

Alternative proteins:

Responding to the growing
consumer focus on Planet Health





Introduction

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The alternative protein sector has seen a significant evolution over recent years. After years of sustained growth, fuelled by changing consumer attitudes and the rise of purpose-driven leadership in boardrooms, the sector faces some major macroeconomic challenges which have slowed market growth.

The cost of living crisis, driven by inflation in the price of energy, food and other household essentials, has impacted consumer spending power. A December 2022 report from KPMG found that two-thirds of UK consumers were planning to reduce discretionary spending in 2023 – with only 4% of consumers reporting that they will be able to increase spending this year.

The same research found that a third of consumers plan to buy more own brand and value produce in 2023, while a third will buy fewer items.

A continuation of high energy prices, alongside rising input costs, presents a further challenge for alternative protein manufacturers and brands looking to scale and reduce their costs base as the manufacturing processes used to create alternative protein products are often more energy intensive than their legacy protein equivalents.

As macroeconomic challenges push consumers towards more value-led products and manufacturers battle with increased input costs, what's next for the alternative protein market?

This global picture varies by region. The IMF's regional growth predictions between now and the end of 2024 vary between 1.0 and 1.6% in the US and Euro area respectively, to 4.1 and 5.2% in sub-Saharan Africa and emerging and developing Asia.

Global labour trends suggest a continued

slowdown in employment growth in 2023, with the International Labour Organization predicting that “progress in labour markets is likely to be far too slow to reduce the enormous decent work deficits that existed prior to, and were exacerbated by, the pandemic.”

A return of energy prices to pre-Ukraine War levels looks unlikely for the foreseeable future. Analysis by the World Bank predicts that energy prices are expected to fall by 11% in 2023 and 12% in 2024, but they are expected to remain more than 50% above their five year average beyond 2024.

The International Monetary Fund (IMF) predicts that global inflation will follow a similar trend, falling from 8.8% in 2022, to 6.6% in 2023 and 4.3% by 2024 – although this will remain above pre-pandemic levels (2017 -19) by around 3.5%.

While wider inflationary pressures are easing, food inflation continues to rise. According to the Office for National Statistics, food and beverage prices rose at their highest level for 45 years in the UK in the 12 months to March 2023, reaching 19.2%.

96%

Proportion of consumers expecting to maintain or reduce discretionary spending in 2023.

All of these factors point to an impact on growth for alternative protein manufacturers and brands, but wider trends mean that forecasts for the market remain strong.

A greater awareness of the impact food and beverage supply chains have on the environment driving more consumers towards a vegetarian or vegan diet, alongside a rise of purpose-driven leadership in boardrooms, means that Boston Consulting Group (BCG) and Blue Horizon Corporation (BHC) **predicted** the market would continue to grow to reach at least \$290 billion by 2035.

We are seeing an accelerating shift towards own label. This trend has happened sooner in more mature markets and has raised the barrier to entry for new brands.

Despite this rise in own label, growth will increasingly be driven by consumers with a purpose-driven lifestyle.

Emerging technologies will continue in their development, but a reduced ROI means that funding will slow. We also expect R&D and product development to be reduced in size, with fewer products coming to market and reaching the scale for wider commercialisation.

We also expect to see consolidation through merger and acquisition activity, as well as the creation of symbiotic relationships to create more efficient and sustainable supply chains.

Despite these macroeconomic headwinds, it's clear that the alternative protein market will continue to rise in prominence with consumers, as well as in importance to overall Planet Health as alternative proteins offer the ability to create food systems with a lower CO₂e and water impact.

In this report, we will explore these trends in greater detail, looking at the processes and technology that will drive the R&D, product development and supply chain efficiencies to continue the growth of the market.

In this report we will explore:

- The wider challenges of becoming a more sustainable sector.
- How the products themselves, and not just the manufacturing process, are driving sustainability.
- What drives consumers towards non-animal derived protein sources?
- The different types of alternative proteins available.
- The technology and processes that the food and beverage manufacturing sector is implementing to mass-manufacture and meet this growing demand.

\$290 billion

The predicted size of the alternative protein market by 2035 according to BCG and BHC.

Sustainability agenda

Consumer awareness of Planet Health has continued to rise, but over the last 12 months macroeconomic changes mean that, for many, sustainability has fallen down the list of priorities.

In the long-term, sustainable food and beverage supply chains will move from a 'nice to have' to become a 'license to operate' for the sector.

