

Foodtech

OPPORTUNITY

Scenari○ map by **CNTA** 

| REPORT

January - December 2024

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Legal deposit: DL NA 159-2024

Funded by:



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Science and technology, the basis for the transformation of the food industry



CNTA, the Spanish National Food Technology and Safety Centre, presents its **2024 Report on the FoodTech Opportunity Scenario Map**, funded by the Ministry of Agriculture, Fisheries and Food

(MAPA).

This report is the result of an observation and information curation process carried out daily throughout 2024. To do this, the **CNTA Vanguard team** analysed

the FoodTech news shows published in **more than 100 information sources** (both Spanish and international) and identified future scenarios which present transformation opportunities for the food industry.



¿WHAT WE CALLFOODTECH NEWS?

Information that covers innovative approaches to solving the challenges faced by society and the food industry which have a technological component and the potential to generate a transformative impact. The aim of this report is to present the FoodTech opportunity scenario map, a visual tool which shows the situation of the FoodTech industry on a two-dimensional plane. The map can help us understand published in more than 100 information sources (both Spanish and international) and identified future scenarios which present

transformation opportunities for the food industry what is being talked about and how much is being said, and reflects the stage of innovation or degree of maturity of a specific technology.

This information can help us understand and make decisions which will affect the future competitiveness of the industry:

Where are the opportunities? Given the situation, where should I invest? And the barriers? What is the next technological milestone that will affect my company? What is the market situation? Which ground-breaking

startups should I know about? What examples can I find to inspire me? In these pages, you will find the maps of both macro scenarios and scenarios so you can navigate with all the detail you need, and a summary of what happened in FoodTech in 2024, with some relevant examples we noticed in the year under analysis.

We hope you enjoy the reading and discover many opportunities for the future.



Methodology

This report is based on the technological surveillance carried out through **CNTA's Alinnova** platform, as well as the knowledge of **CNTA** experts generated in their daily work and in attending **80 national and international** events in the **FoodTech** sector.

Concepts

STAGE OF INNOVATION

The scale consists of 6 innovation stages, shown on the X axis. The 6 stages are:

- **Start-up:** when the technology is in the research stage, in its earliest days.
- **Expectation:** the research is progressing and the great potential of its application are beginning to show. Also called hype .
- **Challenges:** research continues to move forward and, after the initial optimism, the barriers which mean that the technology cannot yet be deployed to its full potential start to become evident.
- **Introduction:** it finally reaches the market, albeit through pilot tests, validations, small runs, etc.
- **Growth:** the stage in which the market adopts the technology and sales growth is significant.
- **Mass Market:** when growth and adoption become more widespread, supply skyrockets and the product begins to enter a mature stage.

The objective of each FoodTech Opportunity Scenario Map is to offer a snapshot through which to understand and find out more about the Opportunity Scenarios depending on their 'stage of innovation' (closer to earlier stages of development or to actual commercial availability) and based on the 'noise' they are generating in the media, that is, assessing the volume of information referring to them.

METHOD OF ANALYSIS

- **Monitoring** and information gathering.
- **Reading the information** and selecting relevant news.
- **Classification** of each news and information item according to the technological component.
- **Classification** of each news and information item according to stage of innovation.
- **Identification** of scenarios and macro scenarios.
- **Calculation of share of voice** for each scenario and macro scenario. Assignment of Y coordinate on the map.
- **Calculation of position** according to stage of innovation. Assignment of X coordinate on the map and % of news in each innovation stage; which shows the deviation and spread.
- **Creation of the map.** Location of each scenario and macro scenario according to coordinates. Design of the rings for each scenario/macro scenario, which represent the % of news associated with each stage of innovation.
- **Qualitative situation analysis.** 0 highlight relevant information.

THEMATIC SCOPE

Information that includes **innovative approaches to solving** the challenges faced by society and the food industry **which have a technological component** and the potential to generate a **transformative impact**.

SOURCES

More than 100 general and specialised information sources on the food industry have been used for this report, including the media, institutions (both public and private), associations, market consultancies, legislation gazettes, attendance at FoodTech events and the experience of the CNTA researchers.

ANALYSIS TECHNIQUES

Documentary research, identification of primary information and qualitative analysis.

SHARE OF VOICE

Number of news items on a scenario/ macro scenario / total news items = % share of voice with respect to the total.

FREQUENCY

Information detected and analysed daily in the period January-December 2023.

GEOGRAPHICAL SCOPE

National (Spain) and international.

A petri dish containing various bacterial colonies in shades of yellow, orange, and red. A gloved hand is using a pipette to add liquid to the dish. The background is a blurred laboratory setting with a yellow biohazard sign.

**2024 at a
glance**
**Macro scenarios
and scenarios**

¿WHAT FOODTECH IS FOR CNTA?

The term **FoodTech** is very recent and, as such, is constantly evolving. Broad in application, each organisation interprets its scope in terms of types of technologies and uses.

For **CNTA**, **FoodTech** refers to the **application of technology** for the transformation of the food industry and to resolve the related challenges which our society faces. As a result of this trans-

formation, food will be healthier, more sustainable, safer and accessible. It should be noted that, with this scope, we do not cover areas such as delivery, e-commerce, supply chain or agritech.



FoodTech, a winter of investments

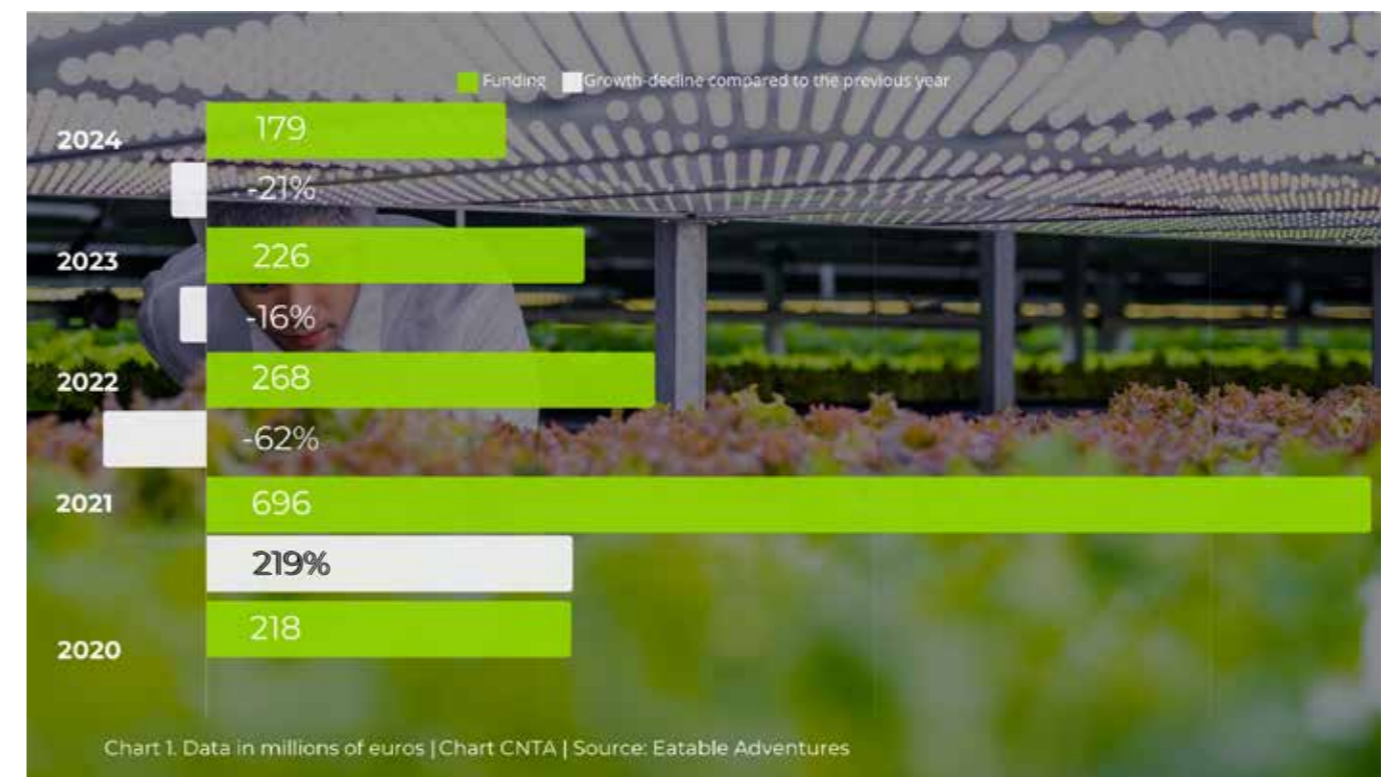
In 2024, according to data from the consultancy DigitalFoodLab, **global investment in FoodTech decreased by -6%** compared to 2023. After years of steep decline, the fall has eased but is still declining. This has been labelled by some industry circles as an 'investment winter'. DigitalFoodLab points out that global investment in the sector reached USD 14.3 billion in

2024, while in 2023 it reached USD 15.2 billion and in 2022 it totaled USD 31.3 billion.

In **Spain**, figures also followed this downward trend. According to Eatable Adventures' report "The state of agrifoodtech in Spain 2024", **investment in FoodTech in our country fell by 20.8%** compared to 2023, totaling 179 million euros, as can be seen in graph 1. This decline

is in line with what happened in Europe, where during 2024 investment in FoodTech fell by 19% compared to the previous year, according to data from Dealroom.

Despite these figures, this Opportunity Scenario Map report showed how the FoodTech sector continued to innovate to find solutions to the major challenges of the food value chain.



2024 at a glance

macro scenarios and scenarios



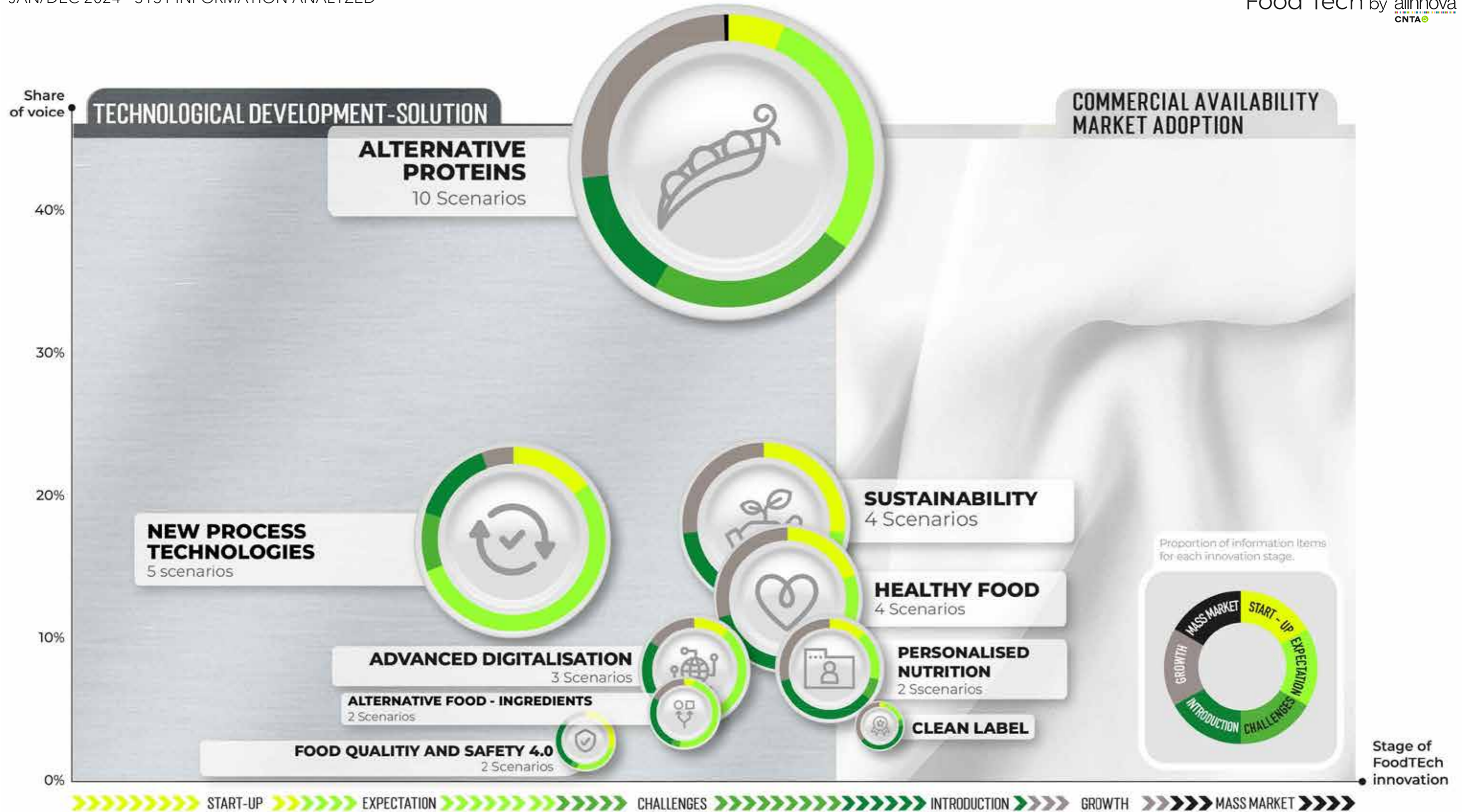
In this **2024 FoodTech Opportunity Scenario Map Report** we can find the **Macro Scenario Map** and different Opportunity Scenario maps. A macro scenario is composed of a certain number of scenarios. In total, there are 9 macro scenarios and 31 scenarios in this analysis.

In 2024, the CNTA Vanguard team produced the different maps, thanks to the analysis and curation of **3,131 pieces of information**. This work helps to understand the current situation and facilitates decision-making on aspects that will affect the future competitiveness of the industry, offering keys to help

answer questions such as: Where are the opportunities? Where should I invest? What are the barriers I face? What is the next technological milestone that will affect my company? What is the market situation? What startups are leading developments? What examples can I find to inspire me?

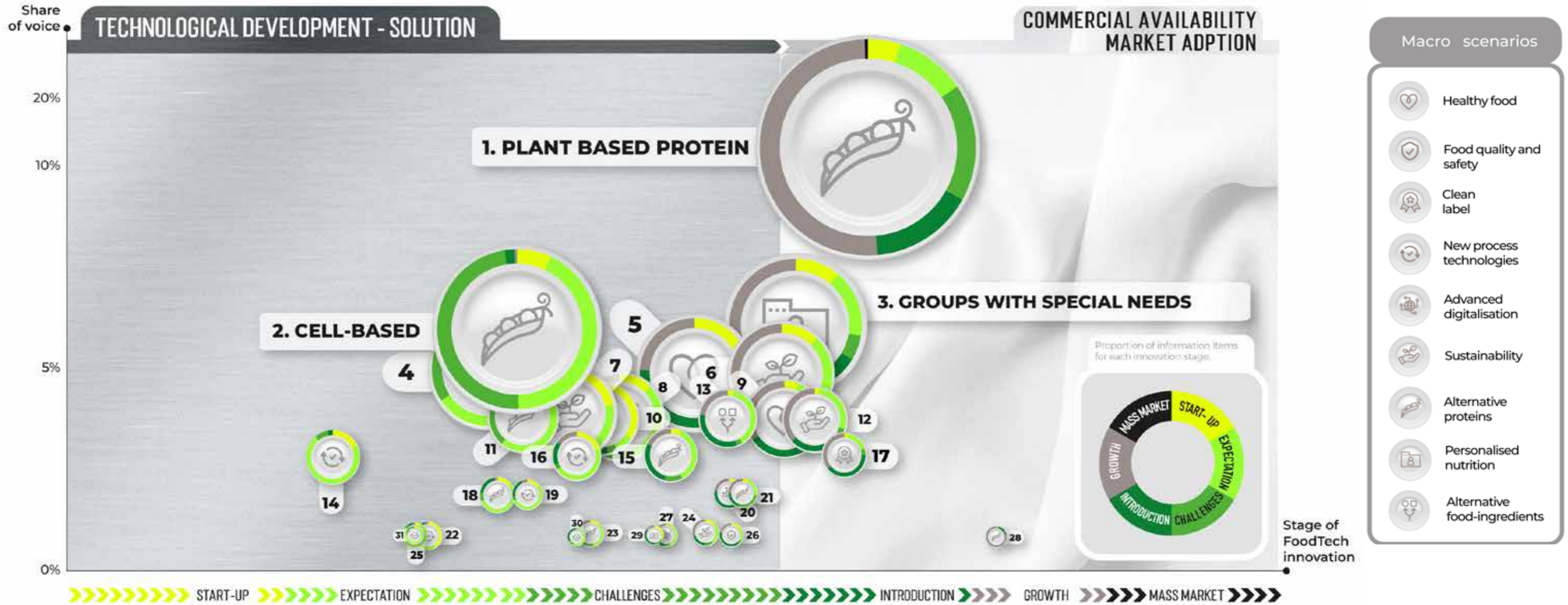
FOODTECH OPPORTUNITY MACRO SCENARIO MAP

JAN/DEC 2024 - 3131 INFORMATION ANALYZED



MAP OF ALL FOODTECH OPPORTUNITY SCENARIOS MAP

JAN/DEC 2024 - 3131 INFORMATION ANALYZED



4	PRECISION FERMENTATION	8	ARTIFICIAL INTELLIGENCE	12	CARBON NEUTRAL	16	FERMENTATION	20	OTHER TECHNOLOGIES (NO IA)	24	VERTICAL INDOOR FARMING HIDROPONICS	28	NO-LO
5	FUNCTIONAL FOODS	9	IMPROVING THE NUTRITIONAL PROFILE	13	OTHER ALTERNATIVE FOOD-INGREDIENTS	17	CLEAN LABEL	21	HYBRID PRODUCTS	25	ALTERNATIVE FATS AND OILS	29	PERSONAL NUTRITION
6	SUSTAINABLE PACKAGING	10	PRE, PRO AND POSTBIOTICS	14	CELL-BASED TECHNOLOGIES	18	BIOMASS FERMENTATION	22	RAPID ANALYSIS TECHNOLOGIES	26	TRACEABILITY	30	AIR
7	UPCYCLING-FOOD WASTE	11	SCP- FERMENTATION	15	FUNGI	19	ALGAE	23	INSECTS	27	FORMULACIÓN INTELIGENTE	31	MOLECULAR FARMING

FoodTech Macro Scenario Map

According to the Macro Scenario Map, **Alternative Proteins** was the macro scenario with the largest share of FoodTech news in 2024, with 32.45% of the news analyzed, losing 2.9% of its share compared to 2023*.

