



FEEDING INDIA TOMORROW

Innovating for Sustainability & Health

Intersectional Analysis of Climate, Health & Food in India

An Initiative by India Animal Fund



INDIA
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EXECUTIVE SUMMARY

Introduction: In an era marked by a global climate crisis, India stands at a crucial juncture. With a population projected to reach 1.67 billion by 2050, the nation faces the monumental task of providing not just food, but ensuring that it is nutritious, sustainable, and healthy.

Addressing Key Challenges: A significant aspect of this challenge lies in addressing the environmental and public health impacts of industrialised animal agriculture, a major element of our current food systems. Moreover, with a projected 70% increase in meat consumption by 2050, India is confronted with the paradox of meeting this growing demand while managing the associated environmental and health risks of animal-sourced foods (ASF).

Exploring Science-Based Solutions: The multifaceted nature of this challenge necessitates exploring science-based solutions at the intersection of food, climate, and public health. This exploration includes strategies like enhancing carbon sequestration, implementing emission-reducing agricultural practices, and minimising food loss and waste.

Dietary Shifts as a Solution: However, among these strategies, dietary shifts towards plant-based diets rich in proteins from legumes, pulses, and millets emerge as the most impactful. These shifts promise substantial benefits for climate and public health. Yet, the transition to such diets faces substantial socio-cultural barriers, inhibiting widespread adoption.

The Role of Alternative Proteins: In this scenario, Alternative Proteins present themselves as a crucial and innovative solution. Their sensory similarity to traditional meats makes them a culturally acceptable alternative, likely to achieve wider acceptance in the market. As such, they offer a sustainable method to meet the increasing protein demands while mitigating the environmental and health concerns tied to traditional ASF.

Need for India-Specific Research: However, to effectively utilise Alternative Proteins in India's unique demographic, economic, and socio-cultural context, India-specific research is imperative. Such research is vital to unlock the full potential of Alternative Proteins as a key catalyst in transforming India's food systems.



INTRODUCTION

As we navigate an era marked by severe and escalating consequences of climate change, the urgency for **transitioning to sustainable systems** becomes ever more apparent. The Intergovernmental Panel on Climate Change (IPCC) highlights the critical need for swift action to limit global temperature rise to **1.5 degrees Celsius** and prevent the worst effects of climate change.

Achieving this ambitious goal **demands halving global greenhouse gas emissions (GHGE) by 2030**, and ultimately reaching **net-zero emissions by 2050**. This transition calls for heightened climate ambition, especially among major economies, to enable a just transition to climate-resilient systems across diverse sectors such as Energy, **Agriculture, Food & Waste**, Nature-Based Solutions, Industry, Transport and Building & Cities. While the energy sector remains a primary focus due to its significant contribution to GHGE, it is essential to recognize that **no single system operates in isolation**.

Holistic and intersectional solutions are vital to drive the transition to sustainability in multiple sectors. One **critical intersection** is that of our food, environment and health systems. As we project forward to 2050, the challenge of providing sustainable, nutritious and healthy food to an expected population of **1.67 billion in India** stands as a testament to the **intricate link between our environment, the food we consume, and our collective health**.

This note aims to explore this nexus, identifying solutions that not only address climate challenges but also ensure the well-being and nutritional needs of India's growing population.



FOOD SYSTEMS TRANSFORMATION

The existing paradigms of food production and consumption, deeply ingrained in our societies, are now at a crossroads, facing the undeniable effects of climate change.

[International research](#) consistently highlights the significant environmental footprint of our current food systems, revealing a stark reality; our food systems are not only adversely affected by climate change but also major contributors to it, accounting for **21 to 37 percent** of worldwide GHG emissions and around [18 percent](#) in India.

Moreover, [experts posit](#) that even if fossil fuel emissions were to cease immediately, the current trajectory of food system emissions would obstruct efforts to limit global warming to **1.5°C**. Thus, to achieve 'net zero' emissions, fundamental changes in our food systems are imperative.

