional retail in India remains largely unorganized, and a number of brands in the smart protein sector have instead opted to launch through digital media and e-commerce. This digital retail paradigm enables companies to reach out directly to their target consumers and create brands that are Indian and culturally resonant, with an ability to innovate on price and formats and scale across the length and breadth of the country. Investors are also looking for brands that can do this successfully. For example, the Indian consumer-centric venture fund **Sixth Sense Ventures** invested in plant-based meat company **GoodDot**, recognizing their ability to capture domestic consumption preferences through varied formats of meat alternatives that resonate with the consumer's motivations across health, climate consciousness, sustainability, and animal welfare.

After Covid-19, consumption patterns changed, and consumer needs continue to evolve. Focusing on health and wellness could propel rapid growth in the plant-based foods market, with similar trends already driving the next wave of change in the direct-to-consumer (DTC) venture space. For instance, India houses more vegetarians than the rest of the world put together ([39 percent](#) of the current populace), and while these cohorts do not consume animal meat or eggs, they consume dairy products frequently. More recently, with growing awareness about lactose intolerance and other impacts of dairy consumption, consumers are becoming more open to trying plant-based alternatives. Building plant-based dairy formats focusing on nutrition, i.e., enhanced protein content and micronutrients, is driving growth for the segment globally, with similar trends projected in India.



Untapped opportunities in smart protein investment

Companies must begin focusing more on serving lower and middle-income cohorts. As a largely protein-deficient country, consumer play for affordable protein in India is essential. Fortified products are at a point of inflection, while meat alternatives are only beginning to get a seat at the table in India. We need to create solutions for high protein absorption, focusing on affordability. India is a largely aspirational market for protein demand and there is a need for innovation beyond the burger—to create products with improved taste profiles, prices, and ingenuity in formats that have the potential to scale in resource-constrained environments. Fermentation-derived proteins may be particularly compelling because of their cost, potential to scale, and adaptability to diverse feedstocks, including waste and sidestreams. Innovation in sidestream valorization will play an important role in de-risking the alternative protein industry at scale by improving supply chain resiliency and environmental sustainability. It's important to note that India will not mirror global markets, and different inflection points for different segments are to be expected.



Emerging markets in Asia, including India, Thailand, and Indonesia represent some of the largest farmer-family cohorts in the world, and there is an opportunity to leverage under-utilized protein sources to advance farmer welfare. Through market intervention, there is potential for creating robust R&D and value chains for crops such as pulses, legumes, millets, and hemp as viable raw materials for smart protein foods, and thereby diversifying global inputs for the sector. **By utilizing these novel and indigenous ingredients, additional sourcing and manufacturing hubs for alternative proteins can be built in the region to cater to the global industry.** Investors are looking to companies in India to build self-sustaining end-to-end value chains for smart protein foods made with high-value novel crop ingredients. A diversified agri-system will also make our food system more resilient and support the diversification of livelihoods.

Investors are diversifying their alternative protein holdings by investing across plant-based, cultivated, and fermentation-derived proteins. There is particular interest in B2B companies providing ingredients and equipment to the industry, which is vital for the sector to scale. Product categories with high interest include precision and biomass fermentation, alternative fats (especially cultivated and fermentation-derived), fermentation-derived ingredients (in addition to fat), cultivated seafood, and cultivated dairy.

Service providers with existing research and manufacturing capabilities stand to compete for global supply chains, particularly in the United States and European Union. India's existing capabilities in biopharmaceutical manufacturing and fermentation could lend themselves as providers of raw materials and ingredients or end-product manufacturers. Linking technologically advanced markets like Singapore and Israel with traditional pharmaceutical manufacturing hubs like India could bring mutual gains to advance the state of the industry globally through cost innovation and localization of existing technologies.

Technical assistance programs could help de-risk the early-stage investment ecosystem.

During the early development stages of startups, a technical assistance provision can provide know-how on crop agronomy, protein extraction, protein recovery, and application-based training. During the implementation phase, support for networking, partnership building, and brokering offtake agreements across the value chain will enable greater success for entrepreneurs. Impact monitoring services can support projects in assessing and reporting their operations' environmental and social impacts, thereby filling a gap in ESG reporting and meeting demands from investors, governments, and consumers for greater transparency.

There is a need for innovative financing instruments to facilitate access to commercial capital for building critical infrastructure for the smart protein sector. Over the past few years, deal flow has focused on equity financing for seed-stage enterprises. On one hand, this demonstrates that the sector has a high growth potential. On the other hand, it showcases the need for capital providers to help scale this ecosystem beyond the early stages of equity financing to support capital-intensive facilities for scale-up. Public sector intervention in agri-integration, infrastructure, value chain investment, and export linkages are equally essential. Blending concessional finance, including loans, grants, and equity, with private finance can enable access to low-cost patient capital through non-dilutive debt financing to build critical infrastructure in India's smart protein ecosystem.



GFI India supports investment partners in accessing opportunities within smart protein, understanding the market and technical landscape, and engaging with any existing portfolio companies. Partners are supported in their thesis-building efforts and in creating linkages and partnerships within the smart protein sector. GFI's [Quarterly Investor Newsletter](#) offers access to investment data and analysis, research, and tools, as well as a list of venture capital funds focused on alternative proteins that are fundraising.

Are we missing your company? Did we get something in this Investment section wrong? We'd appreciate your feedback via [this form](#).

A top-down view of a white plate with a gold rim. The plate features a central piece of golden-brown, breaded cultivated chicken. It is surrounded by a dark red sauce and a yellow sauce. Garnishes include sliced cherry tomatoes, mushroom slices, and fresh basil leaves.

Section 5

Science and technology

Science and technology

Scientific research and expert talent lift all boats in the smart protein wave—and India’s subject matter experts in food technology, biotechnology, and bioprocess engineering are doing precisely that. Over the last five years, scientists from several Indian institutions have participated in national and international collaborative partnerships to conduct interdisciplinary research using revolutionary technologies for developing plant-based meat, eggs, and dairy, fermentation-derived proteins, and cultivated meat and seafood. Such promising science and technological advancements in each category of smart protein have resulted in numerous impactful scientific publications bolstering India’s smart protein research and training ecosystem.

Plant-based

According to the United States Department of Agriculture (USDA) [Industry Report of 2021](#), India is a burgeoning market for plant-based meat alternatives. A 2019 University of Bath and the Good Food Institute [survey](#) revealed that 63 percent of Indian consumers were very or extremely likely to purchase plant-based meat regularly. The USDA Industry report also mentioned that Indian consumers perceive plant-based meat substitutes as highly innovative, healthy, and environmentally friendly. Hence, it is not surprising that the plant-based food industry in India has realized the importance of science and technology in developing products that are innovative, healthy, and sustainable. Notably, during the last four years (2019–2022), the plant-based smart protein industry focused on:

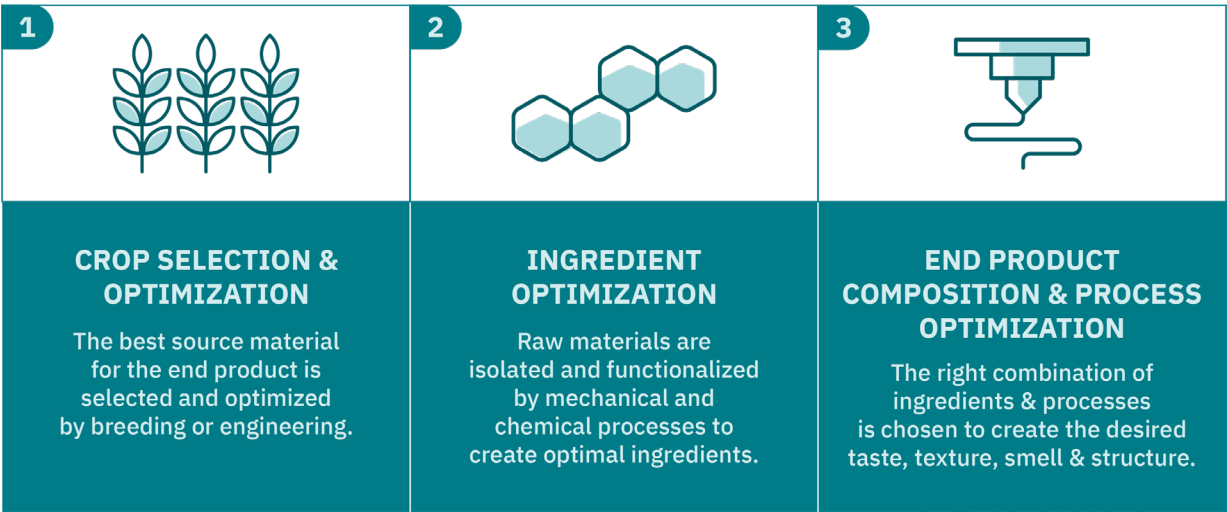
- **Sustainable and chemical-free protein processing:** Developing sustainable, innovative, and commercially viable protein extraction techniques to produce clean label and chemical-free plant protein concentrates from Indian pulses. Enhanced process sustainability and high retention of nutrients and functionality are the key goals.
- **Optimization of ingredients for customized applications in plant-based foods:** Complementing plant-based foods with familiar flavors and umami to impart interesting taste variations in the end-product.
- **Diversification of the plant-based ingredients basket:** Plant-based food startups began thinking beyond soy and wheat as sources of plant proteins. They are looking at the indigenous crops of India that can be processed to enhance their inherent nutritional quality, taste, and functionality.
- **Capacity building to boost new product development:** Developing commercial-scale high-moisture extrusion (HME) machinery to manufacture a diverse range of plant-based meat products at high throughput.