The **New Processing Technologies** macro scenario ranked second, driven by the need to address the challenge of scalability

in the food industry, and increased its share by 3% compared to the previous year. In third place was **Sustainability**, with 15.5%, showing that this topic continues to be one of the main areas of interest for FoodTech.

The largest increases in share of voice in 2024 were for the healthier macro scenarios: **Adapted Nutrition**, which experienced

a rise of more than 40%, and **Healthy Eating**, with a growth of 14.4%, positioning themselves as two areas of strategic opportunity for companies.

Summary: Adapted Nutrition and Healthy Eating were the macro scenarios with the highest growth in share of voice.

*You can find the map of the 2023 Report on page 98.

FoodTech All the Scenarios Map

In the **2024 All Opportunity Scenario Map**, **31 opportunity scenarios** were envisioned, presenting transformational opportunities for the food industry.

One scenario that saw a large growth in share of voice was the **Special Needs Collectives** scenario, with the third largest share after **Vegetable Protein** and **Cell-based**. This scenario

increased its share by more than 70% compared to 2023*, as the food industry focused on trying to personalize its propositions during 2024.

Other scenarios that increased their presence in the media were **fermentation** in all its variants (**precision, biomass or more traditional**), as these technologies made significant

progress thanks to the application of new technological solutions such as **nanobubbles, smart bioreactors or automation with artificial intelligence**, which allow processes to be taken from the laboratory to a more efficient and profitable industrial production.

*You can see the map of the 2023 Report on page 96

Alternative proteins: the funding decreases



Personalized nutrition and Healthy eating were the macrosenarios that experienced the highest growth in share of voice.

Globally, according to data from The Good Food Institute (GFI), global funding for alternative proteins totaled \$1.000 billion in 2024, in an analysis that includes plant-based, cell-based and fermentation-based proteins, as shown in Figure 2.

This funding represents a decrease of -26.7% compared to the 2023 fiscal year. These figures are even further from those of 2022, when a total of

2.9 billion dollars in investment was recorded.

This slowdown in investment in the sector was influenced by the **geopolitical situation, the macroeconomic context and the rise of governments committed to more traditional food sectors**, which led investors to consider betting on projects related to alternative proteins in the face of the threat of new restrictions or bans.

Within this sector, investors mainly directed their interest towards protein produced through fermentation, with notable investments such as the \$90 million of **Perfect Day** and the \$61 million of **Formo**, both focused on the development of dairy proteins through precision fermentation. In this sector, too, there were moves by companies to enter into partnerships. One of the most talked-about was the

commercial agreement between **Grupo Palacios** and **The EVERY Co** for the Spanish company to incorporate egg proteins made using the American start-up's precision fermentation process into its products.

In the field of protein produced by precision fermentation, 2024 saw several legislative approvals for the commercialization of different dairy proteins. Some took place in **Israel** (such as **Imagin-dairy's** beta-lactoglobulin), **China** (**AIIG's** bovine lactoferrin) and **Canada** (**Remilk's** beta-lactoglobulin).

European startups (**Fermify** and **21st.BIO**, among others) obtained **GRAS (Generally Recognized As Safe)** status from the FDA (US Food and Drug Admin-

100 MILLION DOLLARS FOR MEATIFOODS

100 million was the highest amount raised in a financing round in the alternative protein sector during 2024. The win came from startup **MeatiFoods**, known for its mushroom-based products, which will use the funding to expand its product portfolio.

istration) to be able to market different dairy proteins in the **United States** or positive safety opinions from EFSA for genetically modified ingredients made through precision fermentation, such as heme from **Impossible Foods**.

During 2024, legislative milestones were reached for other types of alternative proteins. One of them was Solein, the protein from Finnish startup **Solar Foods**, which could be enjoyed in some of the dishes at **Omsted restaurant in New York**. To achieve this, the startup registered its production plant in Vantaa (Finland) with the FDA, as well as complying with other FDA requirements for marketing this ingredient in the United States.

Solein air protein gets approval to be marketed in the US

Another alternative protein that is taking steps towards market entry is **cell-based**, which in 2024 won the first regulatory approval for a cultured protein. In particular, **Mealty Foods** got the 'ok' in the UK to sell its feed with cultured chicken meat, which is expected to be marketed in 2025.

In the human food area, the French company **Gourmey** submitted its first application to the European Commission in mid-2024 to market its cultured foie gras in the EU. The review of its application is expected to take at least eighteen months

Gourmey is the first company to apply to the European Commission for approval to market a cell-based product in the EU.

Another cell-based foie gras could be tasted in November 2024 in **Hong Kong**, namely that of Australian startup **Vow**, making it the first time that a cell-based product has been

available to Chinese consumers, as in the rest of the country its commercialization is still prohibited. The startup became the third company in the world (after **Upside Foods** and **Good Meat**) to sell a cell-based product (a cultured quail) by gaining regulatory

approval in **Singapore** in the first months of 2024.

This progress contrasts with initiatives such as those in **Italy** and the US states of **Florida** and **Alabama**, where laws were passed to ban the marketing of cell-based meat.

NEW INNOVATION SPACES

To advance the cell-based regulatory framework, some areas are creating new innovation spaces called **sandboxes**: controlled testing environments that allow companies and institutions to experiment and develop innovative projects under the supervision of regulatory authorities, without coming into conflict with existing regulations.

For example, the UK government invested 1.92 million

euros to create the first sandbox in Europe to speed up the approval of cell-based meat and fish. Not to be left behind, the European Union is also promoting initiatives such as Genopole, France's main biocluster, which in September 2024 presented the APROVALS project, an initiative that seeks to create a European sandbox focused on the development and validation of emerging technologies in cell-based agriculture.



Solein Carrot Crepe with Solein protein from Solar Foods, a dish that could be tasted in a restaurant in New York. Photo of the Solar Foods media kit.

Apart from legislative issues, one of the challenges facing the alternative protein sector is to change the perception shared by many consumers that these foods, mainly plant-based, are ultra-processed. To improve this image, 2024 saw a number of product launches promising to be healthy and clean label, two arguments that were more prominent in companies' marketing strategies.

The issue of labelling also continued to challenge companies in this category, as several countries regulated the use of specific terms that, according to their authorities, can be confusing for the consumer. 2024 saw a proposal being prepared in the **Czech Republic** to prevent manufacturers of plant-based products from using terms such as 'escalope',

'sausage' or 'hamburger' or a **UK** court ruling that banned the use of terms such as 'milk' to refer to plant-based dairy analogues, as in **Turkey**.

This challenge could start to be resolved in the courts, in the case of the European Union, following the ruling of the **Court of Justice of the EU**. The EU body reported that Member States cannot prohibit the use of customary or descriptive names for plant-based foods that do not yet have a specific legal name. However, it added that national authorities can still act if they consider that the labelling or advertising of a food misleads or deceives the consumer.

Achieving price parity with animal-based counterparts is another major challenge for the alternative protein industry. In this

regard, initiatives such as **McDonald's France's** inclusion of **Beyond Meat** vegan nuggets on its menu at the same price as chicken nuggets, or that of the Australian company **vEEF**, which introduced its new range of plant-based meat analogues at a lower price than their animal-based counterparts.

Also, in an attempt to lower the cost and price of alternative protein foods, a number of companies are turning to hybrid products. **Quorn** announced its intention to go for mixing its mycoprotein ingredient with meat and **Fable Foods** introduced a shiitake infusion, designed to be mixed with ground beef. One of the reasons for this move is 'to help consumers consume less meat', they argue.

For more information on these scenarios, see page 40.



The labelling is one of the challenges that companies producing food from alternative proteins have to face.

Alternative foods and ingredients: cocoa alternatives sought



In the **Food-Alternative Ingredients** macro scenario (where we include everything that is not alternative protein such as fats or other kinds of ingredients or foods) it was observed in 2024 that **cocoa alternatives** were the focus of much of the news in this category, as the food industry is trying to deal with challenges such

as the following:

- The rise in prices.
- The lack of supply of this raw material.
- The high environmental footprint of cocoa processing, in terms of deforestation, carbon emissions and water footprint.

The combination of these factors prompted investors to bet on

companies producing cocoa alternatives, such as **Nukoko, Voyage Foods, Foreverland and Planet Foods**. These companies use ingredients such as oats, beans, sunflower seeds or carob beans to produce these kinds of products.

To learn more about the scenarios in this macro scenario, scroll down to page 40.

New process technologies: unstoppable progress in precision fermentation

The **New Processing Technologies** macro scenario was positioned as the second with the second largest share of voice (15.71%), growing by more than 3% compared to 2023. This relevance reflects the food value chain's commitment to technological innovation as the key to overcoming challenges such as the scalability of production processes, increased efficiency and cost reduction.

Precision fermentation, a star technology in 2024

Within this macro-scenario, **precision fermentation** is positioned as a key technology within FoodTech driven by technological innovations, large investments or new approvals

15,71%

of high-value ingredients produced from fermentation, as seen in the **Alternative Proteins** macro scenario, which can be found on page 56.

To achieve these developments, companies, regardless of their size or stage of maturity, need access to appropriate infrastructures. 2024 saw the emergence of a growing network of pilot plants and bio-manufacturing facilities such as the **Bio Base Europe**

Pilot Plant in Belgium, which expanded its production capacity with a 75,000-litre fermenter, facilitating process validation under industrial conditions, or **Danone's** open biotech platform in Clermont-Ferrand, France.

In addition, innovations such as **Hydrosome Labs'** nanobubbles, which improve oxygen and nutrient transfer in fermentation processes, or **Cultzyme's** smart bioreactors, which optimize processes through artificial intelligence, are helping to solve different challenges associated with scalability.

In addition to private initiative, public bodies are also investing in the development of precision fermentation. In early 2024, the **European Union** announced a €50 million investment to boost startups developing alternative proteins



Caption: CNTA bioreactors. Photo: CNTA.

Cell-based technologies, an area of interest

Cell-based technologies continued to consolidate their position as an industry focus despite regulatory challenges. This commitment was also seen in Spain with the inauguration of the first industrial plant in Vizcaya using insects as bioreactors for re-

combinant proteins by **Cocoon Bioscience**.

Internationally, **Forsea Foods** claimed to have achieved records in cell density using organoids and **Angel Yeast and Ohly** presented proposals to optimize growth media, a key element for

cell-based viability.

In addition, cell-based technologies are being used for applications beyond meat, with developments such as **Jellat-ech's** bioidentical collagen and **California Cultured's** cultured chocolate.

Biomass fermentation, towards process optimization



Biomass fermentation is positioning itself as one of the industry's bets for sustainable protein production. Companies such as **MicroHarvest** and **Brevel** have made progress in the scalability of these processes, with technological innovations that optimise the use of resources and improve efficiency.

MicroHarvest developed a patented fast fermentation process that can produce proteins in as little as 24 hours, while **Brevel**

worked on combining controlled light and fermentation to produce microalgae with 60-70% protein concentration.

New applications of this technology to manage industrial waste and turn it into new resources were also seen. For example, the Canadian company **Maia Farms** developed an advanced microprotein fermentation process using bioreactors that use waste as a source of sugar, while the Scottish startup

MiAlgae uses microalgae fermentation to produce omega-3, using waste from other industries to feed the microalgae.

As for the **Fermentation** scenario (which includes non-precision and non-biomass fermentation), it was observed how technology is being renewed in this sector. One example is the cross-fermentation process announced by **Nutrumami** to develop its plant-based products, combining solid and submerged fermentation.

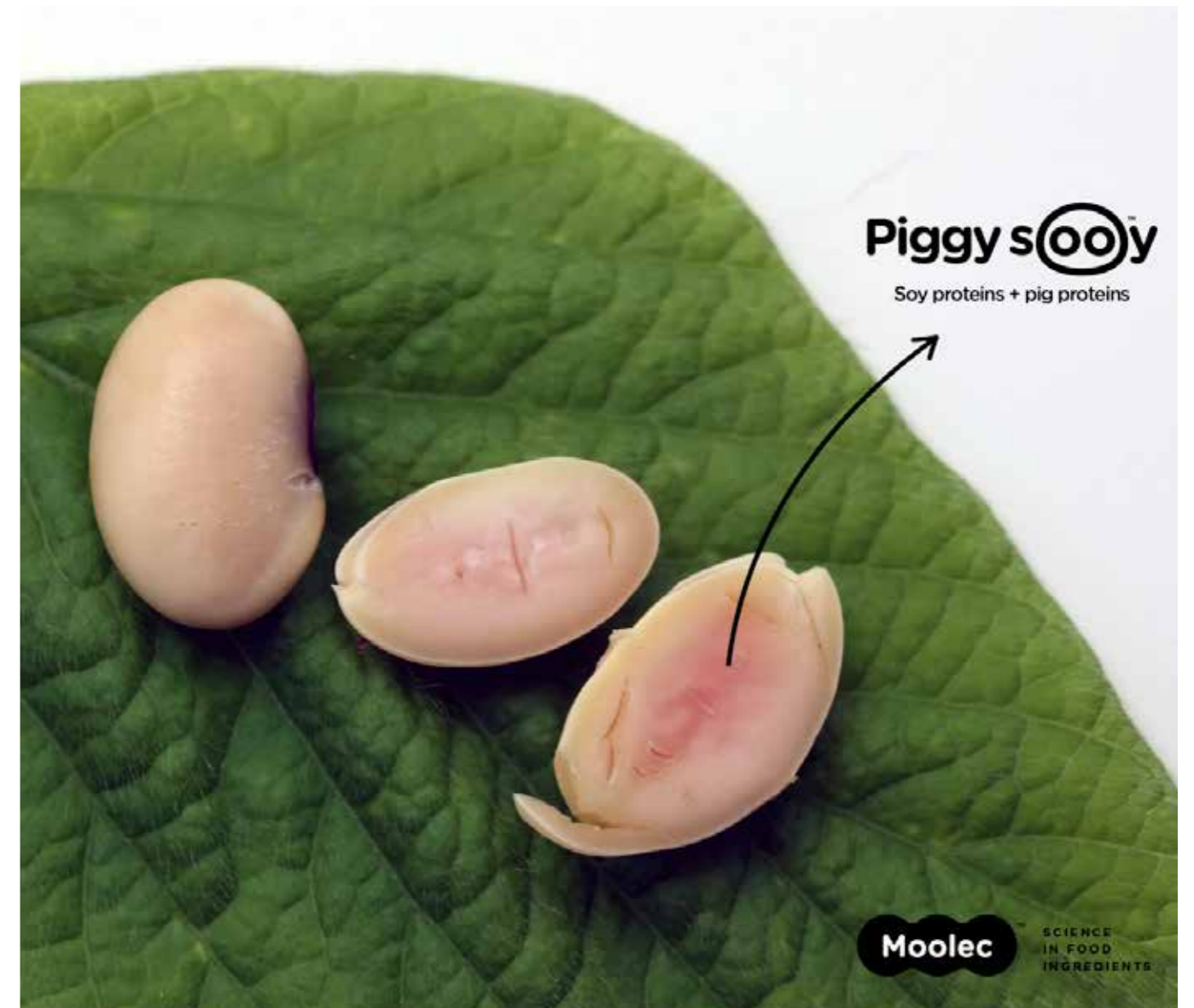
Molecular Farming approvals

Finally, on the **Molecular Farming** scenario, there were two regulatory approvals that bring this technology closer to the market, both of them led by startup **Moleec Science**, which became the first

molecular farming company to gain approval from the United States Department of Agriculture (USDA). The first was achieved in April 2024 for its genetically modified soybeans that produce

its 'Piggy soy' pork protein and the second was achieved in October 2024 to commercialise its peas that produce bovine protein.

