

REPORT

JANUARY | DECEMBER 2023

Foodtech



PPORTUNITY

Scenario map by **alinnova**

CNTA 

Contents

- Science and technology, the basis for the transformation of the food industry..... 4**
- Metodology..... 7**
- 2023 at a glance | Macro scenarios and scenarios..... 11**
 - Macro Scenarios Map..... 16
 - Map of All scenarios..... 18
- In depth..... 37**
 - Alternative proteins, fats and food..... 38
 - Sustainability..... 52
 - New process technology..... 60
 - Healthy food and Personalised nutrition..... 68
 - Advanced digitalisation and Food quality and safety 4.0..... 76
- Anexes | Opportunity Scenario Maps 2022..... 83**

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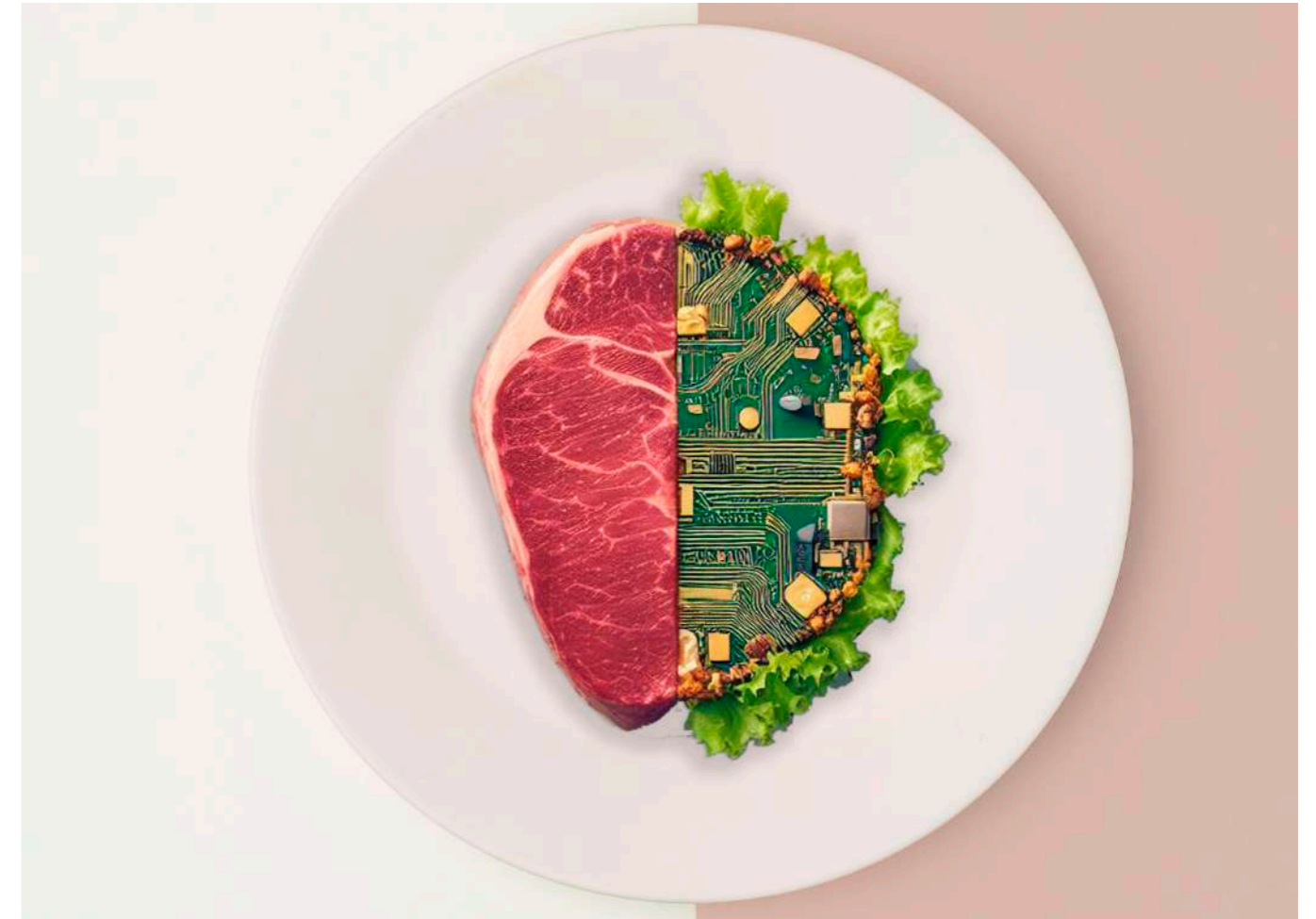
Science and technology, the basis for the transformation of the food industry