When looking specifically at the food and beverage manufacturing sector, it's important to determine what is meant by sustainability. The majority of headlines that appear in the media focus on CO₂e emissions, and this is often the most widely recognised metric where change and improvements need to be made. However, aside from carbon emissions, the food and beverage manufacturing sector has to consider its impact on four main areas of sustainability.

Climate change:

the amount of greenhouse gases, measured in CO₂e, across the whole supply chain, from agriculture to end user. CO₂e is a better metric than CO₂ as it includes not only carbon dioxide, but all of the other gases (such as methane) that are warming the atmosphere.

Water usage:

the amount of water used at the growing and manufacturing stage.

Protein per square hectare:

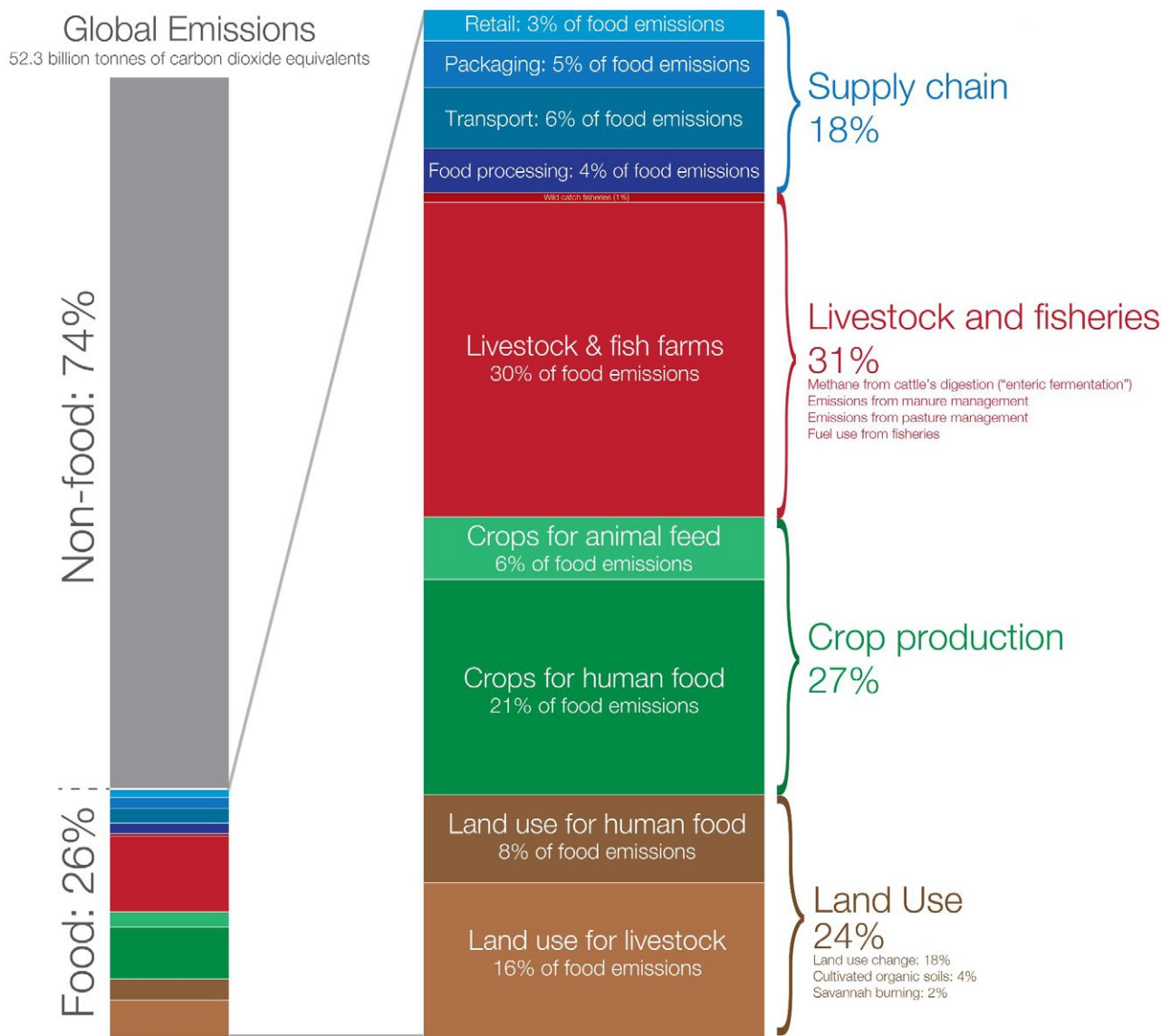
demonstrating the efficiency of growing food and plant products.