For more detailed information about the technologies described below, refer to GFI’s explainer on [The Science of Plant-Based Meat](#), including deep dives into crop development, ingredient optimization, and end-product formulation and manufacturing.

Research across the technology stack

Fig 21: Value chain of plant-based smart protein products



Crop optimization

Since the domestication of plants, the agricultural sector has employed breeding methods to obtain specific target traits. Currently, extensive crop breeding techniques are used to achieve improved yield, abiotic and biotic stress tolerance, and physical uniformity that facilitates automated mechanical harvesting.

Breeding crops to tailor them for applications in the smart protein sector would entail breeding for traits that can improve the content, functionality, and intrinsic organoleptic properties of protein derived from crops. However, breeding efforts to obtain high-protein varieties of crops such as legumes, pulses, beans, and millets are few and far in between. **Leveraging existing knowledge of breeding and crop science and applying it to indigenous crops for enhanced protein content has much potential in future research.** For instance, knowledge of germplasm accessions can enable the development of improved pulse varieties with 20 to 25 percent more protein.

In addition, the extractability of protein is an important aspect of establishing a crop as a protein source for product development and commercial applications. Crop breeding approaches to obtain larger seeds and a lower level of hull per pound of seeds would help in enhancing extraction efficiency. Moreover, breeding to obtain a uniform seed size and shape would also positively influence the ingredient processing steps, such as maintaining consistent soaking times. Recently, plant breeders have realized the importance of novel crop traits such as flavor and functionality. This is relevant because the beany odor and bitter taste of millets and pulses are major barriers to incorporating their protein fraction as an ingredient in meat, dairy, and egg alternatives.



- **The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) led a market-driven crop innovation to release 10 new varieties of chickpeas in 2020.** The new varieties were developed to cater to the growing global market demand for nutritious and protein-rich chickpeas and promote nutrition security, health, and climate resilience. The availability of improved chickpea varieties facilitates expansion and adaptability to new regions, increases their availability of protein extraction, and improves the development of value-added products.
- Notably, three Indian women scientists were successful in developing chickpea varieties with enhanced protein content. Dr. Ritu Saxena, a Principal Scientist at Indira Gandhi Krishi Vishwavidyalaya (IGKV), Raipur, along with ICRISAT, developed a chickpea variety that matures in just 94 days. The variety (ICCV 15101) has an average protein content of 22 percent and exhibits preferred market traits.

Ingredient optimization

The plant-based food industry constantly looks for sustainable, functional, and clean-label protein concentrates and isolates to diversify their ingredient basket beyond the conventional sources. Plant-based food ingredient companies are focusing on innovations related to protein extraction as it governs the yield, purity, and functionality of plant proteins, as well as the environmental footprint of their production. Generally, mild aqueous fractionation (omitting the use of chemicals) has a lower environmental impact than conventional wet fractionation methods. Similarly, validating India's indigenous crops' potential for plant-based food applications has also been a focus. The eventual goal of these ingredient innovations is to achieve the nutritional, functional, taste, and price parity of plant-based ingredients versus their animal-derived counterparts.

- **Devigere Biosolutions** has developed a novel technology capable of producing clean-label and highly functional protein concentrates from cowpea for use in a plant-based whole egg or as an egg-white substitute. Their mung bean protein concentrate has a protein content of over 60%, along with the benefits of natural fibers and vitamins, but without the beany flavor. Devigere Biosolutions claims their clean-label products have the best applications as functional proteins in plant-based dairy products, plant-based eggs (for cooking and baking), and protein supplements.
- In 2022, **Nutrigenetics Life Science Private Limited** received the Biotechnology Ignition Grant (BIG) of Biotechnology Industry Research Assistance Council (BIRAC) for their proposal titled "Plantegg—Plant-based vegan egg protein alternative as a vegetarian masala omelet." Their venture was incubated at the KIIT-Technology Business Incubator (TBI). According to Nutrigenetics Life Science Private Limited, Plantegg is made from selective Indian pulses and spices, which offers consumers clean-label (free of preservatives, stabilizers, and emulsifiers) and nutritional (balanced amino acid profile) benefits.

- **Proeon**, a Pune-based startup manufacturing plant-based protein ingredients, provides a wide-ranging portfolio of protein ingredients derived from [indigenous and sustainable](#) crops like amaranth, hemp seed, mung bean, fava bean, and chickpeas, which undergo mild extraction, processing, and protein conditioning to obtain desirable nutritional quality, sensorial, and functional properties.
- **ICRISAT**'s research work, in collaboration with GFI India and Bill and Melinda Gates Foundation (BMGF) for a specific grant funded project, focused on understanding the nutritional and functional properties of selected millet varieties (sorghum, pearl millet, and finger millet) to develop high-protein millet flours. This research project established the potential of millets as an alternative source of protein for the development of plant-based meat, egg, and dairy products.

The following open-access scholarly publications of Indian researchers related to proteins derived from indigenous crops and plant-based foods are promising signs of future scientific breakthroughs in India's smart protein research:

- [Leveraging Indian Pulses for Plant-Based Meat: Functional properties and development of meatball analogues](#): This research work undertaken by the researchers from **Pondicherry Central University** highlights the potential of Indian pulses such as green gram, horse gram, and cowpea protein concentrates obtained using the alkaline/isoelectric precipitation method to prepare plant-based deep-fried meatballs.
- [Sustaining Protein Nutrition Through Plant-Based Foods](#): This review article authored by scientists from the **ICAR-Indian Agricultural Research Institute**, New Delhi, discusses the nutritional quality of plant proteins, their cost-effective extraction and processing technologies, their impacts on nutrition, and the utility of different food wastes as an alternative source of plant protein. It also provides an overview of emerging technologies for improving the bioavailability, digestibility, and organoleptic properties of plant proteins.



For detailed reading on the use of indigenous crops such as millets and pulses as the sources of plant protein for smart protein products, refer to GFI India's [Indigenous crops for smart protein applications: Literature Library](#).

End-product formulation and manufacturing

Extrusion is an established process to manufacture plant-based meat. A significant challenge encountered by the scientific and industrial fraternities of the Indian plant-based protein industry is the lack of extrusion facilities to conduct pilot-scale trials on innovative whole-cut meat alternatives. In the last two years, Indian plant-based startups focused on establishing extrusion facilities and pursued R&D innovations in developing a multitude of products with novel textures and sensorial experiences.

- **BVeg Foods** unveiled their new [plant-based production facility](#), which can currently produce 4,000 MT of plant-based meat annually, with plans to scale up to 12,000 MT/year.
- **Symega Food Ingredients** is investing ₹100 crore (\$10.3 million) to build a dedicated [plant-based production facility](#) with an on-site R&D laboratory—SYMEGA Protein Innovation Centre (SPIC), in Kochi, India.
- **Flavingred Products** launched a variety of plant-based chicken patties, goat liver products, and plant-based drinks, and a plant-based goat liver product. Besides being allergen-free, the plant-based chicken patty product claims nutrition and taste parity with the conventional chicken patty. According to Dr. Rituja Upadhyay, the uniqueness of Flavingred Products' dairy alternatives is that the formulation comprises just four ingredients. Made of a flavorless base, their plant-based milk product can be consumed plain or used to make tea, coffee, or smoothies. Their flavored plant-based dairy range comes in coconut, passion fruit, chocolate, and kesar pista flavors. Dr. Rituja confirms that their plant-based goat liver analog is the most innovative product, containing only three clean-label ingredients, developed by a simple single-stage clean-label process.
- A team of researchers from the **University of Trans-disciplinary Health Sciences & Technology (TDU), Bengaluru**, reported their [findings](#) on the effects of selected process parameters on the texture of high-moisture meat analogs (HMMA) prepared from soy-based protein blends. The chosen process parameters were protein concentration and moisture content of soy-based protein blends subjected to extrusion and barrel temperature, screw speed, and feed rate of the twin-screw extruder. It was found that the values for hardness, chewiness, and cutting strength were comparable between the extruded plant-based meat and the real meat cuts (chicken breast, lamb meat, and beef meat). However, real meat's resilience, cohesiveness, and springiness were lower than those of the plant-based counterparts. The research also demonstrated that the moisture content, protein concentration, and barrel temperature had the most impact on the properties of HMMA. **The authors suggest that innovative die designs and customized raw material blends can aid in achieving textural parity between extruded meat analogs and real meat cuts.**
- Researchers from the **Indian Institute of Technology Delhi (IIT-D)** developed a [plant-based egg](#) product from farm-based crop proteins that looks and tastes like a poultry egg and has a similar nutritional profile.

- In 2018, the **National Institute of Food Technology Entrepreneurship and Management-Thanjavur (NIFTEM-T)** developed a [millet-based \(non-dairy\) ice cream](#) packed with omega three fatty acids from plant-based sources. This millet-based ice cream has 59% fewer calories, 22% lesser carbohydrates, and 43% lesser fat than the conventional ice creams available in the market.
- Indian researchers have made progress in manifesting the applications of 3D food printing in smart protein products:
 - A [review article](#) penned by researchers from the **Institute of Chemical Technology (ICT), Mumbai**, highlights the potential of 3D food printing in developing meat alternatives.
 - An exclusive book on [3D Printing of Foods](#) by researchers from **NIFTEM-Thanjavur** includes two chapters: Alternative Proteins in 3D Printing and Meat Analogs & 3D Printing.
- Ultrasound processing is a novel technology that is increasingly used in the preparation of plant-based milk.
 - Researchers from **NIFTEM-T** published a [study](#) detailing the development of a plant-based dairy beverage made from chickpea milk extract and flaxseed oil using ultrasound technology. This [technological review highlights](#) the potential of ultrasound to enhance the physical stability, solids, and color of plant-based milk.