CNTA, the Spanish National Food Technology and Safety Centre, presents its **2023 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 2022. To do this, the **CNTA Vanguard team** analysed the FoodTech news

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 CALL FOODTECH 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

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 2022, with some relevant examples we noticed in the year under analysis. We hope you enjoy reading it and discover a lot of 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 **70 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.** O 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 photograph of a laboratory setting, overlaid with a green tint. A hand wearing a white nitrile glove is holding a clear petri dish. In the background, there are several white containers, possibly vials or bottles, on a lab bench. The foreground shows a metal perforated surface, likely part of a biosafety cabinet. The overall scene is clean and professional, representing a scientific or medical environment.

**2023 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 transfor-

mation, 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 investment down

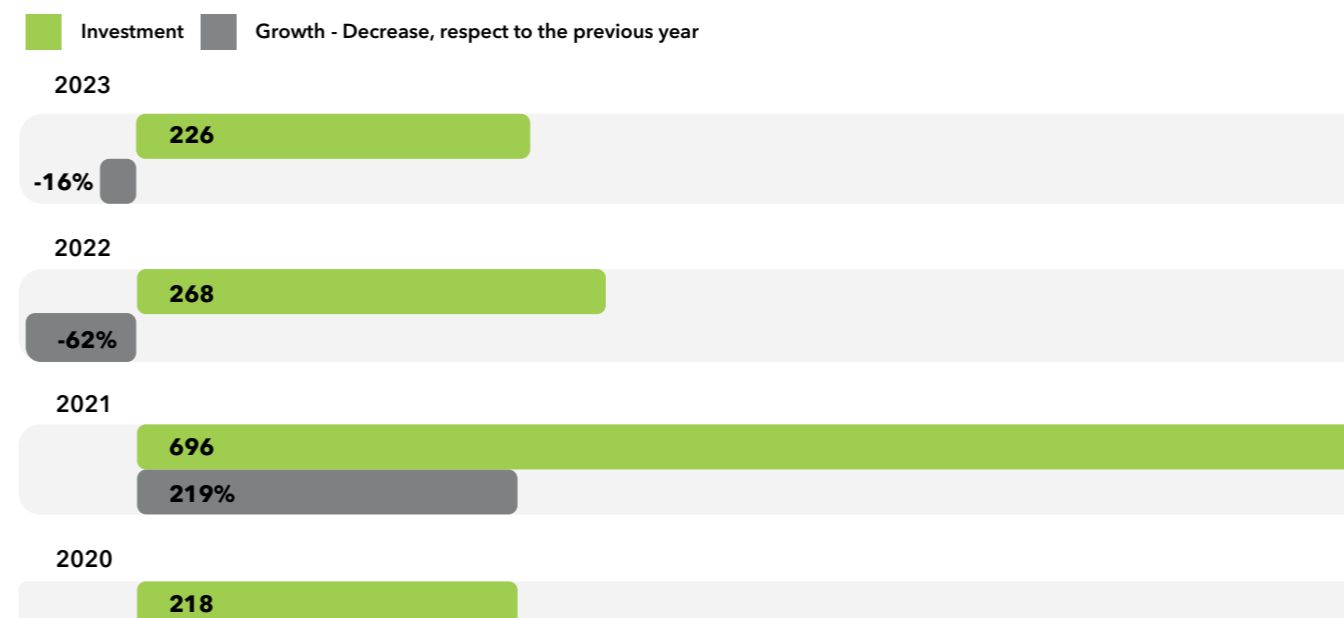
In 2023, investment in FoodTech dropped both in Spain and worldwide. According to DigitalFoodLab, **global** investment fell in 2023 by 61.2% on the figures for 2022

to \$11.6 billion. This decline was due to the instability of the financial market, which led to a fall in investor confidence.