Biodiversity:

the impact of supply chains on the biodiversity of ecosystems.

It's currently estimated that **food production contributes to around 26% of global greenhouse gas emissions**. While it is clear there is work to be done to drive this element of sustainability in the sector, it's equally important to factor in other elements that make up the sustainability agenda.

Global greenhouse gas emissions from food production

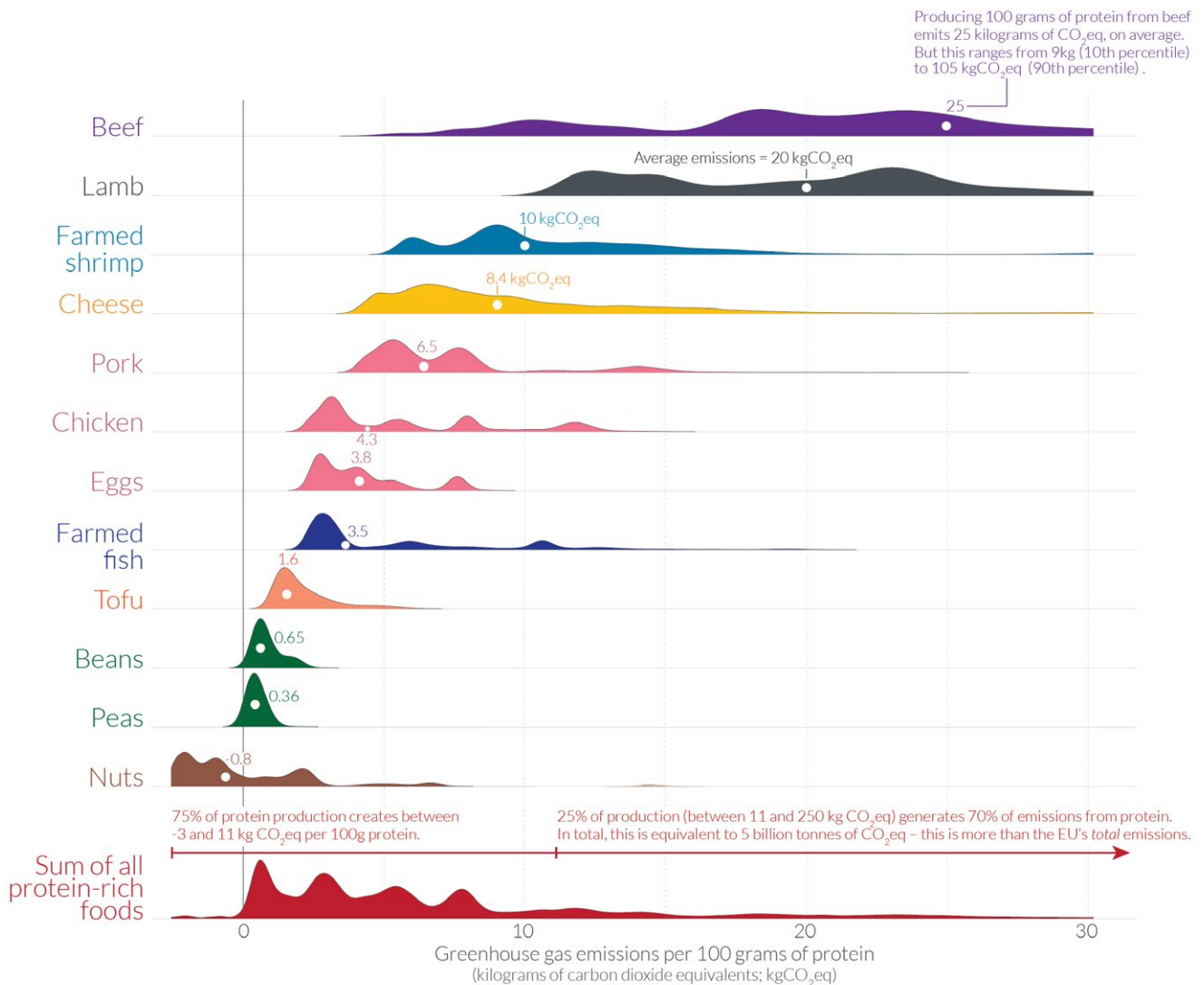


Data source: Joseph Poore & Thomas Nemecek (2018). Reducing food's environmental impacts through producers and consumers. Published in Science. OurWorldinData.org - Research and data to make progress against the world's largest problems. Licensed under CC BY by the author Hannah Ritchie.