Fermentation-derived proteins

Fermentation technology in India has been around for millennia—milk, cereals, pulses, vegetables, bamboo, and even meat have been used in traditional fermented food preparations to improve taste, nutrition, texture, and flavor. As many as one trillion species of microorganisms are estimated to exist on earth, exceedingly few of which have ever been commercialized for use in food. Like other realms of science, we have barely scratched the surface of fermentation’s potential as an efficient food production system and to aid ecosystem restoration by enabling a shift away from resource-intensive ways of food production.

Over the last two decades, ventures producing high-value, low-commodity pharmaceuticals like insulin or low-commodity, high-volume bio-industrials like ethanol and citric acid have dominated the Indian bio product innovation space. **This has paved the way for an enormous new frontier of bio-based foods, which include microbe-derived ingredients produced from biomass fermentation as a single-cell protein (applications in dietary supplements and biofortification) or via precision fermentation to manufacture specific food additives, such as proteins, vitamins, flavors, and fats at large scale.**

Combining India’s knowledge of traditional fermentation practices and the already-booming biotechnology ecosystem, we are entering a new chapter of novel scientific strategies in fermentation processes to discover new functionalities of foods and to create new types of food altogether. Because these technologies are well understood and commercially established, fermentation-derived food products have exceptional potential for acceptance and adoption by the Indian market. With greater investments in R&D and bio-manufacturing, we can harness technological innovation opportunities to explore applications of fermentation across the smart protein sector to produce the animal proteins people want to eat but without the negative externalities.


 For a comprehensive introduction to the current state of fermentation science worldwide, visit GFI’s [The science of fermentation](#) page.

Fig 22: Precision fermentation process

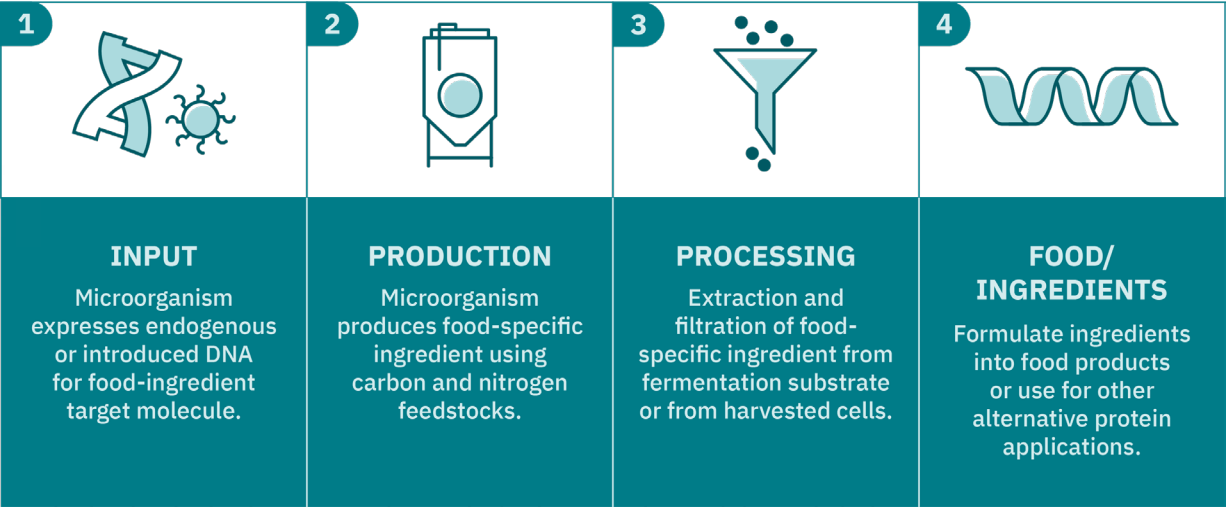
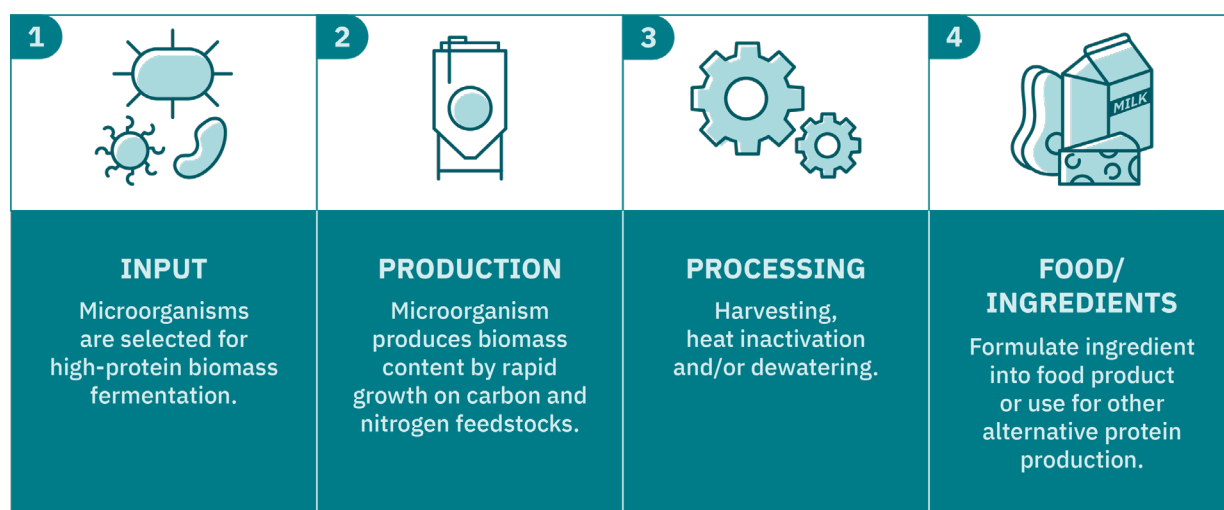


Fig 23: Biomass fermentation process



Research across the technology stack

Broad areas of research in optimizing the production of fermentation-derived proteins include target selection, strain development, feedstock optimization, bioprocess design, and end-product formulation. Over the last five years in India, ongoing innovation has largely focused on strain engineering for target molecule development, feedstock optimization, and bioprocess design.

Target selection and strain engineering

Fermentation-derived ingredients are already widely used across the food industry. Most vitamins in nutritional supplements and fortified processed foods, such as B12 and riboflavin, are produced through fermentation, as are many flavoring components. The food industry was among the first to leverage fermentation to displace animal products in everyday use. Commercialization of fermentation-produced chymosin (the major enzyme in calf rennet, taken from the lining of calves' stomachs) in the 1980s rendered calf rennet's previously vital use as a coagulant in cheesemaking obsolete for most global cheese production.

By using microbial cells as the production host, precision fermentation allows for the highly scalable manufacture of any ingredient. Target selection is the starting point for this process. The molecule of interest is referred to as the target, and it can be a protein, a lipid, a flavor compound, a fragrance, an enzyme, a growth factor, or a pigment. Leveraging precision fermentation technology to produce ingredients for plant-based meat products was first demonstrated by US-based Impossible Foods—the yeast strain *Pichia pastoris* was used to secrete recombinant soy leghemoglobin (a soybean-derived heme protein) for application as a flavoring ingredient and color additive to impart organoleptic properties in the cooked burger.

Recognizing the importance of heme protein as a flavor molecule in meat alternatives, **FemtoFarad Pvt. Ltd.**, an Odisha-based startup incubated at the Center for Cellular and Molecular Platforms (C-CAMP), has [isolated and purified](#) a non-GM heme protein from fermented

microalgal strains through food-grade processes. The heme-secreting microalgal species was screened from dozens of native strains using a bioinformatics approach to identify the highest biomass productivity and natural heme content.

Target molecules such as animal-origin-free growth factors (used in serum-free media formulation for cultivated meat manufacturing) are also produced by precision fermentation technologies. One of the leading Indian companies working in this space is **Laurus Bio** (formerly Richcore Lifesciences) which specializes in developing and manufacturing animal origin-free recombinant proteins, enzymes, and cell-culture media supplements such as albumin, transferrin, FGF, and EGF from bacterial and fungal expression systems. Laurus Bio's contract development services span the entire precision fermentation value-chain from clone development and strain engineering to bioprocess development for commercial scale-up.

Fermentation-derived dairy proteins

Precision fermentation-derived dairy proteins such as casein and whey are key targets for the smart protein industry because of their unique functionality in dairy products. These proteins can be combined with plant-derived ingredients to create a final product. For example, U.S.-based **Perfect Day**'s ice cream base combines sugar, coconut oil, and sunflower oil with fermentation-produced recombinant whey to make a lactose-free dairy alternative. The Indian precision fermentation field has also been active in the development of alternative dairy ingredients.

- In 2021, **Zero Cow Factory**, a Gujarat-based company developed a genetically modified yeast strain to produce the world's first A2 beta-casein milk protein (commonly found casein variant in Gir cattle (*Bos. Primigenius Indicus*)).
- In early 2021, **Phyx44**, an India-based biotech startup recreated [full-stack precision fermentation](#) to produce key ingredients of dairy. These include whey and casein proteins as well as fatty acids. The company aims to develop alternatives to conventional dairy end-products like ice creams, yogurts, and cheeses.