This necessitates a paradigm shift towards a sustainable and climate-resilient food system, a transition that is particularly urgent in India where [food systems face compounded challenges](#) of an increasing population, [changing dietary patterns](#), nutrition insecurity, lack of crop diversity, [deforestation](#), [water scarcity](#), [deteriorating soil quality](#) and substantial greenhouse gas emissions from crops and livestock activities at the farm level, which are estimated to be [650 million metric tons \(MMT\) CO₂eq annually](#).

Central to this transformation is addressing the significant impact of industrialised animal agriculture - a key component of our current food systems that stands at the forefront of escalating environmental and sustainability concerns.



INTERSECTIONALITY

Climate Change & Industrialised Animal Agriculture

Global food production, responsible for 35% of all GHGE, sees a significant contribution from ASF production, accounting for almost 60% of all food production emissions.

Building on this, the Food and Agriculture Organization (FAO) estimates that **industrialised animal agriculture** alone is **responsible** for about 14.5% of all human-induced **GHGE**, equating to roughly 7.1 Gt CO₂eq annually.

However, emerging research indicates that this may be a conservative estimate, with the **sector's true impact exceeding at least 16.5% of global GHGE**. To put these figures into perspective, the GHGE from animal agriculture exceed those from the entire global transportation sector.

In terms of land utilisation, animal agriculture occupies **77%** of global agricultural land, yet astonishingly, it provides only **18%** of the world's caloric supply and **37%** of the total protein supply.

Factory farms also use **significant amounts of freshwater** to raise, feed, and slaughter animals - so much of it that **animal agriculture accounts for almost a third of the water** used in global agriculture, which becomes even more concerning for India, as it faces its most acute water crisis yet, affecting an estimated 600 million citizens.



Public Health & Industrialised Animal Agriculture

Urbanisation, Increased Consumption of ASF & Overnutrition

Urbanised societies, often more economically developed than their rural counterparts, have been observed to consume diets with higher amounts of ASF. Some studies even suggest a correlation between the **increased consumption of ASF and health risks** such as overnutrition, obesity, hypertension and various non-communicable diseases (NCDs).

This issue holds **particular relevance for India**, both now and in the future. Currently, just over one-third of India's population lives in urban areas, a number projected to rise to 50% by 2050. In these urban cities, the health implications are already evident, with 31.3% of women and 26.6% of men being overweight or obese. As India continues to urbanise, the impact of dietary choices, especially the increased consumption of ASF, is likely to become even more pronounced, **posing significant challenges to public health** and the overall well-being of its urban population.

Food-Borne Illnesses, Zoonotic Diseases & Antimicrobial Resistance

Animal Agriculture has also been consistently linked with increased incidences of food-borne illnesses and zoonotic diseases, so much so that the United Nations in their report titled, **"Preventing the Next Pandemic"** identifies increasing demand for animal protein as a key driver of pandemics.

Even more concerning is the rising antimicrobial resistance due to excessive use of antibiotics in animal farming, so much so, that the United Nations warns that by 2050, drug-resistant diseases could cause up to 10 million deaths annually and cause damage to the economy as catastrophic as the 2008-2009 global financial crisis if this issue remains unaddressed.



Rising ASF Demand & Potential Solutions for India

As India grapples with rapid urbanisation and a growing population, the consequent rise in ASF consumption and meat demand poses significant sustainability and public health challenges. By 2050, meat demand in India is projected to increase by as much as 70%, potentially leading to dire consequences for both the environment and public health.

To meet this rising demand while reducing sustainability risks, several levers are being considered. These include production-side measures such as sustainable intensification and enhanced manure management, strategies to reduce food loss and waste, and efforts to increase carbon sequestration. While these initiatives are significant and beneficial, research indicates that the most impactful lever would be a **shift in dietary patterns**.

Among the various dietary shift strategies, transitioning to a **whole food plant-based diet**, rich in proteins from pulses, legumes, beans, and millets, stands out as the most effective. Such a shift would not only align with sustainability goals but also bolster public health in India. However, implementing this transition is fraught with challenges. Barriers include economic constraints, deeply rooted cultural and social norms, ecological considerations, and technological limitations. For instance, many food choices are driven by subconscious habits and preferences rather than deliberate decision-making, complicating the shift towards plant-based diets and economies.