The benefits of the increased adoption of alternative proteins for Planet Health are clear, with 100g of protein from beef contributing an average of 25kg of CO₂e emissions.

How does the carbon footprint of protein-rich foods compare?

Greenhouse gas emissions from protein-rich foods are shown per 100 grams of protein across a global sample of 38,700 commercially viable farms in 119 countries. The height of the curve represents the amount of production globally with that specific footprint. The white dot marks the median greenhouse gas emissions for each food product.



Note: Data refers to the greenhouse gas emissions of food products across a global sample of 38,700 commercially viable farms in 119 countries. Emissions are measured across the full supply-chain, from land use change through to the retailer and includes on-farm, processing, transport, packaging and retail emissions. Data source: Joseph Poore and Thomas Nemecek (2018). Reducing food's environmental impacts through producers and consumers. Science.

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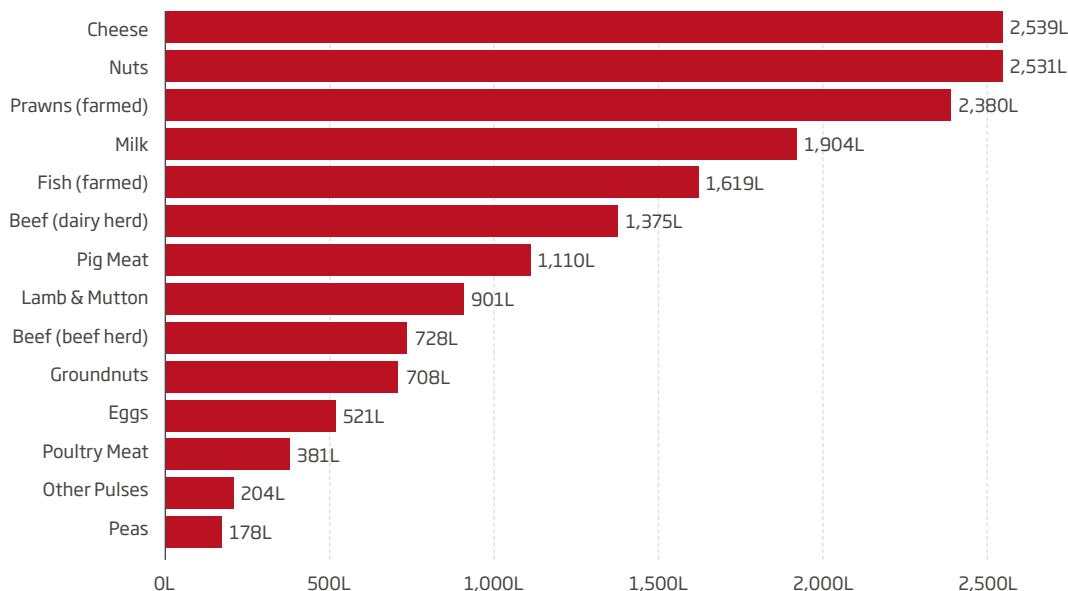
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Water usage doesn't receive nearly the same levels of media attention as CO₂e emissions but, as water becomes '**increasingly unpredictable**', its value and importance are rising.

Cheese and milk use significant amounts of freshwater, with 2,539L of water used per 100 grams of protein produced.

Freshwater withdrawals per 100 grams of protein

Freshwater withdrawals are measured in liters per 100 grams of protein.



Source: Poore, J., & Nemecek, T. (2018). Additional calculations by Our World in Data. OurWorldInData.org/environmental-impacts-of-food • CC BY

As such, food and beverage manufacturers are increasingly treating water as a key commodity to improve efficiency across the sector.

As changing consumer expectations around Planet Health develop, alternative protein sources offer food and beverage manufacturers and brands the opportunity to create food systems with a lower water impact.

Focus is also being placed increasingly on improving biodiversity and maximising protein per hectare metrics. This is of particular importance to the alternative-protein sector, where the **by-product market is in its infancy**.

While it's been commonplace in the meat manufacturing sector for a long time, the valorisation of the by-products beyond their primary use is an area that manufacturers of non-animal derived proteins have yet to fully take advantage of.