According to Eatable Adven-

tures, the drop was not so big in **Spain**. In 2023, Spanish FoodTech start-ups managed to secure €226 million, which was a decrease of 16% on 2022, as shown in figure 1.

FIGURE 1
FOODTECH INVESTMENT IN SPAIN



Data in millions of euros. Figure: CNTA | Source: Eatable Adventures

A look at 2023

Macro scenarios and scenarios



We drafted this Report on the 2023 FoodTech Opportunity Scenario Map using CNTA's definition of FoodTech, as given on page 5. In it, you can find Macro Scenario maps and Scenario maps. A macro scenario consists of a certain number of scenarios. In total, there are 9 macro scenarios and 35 scenarios in this analysis.

We created these maps with

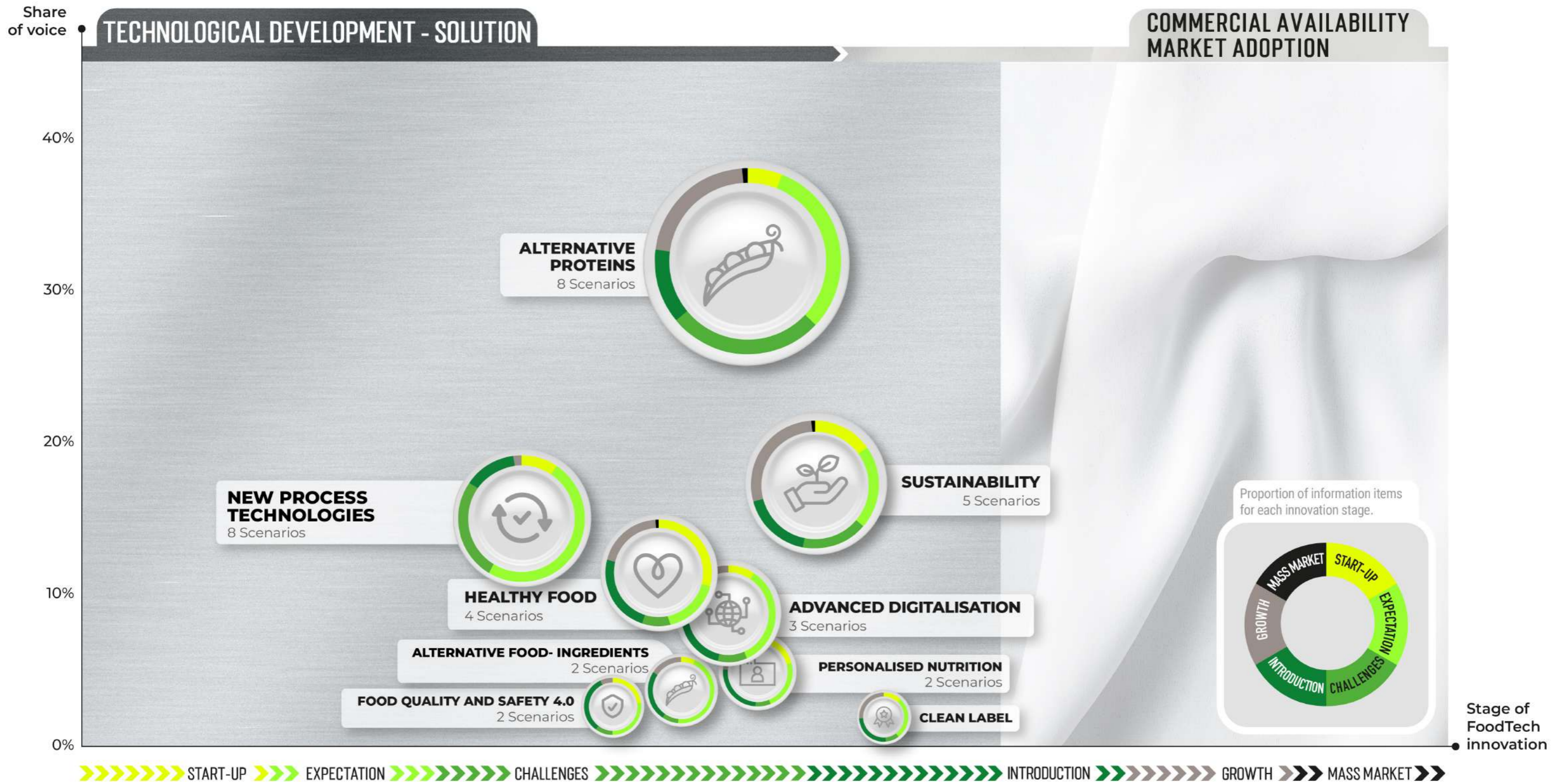
which to navigate the current FoodTech scene quickly and simply in 2023 thanks to the analysis and curation of 2,400 information items by the CNTA Vanguard team following the process described in the Methodology section.