In this context, another innovative solution emerges; the increased production and consumption of **alternative proteins**. These products, which mimic the sensory experiences of ASF using plant-based, cell-based, or fermentation-derived inputs, offer a promising avenue. Owing to their similarity to meat, alternative proteins are likely to achieve broader market penetration, overcoming some of the barriers associated with a direct shift to plant-based diets. This 'sustainability by stealth' approach has the potential to significantly contribute to meeting India's protein needs while addressing the pressing concerns of sustainability and public health.



ALTERNATIVE PROTEINS

What are Alternative Proteins?

In the quest for sustainable food solutions, alternative proteins are emerging as a transformative innovation. These products are meticulously engineered to replicate the **organoleptic or sensory experience** of ASF such as meat, including aspects like **flavour, aroma, texture, bite, moisture, mouthfeel, appearance and colour**. By closely resembling the sensory profile of traditional meats, alternative proteins offer a viable and appealing option for those looking to reduce or replace their consumption of ASF. The spectrum of alternative proteins encompasses three main categories: plant-based meats, cultivated meats and fermentation-derived meats.

Plant-Based Meat

These products are composed of plant-derived proteins, typically sourced from soy, peas, pulses, or legumes, and are expertly blended with fats, vitamins, minerals and other additives to replicate the taste, texture and nutritional profile of animal meat. Designed to go beyond the offerings of traditional plant-based substitutes such as tofu, tempeh, seitan, mushrooms and jackfruit, plant-based meats are tailored to closely match the sensory qualities of their animal-based counterparts.

Cultivated Meat

Cultivated meat is essentially an exact replica of ASF-like meat, but it is created through an innovative, science-backed process that minimises or eliminates the use of animals. This revolutionary approach involves harvesting cells from animals and growing them in controlled environments, such as bioreactors. These cells are carefully cultivated to differentiate into various types, including muscle and fat, resulting in a product that mirrors conventional meat in structure, taste and nutritional content.



Fermentation-Derived Meat

Fermentation-derived meat utilises the unique capabilities of microorganisms to produce proteins that can supplement or replace traditional animal-sourced foods. This innovative category includes two main processes - biomass fermentation and precision fermentation. Biomass fermentation leverages microorganisms as the primary ingredient, creating protein-rich food through their cultivation. On the other hand, precision fermentation focuses on producing specific functional ingredients, such as proteins, vitamins and flavour molecules. These ingredients play a crucial role in enhancing the taste and texture of plant-based foods and can also be instrumental in the development of cultivated meats, facilitating more efficient growth.

Unveiling the Benefits of Alternative Protein

As we delve deeper into the world of alternative proteins, it's essential to examine the broad spectrum of benefits they present. They stand not just as substitutes for traditional ASF but as multifaceted solutions addressing **environmental, public health and economic challenges**.

In India, where the **balance between urbanisation, growing food and protein demands, public health concerns and ecological sustainability is delicate**, alternative proteins emerge as a promising solution.







































This next section delves into the diverse advantages of embracing alternative proteins, shedding light on how they could revolutionise not only consumption patterns but also the broader agricultural and economic landscape in India.



MULTIDIMENSIONAL SOLUTION

Acknowledged by UNEP

Environmental Benefits of Alternative Protein

Environment ¹		Novel plant-based products	Cultivated products	Fermentation-derived products
Land use				
Water use ²				
Biodiversity and habitat loss ³				
 GHG emissions, when fossil fuel energy is used as the energy source for alternatives	Poultry production			
	Pork production			
	Beef production			
	Dairy production			
 GHG emissions, when low-carbon energy is used as the energy source for alternatives	Poultry production			
	Pork production			
	Beef production			
	Dairy production			






-  Higher impact
-  Equivalent or very similar impact
-  Lower impact
-  More research needed
-  Not addressed in this report

Table 01: Overview of environmental implications of novel plant-based, cultivated meat and fermentation-derived alternatives, compared to conventional meat and dairy products ([What's Cooking: UNEP's Special Edition Frontiers Report 2023](#)).