Currently, most of the waste from the manufacturing process that is utilised for another purpose is found in animal feed. This can be seen as problematic for purpose-driven businesses and counterproductive in their efforts to manufacture more sustainable, non-animal derived products.

As the market matures, the sustainability credentials of food and beverage manufacturers will continue to move beyond a 'box-ticking' exercise within an ESG policy, to becoming a fully-fledged licence to operate. Pressure from consumers and retailers for products that meet certain sustainability standards, coupled with the inevitable government intervention, will mean food and beverage manufacturers that are not focusing on sustainability will quickly find themselves falling behind competitors in the sector.

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The rising importance of water efficiency

Søren Nøhr Bak, Senior Expertise Director, NIRAS

Water is our most important resource and the foundation for our society. According to the UN, three out of four jobs are either heavily or moderately dependent on water meaning that water shortages and limited access to water limits economic growth and job creation.

There are also increasingly important commercial factors behind a drive towards increasing water efficiency in food and beverage manufacturing.

Whereas water was once seen as a cheap commodity, the increased pressure on preserving our environment and high cost of water and wastewater discharge means that it is an increasingly difficult consideration for businesses.

Food and beverage manufacturers can increase water efficiency through the four Rs

Reduce - eg. replacement of water seal pumps and vacuum systems

Reuse - eg. collect water from a Pasteurizer and use in a cooling tower

Recycle - eg. wastewater recycling

Rethink - eg. Increased industrial symbiosis

A holistic approach to the local context of manufacturing plants will be vital to long-term solutions to water efficiency. Whereas CO₂e emissions are global, water health has more regional or local nuances.

Some food and beverage manufacturers are choosing to co-locate their manufacturing locations to maximise symbiotic relationships. For example, Norway's TINE dairy factory in Jæren is located next to greenhouses growing tomatoes, which make use of the excess low temperature heat and CO₂ from the natural gas combustion in the dairy.

Case study – **Increasing water efficiency in food and beverage systems**

Sustainable food and beverage supply chains will not be achieved through the increased consumption of alternative proteins alone.

When measured across the four key areas that we have already discussed – climate change, protein per square hectare, biodiversity, and water usage – water efficiency is increasing in importance for manufacturers. As such, it's vital to look at how usage can be reduced across food systems through manufacturing projects. At NIRAS, we have a long history of working with purpose driven businesses to increase water efficiency.



innocent

When working in partnership with innocent's new £200m plant, the blender, at the Port of Rotterdam's new Food Hub, an emphasis was placed on innovative solutions and new technology, such as purposely splitting thermal demands to reduce steam usage and recycling waste heat from the cooling and refrigeration process.

The focus on the reduction of water usage within the factory led to the implementation of a revolutionary line cleaning technology called FluiVac, which helps save an estimated 81,000 litres of water every single day.

The size of ambition and scope of investment from innocent showed the importance of water usage in a brand's sustainability credentials.

Not only was the project purpose driven and in line with the business's own ethics and values but demonstrates how the changing public mindset has created a growing demand for food and beverage products that have been manufactured in a sustainable way.



Carlsberg

With an ambition to cut water usage by 50% by 2030, Carlsberg Brewery's Together Towards Zero programme set ambitious and visionary sustainability targets to create one of the world's most water efficient breweries.

With an ambition of achieving of zero water waste at its breweries by 2030, NIRAS and Carlsberg worked in partnership on the construction of its first total water recycling plant at its Fredericia brewery in Denmark.

The recycling plant brought a new innovative approach to the safe reuse of rinsed process water, and introduced new technologies to improve water efficiency, resulting in 90% of all process water being recycled and overall water usage being halved.

The Fredericia brewery has since become a learning platform for all of Carlsberg's breweries worldwide and won the prestigious 'Industrial Project of the Year' at the Global Water Awards.

Changing diets - drivers of change

Animal derived protein sources have mature and efficient supply chains, which have been optimised over a number of decades and this has resulted in these traditional protein sources being the developed world's central of protein for a very long time.

However, as people become increasingly aware of the impact that farming, manufacturing, and eating large quantities of animal-derived protein sources has on the environment and human health, the market for alternative proteins has been growing.

While historically it was moral and ethical questions around farming and killing animals that was a central driver in people's decision to take up a vegetarian or vegan diet, we are now witnessing a myriad of external factors driving more people towards alternative sources of protein in their diets.