Fermentation-derived lipid production is a relatively unexplored field but is crucial for the success of the alternative meat industry. Fats and oils produced through precision fermentation can improve flavor, texture, nutrition, cookability, and more.

In 2022, **Fermbox Bio Inc.** announced the development of a proprietary manufacturing platform using microbial strains, including yeast, bacteria, and fungi with high scalability and efficient production of high-quality fermentation-derived fats and lipids that are identical to animal fats. The team is working with oleaginous microorganisms, including *Rhodococcus opacus*, *Acinetobacter calcoaceticus*, *Yarrowia lipolytica*, *Rhodosporidium toruloides*, *Mortierella Isabelline*, and *Mucor circinelloides*, which have a natural ability to produce high levels of lipids. Furthermore, they utilize strain engineering techniques to increase the yields of these fermentation-derived fats up to 60 to 80 percent. They also provide contract development services to manufacture customized fats or “designer” fats with new properties and specific applications.

Feedstock optimization

Optimizing feedstocks for microbial fermentation can cut costs, reduce waste, and improve the sustainability of alternative protein production. Currently, much of biomanufacturing (including alternative protein production) relies on [processed fermentable sugars](#) from crops (e.g., maize and sugarcane) and energy-intensive [Haber process-derived nitrogen](#) (e.g., ammonium) to grow microbes. [Utilization of agricultural waste](#) generated from fruit and vegetable-based industries (peels, rinds, and seeds) as fermentation feedstock could create [nutritionally enriched, probiotic beverages](#) with a unique flavor that could serve as value-added alternatives to animal protein-derived yogurts or milk. Additionally, the microbial enzymatic breakdown of such agri-sidestream wastes through fermentation has also demonstrated to be an effective processing approach for improving nutritional characteristics of plant-derived organic content—aiding in better nutrient bioavailability and digestibility.

Research is underway to make more efficient use of standard feedstocks and drive the development of alternative feedstocks. In 2022, researchers from the **Indian Institute of Engineering Science and Technology, Shibpur** [demonstrated](#) side stream valorization of jackfruit seed through bioconversion into a single cell protein using five GRAS filamentous fungi—*Penicillium expansum*, *Aspergillus niger*, *Aspergillus oryzae*, *Rhizopus microsporus*, and *Candida intermedia* by submerged fermentation. **Mycovation**, an Indian fermentation technology company, has developed a novel, scalable process using solid-state and submerged fermentation to transform mycelium from edible gourmet mushrooms into purified novel proteins. The proteins will have applications in dairy-free food products such as cheese and cottage cheese, functional flavor molecules, and scaffolding medium for cultivated meat. **Their unique fermentation platform valorizes locally sourced, low-cost agricultural waste sidestreams as feedstock.**

Established in 2013, India-based biotechnology company **String Bio Pvt. Ltd.** established its first multi-purpose gas fermentation facility in Bangalore that leverages advances in bacterial fermentation technology and bioprocess engineering to convert the energy in methane and low-value feedstock (such as waste wood and agricultural waste) into diverse value-added products such as protein-rich food and feed. In 2022, String Bio partnered with Australia-based [Woodside Energy Technologies](#) to develop a platform to convert trapped methane emissions into protein.

Bioprocess design

The bioprocess for fermentation-derived ingredients involves upstream cultivation of the microorganism in large-scale bioreactors followed by downstream purification of the target product. Innovations in bioprocess design through improvements to downstream yield, upstream medium recycling, improved system control, or novel growth strategies can unlock new opportunities for cost reduction, scale-up, and environmental sustainability for fermentation's use within alternative proteins.

- **Reliance Industries Limited's** Synthetic Biology R&D team developed an efficient and scalable marine microalgal fermentation system to produce sustainable single cell protein for human nutrition and animal feed applications. Purified protein from the fermented algal biomass will be explored as flavoring agents for plant-based meat products. Additionally, investigations are ongoing to validate these non-toxic algal protein extracts as a low-cost animal cell culture additive and FBS-replacer.
- **Prof. KV Venkatesh's** research group from **IIT Bombay**, who are experts in systems biology with applications in metabolic engineering and bioprocess optimization, optimized the fermentation bioprocess of a local algal strain of *Chlorella sp.* (native to North Eastern India) to produce edible protein (about 600 g of protein in 1000 g of algal biomass) using a patented design of photobioreactor for optimal and consistent production of fermented proteins. They are now actively working on scaling up the production process to 100 kg of fermented biomass per day. The algal fermentation system is a zero-waste model wherein carbon dioxide, as the carbon source, is sequestered with no special feedstock required for food products because nearly 25% of the algal mass is made up of carbohydrates, and the growth system is set up in natural sunlight. Furthermore, the group is also looking to create a cheese alternative from a mushroom-algal co-culture system where the product would have a stringy texture, better digestibility, and superior nutritional composition compared to plant-based dairy alternatives.
- **Kawakasthya Superfoods Pvt. Ltd.** is a Mumbai-based startup that developed a submerged culture technique in addition to producing fruit body for oyster mushroom mycelia with a possible turnover of up to one tonne per day. The extracts from fermented mushroom biomass have a meaty, fishy flavor that could be converted to dried mushroom powder (30–35% protein composition by weight, which is comparable to animal-derived proteins) with potential applications as flavor ingredients for plant-based meat products.



Retrofitting existing facilities—an opportunity in India?


The Indian biotechnology sector is world renowned for its large scale, high quality, cost-effective manufacturing capabilities. To meet the growing demand for global biobased food production capacity, we need to leverage Indian bioprocessing engineering expertise and talent for fermentation-derived smart proteins.

In July 2023, GFI published a thorough [report](#) on the current state of manufacturing capacity (globally) for fermentation-derived proteins. The analysis also provides insights into strategies to scale manufacturing, including the advantages and disadvantages of different scale up strategies, from using contract manufacturing organizations (CMOs) to developing existing brownfield manufacturing sites and retrofitting used equipment. Interestingly, the study discovered that there are potential opportunities within beer, wine, and biofuel industries to retrofit equipment, estimated to make up to 85 percent savings on capital expenditure for biomass fermentation-related smart protein production.

A vital opportunity for India is to conduct a thorough assessment of the current state of infrastructure, talent, technical expertise, and manufacturing capabilities of sector-relevant Indian companies (such as food and beverage industries, nutraceuticals, agri-bioprocessing, biofuels). This would be critical to understanding if retrofitting would be a technically and economically feasible option for allied industries to enter the fermentation-based smart protein production game.

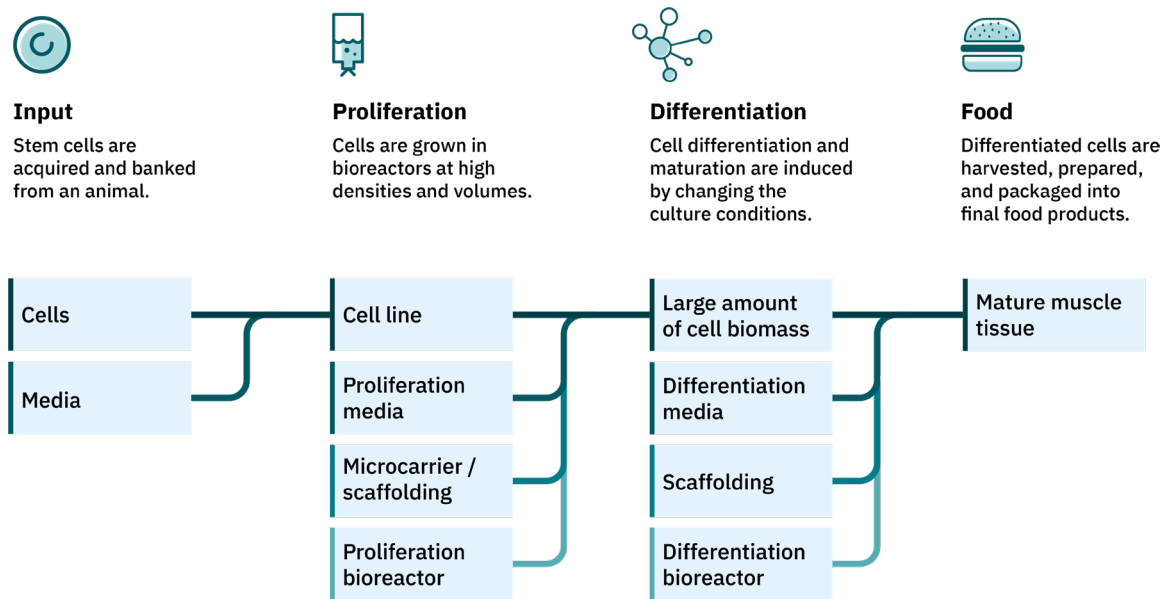
Cultivated meat and seafood

Across the global cultivated meat ecosystem, scientific and technological progress has accelerated in the last five years. Although the field is still nascent in India, rapid R&D ecosystem growth is expected in the category soon. India could play a vital role in the upcoming biotechnology era owing to its young talented workforce, vast resources, and enhanced manufacturing capabilities. By enabling more large-scale international scientific and industrial collaborations (leveraging our decades-old bioeconomy expertise), India could become a production powerhouse in the emerging cultivated meat industry and pave the way for other emerging economies. Key early-stage scientific advancements in the country over the last five years have helped build the foundation of India’s cultivated meat and seafood sector and continue to inspire future research endeavors. As this longer-term vision plays out, Indian scientists and entrepreneurs are already unraveling the foundational sciences of cultivated meat and seafood, specifically related to cell lines, serum-free cell culture media development, and scaffolding.