Reduced Land Usage

A significant advantage of alternative proteins is their efficient use of land. Unlike traditional animal farming, these proteins are derived directly from plants, bypassing the resource-intensive process of animal rearing. Plants, the primary source of global protein, utilise only a quarter of all agricultural land to provide nearly two-thirds of the protein supply. Transitioning to alternative proteins could potentially liberate an area double the combined size of China and India, with the potential for reforestation and carbon sequestration. This shift could remove about 26 gigatons of carbon dioxide equivalent annually, nearly half of the current global emissions.



Moreover, producing plant-based meat requires up to [99% less land](#) than conventional animal farming, and cultivated meat can reduce land use by as much as [95% while cutting feed consumption by 93%](#). Thus, such a transition plays a crucial role in lowering land usage and thereby mitigating deforestation and preserving biodiversity.













Reduced Greenhouse Gas Emissions (GHGE)

By sidestepping the need for methane-emitting livestock and the extensive cultivation of crops for animal feed, alternative proteins offer a profound impact in reducing greenhouse gas emissions. Their adoption could be pivotal in transforming our food systems to be more carbon-efficient.

[Research](#) indicates that if alternative proteins capture half of the global protein market, including dairy, this shift could lead to a decline of about **31% in agriculture and land-use-related GHGE by 2050**, equivalent to mitigating approximately **5 gigatons of carbon dioxide each year**.

Remarkably, even a modest market penetration - [capturing just 11% of the protein market by 2035](#) - could yield GHGE reductions on a scale comparable to the complete decarbonization of the aviation industry, underscoring the significant role alternative proteins can play in global efforts to reduce emissions.

Public Health Benefits of Alternative Protein

Health		Novel plant-based products	Cultivated products	Fermentation-derived products
Risk of emerging zoonoses				
Risk of antimicrobial resistance				
Nutritional quality and dietary health outcomes				






-  Higher impact
-  Equivalent or very similar impact
-  Lower impact
-  More research needed
-  Not addressed in this report

Table 02: Overview of health implications of novel plant-based, cultivated meat and fermentation-derived alternatives, compared to conventional meat and dairy products [\(What's Cooking: UNEP's Special Edition Frontiers Report 2023\)](#).



Switching to Alternative protein can significantly improve public health by reducing the risk of **zoonotic disease transmissions**, attributed to decreased human-livestock contact and less habitat destruction. This shift also lowers antibiotic exposure and antimicrobial resistance, as crop agriculture employs far fewer antibiotics than livestock farming.

Moreover, with increased urbanisation and a growing propensity to consume ASF, the urban Indian consumer is facing rising instances of lifestyle-related non-communicable diseases. Alternative protein options, by offering essential nutrients while reducing the intake of saturated fats and cholesterol, present an opportunity to positively influence and shift these dietary trends and thereby **improve overall health outcomes** for India's urban population.