The following consumer decision tree details what is driving changing habits:

- 1. Animal welfare**
- 2. Human Health**
- 3. Planet Health**
- 4. Cost**

Focusing on the impact that a 'planet health mentality' is having on consumer decision making, there are a number of ways that human activity is damaging the environment. However, specific issues such as rising CO₂e levels and deforestation have become embedded in the public consciousness - both of which can be directly linked to the mass production of animal derived protein sources.

It is very apparent that, within the Western world, the impact that farming and manufacturing of meat, dairy and egg products - especially beef - has on the environment is becoming more visible.

Awareness of the finite lifecycle of our approach towards the aquaculture is also rising. After developing farmed fish supply chains to increase efficiency, while continuing to exploit natural marine ecosystems to feed these aquacultures, it's increasingly clear that our current fish supply chains are not sustainable in their current guide.

This, coupled with a wider awareness amongst consumers of their own health and wellbeing, especially in the wake of COVID-19 pandemic, is leading more people to explore alternative diets. This comes in the form of either sourcing products with new ingredients or reducing, or completely removing, animal products from their diets, as such the demand for alternative proteins is growing.

Diets are clearly evolving, especially among younger people who are actively seeking out alternatives to meat. A 2022 YouGov [survey](#) showed that 18% of those aged between 16 and 24 years old never eat meat, compared with just 6% of the UK population aged over 60.

A consumer revolution is well underway, and the food and beverage manufacturing sector is, in turn, innovating and investing in new technology to find and mass manufacture non-meat derived proteins, while also simultaneously building factories and designing supply chains that make the process more environmentally friendly.

18%

of those aged between 16 and 24 years old never eat meat.

Barriers to non-animal derived protein diets

Despite the increasing number of people switching to vegetarian or vegan diets, either partly or fully, there are a number of barriers which, at present, can often hold people back from making the change.

Food and beverage manufacturers of non-animal derived proteins will need to overcome these barriers through innovation, implementation of new technology and processes, purpose-driven leadership and education of consumers.



“The market’s growth over recent years has put it in a strong position to overcome many of these challenges and – while the short-term outlook suggests a period of consolidation for alternative proteins – the long-term trends suggest the influence of these factors will only diminish over time. Resistance to changing habits will wane as both the number of protein alternatives and their quality continues to improve. Investment in manufacturing capabilities is now even more important for the sector to improve scale and drive cost efficiencies, in order to overcome wider macroeconomic challenges over the next few years.”

Matthew Carr

Costs

At present, products made of non-animal derived protein can often be more expensive than their traditional counterparts. New brands continue to enter the market, and as products become more popular, the requirement to expand manufacturing facilities will drive prices down. However, the challenges of an uncertain and difficult economy mean that many people are looking at a more sustainable diet as a luxury that their squeezed disposable income cannot afford.

Resistance to changing habits

“Meat, veg and potato”, the general make-up of traditional western meals that have been found on the dining tables of family homes has largely remained unchanged for decades. People are used to eating meat, and advertising campaigns throughout the 70s, 80s and 90s drilled the ‘importance’ of including meat in a daily diet. Such ingrained habits can be hard to break and, while younger people will be less influenced by the diets of older generations, people who have had a meat-centric diet for 30 or 40 plus years will find it harder to make a change.

Desirable protein alternatives

The last five years has seen the market for ‘alternative protein’ expand and improve dramatically, and as technology and processes have advanced, so too has the quality and choice available to consumers. Historically, the perception has been that manufactured meat-free alternatives don’t provide the same quality in terms of taste or nutritional value – these negative connotations are hard to shake, but with the options available today, are proving increasingly difficult to justify.

Defining protein sources

Nigel Devine, associate project director, NIRAS:

"There is a plethora of protein sources available to the food and beverage manufacturing sector today, from traditional meats and fish, through to new products driven by innovative technologies. These new protein sources, when used in food and beverage products, are often referred to by the consumer as 'plant-based'.

"However, we know that 'plant-based' is not nearly a broad enough term to cover the range of new sources of protein available to the food and beverage manufacturing sector. This matrix encompasses the full range of protein sources available today and clearly displays just how far technology and innovation within the sector has advanced.

"Not only is the sector at the cutting edge of technology, such as with a new protein called Solein created using carbon dioxide from the air – but we are also seeing more protein sources which have always been there be utilised in new and exciting ways.