 For a comprehensive introduction to the current state of the science in cultivated meat from across the globe, visit GFI’s [The Science of Cultivated Meat](#) page.

Research across the technology stack

Fig 24: Cultivated meat process flow



Cell lines

[Cell lines](#) are the foundational building blocks that make cultivated meat production possible. A variety of high-quality cell lines derived from [multiple cell types](#) (pluripotent stem cells or adult stem cells capable of becoming fat, muscle, or connective tissues) and many species are required to match the range of conventional meat products on the market. Researchers and entrepreneurs are working to develop and characterize new cell lines and better understand

the properties of different cell types—their growth potential, metabolism, growth media requirements, and effects on the properties of the final product—that will determine how suitable each cell type is for cultivated meat.



Learn more about vital molecular biology cues for cell line establishment and myogenesis in this [deep dive article](#). Explore this [review article](#) on uses for fish cell lines published by GFI grantee Mukunda Goswami.

- **Dr. Mukunda Goswami**'s research team from **ICAR-CIFE** developed continuous cell lines from the skeletal muscle of [labeo rohita \(rohu\)](#), a type of tropical freshwater carp popular in India, for cultivated seafood production. This GFI-funded international [collaborative project](#) performed characterization of the myogenic differentiation potential of the primary muscle cell lines and confirmed the [expression of myogenic](#) regulatory factors namely MyoD, MEF2A, Mrf-4, Myogenin, and Myf-5. The cells exhibited up to 80% revival efficiency after six months of cryopreservation with no significant changes observed in cellular morphology and growth rate after thawing. The skeletal muscle line was also examined for [attachment and growth](#) on mycelial scaffolds manufactured by **MyoWorks**, an Indian biotech startup.
- Research teams from **CSIR-Centre for Cellular and Molecular Biology** and **ICAR-National Research Center on Meat** received [funding support](#) of ₹4.5 crore from the Department of Biotechnology (DBT), Government of India, for the development of methods of derivation of muscle stem cells from three to four month-old sheep calves. The project resulted in the establishment of sheep primary muscle stem cell lines with the potential to expand up to 30 passages and achieve various stages of myogenic differentiation. The team also worked on developing serum-free culture media by formulating a unique combination of growth factor cocktails (bFGF, IGF1, IGF2, TGFb) to support the large-scale expansion, proliferation, and differentiation of sheep-derived muscle stem cells. In 2022, India-based cultivated meat startup, **Neat Meatt Biotech Pvt. Ltd.** acquired the data and intellectual property for advancing the scaleup and development of cultivated mutton products.
- **Neat Meatt Biotech Pvt. Ltd.**'s R&D team has created GM-free, antibiotic-free primary cell lines from chicken (myoblast, fibroblast, adipoblast cell types) to develop cultivated chicken meat. The team is also collaborating with the **ICAR-Central Institute of Brackishwater Aquaculture** to develop myogenic cell lines from indigenous marine fish species such as the Asian sea bass.
- A team of stem cell biology experts from **Sanjay Gandhi Post Graduate Institute of Medical Sciences, Lucknow** have worked on the generation and differentiation of [footprint-free goat \(*Capra hircus*\) induced pluripotent stem cells](#) (iPSCs) into muscle cells to produce cultivated mutton end products.



To learn more about the current cell line utilization trends and predicted cell-sourcing bottlenecks in the cultivated meat sector, read GFI APAC's [report](#) from June 2023—Cell Line Development and Utilization Trends in the Cultivated Meat Industry.

Cell culture media

Cell culture media contains the nutrients and growth factors needed to cultivate cells outside the body. Traditionally, lab-scale cell culture has relied on media containing animal serum, a complex mixture derived from animal blood that contains growth factors, other proteins, hormones, lipids, and nutrients. While the serum is effective at maintaining cell health, its use in cultivated meat production is not viable at scale due to a number of challenges, including limited availability, batch-to-batch variability, and poor sustainability. More research is needed to derive animal-free formulations of serum replacers that match the metabolic requirements of each cell line, in addition to creating a supply chain of more affordable, animal-free, and food-grade ingredients. Multiple Indian startups are working on developing unique serum-free formulations of [culture media](#) for use in the cultivated meat industry.



Learn more about cell culture media and its role in differentiating cells for cultivated seafood in this [review](#) by GFI scientists and colleagues.

- In 2022, **MealTech Pvt. Ltd.**, a startup incubated at Bangalore Bioinnovation Center developed and commercialized a serum-free, food grade media formulation (McSol growth media) optimized for the growth of primary chicken muscle cells for cultivated meat production.
- **Neat Meatt Biotech Pvt. Ltd.** has optimized FBS-free culture of primary chicken cell lines using an in-house media recipe containing the optimal concentration of chicken blood-derived serum required to support chicken cell growth.
- **Clear Meat** manufactures [ClearX9®](#) range of patented serum-free media formulations optimized for the growth of various cell types from chicken. The company has developed cultivated chicken, [EcoMeat®](#) at lab-scale in minced and whole cut forms.

Scaffolding

Scaffolding provides structural support for cells to adhere, differentiate, and mature, and also facilitate nutrient, oxygen, and waste transport. Scaffolding is crucial to provide structure to the final product. Research on [scaffolding for cultivated meat](#) focuses on identifying the best materials (or combinations of materials) and developing innovative manufacturing technologies for scalable and cost-effective scaffolds. More research is needed to uncover the best materials and methods for developing different types of cultivated meat products.



Learn about scaffolding biomaterials in this [review article](#) published by a team of GFI scientists and research fellows. Learn more about recent advances in bioengineered scaffolding for cultivated meat production in this [review article](#).



In 2020, **MyoWorks**, an Indian biotech startup was funded ₹50 lakh by **DBT-BIRAC** to develop edible mushroom mycelium-based scaffolds to create textured, structured, and bulked cultivated meat products. These scaffolds have been demonstrated to be animal-origin protein-free and have been successfully tested with a variety of cell types, including immortalized mouse muscle cells and chicken muscle cells. Recently, the team has validated the efficacy of their microcarriers with primary chicken muscle cells.

Bioprocess design

Once appropriate cell lines and cell culture media have been developed for cultivated meat applications, bioprocess scale up can begin. The [bioprocess](#) for cultivated meat encompasses production lines of bioreactors outfitted with [sensor equipment](#), integrated with cell-harvesting and food-processing equipment, and designed with automation in mind. Production lines can be constructed in various ways, and research is needed to determine the best-suited bioreactors and technologies required to create and scale a spectrum of cultivated meat product types. Presently, laboratories in India remain in the research and development phase of deriving cell lines and optimizing cell culture media, and much of the published work to date in bioprocessing is conceptual or model-based.



Learn more about bioprocessing in this [review article](#) by GFI grantee Che Connors and colleagues.

Scientific ecosystem in India

Indian scientists from dozens of research institutions collaborate nationally and internationally to conduct interdisciplinary research to help build revolutionary technologies in plant-based, fermentation-derived proteins, and cultivated meat. Figure 25 represents the geographical spread of active researchers in the field of smart proteins, with starred pointers on India's unique Smart Protein Innovation Hubs, where multiple champion scientists, students, and early-stage entrepreneurs are working tirelessly to advance the field of smart proteins across the Indian academic, research, and startup ecosystem.

Fig 25: Innovation hubs for smart protein research, training, and entrepreneurship