This information helps understand the current situation and facilitates decision-making on points that will affect the future compe-

titiveness 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? Which startups are leading developments? Or what examples can I find to inspire me?

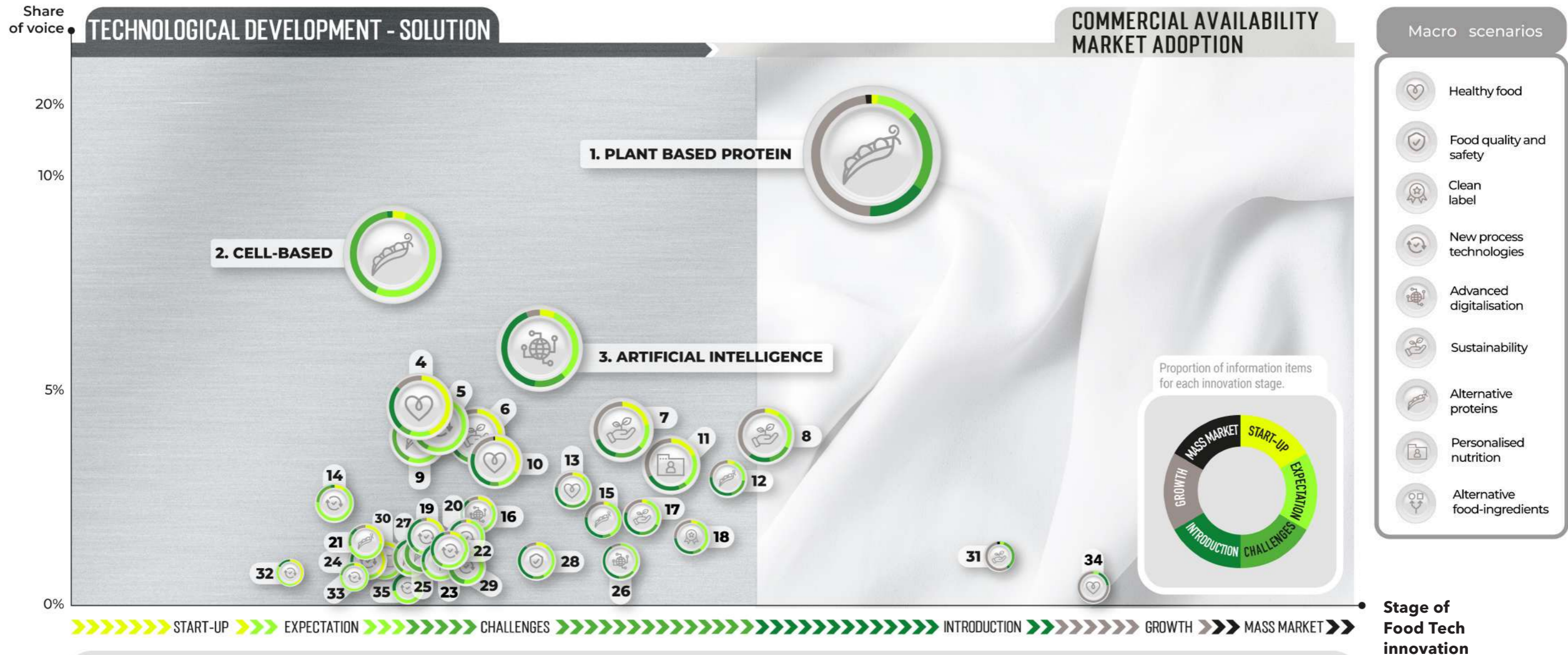
FOODTECH OPPORTUNITY MACRO SCENARIOS MAP

JAN/DEC 2023 - 2.400 INFORMATION ANALYZED



MAP OF ALL FOODTECH OPPORTUNITY SCENARIOS

JAN/DEC 2023 - 2400 INFORMATION ANALYZED



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

Stage of Food Tech innovation

FoodTech All the Scenarios Map

On the **Map of All the Opportunity Scenarios** from 2023, we can see **35 opportunity scenarios** providing the food industry with opportunities for transformation.

One scenario that surged in 2023 was **Artificial Intelligence (AI)**, which grew by almost 90% in share of voice on 2022*, and became the third opportunity scenario with the greatest media impact according to our analysis.

This increase in quota was down to a number of food companies beginning to try out AI in their processes and cases where it was used for crop monitoring, sales forecasting, food quality and safety control, bioreactor management and the creation of customised plans, among other applications. Other food and beverage firms used this techno-

logy to discover new ingredients and design novel products.

Plant protein continued to be the opportunity scenario with the highest profile in the media in 2023 although its share fell by 23.7% on 2022. A lot of the information analysed focused on launches or news about the challenges faced, such as trying to enhance **taste**, the **quality-to-price** ratio or **clean label** ideas.