"The mainstreaming of both non-animal derived proteins such as seaweed, and animal-derived proteins such as insects and jellyfish are prime examples of the sector innovating to create and manufacture products in a much more sustainable manner.

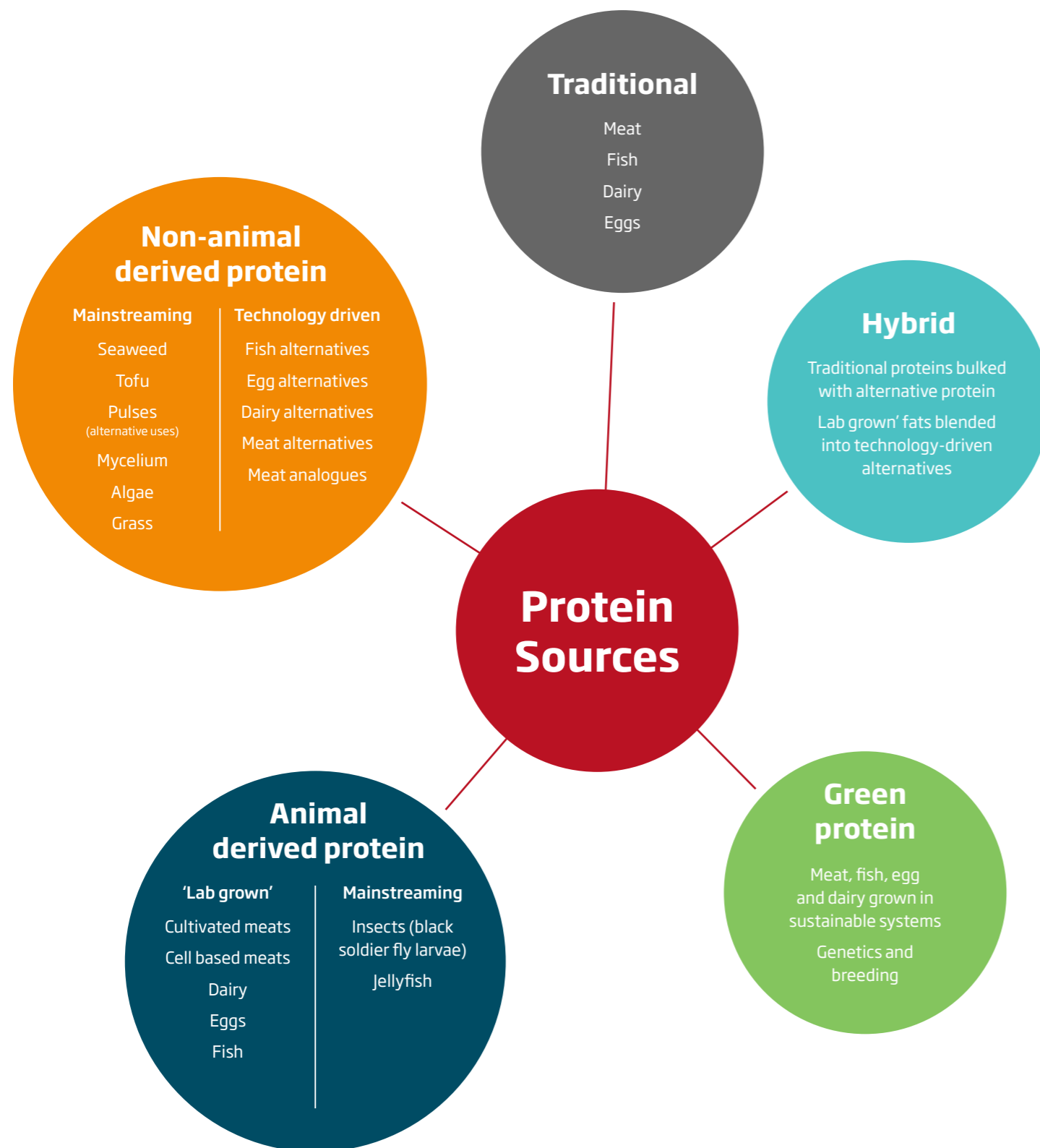
"The widening range of protein sources is providing food and beverage manufacturers with new options and ingredients to create more desirable products, this in turn will combat some of the negative stigma with regards to the quality of 'plant-based' ranges.