Economical & Social Benefits of Alternative Protein

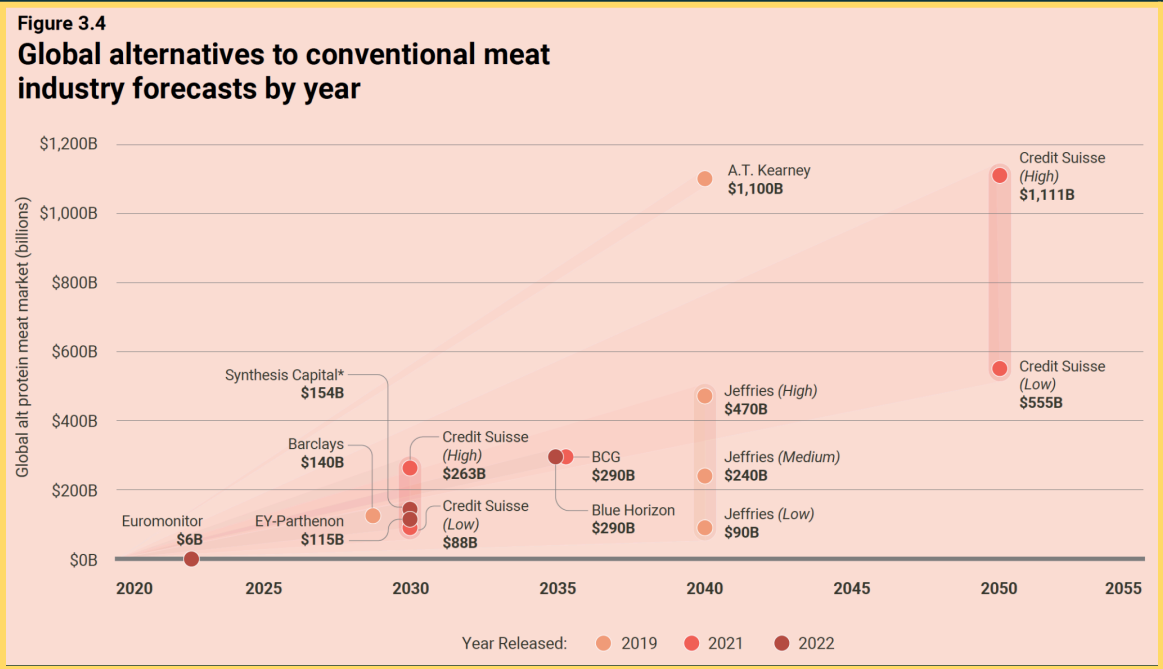





Table 03: Overview of economic implications of novel plant-based, cultivated meat and fermentation-derived alternatives, compared to conventional meat and dairy products (What's Cooking: UNEP's Special Edition Frontiers Report 2023).



Social		Novel plant-based products	Cultivated products	Fermentation-derived products
Food security		●	●	●
Job gains/losses ⁴		●	●	●
Changes in inequalities, e.g. global South and North, rural-urban, gender		●	●	●

- Higher impact
- Equivalent or very similar impact
- Lower impact
- More research needed
- Not addressed in this report

Table 04: Overview of social implications of novel plant-based, cultivated meat and fermentation-derived alternatives, compared to conventional meat and dairy products ([What's Cooking: UNEP's Special Edition Frontiers Report 2023](#)).

The Alternative Protein sector represents a significant economic opportunity for India. According to recent data, [investments in Alternative Protein witnessed a surge of 60% from 2020 to 2021](#), reaching a significant total of **USD 5 billion** globally.

Market analysts like Barclays and AT Kearney project that the plant-based food market alone could reach a valuation between [USD 140 billion](#) and **USD 370 billion** within the coming decade.

The alternative protein industry has attracted considerable attention, and not just globally; [63% of Indian consumers](#) have expressed a likelihood to purchase plant-based meat products. This high level of consumer interest in India is especially noteworthy when considering that over 71% of India's 1.3 billion people consume ASF.

As demand for poultry meat alone is projected to see an [850% increase by 2040](#), the potential market for Alternative Protein in India is undeniably vast. As per a [study](#) conducted by GFI India and Deloitte, forecasts for the domestic market size for plant-based meat, eggs and dairy by 2030 range from **INR 7,475 crore** (approximately USD 976 million) to **INR 18,963 crore** (around USD 2.5 billion). In terms of export potential, figures range from **INR 2,919 crore** (USD 381 million) to **INR 9,344 crore** (USD 1.2 billion).

Moreover, the study also posited that the Alternative Protein sector also offers significant employment opportunities, and could create jobs for up to **320,000 people by the year 2030**. Thus, the economic impact of the industry could be as high as **INR 16,017 crore**.



Transforming Indian Agriculture with Alternative Protein

In the context of India's agricultural sector, the rise of Alternative Protein presents a unique opportunity for **crop diversification**, a key to sustainable farming for the future.