For a more in-depth look at these scenarios, turn to page 56.



Genetically modified soybeans from Moleec Science that produce the 'Piggy soy' pork protein. Photo Media kit from Moleec Science.

Sustainable transformation in the food sector: innovation, circularity and carbon neutrality

Sustainability has become a transformative focus in the food industry, driven by increasing regulatory pressure, consumer demands and the need to mitigate environmental impact. This approach not only responds to global challenges such as climate change and resource scarcity, but also opens up opportunities for innovation and market differentiation. Within this context,

several opportunity scenarios were identified that can redefine the future of the sector.

In the field of **sustainable packaging**, material innovations are leading the way. Companies such as **Lactips** and **Notpla** are exploring biodegradable alternatives based on natural components, while others, such as **PureCycle**, are focusing on developing recycled resins with properties

equivalent to virgin materials. This progress reflects the integration of the circular economy, promoting reuse and recycling to reduce environmental impact. Despite this progress, significant challenges remain, such as high production costs and lack of education on recycling and composting practices.

The **valorization of food by-products** remains a key strat-

egy to reduce waste and maximize resources. The transformation of agro-industrial waste into innovative products, such as sustainable oils developed by **ÄIO** or whey proteins promoted by **Arla Foods**, stand out as examples of how industry can turn problems into opportunities. In addition, initiatives in the creation of alternatives to cocoa and coffee respond to supply crises, while digital platforms such as **Too Good To Go** facilitate the management of food surpluses. While this approach is promising, lack of investment remains a barrier to its expansion and consolidation.

Regarding **carbon neutrality**, the food sector has taken signif-

icant steps to reduce emissions and enhance transparency. The European Union has strengthened regulations against misleading practices, requiring verifiable evidence for environmental claims. Technologies such as advanced sensors (by **Collo**) and local micro-factories (by **Reocalize**) are transforming operations by reducing emissions and optimizing resources. Additionally, sustainable agriculture has progressed with solutions like the **Bovaer®** additive, which reduces methane emissions from dairy cattle, while companies like **Campofrío** and **Grupo Bimbo** are leading the transition toward more sustainable logistics fleets.

Finally, the **Vertical Indoor Farming** sector is redefining agriculture by combining technological advancements with a sustainable approach. Genetic editing and the use of artificial intelligence are optimizing yield and reducing energy consumption, respectively. Ambitious projects, such as **Plenty's** initiative in the Middle East, showcase this model's potential to meet local demand in regions highly dependent on imports. However, this sector faces significant challenges related to scalability and high initial costs, as evidenced by the bankruptcy of **Smallhold** in the United States.

Discover more about these scenarios on page 66.



The rise of healthy eating: a continuously evolving trend

Healthy eating is becoming a **key opportunity area for the food sector**. Consumers are looking for products that not only meet their nutritional needs but also contribute to their physical, mental, and emotional well-being. This holistic approach is driving innovation in the industry, creating opportunity scenarios that address various aspects of health and wellness.

33.73%

The **Functional Foods** scenario remains the most relevant within the healthy eating trend, reaching a 33.73% share of voice and increasing its relevance by 15.2% compared to the previous year. This growth reflects a rising consumer interest in products that not only provide nourishment but also offer additional benefits for overall well-being, further driving innovation in the sector.

Functional beverages lead this scenario as the preferred format, thanks to their convenience and the specific benefits provided by naturally sourced ingredients. Examples like **Laird Superfood's** Maca Latte, which combines adaptogens and functional mushrooms, showcase how new products are being developed to **enhance physical and mental performance in a healthy way**.

Additionally, **blood sugar control has gained significant attention** with products such as Good Idea's functional sodas or supplements from brands like **Boost**, designed to help maintain stable glucose levels.

Regarding **mental and physical well-being**, innovations have emerged in detox beverages and products incorporating adaptogens and nootropics to reduce stress, **improve hydration, and promote cognitive health**.

In the **Nutritional Profile Enhancement** scenario, the industry has focused on reducing harmful ingredients such as sugar, opting for alternatives like sweet proteins, fibers, or low-glycemic-index sugars. A notable example

is **Oobli**, a company developing sweet proteins through precision fermentation. High-protein offerings also stood out, with products from **Covap, Lidl, and Campofrio**, ranging from fortified milk to protein-rich snacks and ice creams.

In the **Pre-, Pro-, and Postbiotics** scenario, interest in the microbiome continues to grow, though it still faces challenges. Innovations such as **Komvida Fibra** kombucha, enriched with prebiotic fiber, or **Supergut** products, which combine prebiotics, probiotics, and postbiotics to help regulate glucose, demonstrate efforts to strengthen this category. The industry is also exploring the use of postbiotics,

as seen in **Matinal Livre**, a dairy product that does not require refrigeration thanks to UHT technology, making consumption more convenient while promoting sustainability.

Meanwhile, the **No-Lo** scenario continues to gain traction, reflecting a shift toward healthier and more conscious choices beyond non-alcoholic beer. Technologies such as the **DIAZYME® NOLO** enzyme are enhancing flavor and reducing production costs in low-alcohol beverages, while brands like **Raimat Zero** and **French Bloom** are leading innovation in dealcoholized wines.

If you want to learn more about this macro scenario, go to page 74.



Adapted nutrition: personalized solutions for every need



Adapted nutrition represents a significant step toward personalized eating, offering specific solutions for groups with special needs and adaptations based on each individual's lifestyle.

The **Special Needs Groups** scenario is strengthening its focus on segments such as **healthy aging, women's wellness, and child nutrition**. Major companies like **Nestlé** are investing in

innovative bioactives to combat cellular aging, while brands like **ADM** and **Ritual** are dedicated to supporting women's health. In the infant nutrition sector, **CarboCode** is developing dairy formulas that closely resemble human breast milk. Meanwhile, in pet nutrition, startups like **Meatly** are innovating with alternative proteins in their formulations.

In the **Personalized Nutrition**

scenario, despite a decline in relevance, interesting initiatives persist, such as the use of **artificial intelligence** to design tailored nutritional strategies. Companies like **Zoe** and **AHARA** are leading this shift with platforms that analyze microbiome data and lifestyle factors to offer **hyper-personalized recommendations**.

You can find more details about these scenarios on page 74.

Digitalization: artificial intelligence shows its potential and is regulated in the EU

In the **Advanced Digitalization** macro scenario, proposals from the **Artificial Intelligence (AI)** scenario stood out, representing 4.25% of the news analyzed in 2024.

With the help of this technology, various AI-driven platforms continued to be developed to help companies become more efficient and accelerate their progress toward the market. Some examples in this regard include:

- The \$60 million in funding secured by **Basecamp Research** to create AI models that help de-

sign complex biological systems.

- The \$16 million raised by **Shiru** to develop its **ProteinDiscovery.ai** platform, which contains a large database of plant-based and microbial proteins and helps companies identify and test ingredients more quickly.

The rapid technological advances in AI are presenting a range of challenges that need to be addressed or regulated in order to implement this technology. Key issues to be tackled include intellectual property management, data privacy, ethi-

cal dilemmas, and controlling its potential, among others.

This fear of the potential that AI could reach and its possible influence on the food industry prompted the EU to publish a AI Act on July 12, 2024, a world-first regulation, most of which will be applied in August 2026. However, some provisions will come into effect starting February and August 2025, and from August 2027.

You can explore this macro scenario further by visiting page 86.

AI REVOLUTIONIZES SMART FORMULATION

Artificial intelligence is also revolutionizing the **Smart Formulation** scenario, where companies are exploring its potential to identify optimal ingredients and improve the success of their products.

Examples like **Cradle**, which secured \$73 million to expand

its AI-driven protein engineering platform, apply this technology to the development of "no animals" foods, pesticides, and other products. Meanwhile, **NotCo** introduced a generative AI that creates flavors and fragrances from simple text prompts.



Quality and Food Safety 4.0: a bet on hyperspectral, NIR, and blockchain technologies

The **Quality and Food Safety 4.0** macro scenario was dominated by research and initiatives aimed at developing new analytical techniques to reach the market.

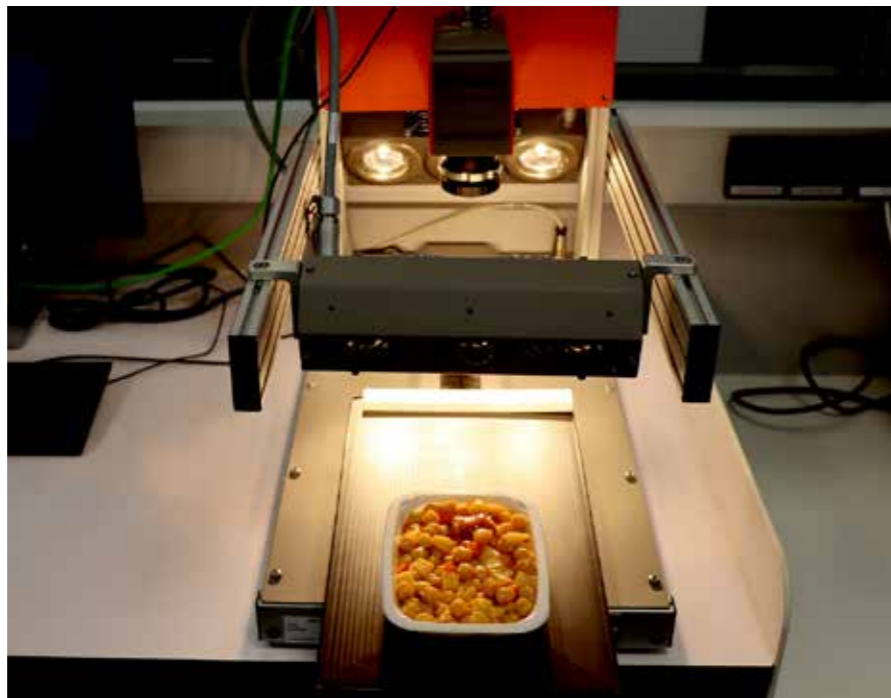
Specifically, in the **Rapid Analytical Technologies** scenario, developments focused on creating various applications using technologies like hyperspectral and NIR, primarily. These technologies, combined with others, are progressing to be used in detecting microplastics, estimating the nutritional value of prepared dishes, verifying different types of fish, quantifying additives and ingredients in samples, and predicting shelf life in fresh products, among other uses.

Regarding the **Traceability** scenario, more companies incorporated it into their operations in 2024. The technology most invested in this area was **blockchain**, with examples like the **SmartZ4Milk** proj-

ect, which developed a platform to track the journey of milk from collection to the final consumer, or initiatives like the **Bunge platform**,

which allows tracking the path of soybeans.

You can learn more about these scenarios starting from page 86.



Use of hyperspectral imaging to estimate the nutritional value of a prepared dish. Photo: CNTA.

Clean label: a concept gaining more importance

We conclude our review of the macro scenarios with **Clean Label**, a concept that has become indispensable for companies, driven by increasingly informed

consumers who are more conscious of what they eat. In fact, a 2024 survey by **The Acosta Group** indicated that 83% of U.S. consumers are familiar with the clean

label concept or have at least heard of the term. In Europe, a 2024 study by **Ingredion** found that 73% of European consumers actively seek products made with recognizable ingredients.

Throughout 2024, several product launches emphasized the clean label message, especially in the alternative protein sector. Some of these included:

The new **Beyond IV platform** from **Beyond Meat**, which includes products with revised recipes to be cleaner label and improve their nutritional profile, such as the new formulations of **Beyond Burger**, **Beyond Beef**, and **Beyond Sun Sausage**.

Heura's commitment to developing plant-based sausages, cheeses, and pastas that are rich in nutrients and free from additives, modified starches, and saturated fats.



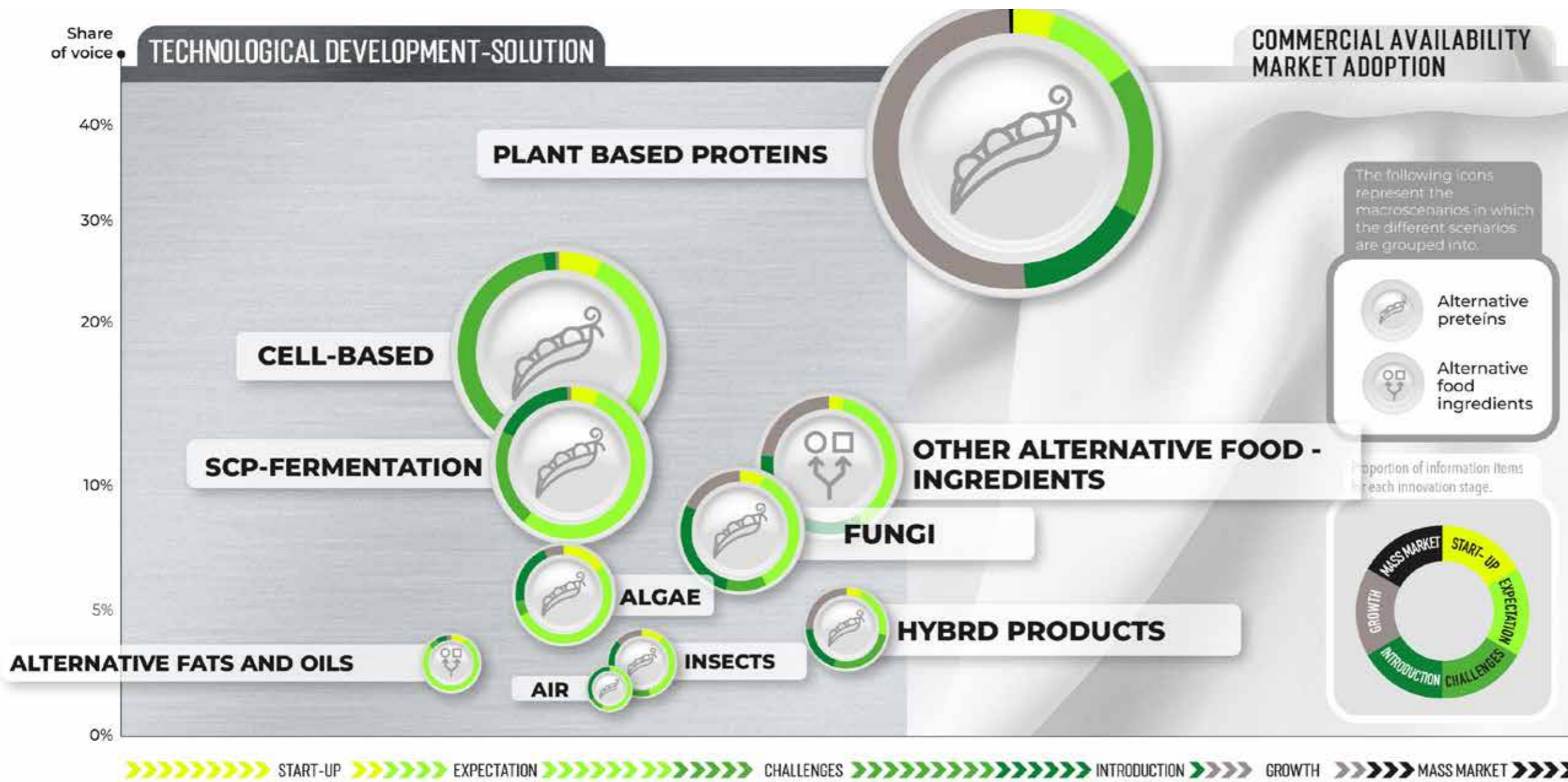


In depth

This section provides a **detailed overview of the opportunity scenarios** identified in this report. It organizes the opportunity scenarios within five macro-scenario maps: **Alternative proteins, fats, and foods; Sustainability; Healthy food and Adapted nutrition; New process technology and Advanced digitalization and Food quality and safety 4.0.** In the following pages you will discover some reflections, product launches, relevant data, new startups, technological innovations, etc., that had a relevant role in the FoodTech sector during 2024.