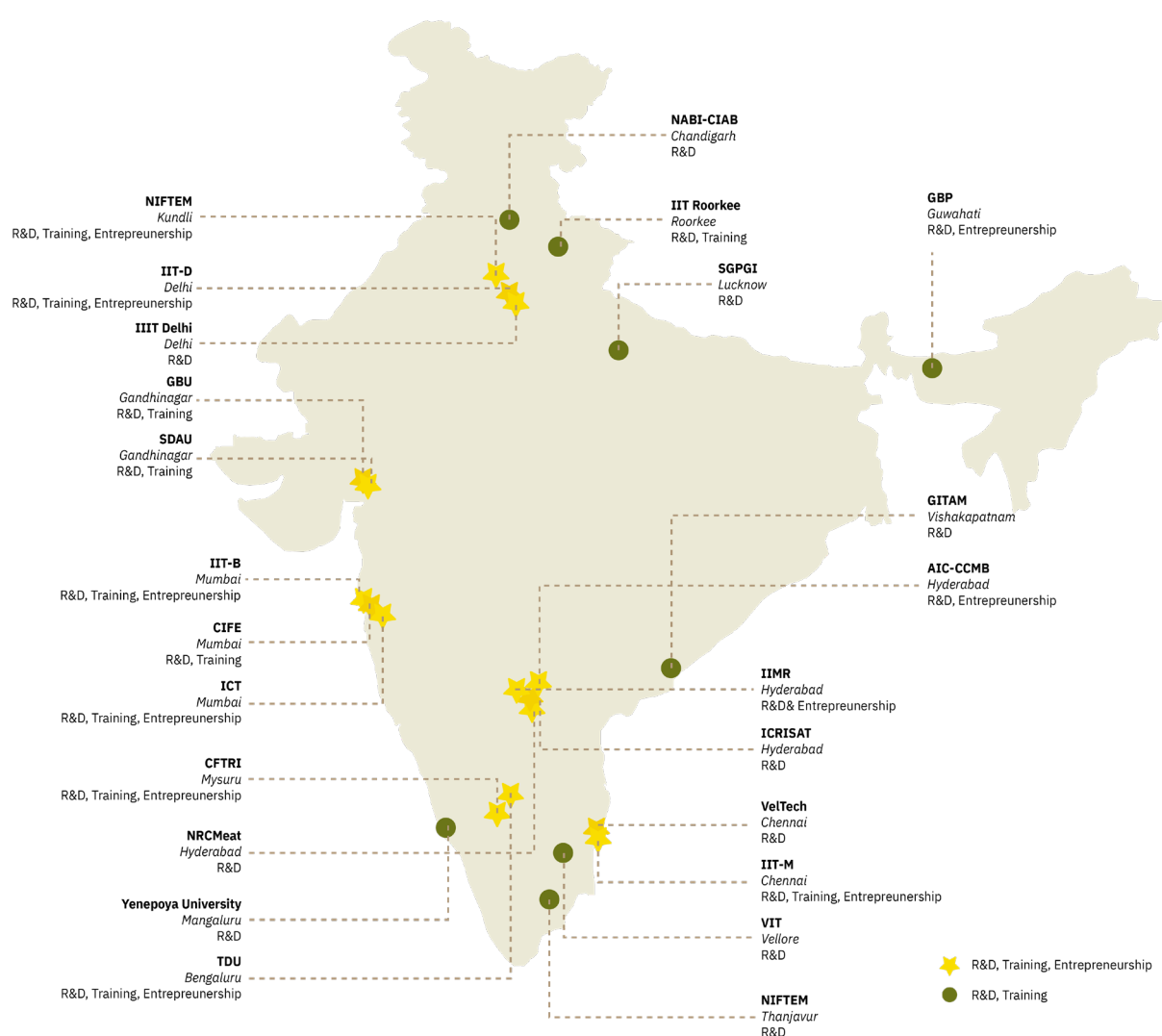
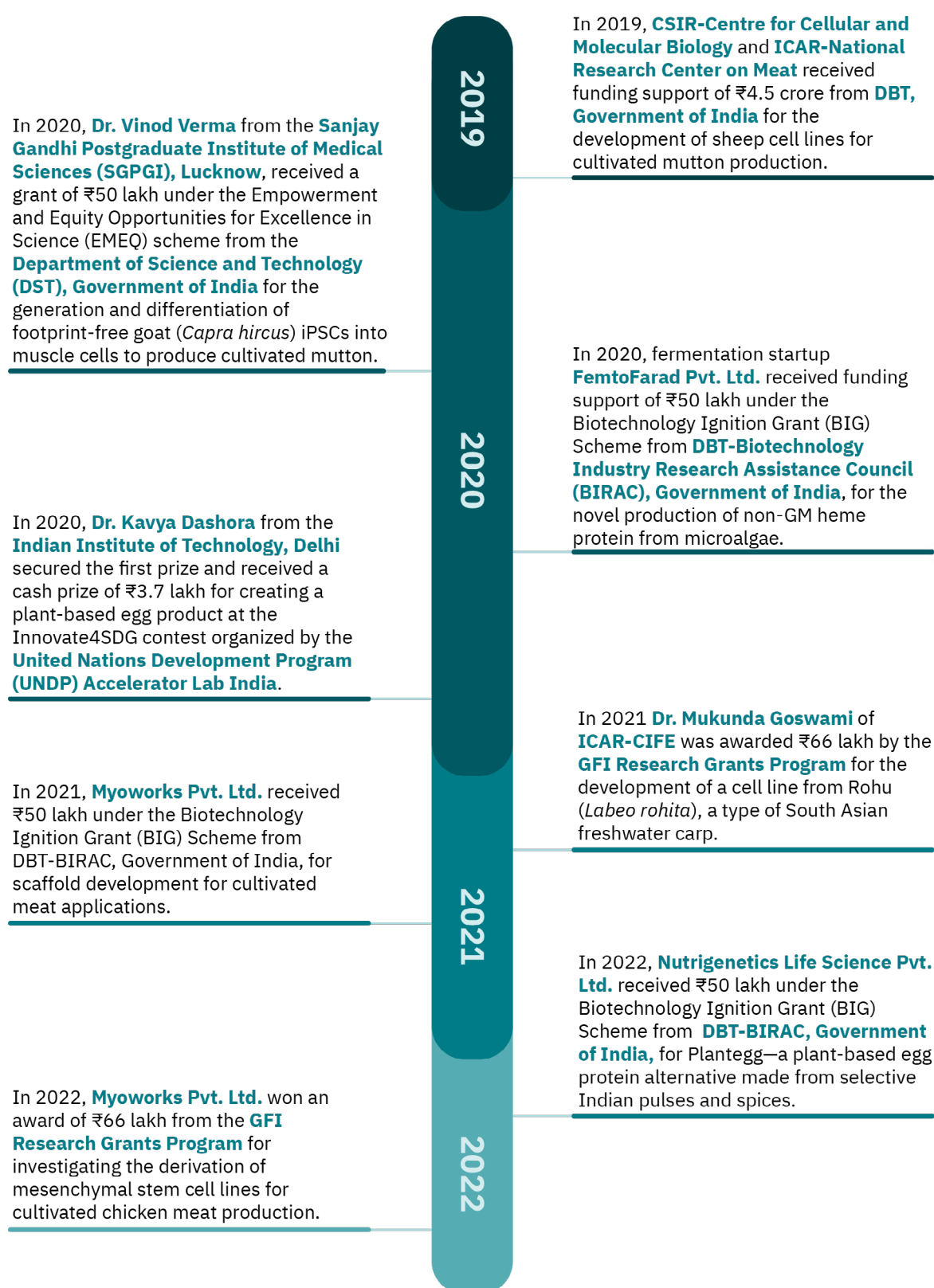


Fig 26: Major research grants awarded for smart protein R&D



Check out GFI's [research grants](#) page to explore grant opportunities and meet the scientists leading open-access research in all three modalities of alternative proteins. You can also find external funding opportunities via our [research funding database](#).

Talent and workforce development

Indian talent powers the global smart protein sector just as it does other strategically important industries. To propel India forward as a driver of a more secure, sustainable, and just future of food, there is a need to strengthen the ecosystem of education, incubation, and technology transfer in smart protein.

The [Alt Protein Project](#) is one of GFI's key talent development initiatives for smart proteins and aims to advance the sector under the following four-point goals:

- Build a dedicated talent pipeline for the smart protein space by pushing for coursework at universities.
- Grow an active community of student leaders to raise awareness and generate discourse around smart protein.
- Promote scientific research in critical whitespaces and build infrastructure capacity at university ecosystems.
- Facilitate industry-academia collaboration leading to increased tech transfer, commercialization, and venture creation.

In October 2022, at the Smart Protein Summit 2022, GFI India launched the country's first student-led body championing smart proteins—the [Delhi Smart Protein Project](#) (DSPP) with student representation from Delhi University. The DSPP marked the first university chapter from India to join the global Alt Protein Project. In the first year of its officialization, the DSPP developed a curriculum for the world's first [Smart Protein Digital Lab](#), a curated massive open online course on smart proteins. Some other noteworthy community building activities include piloting a global alternative seafood course in collaboration with other global Alt Protein Project chapters. The DSPP has also conducted in-person networking events such as hosting a parliamentarian dinner convening industry, academia, and government with the overall goal of advancing policy support for the smart protein sector in India.



In a landmark move toward building a dedicated smart protein workforce, GFI India and the Food Processing Sector Skill Council (FICSI) in 2022 worked to develop a job role and the eligibility criteria for a **Plant-Based Food Technologist**. This job is recognized by the National Council for Vocational Education and Training and can be found on the government's public record under the National Qualifications Register. A Food Technologist in plant-based proteins is responsible for executing the product development of plant-based products from bench to product launch. Job roles like these will play a very important role in the global market as the production of alternative protein rises, and manufacturers look toward countries like India for a skilled workforce.



Empowering our food technologists and regulatory experts with the knowledge and expertise required to navigate the complex landscape of the smart protein sector is not just an investment in our future, but a pivotal step towards ensuring the safety and sustainability of our food supply. Through a structured policy approach to building this knowledge, we can equip these professionals with the essential tools to understand the evolving safety assessment standards, technological innovations, and regulatory frameworks that govern smart proteins worldwide.

**Subhaprada Nishtala, Director In-Charge, ITCFSAN,
Government of India**

Are we missing something from the Science and technology section? Did we get something wrong? We'd appreciate your feedback via [this form](#).



Section 6

Government and regulation

Government and regulation

In India, government support is and will continue to be imperative to accelerate the development of smart protein innovation. Public funding inspires more open-access research and decentralized breakthroughs, while regulatory frameworks provide a roadmap to take innovation to market shelves.

As government attention and acceptance of smart protein increases, it is necessary to fit this category within national strategic plans. Smart protein cuts across several governmental priorities—from nutrition security, climate change adaptation, and economic development to talent building and protein diversification. So far, government measures have been piecemeal and with select policy-makers. A coordinated approach through a national policy plan or a roadmap is best suited to address the interventions needed for further growth of the sector.

Government support for smart protein

The Ministry of Science and Technology

The Ministry of Science and Technology has made the most significant strides in promoting smart protein research in India. Within the Ministry:

The Department of Science and Technology (DST): In 2021, The Science and Engineering Research Board (SERB) under DST included cultivated meat research as a category under their [Competitive Research Grant Programmes](#). In January 2023, DST announced a millet-focused [call](#) for funding. The announcement stated, “India, the world’s largest producer of millets, has great potential to become the epicenter of millet protein-based meat, egg, and dairy-based smart protein products.”