The integration of diverse crops like indigenous legumes, pulses and millets into the production of Alternative Protein can be a game-changer. This shift towards varied crops not only supports soil health but also helps in reversing the trends of groundwater depletion. It opens new avenues for farmers to grow a wider range of crops, moving away from the traditional monoculture practices that have long dominated Indian agriculture.

By diversifying the crops used in the Alternative Protein supply chain, there's potential not just to meet the demands of this emerging sector, but also to enhance the overall resilience and sustainability of India's agricultural system. This approach aligns with the dual goals of **improving farmer welfare and promoting sustainable farming practices**, laying a foundation for a more robust and diverse agricultural future in India.



INDIA-SPECIFIC RESEARCH

As highlighted in this note, dietary shifts are the most impactful lever for creating food systems that are both sustainable and healthy. However, realising these shifts likely necessitates a combination of political and economic action, complemented by systemic and cultural interventions. These are essential to shift norms and facilitate the widespread adoption of sustainable dietary practices. Among these interventions, the **innovation in production and consumption of Alternative Proteins** emerges as one of the key catalysts.

However, the effective implementation of Alternative Proteins in India is hindered by a lack of India-specific research. To truly harness their potential in transforming India's food systems, it is crucial to understand their impact in relation to India's unique challenges. This includes **exploring inter-linkages and assessing the impact of Alternative Proteins on various key issues:**

- Their role as a solution to India's climate change vulnerabilities, inclusive of but not restricted to its impact on GHGE, land use, water use, biodiversity loss, and soil health.
- Public health implications, addressing the antimicrobial resistance (AMR) crisis, rising instances of food-borne illnesses and zoonotic diseases.
- Contributions to food security amidst India's diverse nutritional challenges.
- Influence on India's Economy and consequently, farmers' livelihoods.
- Consumer behaviour and awareness are vital for the successful adoption of Alternative Proteins.

In-depth and localised research addressing these areas is imperative to develop an effective strategy for the Alternative Protein sector in India, ensuring it contributes positively to the country's **sustainability, health, and economic objectives.**



STRATEGIC INTERVENTION

Recognizing the imperative for detailed, region-specific research at the nexus of Food, Climate, and Health, the [India Animal Fund \(IAF\)](#) is initiating a philanthropic fund, backed by the commitment of several anchor funders. This fund is strategically aimed at:

- **Fostering India-Specific Research:** The primary thrust will initially be towards conducting research that intricately explores the intersection of climate, food, and health in India. While the central focus is on Alternative Protein, the scope of this initial research will be broad, investigating other potential complementary solutions that contribute to a holistic and sustainable food system, beneficial for both climate and public health.
- **Implementing Identified Interventions:** The subsequent deployment of the fund will focus on actualizing interventions identified through this research, translating insights into tangible, impactful actions.

We aim to collaborate with a diverse array of stakeholders, including academic institutions, civil society organisations, government entities, and others. As India progresses towards becoming a developed nation with the largest population, it is imperative to devise solutions tailored to our unique context. These solutions must not only sustain our planet but also ensure food and nutrition security for our nation.



REFERENCES

In the preparation of this note, we employed a **comprehensive research approach**, drawing on a variety of credible and authoritative sources. Our research encompassed a blend of academic journals, research articles, and books for in-depth theoretical and empirical insights, alongside up-to-date information from respected online databases. We also included reports and studies from renowned think tanks, government bodies, and international agencies to provide both a global perspective and specific case studies.

The foundation of our research's credibility is built upon contributions from esteemed publications and organisations, including Nature, Science, ScienceDirect, PubMed, the Food and Agriculture Organization (FAO), the Intergovernmental Panel on Climate Change (IPCC), and the United Nations Environment Programme (UNEP) among others. These sources have been instrumental in offering a robust and nuanced understanding of the **interplay between food systems, climate change, and public health**.

Please click on this [link](#) to access the **entire list of references** and gain a deeper understanding of the research background for this note.