ALTERNATIVE PROTEINS, FATS AND FOODS

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The first map is the **Alternative proteins, fats and foods**, which analyses both Alternative Proteins and Alternative foods-ingredients macro-scenarios, within which we compile news related to the development of **products made from alternative proteins or alternative ingredients**.

This map is made up of 10 opportunity scenarios: **plant-based** was the scenario with the **highest share of voice in 2024**, reaching **39%**, slightly higher than the numbers achieved in 2023*. It is followed in share of voice by Cell-based, SCP-Fermentation and Other alternative foods-ingredients, a scenario that had the **largest increase in share of voice** within this map, driven by the news about investments in companies working on the development of **alternatives to cocoa and honey**, among others.

*You can consult the map of the 2023 Report on page 100.

Stage of FoodTech innovation

SCP-fermentation: fermentation- based protein drives investment in alternative proteins



Perfect Day dairy protein. Photo from the Perfect Day media kit

Alternative proteins dominated Foodtech news in **2024**, with investors demonstrating a preference for **fermentation-derived proteins**. As shown in **Chart 2 on page 21**, global investment in this protein reached **651 million dollars in 2024**. This figure accounts for **60% of total investment**, according to GFI data, and **represents a 43% increase** compared to the 2023 fiscal year.

Several significant funding rounds supported the development of these **alternative proteins** throughout the year. Notably, **Perfect Day** secured **\$90**

million in early **2024** to advance strategic objectives and expand production of its **precision fermentation-derived dairy protein**.

Other major funding rounds included:

- **\$61 million** for **Formo** to accelerate the commercialization of animal-free casein through a collaboration with **precision fermentation** startup **Those Vegan Cowboys**, aimed at developing cheese analogs.

- **\$45 million** for **Helaina** to scale production of its patented Efferia ingredient, a **fermentation-produced lactoferrin**.

- **€40 million** for **Onego Bio** to advance commercialization of its animal-free egg **protein, Bioalbumen**.

Commercial Approvals

This investment trend enabled several companies to overcome regulatory obstacles in **2024**, to navigate towards market entry. Some secured approvals to market various **dairy proteins** in Israel, China or Canada, while other European startups achieved GRAS status from the **FDA** or received positive safety opinions from the **EFSA**.

For instance, **AIIG** became the first company to receive approval to sell its **precision fermentation-produced bovine lactoferrin** in China. Furthermore, it obtained self-affirmed GRAS status in the United States at the end of **2024**.

Several dairy proteins produced via precision fermentation have received regulatory approvals for marketing in China, Israel, the United States, and Canada.

PARTNERSHIPS TO PROMOTE PRECISION FERMENTATION-PRODUCED PROTEIN

The sector also witnessed **collaborative efforts** to advance the development of precision fermentation-produced proteins. An interesting example is the **partnership between Grupo Palacios and The EVERY Co** to incorporate the American startup's animal-free egg

proteins into traditional products like tortillas.

The American startup announced in late 2024 that it received a European Union patent for its **recombinant ovalbumin**, complementing existing patents in the United States, Finland, Germany, Denmark, and Mexico.



The Every Co.'s egg proteins. Photo: The Every Co.

In late November **2024**, **Imagindairy** announced Israeli government approval for its **precision fermentation-derived beta-lactoglobulin**. This follows previous approval in the United States, making **Imagindairy** the second company authorized to sell a **precision fermentation-produced protein** in Israel, after **Remilk**. **Remilk** also obtained regulatory approval from the **Singapore Food Authority (SFA)** and a "no questions letter" from the U.S. **FDA** in **2024**.

European startups have also

made progress in marketing their **dairy proteins** produced through **precision fermentation** in the United States: Austrian **Fermify** achieved GRAS status for its animal-free casein, and Danish **21st. BIO** obtained self-affirmed GRAS status for its BLG Essential+, a **precision fermentation-produced beta-lactoglobulin**.

Additionally, the European Union is closer to approving **Impossible Foods' Impossible Burger**. The **EFSA's** Panel on Genetically Modified Organisms concluded that the use

of its soy leghemoglobin (heme), responsible for the product's bloody appearance and derived from genetically modified yeast, is "safe for human consumption with respect to the effects of genetic modification."

This ruling marks a significant milestone in the company's EU market entry process. The **EFSA's** final ruling will follow a public consultation period before final approval requests are submitted to the European Commission and its Member States.

Plant-based protein: overcoming key barriers



Beyond Meat nugget analogues. Photo: Beyond Meat.

In the evolving landscape of **plant-based proteins**, companies continue to leverage various claims to attract consumers, emphasizing sustainability, minimal processing, and competitive taste, texture, and affordability compared to animal-based counterparts.

One of the most significant challenges in this sector is price parity. In **2025**, several initiatives aimed to bridge this gap. For instance, in Europe, **McDonald's France** introduced **Beyond Meat's** vegan nugget analogues at the same price as their chicken equivalents. In the United States, **Chunk Foods** launched four **plant-based** products in retail stores at prices comparable to conventional meat. Meanwhile, in Australia, **vEEF** introduced a new range of **plant-based** meat analogues priced

lower than their animal-based counterparts.

Another key challenge is the perception of **plant-based** products as ultra-processed. To address this, producers are striving to develop "clean label" alternatives with naturally sourced, familiar ingredients. A notable example is **Beyond Meat's** Beyond IV platform, featuring reformulated products with cleaner ingredients, improved nutritional profiles, and enhanced cooking properties. Similarly, **Heura** is committed to offering nutrient-rich **plant-based** sausages, cheese analogues, and pasta, free from additives, modified starches, or saturated fats.

Labelling regulations also present a significant barrier. Various countries have proposed restrictions on the terminology used for **plant-based** products. For

example, in the Czech Republic, authorities have suggested banning terms like "schnitzel," "sausage," or "hamburger" for **plant-based** alternatives. In the United Kingdom, a court ruling prohibited the use of "milk" to describe **plant-based** dairy analogues.

Additionally, inconsistencies and ambiguities in the terminology of novel foods complicate international regulatory harmonization. A ruling from the Court of Justice of the European Union (EU) clarified that Member States cannot prohibit the use of customary or descriptive names for **plant-based** foods unless a specific legal designation exists. However, national authorities retain the right to intervene if a product's labelling or marketing is deemed misleading or deceptive.

NOTABLE INVESTMENTS

Despite a global decline of **3.5%** in **plant-based protein** investments during the first three quarters of **2024** (according to **Good Food Institute** data), several key financing rounds took place:

- **Heura** raised **40 million euros** in early **2024** to

support its path to profitability.

- **Outside**, a startup specializing in oat milk analogues, secured **35 million dollars** to expand its market presence and develop new products.

- **Plantible Foods** raised **30 million dollars** to scale

up the production of its **Rubi protein**, extracted from duckweed (*Lemna*), a green aquatic plant.

These investments underscore the continued momentum and potential of the **plant-based protein** sector despite economic fluctuations.

Cell-based: steps forward and backward

The global investment in **cell-based** products declined, dropping from **\$230 million** in the **2023** to **\$137 million** in **2024**—a decrease of over **40%**, according to **GFI** data.

Despite this downturn, **2024** saw notable advancements, including new products and expanded regulatory approvals for human consumption. Hong Kong joined a list of markets that began with Singapore, followed by the United States and Israel.

Australian startup **Vow** introduced its **cell-based** foie gras in a Hong Kong restaurant, marking the first time such a product was available in the city. While

the rest of China continues to prohibit the sale of **cell-based** products, Hong Kong became the third market worldwide to grant regulatory approval for **cultured meat**. The city's **Center for Food Safety (CFS)** authorized **Vow** to market its **cultured** foie gras, 'Forged Gras,' a variant of its **cultured** Japanese quail, which had already received regulatory approval in Singapore in **April 2024**.

In the European Union, steps were taken to facilitate the commercialization of these products. French startup **Gourmey** submitted the first application to the European Commission

in **mid-2024** to market **cultured** foie gras in the EU, with a review process expected to take at least eighteen months. Meanwhile, the Netherlands hosted the first EU-approved **cultured meat** tasting in **April 2024**, where guests sampled **Meatable's** **cultured** pork sausages.

However, not all developments were positive. In **2024**, opposition to **cell-based** foods gained political traction, with several countries moving to **restrict** or ban production and sales. **Italy and U.S.** states such as **Florida and Alabama** have already enacted prohibitions, with **Nebraska** likely to follow in **2025**.

New regulatory sandboxes

The absence of clear **regulatory frameworks**, along with their restrictive or overly complex nature, remains a key barrier to the commercialization of **cell-based proteins**. To address this, new innovation spaces are being created to provide companies with flexible environments for research and product development while ensuring compliance with legal requirements.

One such initiative is the **regulatory sandbox**—a controlled testing environment that allows companies and institutions to experiment under the supervision

of regulatory authorities without breaching existing laws. The UK government has invested **€1.92 million** in a sandbox designed to accelerate the approval of **cell-based meat** and fish.

Similar initiatives are emerging in the EU. In September **2024**, **Genopole**, a French biocluster, launched the **APROVALS** project in collaboration with other European research institutions. This initiative aims to establish the EU's first **regulatory sandbox** dedicated to developing and validating emerging technologies in **cellular agriculture**.



Participants of the APROVALS project. Genopole Media Kit photo.



Vow's cell-based foie gras. Photo: Vow.



CELL-BASED ANIMAL FEED APPROVED IN THE UK

A significant milestone in **2024** was the UK's approval of a **cell-based** product: a pet food containing **cultured** chicken, produced by **Mealty Foods**, set to launch in **2025**.

But **Mealty** is not the

only one: **Noochies** has partnered with **Umami Bio works** to develop cat treats made from **cultured** fish, while **BioCraft** is preparing to market **cultured** mouse meat at prices comparable to conventional wet pet food.

Mushrooms: notable investments

Mushrooms scenario saw significant growth in **2024**, driven by key agreements and investments. The largest investment in the **alternative protein** sector that year went to **Meati Foods**, a company specializing in **mushroom**-based products. **Meati** secured a **\$100 million** funding round to expand its product portfolio and prepare for new launches.

Another noteworthy investment was made in **Infinite Roots**, which set a record in Europe by raising **€58 million**. The funds will sup-

port the commercialization of **mushroom**-derived products and a strategic partnership with **Pulmuone**, a leading South Korean food manufacturer, to develop innovative products tailored to the South Korean market.

However, this sector is not exempt from regulatory challenges. Finnish startup **Enifer** began the lengthy approval process in **2024** to market its **Pekilo** mycoprotein in the EU. The company is also planning regulatory submissions in the UK, the US, and Singapore,

where it expects to gain market entry first.

In fact, Singapore has already granted regulatory approval for **The Better Meat Co.'s** **Rhiza** mycoprotein. Additionally, the startup secured GRAS (Generally Recognized as Safe) status in the US and obtained its fifth patent for Enhanced Aerobic Fermentation Methods for Producing Edible Fungal Mycelium Blended Meats and Meat Analogue Compositions—its proprietary process for producing and utilizing **Rhiza**.



Pekilo mycoprotein from Enifer. Photo: Enifer.

Algae, a scenario with initiative.



Protein and colouring algae extract. Photo CNTA

In **2024**, research, product launches and investments took the center stage, highlighting the growing support for this scenario. A good example is **Brevel**, an Israeli startup that inaugurated new facilities in mid-**2024**. The company uses biomass

fermentation to produce microalgae-based proteins.

Regarding financing, several significant investments stood out. **MiAlgae** secured **\$18.5 million** to fund a new commercial-scale facility in Scotland; **Umaro Foods** raised **\$3.8 mil-**

lion to advance the development of algae-based alternatives, including its algae-derived alternative "bacon"; and the Spanish company **Poseidona** obtained **€1.1 million** to further the development of algae-based protein ingredients.

Insects: big numbers and challenges for a benchmark

The insect scenario saw both positive and negative news during **2024**. On the positive side, the Spanish company **Tebrio** secured **€30 million** in funding to expand production at its **90,000 m²** facility under construction in Puerto Seco (Salamanca). The company plans to invest a total of **€110 million** by **2028** to produce *Tenebrio molitor* (commonly known as the mealworm) at scale, aiming for an annual output of **100,000 tons**.

Another notable funding round involved **FreezeM**, an Israeli company that raised **\$14.2 million**. **FreezeM's** innovative PauseM method delivers ready-to-use young larvae of the black soldier fly (*Hermetia illucens*), whose growth is "paused" for **14 days** but can be reactivated when needed. This technique eliminates the need for the fly-rearing stage, streamlining operations by separating rearing from growth and processing. The

result is greater efficiency, cost savings and improved production processes. Meanwhile, **Protix** secured a loan of up to **€37 million** from the European Investment Bank to support the construction of a new black soldier fly production facility in Poland.

On the downside, in October **2024**, **Ynsect**, a leading French food-tech company, filed for voluntary bankruptcy before the Évry Commercial Court.



Ynsect facilities. Ynsect photo

Air protein lands in the United States



Ice Cream Sandwich by Solar Foods. Photo: Solar Foods Media Kit.

Solar Foods set up the pace in the **air protein** scenario during **2024**. In November, the startup announced that Solein, its air-derived protein, was featured in select dishes at New York's Olmsted restaurant. Diners could sample creations such as Beer-Battered Delicata Solein Squash Rings, Solein Brussels Sprout Spätzle, So-

lein Carrot Crepe, and Old School Solein Chocolate Mousse.

This milestone was possible after **Solar Foods** successfully registered its production facility in Vantaa, Finland, with the **FDA**, and met other agency's regulatory requirements for marketing its protein in the United States.

Additionally, the Finnish startup

announced a partnership with Japan's **Ajinomoto Group** to launch two **air-protein**-based products—Traditional Flowering Mooncakes and Ice Cream Sandwiches—in Singapore. Earlier in **2024**, **Solar Foods** had already debuted the world's first Solein-based chocolate bar in collaboration with **Frazer**.

Hybrid products: a potential solution for cost reduction



Quorn bets on hybrid products. Photo: Quorn.

For the **hybrid products** sector—where **proteins** from different sources are combined—one of the key challenges is standardizing the proportion of each **protein** source to define what qualifies as a **hybrid product**.

As of **2024**, no regulations governed this aspect. Several companies adopted a **50/50** ratio as a straightforward way to introduce **hybrid products** to consumers. However, this proportion is

not always fulfilled. For instance, **Good Meat's** product, available at **Huber's** butcher shop in Singapore, contains only **3% cultured meat** and **97% plant-based proteins** and seasonings—a ratio that has drawn some criticism. Increasing the percentage of **cultured meat** raises production costs, making these products more expensive.

For many companies, **hybrid products** represent a strategy to

lower costs, achieve scalability, and navigate regulatory barriers more easily.

Several companies in the sector announced commitments to **hybrids** in **2024**. **Quorn**, previously focused exclusively on fungal-based products, revealed plans to blend its **mycoprotein** ingredient with meat. Meanwhile, **Fable Foods** introduced a shiitake infusion designed to be mixed with ground beef.

Alternative Ingredients: addressing scarcity and environmental concerns

A major focus of food innovation in **2024** was the development of cocoa alternatives, driven by supply shortages, environmental concerns, ethical considerations and price volatility.

These factors spurred investments in companies such as **Nukoko**, **Voyage Foods**, **Foreverland** and **Planet Foods**, which develop cocoa alternatives using ingredients like oats, beans, sunflower seeds and carob.

Other companies opted to use **cellular agriculture** to produce

sustainable cocoa. **Celleste Bio** integrates agricultural technology, biotechnology and artificial intelligence to extract cocoa plant cells, while **Kokomodo** applies the same technology used in **cultured meat** production to cultivate cocoa.

Honey alternatives also gained attention. **Melibio** secured undisclosed funding to advance its bee-free honey solutions, which include **plant-based** honey and honey made through **precision fermentation**.



Alternative Ingredients: addressing scarcity and environmental concerns



Alternative fats and oils: scaling challenges

The **alternative fats and oils** sector faces key challenges, including scalability, sourcing quality raw materials, and securing funding for infrastructure—particularly when employing technologies like **precision fermentation** or **cellular agriculture**.

Partnerships can facilitate scaling. A notable example is the

collaboration between Australian startup **Nourish**, which produces **alternative fats** through **precision fermentation**, and China's **CABIO Biotech**, a biomanufacturing company. This agreement will allow **CABIO Biotech** to commercially produce **Nourish's alternative fat, Tastilux**.

On the funding front, notable

investments in **2024** included: **Äio** (**€6.1 million**) to build a production facility in Estonia for sustainable oils and fats derived from wood and agricultural waste; **NoPalm Ingredients** (**€5 million**) to scale yeast-derived oils and fats and work toward price parity; and **MicroLub** (**\$4.5 million**) to develop **plant-based microgels** which replace fat and oil.