"This matrix is only a snapshot in time of what is available today, but I fully expect it to grow as consumer demand drives new tech and processes, leading to an expansion of manufacturing capabilities, but also the need for new technology and processes to source more sustainable protein sources."



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Technology deep dive

The processes by which food and beverage manufacturers are able to 'create' new protein sources for mass consumption are expanding all of the time.

Fresh thinking, innovation and improving technology is creating new opportunities for better quality ingredients in products, and more efficient processes that further drive the sustainability credentials of food and beverage manufacturers.

Here Ed Keenan, joint head of process at NIRAS takes us through some of those processes and technologies:

Primary processes

Biomass fermentation:

Biomass fermentation uses fast growing, high-protein microorganisms to produce more protein, in this process the reproducing microorganisms are part of the final product.

Solid state fermentation:

Solid-state fermentation (SSF) is a type of fermentation process using microorganisms such as bacteria, fungi, and yeast that takes place on a solid substrate (such as grains, seeds, or even waste), without the presence of free-flowing liquid.

Traditional fermentation:

Traditional fermentation changes the properties of food by using bacteria and yeasts to convert simple sugars into acids or alcohols through anaerobic digestion.

Precision fermentation:

Precision fermentation uses microorganisms as factories to produce functional ingredients such as proteins, enzymes, flavour molecules, vitamins, pigments, and fats.

Gas fermentation:

Gas fermentation uses microorganisms to convert gases into products such as proteins.

Plant molecular farming:

Plant Molecular Farming (PMF) is similar to precision fermentation but instead of yeasts and bacteria in a bioreactor or fermenter, it uses plants as the factories to produce proteins, including animal proteins.

Secondary processes

Cultivated meat scaffolding:

Cultivated meat scaffolding is the structure to which cultivated meat cells are attached in order to create products with similar appearance, texture, and mouthfeel to whole-muscle products.

Extrusion:

Extrusion is the process of forcing ingredients through an opening in a perforated plate or dye designed to produce a specific shape.

- **High-moisture extrusion (HME)** is a type of extrusion process used to replicate the fibrous appearance texture of whole-muscle meat.

3D food printing:

3D food printing is the process of creating food products most commonly by depositing the food material layer by layer through a nozzle.

- **3D Bioprinting** is a type of 3D printing where cells are printed onto scaffold structures based on CAD images typically generated by MRI and CT scans of real tissue in order to replicate specific cuts of meat.

Cellular agriculture:

Cellular agriculture is the production of agricultural products such as proteins, fats and tissues by using technology rather than traditional agriculture.

- **Cultured meat** is a form of cellular agriculture where the meat is produced by culturing animal cells in a vessel rather than by raising and slaughtering an animal.

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Conclusion

Consumers are increasingly aware of the impact of their individual choices when it comes to protein sources. While market demand for traditional, animal-derived sources of protein will not disappear overnight, more people will continue to transition their diets and the market share of alternative protein sources is only going to increase.

While innovation and technological developments are increasing possibilities for new types of products, humans have been controlling the fermentation processes for thousands of years, dating back to 10,000 BCE with the preservation of milk from camels, cattle, sheep and goats.

In many ways, the rapid growth of alternative protein products, many developed through different types of fermentation, represents a combination of heritage and technology, as well as an evolution of ancient forms of food and beverages.

As we see this evolution continue, the options available to the sector will widen further in line with technology-driven alternatives and the mainstreaming of existing ingredients increase in availability.

These developing food systems will have a significant impact on Planet Health, as more alternative protein options help to reduce the impact of food and beverage supply chains on the four key pillars of sustainability: CO₂e, biodiversity, water impact and land usage.

In the long-term, the environmental credentials of all food and beverage systems will become even more important for consumers, as sustainability continues its trend of becoming a de facto 'licence to operate' in the sector.

This trend presents a huge opportunity for food and beverage manufacturers and brands to take advantage of the growing appetite for alternative protein sources. In the short- to -medium-term, however, the sector faces a number of headwinds as businesses look to scale production and develop more mature supply chains.

As macroeconomic challenges threaten to dampen the rapid growth of the sector, the need to scale manufacturing process and supply chains is intensified. Supermarket shelves and restaurant kitchens will need more products, and the sector has to grow with the demand.

The manufacturers and brands that are able to achieve this scale and efficiency while keeping sustainability at the heart of their operations will be best-placed to maximise the growth of increasingly purpose-driven consumers.

Realising your sustainable potential



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