The Department of Biotechnology (DBT): The Department of Biotechnology has set an ambitious target of India becoming one of the top five countries to be recognized as a [Global Biomanufacturing Hub](#) by 2025, with the sector growing exponentially to \$150 billion from the estimated amount \$63 billion in 2020. To achieve this objective, the Department has laid a National Biotechnology Development Strategy emphasizing the need for new initiatives and certain policy changes to deliver this target, with food production as a major area of focus. It has also included smart protein experts and enterprises in their consultations. While presenting India’s policy priorities for high-performance biomanufacturing in mid-2023, Dr. Rajesh S Gokhale [included smart protein](#) in the six total thematic sectors that the government would focus on to drive biotechnology excellence in India. The inclusion of smart protein in their policy roadmap will have positive outcomes for not only driving public and private investments but also creating research opportunities, increasing local manufacturing, and driving talent development for the sector.



First Smart Protein Sub-Committee meeting at the Institute of Chemical Technology, Mumbai.

Source: [Image](#) from the Department of Biotechnology

- **The Biotechnology Industry Research Assistance Council (BIRAC)** is a nonprofit body set up by the DBT to serve as an interface agency to strengthen and empower emerging biotech enterprises. BIRAC bridges the industry-academia gap through various impactful initiatives, such as providing access to risk capital through targeted funding, facilitating technology transfer, managing IP, and offering schemes that make biotech companies globally competitive. As mentioned earlier in the report, BIRAC has funded multiple smart protein startups in India through initiatives such as the Biotechnology Ignition Grant Scheme (BIG).
- **The Office of the Principal Scientific Advisor (PSA):** The Office of the PSA is set up with the primary objective of providing advice and recommendations to the Prime Minister and the Cabinet on areas of prime scientific importance for India. The Office of the PSA is governed by an overarching council—the Prime Minister’s Science, Technology, and Innovation Advisory Council (PM-STIAC). During the 23rd meeting of the PM-STIAC in mid-2023, the DBT presented smart proteins as a key emerging technology.

The Ministry of Food Processing Industries (MoFPI)

The Ministry of Food Processing Industries is significant for the growth of the smart protein sector in India. Especially during a time when the government is making startup-friendly policies for an *Atmanirbhar Bharat* (the government’s vision for a self-reliant India) with an objective to go vocal for local, MoFPI can play a huge role to help develop local manufacturing of smart protein ingredients and final food products. The representatives of the Ministry have spoken publicly about supporting the development of the smart protein sector in India.

In March 2022, while answering a Parliamentary question, the Hon’ble Minister, Shri Pashupati

Paras, confirmed that smart protein is eligible for financial assistance under the *Pradhan Mantri Kisan Sampada Yojana*. The scheme, provided by the central government, provides financial assistance to develop food processing and preservation infrastructure to set up food processing units. The Minister also referenced the Organization for Economic Co-operation and Development-Food and Agriculture Organization's Agricultural Outlook 2020–2029 [report](#) to note that “consumers’ growing environmental and health-consciousness is expected to support a transition from animal-based protein towards alternative sources of protein, which consumers perceive as healthier alternatives.”

Ministry of Commerce

The Ministry of Commerce can play a strategic role in helping India scale the list of leading smart protein manufacturing and trading nations globally. In February 2022, the Agricultural and Processed Food Products Export Development Authority (APEDA) of the Ministry of Commerce set up a Vegan Committee on Export Standards, Guidelines and Promotion for Vegan Food Products (and further [revised its constitution](#) in August 2022) to examine methods to support the growth of the vegan industry in India and to set guidelines for the export of vegan products into the international market.

This committee is a part of the National Programme on Vegan Products (NPVP) that aims to position India as an export leader in the plant-based or vegan category by producing and exporting high-quality plant-based food products that adhere to domestic and international standards. To achieve this, APEDA has planned several initiatives and activities such as compiling data on ingredients, production and consumption patterns of plant-based products in importing countries, promoting Indian plant-based foods in the international market, preparing e-catalogs for these products along with the development of an e-market portal, and setting up of export facilitation centers and custom-bonded warehouses in countries of import.

APEDA has also been supporting companies in promoting their plant-based exports by supporting flag-off ceremonies of smart protein exports from India (for brands like [Greenest](#) and [Wakao](#)) and plans to provide continual support through promotional activities in the countries of importing. Currently, the Committee comprising GFI India, is drafting standards for granting accreditation to organizations to provide vegan certification to plant-based products.

Scaling smart protein with state governments

The smart protein sector as a sunrise industry has massive potential to scale in India, and for this to be a reality, the participation and support of state governments is indispensable. The sector needs to integrate into the policy apparatus of various states in India to create multi-sectoral stakeholder programs that generate manufacturing and processing value chains for smart protein. These processing value chains will smoothly forge backward linkages in the agricultural sector, especially for the plant-based category. A supportive and proactive state government ecosystem for smart protein biotechnology and biomanufacturing will also be very impactful for the growth of sustainable food.



- **The Maharashtra Government aims to achieve a \$1 trillion economy by 2030 with a strong focus on enhancing the agriculture and allied services in the state that would contribute to objectives like Make in Maharashtra⁶. Smart protein manufacturing initiatives fall perfectly within the scope of this vision.**
- Most recently as a positive development in Maharashtra, the Deputy Chief Minister's Office has signed a Directive for the Establishment of Smart Protein Manufacturing Hubs that will focus on the creation of plant-based protein value chains with an emphasis on farmer integration and utilization of local crops, especially in and around the Vidarbha region.
- The Principal Secretary's Office at the Industries, Energy and Labour Department in Maharashtra has carried out an in-depth understanding of the opportunities of the smart protein sector for socio-economic growth and sustainable development of agricultural value chains. The Department is keen to establish such Manufacturing Hubs to achieve these objectives and allow for them to mainstream sustainable food production and boost employment opportunities and farmer welfare in the state.
- The Skills, Employment, Entrepreneurship and Innovation Department, Maharashtra is working to create a New Start Up Policy 2023 and is in the process of reviewing the focus areas. GFI India has submitted a representation to include smart protein as one focus area and the Department is considering the possibility of its inclusion.

The potential for other state governments to chart a path for the smart protein sector is huge, especially since every state in India is uniquely positioned to benefit from various aspects of the innovation and production of smart protein food value chains. Nearly all states in India have robust policy frameworks for biotechnology, agricultural and allied services, innovation, and food processing which can help grow the smart protein industry. Several state governments like Gujarat, Telangana, and Assam have diverted their attention towards the opportunity for localized ingredients manufacturing and innovation across the three modalities of smart protein food, and this new interest can have major benefits for mainstreaming the alternative protein sector in India.


Regulation and labeling

Food regulations for licensing, labeling, and approvals affect how smart protein products reach consumers in India. The Food Safety and Standards Authority of India (FSSAI) is the apex food regulatory body in India. It sets science-based standards to regulate the manufacture, storage, distribution, sale, and import of food products and ingredients to ensure the availability of safe and nutritious food to consumers. The Food Safety and Standards Act, 2006, along with rules and regulations formulated under it, governs the path to market of all food products, including smart proteins. The FSSAI has granted approvals to several plant-based companies and a select group of fermentation-derived companies to enter the market. Apart from the FSSAI's central authority, it also has four regional offices that grant food licenses to food business operators, including smart protein companies.

Regulatory framework for smart protein

Over the past three years, the FSSAI has amended some of its regulations relevant to smart protein companies after obtaining comments from the public. As per the existing framework, smart protein products are either categorized as proprietary foods or non-specified food products depending on the ingredients and processes used.

A proprietary food product utilizes ingredients that have been standardized by the FSSAI in the Food Safety and Standards (Food Product Standards and Food Additives) [Regulation](#), 2011, but is made in a new format that has not been defined by standards. Ingredients like soya, jackfruit, and almond are standardized with a long history of use in different formats and product formulations. However, plant-based alternatives to conventional meat or dairy, which use these ingredients to mimic the taste and texture, might be considered proprietary foods. This is because these end products still require standardization. The approval of proprietary foods must also fulfill food safety requirements, including submitting relevant food safety test results to the FSSAI.



The other regulatory framework within which smart protein will likely receive approval is the Food Safety and Standards (Approval of Non-Specified Food and Food Ingredients) [Regulations](#), 2017 (NSF regulation). If a product or ingredient does not have a history of human consumption, or it is obtained using new technology with an innovative engineering process that significantly alters its composition, it is classified as a non-specified or novel food product. Cultivated meat, as well as precision and biomass fermentation products, would be governed under this regulation. The said regulation requires food business operators to make an application supported by relevant information and documents for approval of the non-specified food or food ingredient prior to manufacturing or importing it. However, no prior approvals are required to conduct R&D.

The FSSAI also formed a working group on cultivated meat (called Working Group on Cultured Meat) in 2020 with regulatory and scientific experts to understand the possible regulatory pathways for cultivated meat in India. GFI India shared information with and presented to the Working Group on the scientific developments, market status and regulatory status of cultivated

meat in other countries and recommended a regulatory roadmap for India. At the time of this report’s publication, the findings of the Working Group have not been publicly shared.



We need a predictable regulatory framework, which is globally harmonized and is based on safety and risk assessment rather than being hazard-based. This will ensure that limited national regulatory resources are judiciously spent on bolstering safety assessment and risk management activities instead of only concentrating on potential and speculative risks which may turn out to be not real. This predictable framework, coupled with a very clear and unambiguous criteria about what constitutes compliance will go a long way in giving the needed boost to investor’s confidence in this area.