NoPalm's alternative oil. Photo: NoPalm.

NEW PROCESSING TECHNOLOGIES

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The second map we present is **New processing technologies**, which highlights technologies that are transforming the way food products are made. This macro-scenario gained momentum in 2024 due to the need to address the challenge of **scalability** in the food industry.

This map consists of five opportunity scenarios, with **Precision Fermentation** leading in share of voice at 29%, a figure similar to that of 2023*. It is followed by **Cell-based technologies**, **Fermentation** and **Biomass fermentation**.

You can find the 2023 report on page 102.

Stage of FoodTech innovation

Precision fermentation, a key technology

Precision fermentation was a leading technology in foodtech media during 2024. This prominence resulted from significant innovation, private and public investment, and regulatory approvals for new ingredients that aim to make the food industry more sustainable, accessible, and healthy.

Scalability is a major challenge for this sector. In 2024, companies explored technologies like

nanobubbles and smart **bioreactors** to transition from laboratory processes to efficient and profitable industrial production.

Hydrosome Labs, for example, uses nanobubble technology. This allows microorganisms like yeasts and bacteria to efficiently receive oxygen and nutrients, accelerating fermentation and increasing culture yield while reducing average production times. **Cultzyme**, based in San Sebastián,

introduced smart bioreactors powered by artificial intelligence and equipped with cloud connectivity. Their technology, called **Bioreactor Intelligent Operative Nanotechnology (BION)**, automates and controls fermentation using sensors that monitor parameters like temperature, pH, nutrient concentration, and oxygen levels in real time. **Artificial intelligence** adjusts conditions to optimize fermentation performance.



CNTA bioreactor. Photo by CNTA.

Democratization of technology

In 2024, a growing network of pilot plants and biomanufacturing facilities began operations, enabling more food tech companies to develop and scale their innovations.

In Belgium, the **Bio Base Europe Pilot Plant** added a 75,000-liter fermenter to validate processes

under industrial conditions. This allows smaller companies to test their technologies without building their own facilities. In Australia, the **Cauldron Ferm** plant in Queensland is one of the largest in the Asia-Pacific region, with a production capacity exceeding 1,000 tons per

year.

In the private sector, **Solaris Bio-tech** developed modular fermentation systems that provide access to advanced technological equipment at lower costs. **Danone** established an open biotechnology platform in Clermont-Ferrand, France.

SUPPORT FROM PUBLIC ADMINISTRATIONS

Public commitment played a significant role in advancing **precision fermentation** technologies. In January 2024, the **European Union** invested €50 million to support startups using **precision fermentation** to develop alternative proteins as part of a strategic plan to revo-

lutionize the food industry. In the United States, the **Illinois Institute for the Advancement of Biomanufacturing (iFAB)** received a \$51 million grant from the federal government to become a global leader in biomanufacturing and **precision fermentation**.

The **Singaporean government** invested \$14.8 million to establish the **Center for Precision Fermentation and Sustainability (PreFerS)**, which will use **precision fermentation** to transform compounds like sugars into alternative proteins, healthy fats, and vitamins.

Cell-based technologies: process advances and new applications



Good Meat pilot plant. Good Meat media kit photo

The **cell-based technology** scenario was boosted by increased technological accessibility, process advancements and application diversification.

Democratizing access to **cell technology** is crucial for widespread innovation. For example, the Japanese company **Intergri-culture** launched a starter kit in 2024, including a fermenter, providing startups and researchers

with the tools they need to explore **cell cultivation** of meat.

The Czech startup **Bene Meat Technologies (BMT)** is facilitating access to high-quality **primary cells**. Its bank of over **5,000 cells**, obtained with minimal impact on animals, ensures the stability and purity required for developing innovative products for both pets and human consumption.

2024 also saw initiatives fo-

cused on more efficient and profitable **production**. **Cocoon Bioscience**, located in the **Bizkaia Technology Park** in **Derio (Vizcaya)**, opened the first industrial plant using **insects as living bioreactors** for **recombinant protein** development. While initially applied to the **pharmaceutical sector**, this technology has the potential, according to its developers, to revolutionize **growth factor** production

for **cultured meat**, offering a more accessible and sustainable solution.

Also in Spain, the **Zaragoza-based startup Levprot Bioscience** is exploring new **food industry** opportunities beyond **brazein**. It is developing **recombinant bovine serum albumin**, a **non-animal-derived albumin** with

significant potential as a **culture media** ingredient for the **cultured meat industry**.

Internationally, **Forsea Foods**, an Israeli startup specializing in **cultured seafood**, announced achieving a record **cell density** of over **300 million cells/ml**. Using its **organoid technology**, **Forsea** recreates natural growth envi-

ronments, enabling cells to form **three-dimensional tissues** without scaffolding. **Meatable** has developed a platform using **pluripotent stem cells** and **opti-ox™ technology**, replicating **natural cell growth** with precise control. The company claims this platform has reduced **cultured pork sausage** production time to just **four days**.



Jallatech media kit photo.

DIVERSIFYING APPLICATIONS: BEYOND MEAT

The potential of **cellular technology** extends beyond meat. **Jellatech** is exploring new frontiers with **bioidentical collagen** production derived from **bovine, porcine, and human cells**. **ReaGenics** is developing **potatoes** with **31% protein content** using plant

cell culture.

The **cocoa industry** is also exploring this technology. Examples include **California Cultured**, which is scaling up **cellular chocolate** production, and **Food Brewer**, a Swiss startup producing **cultivated cocoa and coffee**.

Optimizing culture media: key to scalability

The viability of **cell-based technologies** heavily depends on **optimizing growth media**. Advances in this area include **Ohly's** development of **yeast-based bionutrients** for improved **fermentation performance**; **Angel Yeast's** introduction

of **protein hydrolysates** for partial replacement of **fetal bovine serum**; and **Multus's** launch of **Proliferum B**, a new **animal-component-free** alternative to **fetal bovine serum** designed to accelerate **cell-based meat** production.



Fermentator. Photo CNTA

Biomass fermentation: a rapidly evolving technology

Biomass fermentation is a promising **food tech** technology due to its ability to efficiently produce **sustainable proteins** with a reduced **environmental impact**. **2024** saw advancements in **industrial scalability** and **innovation** through **by-product utilization** and new **patented technologies**.

Scalability remains a significant barrier to wider **biomass fermentation** adoption. Several initiatives are addressing this challenge and **optimizing processes**. For example, the German **biotechnology** company **MicroHarvest** claims to have developed a **patented technology** for **protein production in 24 hours** via **biomass fermentation**. The Israeli company **Brevel** combines **fermentation** and **photobiology** in its **patented process**, using **industrial fermenters** that inte-



CNTA bioreactor in operation to produce biomass. Photo: CNTA

grate **heterotrophic microalgae cultivation** (fed with sugars) to accelerate **fermentation**.

By-product utilization is another explored solution for improving **fermentation processes**. The Canadian company **Maia Farms** developed an advanced **myco-protein fermentation** process us-

ing **bioreactors** that utilize **waste as a sugar source**, and the Scottish company **MiAlgae**, which invested **\$18.5 million** in **2024** to expand its **production capacity**, uses **microalgae fermentation** to produce **high-quality omega-3** from **industrial by-products**, contributing to a **circular economy**.

Renewal of fermentation technology

The **fermentation scenario** (including non-precision and non-biomass fermentation) is seeing **technological innovation**. **Nutrumami** announced a **cross-fermentation process** for its plant-based products, combin-

ing **solid-state** and **submerged fermentation**. Besides, startup **Hypesound** developed **So'Sweep**, a technology using **low-frequency sound waves** to increase microorganism reproduction by up to **300%**.

Infrastructure expansion is also crucial for industrial-scale fermentation. During the analyzed period, **Royal Cosun** invested in expanding **fermentation processes** for **large-scale sustainable ingredient production**.



Royal Cosun facilities. Photo <https://www.cosun.com/news/royal-cosun-invests-in-peakbridge-growth-fund-ii/#gallery>

Molecular farming: new approvals and financing

Molecular farming garnered significant attention in **2024**, with technological advances and regulatory approvals solidifying its viability for producing proteins and other valuable compounds from plants.

In April 2024, **Moolec Science** became the first **molecular farming** company to receive **USDA approval** for its genetically modified soybean seeds producing “**Piggy soy**” pork protein. Months later, it received a second USDA approval for

genetically modified peas producing bovine myoglobin, a key protein in animal-based meat. These approvals will accelerate the startup’s commercialization strategy, announced for 2025.

Beyond regulatory progress, 2024 saw **investments and partnerships** in molecular farming. Elo Lyfe System raised \$20.5 million to develop a natural sweetener derived from monk fruit using this technology.

Polopo was also prominent in this sector, establishing a col-

laboration with CSM Ingredients to develop and commercialize molecular farming technology. It also developed **Super AA**, a platform using patented metabolic engineering techniques to produce proteins like ovalbumin.

Despite **advances**, some companies faced **financial challenges**. **Tiamat Sciences Corp.**, specializing in molecular farming protein production, ceased operations due to financial constraints.



Moolec Science plantation. Photo of the Moolec media kit

SUSTAINABILITY

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The third map we present to you is the **Sustainability** map. In this map, we find five opportunity scenarios, with **Sustainable Packaging** and **Upcycling-Food Waste** having the highest share of voice at 32%, both growing compared to 2023. In this regard, they are followed in third place by **Carbon Neutral**, with 27%.
 You can check the 2023 Report map on page 104.

Stage of FoodTech innovation

Sustainable packaging: a commitment to sustainability and an opportunity for differentiation

In **2024**, the sustainable packaging scenario was one of the main focuses of interest within the sustainability macro scenario, reaching a voice share of over **28%**. This growing prominence reflects a shift in the food sector toward more responsible packaging design and production, driven by both regulatory pressures and evolving consumer expectations.

In fact, the global sustainable packaging market continues to expand. According to a report by **Mordor Intelligence**, the sector is projected to reach **\$315.16 billion** in **2024**, with an annual growth rate of **7.67%**, ultimately reaching **\$456.04 billion** by **2029**. This growth is fueled by the integration of sustainability into corporate strategies, positioning it as both a social responsibility and an opportunity

for innovation and competitive differentiation.

Within this area of interest, material innovations stand out as a leading trend. Companies such as **Lactips** are developing plastic alternatives using bioactive compounds like casein, which is water-soluble, biodegradable, and offers excellent barrier properties. Additionally, the valorization of by-products is gaining traction. For example, **W-Cycle** transforms agricultural waste into bioplastics, while **Notpla** utilizes seaweed to create compostable packaging.

The circular economy applied to packaging is also gaining momentum, emphasizing material reuse and recycling. An interesting example is **PureCycle's PureFive** recycled resin, **FDA-approved** for food contact, which

maintains the same barrier properties as virgin polypropylene while being more sustainable. Companies such as **Puleva** have incorporated recycled materials, using **30%** recycled PET in their bottles to reduce virgin plastic consumption. Meanwhile, **Tetra Pak** is developing packaging solutions that integrate renewable polymers and **FSC-certified** cardboard.

Despite these advancements, the widespread adoption of sustainable materials faces several challenges, including high production costs, limited material availability, and the need for greater consumer education on recycling and composting. For instance, **Coca-Cola** recently adjusted its recycled material targets from **50%** to **35%-40%** by **2035** due to these hurdles.



Upcycling: unlocking new product lines

The valorization of by-products emerged in **2024** as a key strategy for reducing food waste and improving waste management efficiency. This approach not only enhances sustainability but also creates new business opportunities within the agri-food industry.

A particularly promising area is the transformation of agro-industrial waste into innovative ingredients. For instance, the startup **ÄIO** employs yeasts to convert wood by-products into sustainable food oils and fats—a process that is both faster and more environmentally friendly than traditional methods. In the fishing sector, companies such as **Hailia** and **Hätälä** leverage advanced technologies to repurpose salmon bones and heads—by-products typically discarded in industrial processes—into products with textures similar to fish fillets, thereby maximizing resource

utilization and significantly reducing waste.

The dairy industry has also made interesting advances in by-product valorization. **Arla Foods**, for example, has developed beverages such as drinkable yogurts and soft drinks containing up to **73%** recycled whey—one of the most challenging waste products in dairy processing. Meanwhile, research initiatives in **Germany** are exploring whey fermentation to produce fungal proteins, broadening the spectrum of sustainable protein sources.

Additionally, companies like **Yeastup**, which recently secured **€9.47 million** in funding, are converting surplus yeasts from the brewing industry into food ingredients.

In response to raw material shortages, several sustainable alternatives to cocoa and coffee have also emerged. **Planet A Foods** and **Voyage Foods**,

for instance, are developing alternatives to cacao using sunflower and grape seeds, respectively. Similarly, **Nestlé** has repurposed coffee bean husks—usually discarded—to create a low-caffeine beverage tailored for the **Chinese** market.

At the retail level, digital platforms are proving effective in combating food waste. Initiatives such as **Too Good To Go's "Pantry Boxes"** and **Foodsy's** mobile applications enable manufacturers and restaurants to sell surplus food at discounted prices. Meanwhile, **Aldi** has demonstrated how large retailers can integrate upcycling into their sustainability strategies by introducing beers made from surplus food.

Despite these advancements, the sector faces challenges, particularly a lack of investment, as illustrated by the recent shutdown of **Agrosingularity** in **Spain**.



Carbon neutrality: a global commitment



The global commitment to carbon neutrality remains a driving force of transformation in the food industry, fueled by technological innovations, stricter regulations, and the growing demand for sustainability.

The new **European Union** directive against “**greenwashing**”, published in the **Official Journal of the EU** last **March**, strengthens transparency by requiring that any environmental claims on products be backed by verifiable evidence. This regulation aims to prevent misleading practices, such as generic statements of being “**climate neutral**” without concrete foundations. These measures will encourage companies to adopt approved certifications and provide accurate information on their

environmental impact.

Technology has become a key tool in the transition to a sustainable food sector. A notable example is the **Finnish** startup **COLLO**, which, through advanced sensors and data analysis, enables dairy plants to reduce up to **11 million kilograms** of CO₂ emissions annually. Another significant innovation is the use of **local micro-factories** developed by **Reocalize**, which eliminate intermediary transport, reducing associated emissions and improving energy efficiency.

In the agricultural sector, solutions such as **Bovaer®**, a feed additive for dairy cattle, have proven effective, cutting methane emissions by **30%** without compromising animal health.

Waste management optimiza-

tion also remains a key priority. **Goterra** has developed a technology combining **insect larvae and robotics** to convert organic waste into protein and fertilizer, significantly reducing methane emissions typically produced by landfills.

Sustainable logistics has also driven major progress in emission reduction. For instance, **Campofrío** cut more than **20%** of its **greenhouse gas (GHG) emissions** in logistics operations by optimizing routes, adopting electric fleets, and installing solar panels. Meanwhile, **Grupo Bimbo** is advancing in fleet electrification and efficient transportation management, reinforcing the logistics sector’s role in the fight against climate change.

Vertical Indoor Farming: advances and challenges



The **Vertical Indoor Farming** scenario has seen significant evolution this year, driven by technological advancements, substantial investments, and structural challenges. These trends highlight both the potential and the difficulties of transforming global agriculture.

One breakthrough is the use of genetic technology to optimize

crop yields. Companies like **Phytoform Labs** have developed genetically edited tomato varieties that can increase production by **400%** in vertical environments.

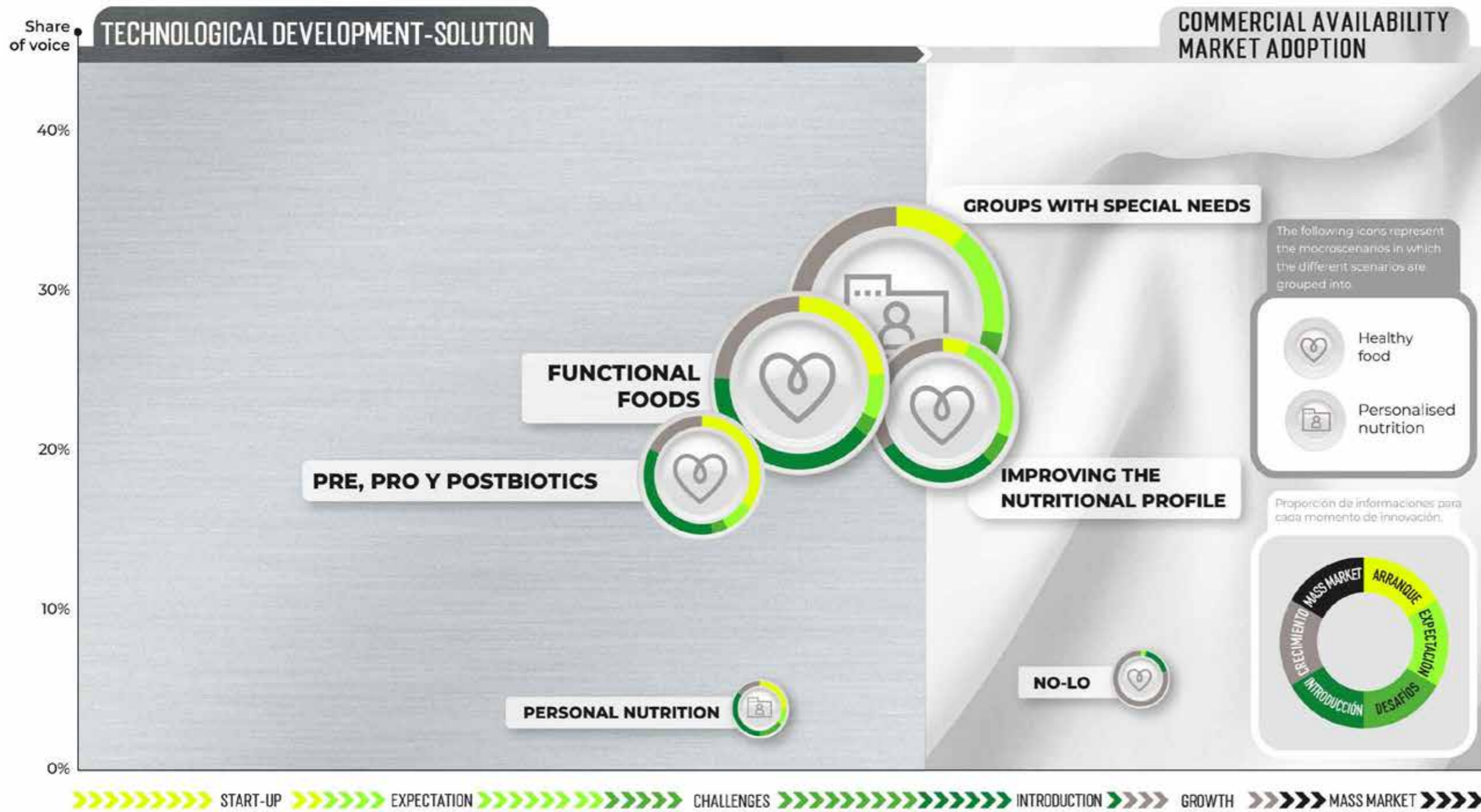
Artificial intelligence has also emerged as a key solution to address energy consumption, a critical factor in indoor operations. **AI-based** systems optimize resources like lighting and tem-

perature, reducing energy use by up to **25%**, making long-term projects more viable in an increasingly sustainability-focused market.

However, the industry also faces significant challenges. Cases like the bankruptcy of **Smallhold** in the **U.S.** illustrate the financial difficulties some companies encounter, particularly those requiring high initial investments.

HEALTHY FOOD AND ADAPTED NUTRITION

JAN/DEC 2024 - 619 INFORMATION ANALYSED



The fourth map we analyzed is the one on **Healthy Food and Adapted Nutrition**. This map consists of two interconnected macro-scenarios, as both are focused on health.

In this map, six opportunity scenarios are outlined, with **Groups with special needs** standing out in terms of share of voice at 29%, moving from the third position in 2023* to the first in 2024. It is followed by **Functional foods**, **Improving the nutritional profile** and **Pre-, Pro- and Postbiotics**.

*You can refer to the 2023 report map on page 106.

Stage of FoodTech innovation

Groups with special needs: towards a healthy aging

The food industry is increasingly adapting products to meet the nutritional needs of specific groups. This focus is reflected in the **Groups with Special Needs** scenario, which ranked as the third most discussed topic in this annual industry report.

One key area is healthy aging, driven by global longevity and a senior population with greater purchasing power and well-being awareness. In response, companies like **Nestlé** are investing in bioactive compounds such as **nicotinamide** and **oleuropein**, which may help combat cellular aging and support muscle health. The company also allocated **7 million euros** to its **Asurias** plant for producing supplements like **Meritene Drink**. Meanwhile, **Danone**, through its **Nutricia** division, is focusing on medical nutrition, investing **70 million euros** in its **France** plant

to develop products like **Souvenaid**, designed for brain health.

Another emerging focus is women's health, with the launch of supplements tailored for menopause, pregnancy, and hormonal balance. Companies like **Biohm** and **ADM** are collaborating on gut and hormonal health solutions, while brands such as **Ritual** have introduced functional beverages for fertility support.

The glucose control market has seen a surge, coinciding with the rise of **GLP-1 agonists**, used for type 2 diabetes and weight management. For instance, **Supergut** developed prebiotic shakes designed to replicate the effects of these medications, while **Daily Harvest** launched **GLP1-Friendly** meals tailored for users of these treatments.

In infant nutrition, companies are innovating to make infant

formula more similar to breast milk. The Portuguese company **CarboCode**, which secured **15 million euros** in **2024**, is working on extracting **gangliosides**, essential for cognition and gut health, naturally found in breast milk.

Meanwhile, the pet food industry is expanding into alternative proteins, using **cell-based proteins**, **precision fermentation**, and **air proteins**. **Meatly** became the first startup approved in **Europe (UK)** for **cell-based pet meat**. In personalized pet nutrition, **Maikai** introduced functional ice creams enriched with **collagen** and **inulin**, while **Bond Pet Food** and **Wilbur-Ellis Nutrition** collaborated on no-animal ingredients. **Calysta**, on the other hand, advanced the use of **air-based proteins** for pet food, showcasing technological progress and regulatory flexibility.



The hyper-personalization of diet



Calbee granola. Photo: <https://bodygranola.jp/>

Personalized nutrition aims to create tailored strategies based on genetics, microbiome, and lifestyle factors. While this approach has slightly declined in prominence, several key initiatives have emerged in **2024**.

For example, **Calbee** is re-shaping the market with **hyper-personalized granola**, formulated using **microbiome**

analysis to adjust ingredients to each consumer's unique profile. Meanwhile, **Zoe** secured **\$15 million** to expand its **U.S.** platform, offering individualized nutritional recommendations based on **blood and stool analysis**.

Artificial intelligence (AI) is also playing a crucial role in personalized nutrition. **RxDiet**,

which raised **\$3 million**, utilizes **AI** to optimize dietary recommendations. Similarly, **AHARA** employs **machine learning** to analyze detailed questionnaires covering dietary habits, medical history, and health goals. By applying advanced algorithms, **AHARA** identifies patterns and correlations, enabling scientifically grounded nutrition plans.

Functional nutrition: functional hydration, the preferred format

The **functional foods** category remains the most significant opportunity within **healthy eating**, capturing **33.73% share of voice** and increasing its relevance by **15.18%** compared to last year. This growth reflects consumers' rising interest in products that not only nourish but also provide **well-being benefits**, driving **innovation**.

Functional drinks stand out as the preferred format, offering **convenience** and **natural ingredients** with specific properties.

A **Euromonitor International** report projects the **functional drinks market** will reach **\$249.5 billion by 2026**. Products like **Laird Superfood's Maca Latte**, combining **adaptogens** and **functional mushrooms** for sustained energy, exemplify this trend. Innovations such as **KEY's ketone-based drinks** and **Zynamite S mango extract** highlight the industry's focus on **physical and mental performance**.

Blood sugar control is also gaining attention. Brands like

Boost incorporate ingredients such as **cinnamon, chromium, and mulberry extracts** to help maintain glucose levels. Solutions like **Good Idea's soft drinks** and **A1C Drinks** target **blood sugar management**.

For **mental and physical well-being**, new products are emerging. **Nbuzz's detox drinks** support **hangover relief**, while **G Spot Wellness Drinks** integrate **adaptogens** and **nootropics** to improve **hydration and cognitive health**.



Improving the Nutritional Profile: More Protein, Less Sugar



The **nutritional profile improvement** is a significant scenario in **healthy eating**, demonstrating a **47%** growth in voice share compared to **2023**. Within this trend, the **food value chain** has prioritized **innovation** and **product reformulation**, aiming to create healthier options by reducing undesirable ingredients and incorporating beneficial alternatives.

Fueled by factors like the increasing use of **weight-loss drugs**, companies are aligning

themselves with the demands of increasingly informed consumers who understand the impact of their dietary choices on their overall well-being.

This position presents the **food industry** with opportunities for continued **innovation** and adaptation to market demands. This year's focus has been on **sugar reduction**, a trend influenced by both the rise of **GLP-1 drugs** and the search for healthier **sugar substitutes**, such as **sweet pro-**

teins, sweet-tasting fibers, and natural low-glycemic sugars. Notable examples include **Oobli**, which produces **sweet proteins** like **brazzein** via **precision fermentation** and has received **GRAS certification** from the **FDA** for its **monellin protein**. **Oobli** is also collaborating with **Grupo Bimbo** to incorporate these proteins into **baked goods**. Another relevant example is **Novel Foods Group**, an **Abu Dhabi-based** company producing **sweet pro-**



COVAP dairy products: <https://tienda.covap.es/>

teins. They announced a major agreement to build the first phase of a **\$500 million biotech production center** in the **United Arab Emirates**, focused on **precision fermentation** and the development of **brazzein**. Additionally, **Better Juice** has obtained **GRAS certification** for its **enzymatic technology** that converts **fruit sugars** into **dietary fibers**. **Bonumose** is also working on scaling the production of **tagatose**, a **rare sugar**

with a **low glycemic index**.

Besides, the **high-protein trend** has expanded beyond sports nutrition, establishing itself in various categories, including dairy, meat, and snacks. Driven by diets like ketogenic and low-carb, this trend not only supports muscle repair and growth but also contributes to weight management by promoting satiety. Examples from 2024 include **Covap's** new lactose-free skimmed milk with

20 grams of protein per glass. **Emcesa** introduced a line of protein-enriched meats, while **Lidl** launched protein ice creams, and **Campofrío** expanded its high-protein snack offerings. Nestlé launched its Pro+ range, encompassing fortified drinks, puddings, and bars. Finally, the startup **Ironic Biotech**, having secured \$1 million in investment, is developing iron-rich vegetable proteins through precision fermentation.

Pre, pro, and postbiotics: interest in microbiome and glucose regulation

Interest in gut health and the microbiome continues to grow, although the **prebiotics, probiotics, and postbiotics** category faces some challenges. While holding a **29.46%** share of voice and ranking third within the healthy food macro scenario, this segment is still in the expectation phase, one step behind more consolidated categories. However, innovations and new applications are driving its relevance and consolidation in the market. The intestinal microbiome has become one of the main focuses of products that in-

tegrate **prebiotics, probiotics, and postbiotics**. The sector is innovating with products such as **Komvida Fibra**, a kombucha enriched with **prebiotic fiber** from chicory root, which affirms that it provides **8 grams of fiber per bottle**, covering more than **30%** of the recommended daily consumption and promoting better digestive health. Another interesting example is **Supergut**, which has combined **pre-, pro-, and postbiotics** in products designed to regulate blood sugar and support metabolic health. This approach

aligns with the growing demand for products that complement drugs such as **Ozempic**, used for weight control and diabetes. In addition, **One Bio** innovates with odorless, invisible, and tasteless vegetable fibers obtained from by-products. These **prebiotic fibers**, applicable in foods such as vegetable milks and cereals, are integrated into the trend of taking advantage of functional foods compatible with the use of **GLP-1 agonists**. Beyond **prebiotics** and **probiotics**, companies are exploring the potential of synbiotics and

postbiotics. **Vivifem™**, a collaboration between **ADM** and **Biohm Health**, is designed for women aged **40 to 65**, integrating **pre-, pro-, and postbiotics** to modulate the microbiome and support healthy aging. This formulation leverages advanced computational biology to identify imbalances in the female microbiome and provide targeted solutions. Another interesting innovation is **Matinal Livre**, a dairy product from **Lactogal** that incorporates **postbiotics**. Thanks to **Tetra Pak's** UHT technology, it remains shelf-stable at room

temperature, offering a convenient and functional option. While **postbiotics** remain less well-known than **prebiotics** and **probiotics**, their potential is gaining industry attention. At the recent **Nutrevent** event in France, discussions highlighted the emerging role of inactivated microorganisms and their derivatives as promising alternatives in microbiome-related innovations. For example, they provide advantages at an industrial level with respect to **probiotics** or **prebiotics**, as it's not necessary to keep the microorganisms alive,

which allows more options when processing them and using them in food processing. The integration of **prebiotics** and **probiotics** extends beyond human nutrition into pet health. **YowUp!** has developed yogurts specifically formulated to enhance dogs' digestive well-being. **Royal Canin** has launched the **Gastrointestinal Tract** line, targeting digestive and liver conditions in dogs and cats, while **Affinity Petcare** has introduced its **Active Defense** formula, tailored to support pets' intestinal microbiota.



No-Lo: beyond beer

The **No-Lo** scenario is experiencing a slight increase in share of voice and is already in the market phase, driven by consumer demand for appealing alcohol-free alternatives. This trend is also substantiated by market data: **Innova Market Insights** reports a **20%** increase in low-alcohol beverage launches over the past five years, with projections estimating a market value of **\$10 billion** by **2025**. Within the **No-Lo** category, the non-alcoholic beer segment, typically the sales leader, is projected to double from its **2023 valuation** of **\$20 billion** to **\$40 billion** by **2033**. This market has attracted significant investment, exemplified by **Best Day Brewing**, which, since entering the market in **2022**, has rapidly expanded and secured over **\$22 million** in funding

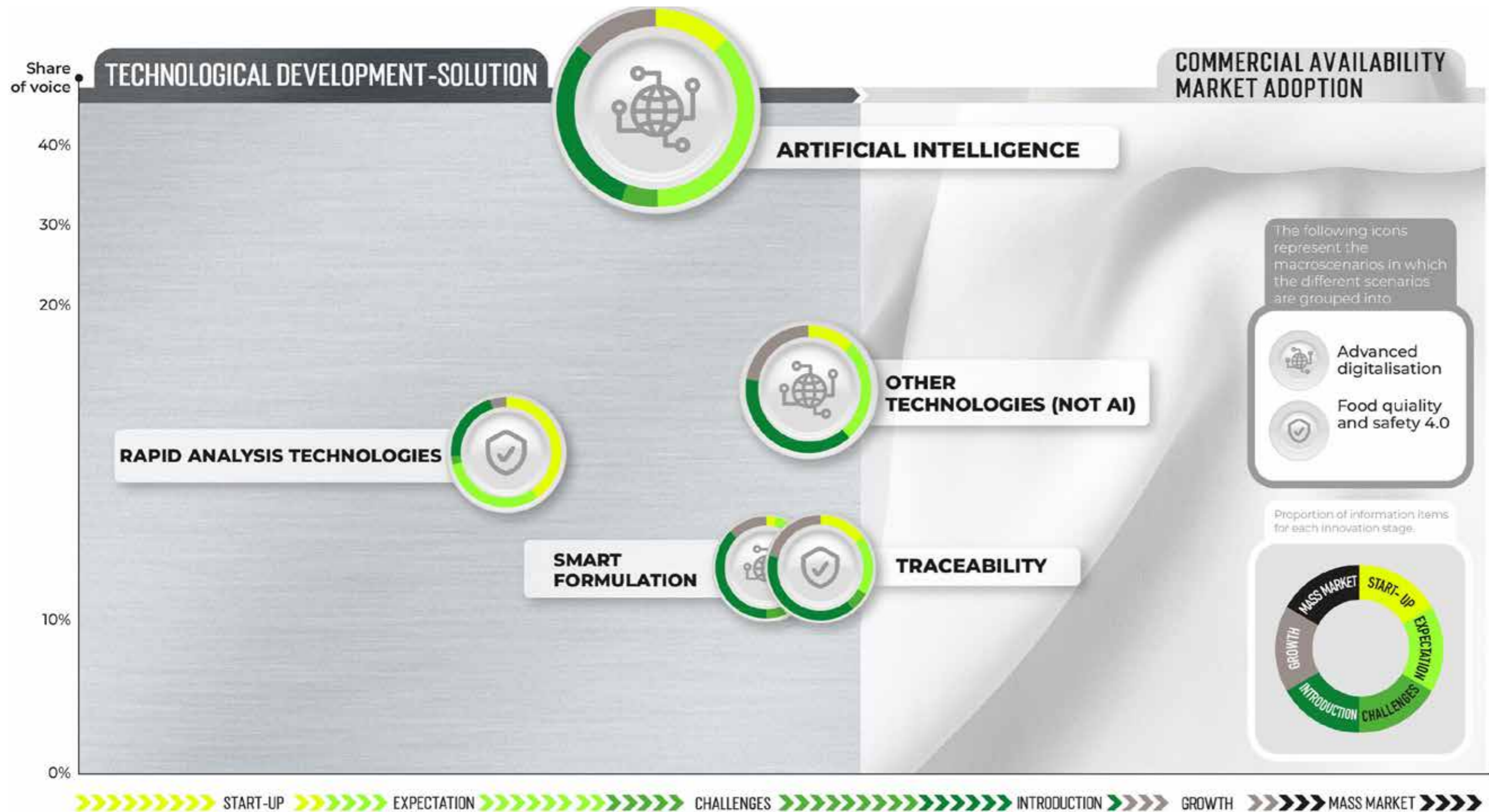
throughout **2024** to diversify its product portfolio and broaden its U.S. distribution network. Technological advancements are playing a crucial role in enhancing the sensory properties of non-alcoholic beverages. **IFF's** patented enzymatic technology, **DIAZYME® NOLO**, converts maltose into isomaltooligosaccharides (**IMO**), resulting in a lower real degree of fermentation (**RDF**). This process allows brewers to create **No-Lo beers** with a fuller body and flavor profiles comparable to their higher-alcohol counterparts. The conscious consumption trend is also influencing innovation within traditional wine regions. In **Spain**, **Codorníu** has introduced **Rimat Zero**, a line of dealcoholized wines that utilizes a sophisticated distillation

process to preserve original aromas. **French** startup **Moderato** has secured over **€3 million** in funding to expand its operations and establish a dealcoholization center of excellence, projecting revenues of **€10 million** by **2026**. Luxury goods conglomerate **LVMH** has invested in **French Bloom**, a non-alcoholic sparkling wine brand currently available in over **30 countries**, targeting consumers seeking a sophisticated wine experience without alcohol. Beyond wine, the non-alcoholic spirits market is also experiencing substantial growth. Globally, **Pernod Ricard** has invested in **Almave**, a non-alcoholic tequila co-founded by **Lewis Hamilton**. **Almave** employs traditional, non-fermentation techniques to replicate the authentic flavor of blue agave.