Dr. Jasvir Singh, Director, Head of AMETI Regulatory Affairs, International Flavours and Fragrances

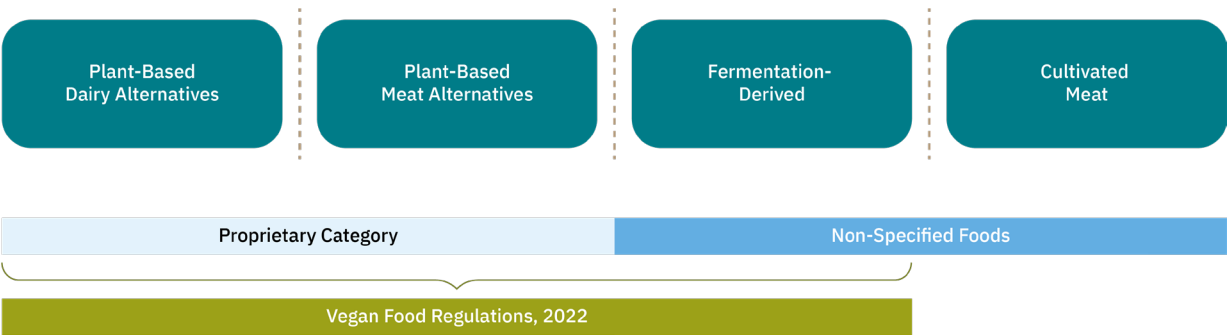
- The FSSAI has approved Perfect Day’s non-animal whey protein that utilizes precision fermentation.
- The FSSAI has approved mycoprotein derived from *Fusarium venenatum* under the NSF Regulations.

So far, the FSSAI has not received any applications for the approval of cultivated meat products or any ingredient utilizing biomass fermentation.

The FSSAI has also allowed the use of certain enzymes derived from genetically modified microorganisms in limited quantities as per Good Manufacturing Practices (GMP) under the FSS (Food Products Standards and Food Additives) Regulations, 2011 (compendium) and allows their use as processing aids in limited quantities as per GMPs.

Labeling and nomenclature

Fig 27: Labeling smart protein in India



The FSSAI's Labeling and Display [Regulations](#), 2020 prescribe the labeling requirements of pre-packaged foods and for the display of essential information at the premises where food is manufactured, processed, served, and stored. The regulations have specified that "a common or usual name or an accompanying description of the true nature" of the smart protein product can be used to label it. The label can also have "a coined, fanciful, brand, or trade name" subject to Food Safety & Standards (Advertising and Claims) [Regulation](#), 2018 compliance.

The FSSAI does not permit the use of dairy terms for plant-based dairy products. There is currently an injunction order in a pending set of writ petitions before the Delhi High Court on directions dated July 15, 2021, and September 1, 2021 by the FSSAI wherein the FSSAI had directed the enforcement of this ban.

The FSSAI has defined analogs in the dairy context in the Amendment to the Food Products Standards and Food Additives [Regulations](#) notified on December 27, 2021, and has specifically stated that such analogs are not to be considered as milk, milk products (which includes *curd*) or composite milk products (which includes fermented milk products). This amendment also requires dairy analogs to declare the actual ingredients used in place of milk.

In June 2022, the FSSAI finalized the [Vegan Foods Regulations](#), which establishes a separate regulatory framework for foods and food ingredients free from animal products. Producers of plant-based foods must comply with the regulations and apply to the FSSAI for approval of their products to be labeled as vegan. The FSSAI has also published [a list of FAQs](#) under the regulations to provide further clarity to the companies. However, the FAQs mention that dairy and cheese analogs (as defined by the FSSAI) are not eligible for consideration as vegan foods. This has led to some confusion since plant-based dairy products fall within the ambit of the Vegan Foods Regulations and also satisfy the definition of a dairy analog. Hence, it is not clear whether alternative dairy products can be classified as analogs.

The regulations require that for approved applications, products must use the FSSAI-designated vegan logo. The FAQs also clearly mention that the term vegan cannot be clubbed with terms associated with meat and meat-based products like salami, chicken, bacon, and the like on the label. As per the FAQs, there cannot be a claim comparing alternative meat products to conventional meat products in any sensory manner.

Advertisement and claims

As per the FSSAI's Food Safety and Standards (Advertising and Claims) [Regulation](#), 2018, all claims made for a smart protein product must be "truthful, unambiguous, meaningful, not misleading and help consumers to comprehend the information provided." There are distinct compliance requirements for different kinds of claims, such as nutrition claims, health claims, reduction of disease risk claims, etc., that have been listed in the regulations and must be complied with. The FSSAI, along with the Advertising Standards Council of India (ASCI), ensures compliance with the aforementioned regulations and ASCI guidelines pertaining to advertisement. GFI India has compiled an [Advertising and Claims Guide](#) to share all relevant information with smart protein companies.



The FSSAI, in addition to setting standards, conducting risk evaluations, and granting approvals for emerging smart protein technologies, also plays a key role in educating consumers and supporting research capacity development, through ITCFSAN, to ensure that safety aligns with evolving smart protein innovations. Building trust in these safe, sustainable, and scalable alternatives to conventional proteins is paramount. We envision a future where innovation, safety, and sustainability coexist harmoniously, enriching the dietary choices of the Indian public. Together, we can chart a path towards a more resilient and diversified protein ecosystem in India.

**Subhaprada Nishtala, Director In-Charge, ITCFSAN,
Government of India**

Are we missing something from the Government and regulation section? Did we get something wrong? We'd appreciate your feedback via [this form](#).



Conclusion

Conclusion

The smart protein sector in India has witnessed some extraordinary developments over the past 3–5 years despite its modest beginnings. There are miles to go and lots to accomplish before it reaches its full potential. We offer three closing reflections for the year ahead:

1 The need is real.

With a burgeoning population, rising incomes, and a growing awareness of health and sustainability, there is no denying the pressing yet unmet demand for protein sources that are nutritious and environmentally responsible. Smart protein alternatives offer a pathway to address this need, as identified in the report. As India grapples with the challenges of food security, climate change, and public health, the adoption and expansion of smart protein sources hold great promise in meeting the dietary requirements of its population while advancing sustainability goals.

2 Challenges are plenty.

While the smart protein sector in India is consistently growing, it faces significant challenges. These challenges include cost competitiveness, infrastructure limitations, heterogeneous demand, and regulatory hurdles. However, these challenges also present opportunities for innovation and collaboration. Entrepreneurs, researchers, and investors are actively working to overcome these obstacles, resulting in a dynamic ecosystem that is fostering technological advancements, sustainable practices, and the emergence of a vibrant startup culture in the smart protein space.

3 Change is possible.

At GFI India, we bring determination and informed optimism to our work, knowing that a better food future is possible. Similar passion and resilience have been shown by others committed to advancing the field, as highlighted in this report. Across sectors and regions, there is a growing recognition of the need for viable protein alternatives. Indian consumers want more. The Indian government wants more for its people and its land. Mindset change takes eons, but the process has begun and the shift is noticeable in consumer choices, industry involvement, and policy recalibration. Just as the world is reimagining how energy is produced, it has begun taking notice of its food system. At present, we might only be scratching the surface, but soon, we will, no doubt, transform it from the ground up.

To those who are actively engaged in this sector already, we hope GFI India's State of the Industry Report gives you a deep dive into this rapidly evolving sector. For those new to the field, welcome. Stay a while, grow with us, and we hope you embark on our journey of changing the world.

Appendix

1. All \$ values are in USD unless specified otherwise.
2. Non-vegetarian: A term commonly used in India to describe food items, dishes, or individuals who consume animal flesh such as chicken, goat meat, beef, and seafood. The term generally does not encompass the consumption of milk, milk products, or eggs, although the classification of eggs can vary based on cultural factors.
3. Fermentation-derived and cultivated meat products are not yet available in the Indian market. Fermentation-derived products require pre-market approval from the Food Safety and Standards Authority of India (FSSAI) under the Approval of Non-Specified Food and Food Ingredients regulation. As per the current regulatory framework, novel foods such as cultivated meat should also fall within the ambit of this regulation but they have not been specifically defined in the regulation.
4. Agrifood-tech startups include startups working across upstream, midstream, and downstream channels on technologies or products like innovative food (including smart protein) agribusiness marketplaces, agri-biotechnology, farm management software and sensing, biomaterials, novel farming systems, farm robotics, midstream technologies, agrifood fintech, restaurant marketplaces, eGrocery, online restaurants, premium branded foods and restaurants, in-store retail tech, and cloud retail infrastructure.
5. Refers to an economic and industrial development initiative launched by the government of the Indian state, Maharashtra. The initiative is aimed at promoting manufacturing and industrial growth within the state, with the goal of making Maharashtra a preferred destination for investment and manufacturing activities. It is part of the larger Make in India campaign launched by the Government of India to boost the manufacturing sector and create job opportunities across the country.

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About GFI India

The Good Food Institute India (GFI India) is the central expert organization, thought leader, and convening body in the Indian ‘alternative protein’ or ‘smart protein’ sector in India. As part of an international network of organizations with partners in the U.S., Brazil, Europe, Israel, and Asia Pacific, GFI India is on a mission to build a secure, sustainable, and just global food future. With unique insight across science, business, and policy, we are using the power of food innovation and markets to accelerate the transition of our food system toward smart proteins. In building the sector from the ground up in India, we’re aiming to establish a model for its growth all across the developing world.

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.



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