ADVANCED DIGITALIZATION AND FOOD QUALITY AND SAFETY 4.0

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The last map presented in this section of the report focuses on **Advanced digitalization** and **Food quality and safety 4.0**, two key opportunity macro scenarios in which technologies are being developed to improve efficiency in product design, production, and the detection of quality, composition, or safety in food, among other factors. This map highlights five opportunity scenarios, with **Artificial Intelligence** standing out, holding a dominant **46% share of voice**, a figure very similar to that in the **2023 report**. In 2024, several **AI-driven platforms** were developed to help companies become more efficient and accelerate their progress to market. However, challenges also emerged with this technology, such as issues related to intellectual property management, data privacy, ethical dilemmas, and controlling its potential, among others. You can consult the 2023 report map on page 108.

Stage of FoodTech innovation

Artificial Intelligence: potential and risks

The main focus within the **Advanced Digitalization** landscape has been **Artificial Intelligence (AI)**. This technology continues to generate high expectations due to its transformative potential in the food industry, particularly in enhancing efficiency and innovation.

In 2024, several AI-powered platforms were developed to assist companies in bringing new products to market more swiftly and successfully. Some notable examples include:

- **Basecamp Research**, which secured \$60 million in funding to develop AI models for designing complex biological systems.

The company collaborates with biopharmaceutical firms and academic research institutions to engineer new protein sequences and biological systems.

- **Shiru**, a startup that raised \$16 million to further develop its **ProteinDiscovery.ai** platform, which houses an extensive database of plant- and microbial-based proteins. This platform helps food, personal care, agriculture, and advanced materials companies identify and test ingredients quickly, reducing research and development costs and accelerating time to market.

- **Unilever**, a multinational cor-

poration leveraging AI to assess product shelf life, flavor, texture, and shifts in consumer preferences, among other aspects.

Despite rapid technological advancements, AI implementation presents risks, such as **cybercrime, legal and technical challenges, and a lack of regulatory frameworks** regarding data, privacy, and security. To address this, the **European Union introduced the world's first AI Law on July 12, 2024**. Most provisions will take effect in **August 2026**, with some applicable as early as **February and August 2025** and **August 2027**.



KEY ASPECTS OF THE EU ARTIFICIAL INTELLIGENCE LAW

The **EU AI Law** is a European regulation designed to govern AI applications, ensuring their positive societal impact while limiting potential negative uses. Key highlights include:

- AI applications are classified into **four risk categories**: unacceptable, high, limited, and minimal.
- Systems deemed **unac-**

ceptable, such as real-time biometric surveillance in public spaces and social scoring systems, are strictly prohibited.

- AI systems classified as **high-risk**, such as those profiling individuals, must meet stringent requirements for transparency, security, and human oversight.

- AI providers must conduct **compliance assessments, maintain records, and provide accurate information** regarding the use and operation of their systems.

- Consumers have the **right to file complaints and receive explanations** regarding AI-driven decisions.

Smart formulation: AI-driven ingredient and flavor development

One of the food industry's greatest challenges is developing flavors and ingredients that align with consumer preferences while driving innovation. The **Smart Formulation** opportunity area focuses on AI-driven solutions that accelerate the discovery and selection of optimal ingredients for product development.

In 2024, several advancements emerged in this field, including:

- **Cradle**, which raised \$73 million to scale its AI-driven protein engineering platform, designed to discover and develop alternative food ingredients, pesticides, and other biological solutions.

- **Nuritas**, an Irish startup that secured \$42 million to expand its AI-powered peptide discovery platform, focusing on plant-based bioactive compounds.

- **Generative Aroma Transfor-**

mer (GAT), developed by **NotCo**, a Chilean startup. This generative AI model can create new flavor and fragrance formulations, translating textual inputs into ingredient combinations.

- **Arzeda**, which developed an AI platform for designing alternative proteins and enzymes. Its first product was a **stevia-based natural sweetener** for an undisclosed consumer brand.



Cradle Lab. Photo of half a kit by Cradle.

Other digital technologies: towards the smart factory



Beyond AI, **other digital technologies** continue to drive factory automation, machine learning, and process optimization. Companies such as **General Mills**, **Tyson Foods**, and **Rohlik** are investing

millions in digital capabilities to obtain **real-time data**, optimize performance, reduce costs and waste, and enhance safety.

In Spain, **Alcampo** implemented a **highly automated warehouse** in

San Fernando de Henares (Madrid), streamlining reception, sorting, order preparation, loading, and delivery processes while monitoring goods from arrival to dispatch.

Rapid analysis technologies: trust in hyperspectral and nir imaging

The **Rapid Analysis Technologies** sector continues to expand, with growing applications for **hyperspectral imaging and Near-Infrared (NIR) technology**. These advancements enable:

• **Microplastic detection**

• **Nutritional assessment of ready-to-eat meals**

• **Fish species verification**

• **Quantification of additives and ingredients**

• **Shelf-life prediction for fresh products**

At the **9th International Conference on Hyperspectral Imaging (IASIM-2024)**, experts highlighted the potential of **hyperspectral imaging** in detecting microplastics by characterizing their size, shape, and polymer type simultaneously. The **Spanish National Food Technology Center (CNTA)** presented an innovation using hyperspectral imaging to **instantly estimate the nutritional value of ready meals** without sample

processing—simply by capturing an image.

In **NIR technology**, researchers from the **University of Córdoba** developed a tool for **real-time, non-destructive shelf-life prediction of strawberries**.

Traceability: blockchain as the leading solution

Traceability is becoming increasingly vital in the food industry, ensuring transparency and food safety by tracking products from origin to consumer. **Blockchain technology** remains the dominant solution, with notable implementations including:

• **Carbonell**, which integrated blockchain to provide consumers with oil origin details through its bottle labels.

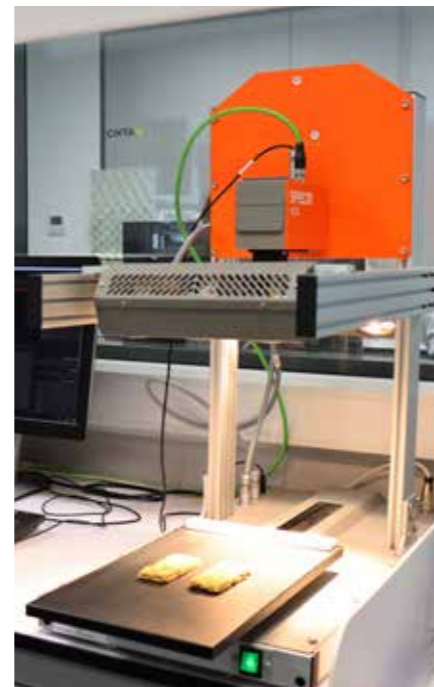
• **La Vega Innova**, which developed **TrustOS**, a platform helping users understand and benefit from blockchain technology.

• **Trusty**, a startup specializing in **blockchain-based traceability**

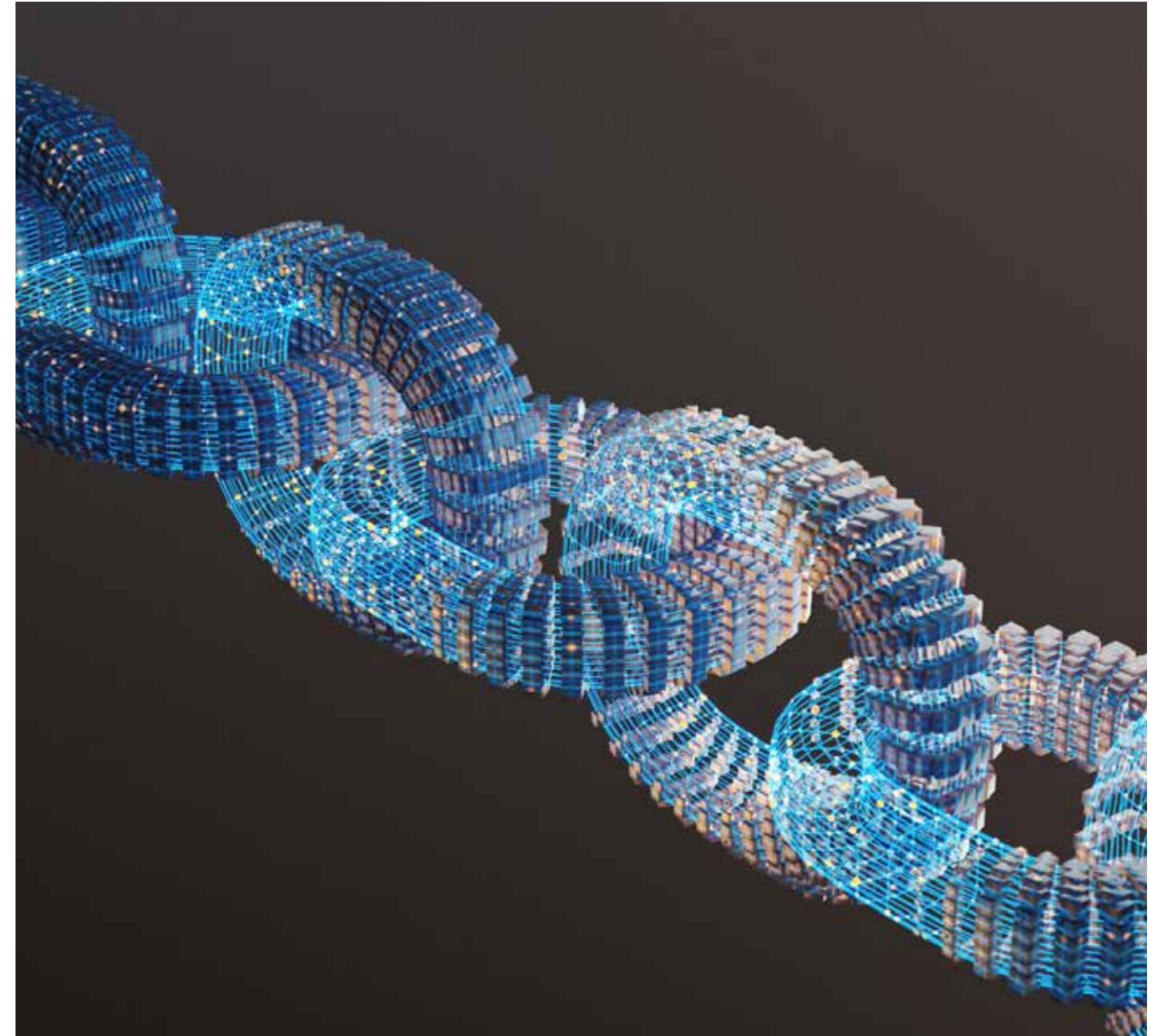
solutions for the cocoa industry.

• **SmartZ4Milk**, a platform enabling **end-to-end tracking of milk** from collection to final consumer.

• **Bunge**, which implemented a **soybean traceability system**.



Use of hyperspectral technology. Photo: CNTA



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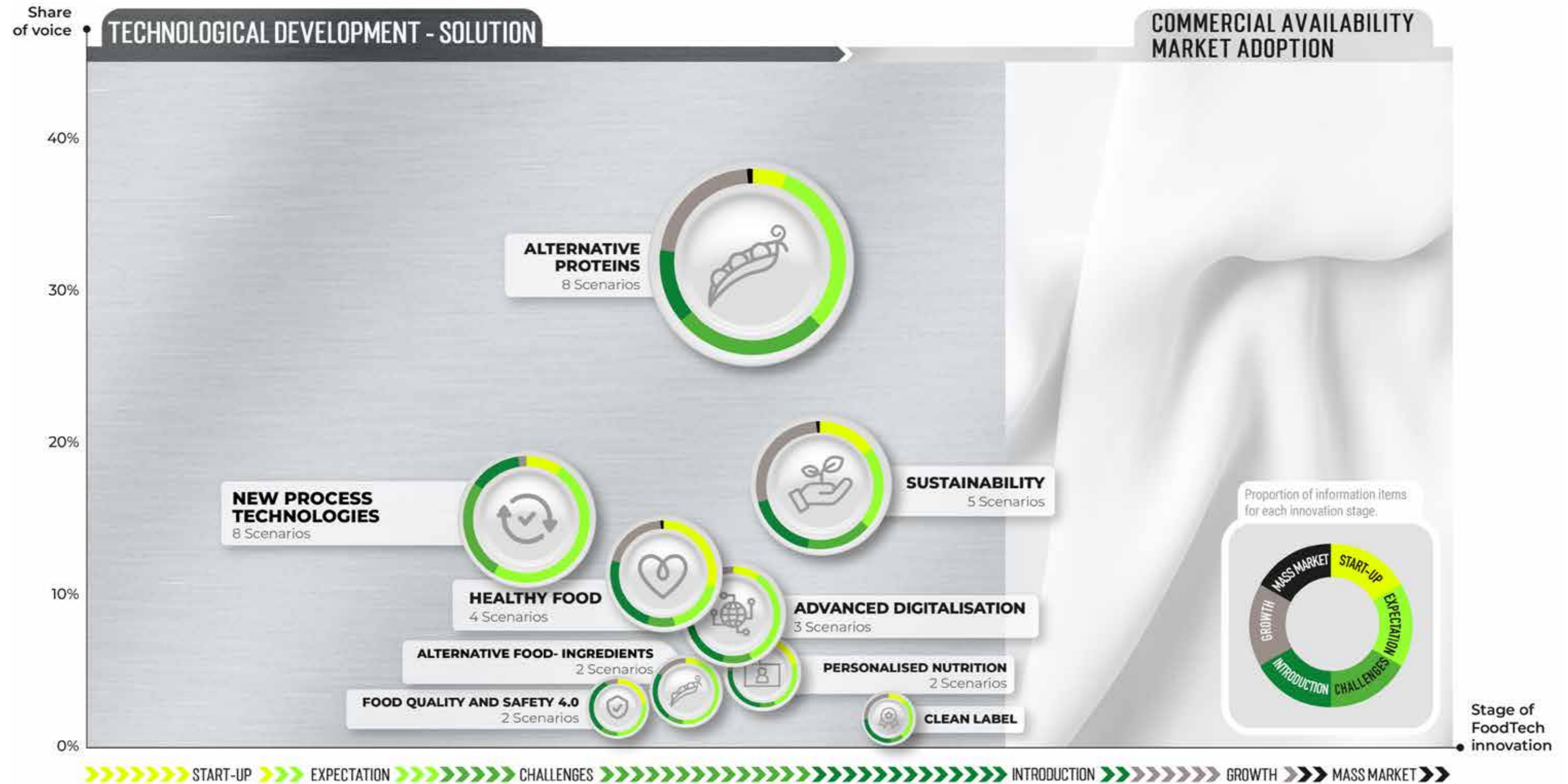
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Anexes
Macroscenarios
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2023

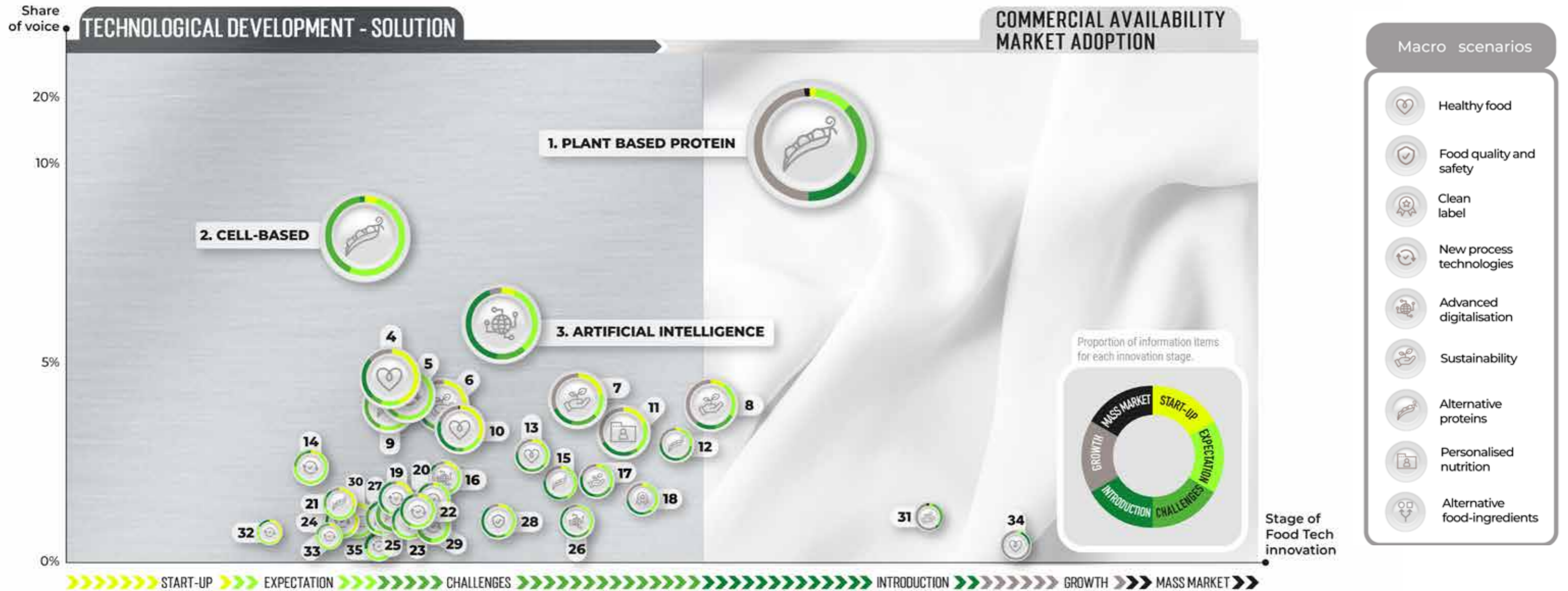
FOODTECH OPPORTUNITY MACRO SCENARIO MAP

JAN/DEC 2023 - 2400 INFORMATION ANALYSED



MAP OF ALL FOODTECH OPPORTUNITY SCENARIOS

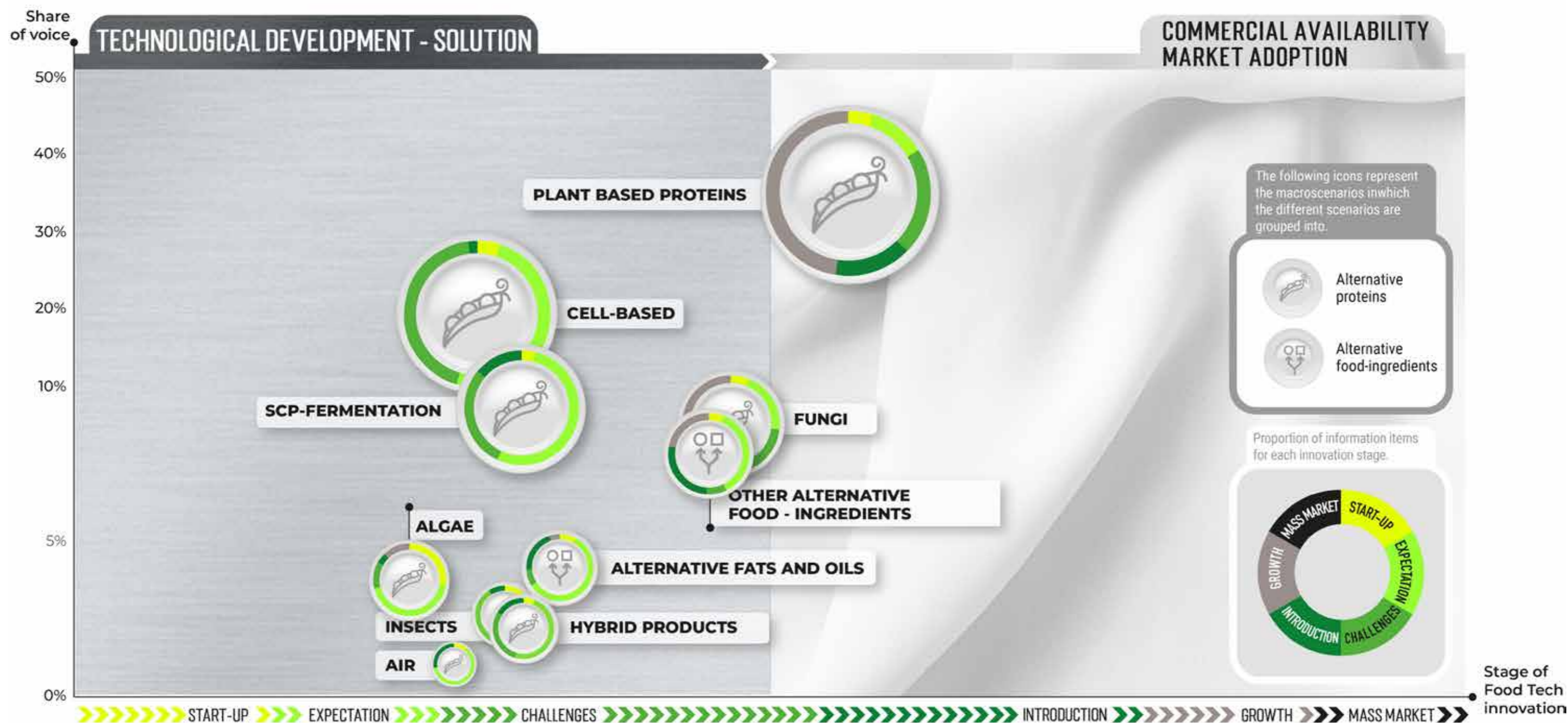
JAN/DEC 2023 - 2400 INFORMATION ANALYSED



4 PRE, PRO AND POSTBIOTICS	8 CARBON NEUTRAL	12 FUNGI	16 OTHER TECHNOLOGIES (NOT IA)	20 BIOMASS FERMENTATION	24 CONSERVATION TECHNOLOGIES	28 TRACEABILITY	32 ENCAPSULATION
5 PRECISION FERMENTATION	9 SCP-FERMENTATION	13 IMPROVING THE NUTRITIONAL PROFILE	17 VERTICAL INDOOR FARMING/ HYDROPONICS	21 ALGAE	25 INSECTS	29 3D PRINTING	33 MOLECULAR FARMING
6 UPCYCLING-FOOD WASTE	10 FUNCTIONAL FOODS	14 CELL-BASED TECHNOLOGIES	18 CLEAN LABEL	22 FERMENTATION	26 SMART FORMULATION	30 PERSONAL NUTRITION	34 No-Lo
7 SUSTAINABLE PACKAGING	11 GROUPS WITH SPECIAL NEEDS	15 OTHER ALTERNATIVE/ FOOD- INGREDIENTS	19 RAPID ANALYSIS TECHNOLOGIES	23 ALTERNATIVE FATS AND OILS	27 HYBRID PRODUCTS	31 ORGANIC	35 AIR

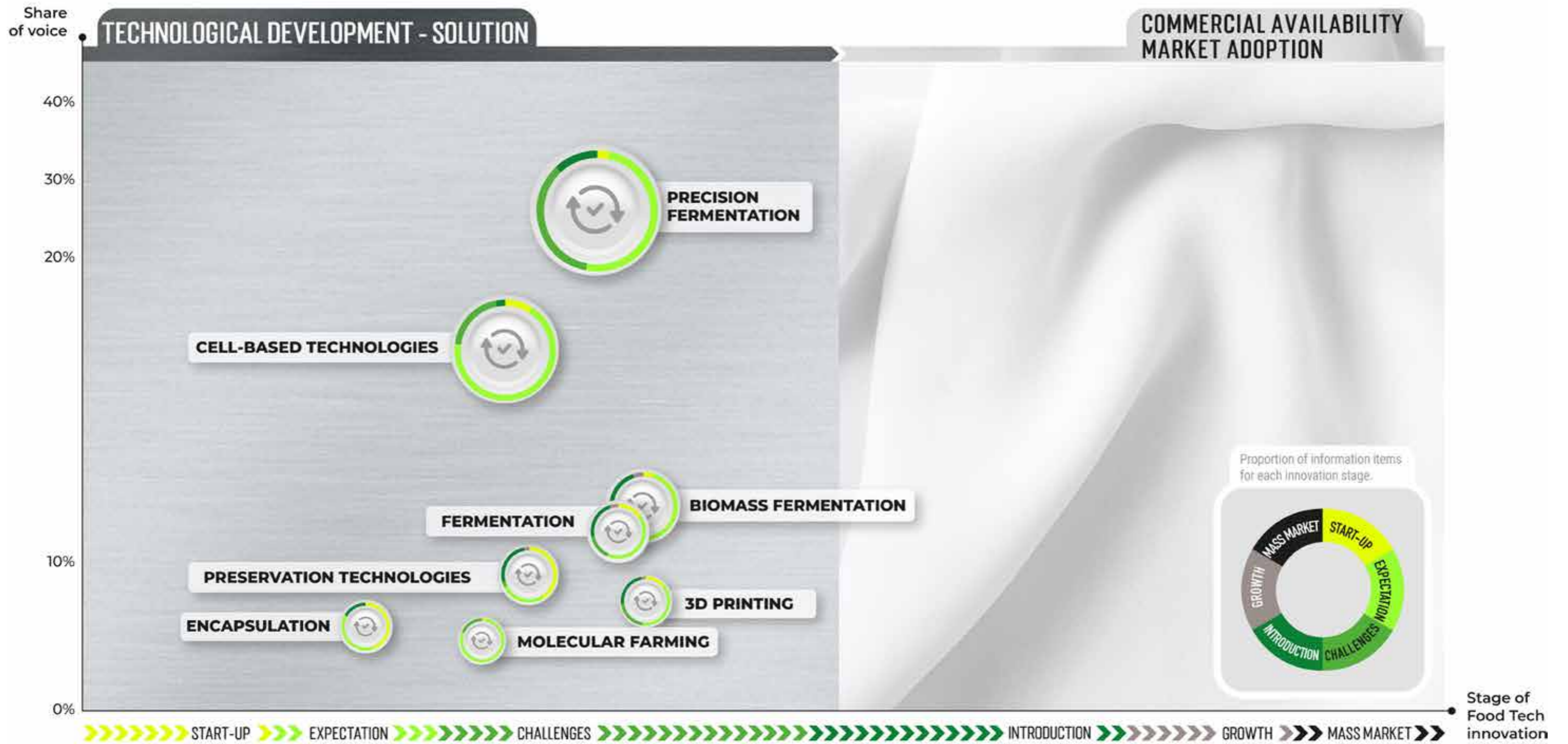
FOODTECH OPPORTUNITY SCENARIO. PROTEINS, FATS AND ALTERNATIVE FOODS

JAN/DEC 2023 - 902 INFORMATION ANALYSED



FOODTECH OPPORTUNITY SCENARIOS. NEW PROCESS TECHNOLOGIES

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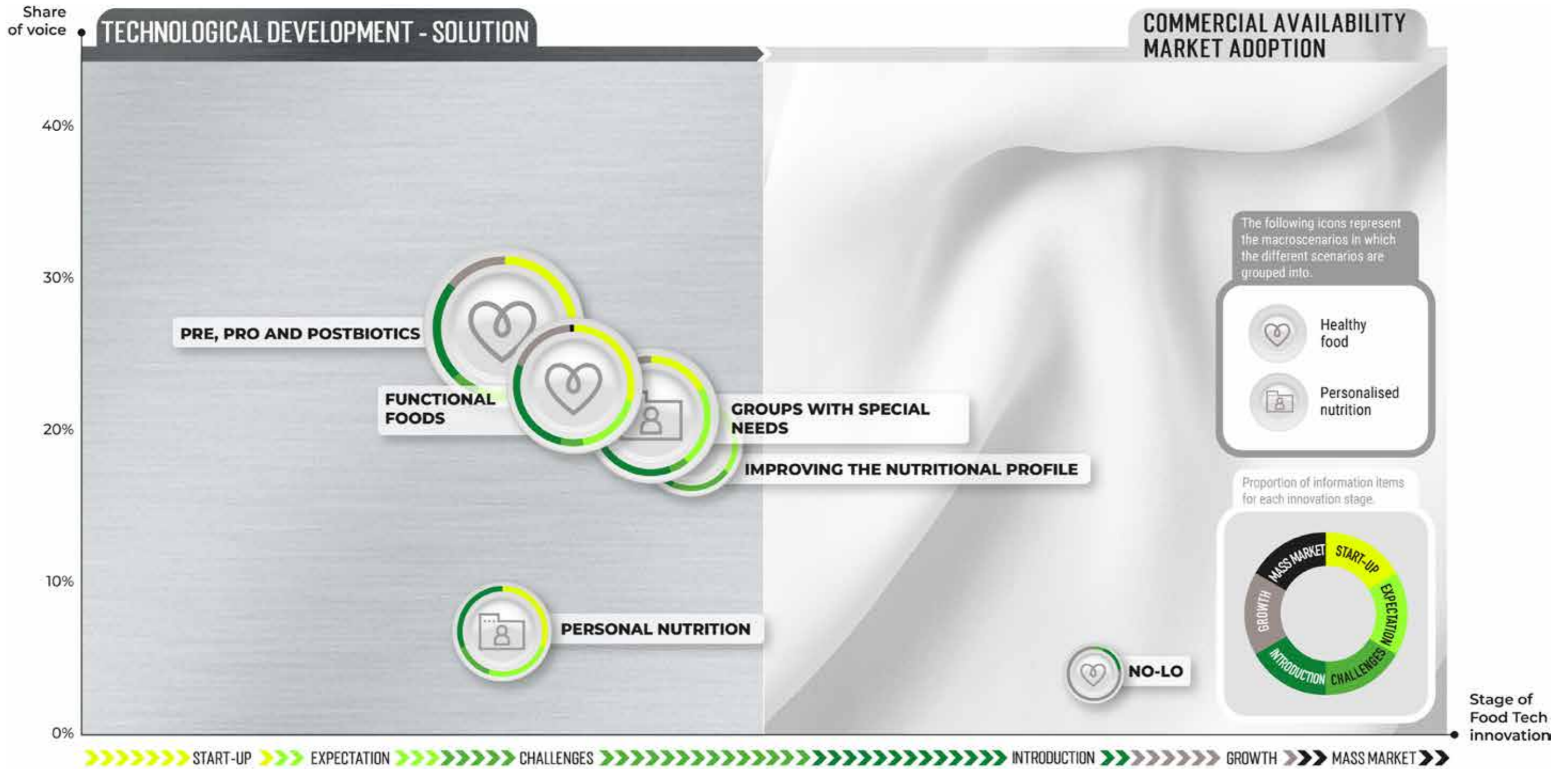
FOODTECH OPPORTUNITY SCENARIOS. SUSTAINABILITY

JAN/DEC 2023 - 382 INFORMATION ANALYSED



FOODTECH OPPORTUNITY SCENARIOS. HEALTHY FOOD AND ADAPTED NUTRITION

JAN/DEC 2023 - 390 INFORMATION ANALYSED



FOODTECH OPPORTUNITY SCENARIOS. ADVANCED DIGITALIZATION AND QUALITY AND FOOD SAFETY 4.0



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TECNOLOGÍA Y CONOCIMIENTO
PARA LA COMPETITIVIDAD DE
LA INDUSTRIA ALIMENTARIA

CNTA 

RESEARCH & TECHNOLOGY
FOR THE COMPETITIVENESS
OF THE FOOD INDUSTRY