In second place, we find **Cell-based** (cell-based foods), with a share similar to that seen in 2022. This opportunity scenario continued to face four main challenges: consumer acceptance, reducing production costs, increasing industrial scalability and attaining a favourable regulatory environment. Also noteworthy was the legislative

progress seen in 2023 (regulatory approval in the **United States** and approval applications in **Europe**) and the ban on marketing and producing this type of alternative protein introduced in **Italy**.

In fourth place is the **Pre-, pro- and postbiotics** scenario, which saw an increase of 23.4% in share thanks, in part, to the proliferation of research to understand the relationship between these ingredients and reducing the symptoms of depression, stress or anxiety.

Precision fermentation is the last scenario in the 'top five' with the most share of voice. In 2023, this technology was mainly used to make ingredients such as whey protein or casein.

*You can consult the 2022 report map on page 86.

FoodTech Macro scenario map

On the Macro Opportunity Scenario Map, we can see that **Alternative proteins** was still the subject generating the most 'noise' in the media, with 33.42% of the news analysed in the period, although there was a drop of 12.22% in its share on 2022*.

Alternative proteins is fo-

llowed by the **Sustainability** macro scenario, with 16.96%, and the **New Process Technology** macro scenario, with 15.25%, figures similar to those of last year. As for Stages of Innovation, there was continuity compared to what happened in 2022.

*You can consult the 2022 report map on page 84.

Alternative proteins, Sustainability and New process technologies were the macro scenarios with the greatest share of voice.

Alternative proteins, a macro scenario brimming with challenges

FIGURE 2
WORLDWIDE ALTERNATIVE PROTEIN INVESTMENT FROM JANUARY 1, 2023 TO SEPTEMBER 30, 2023

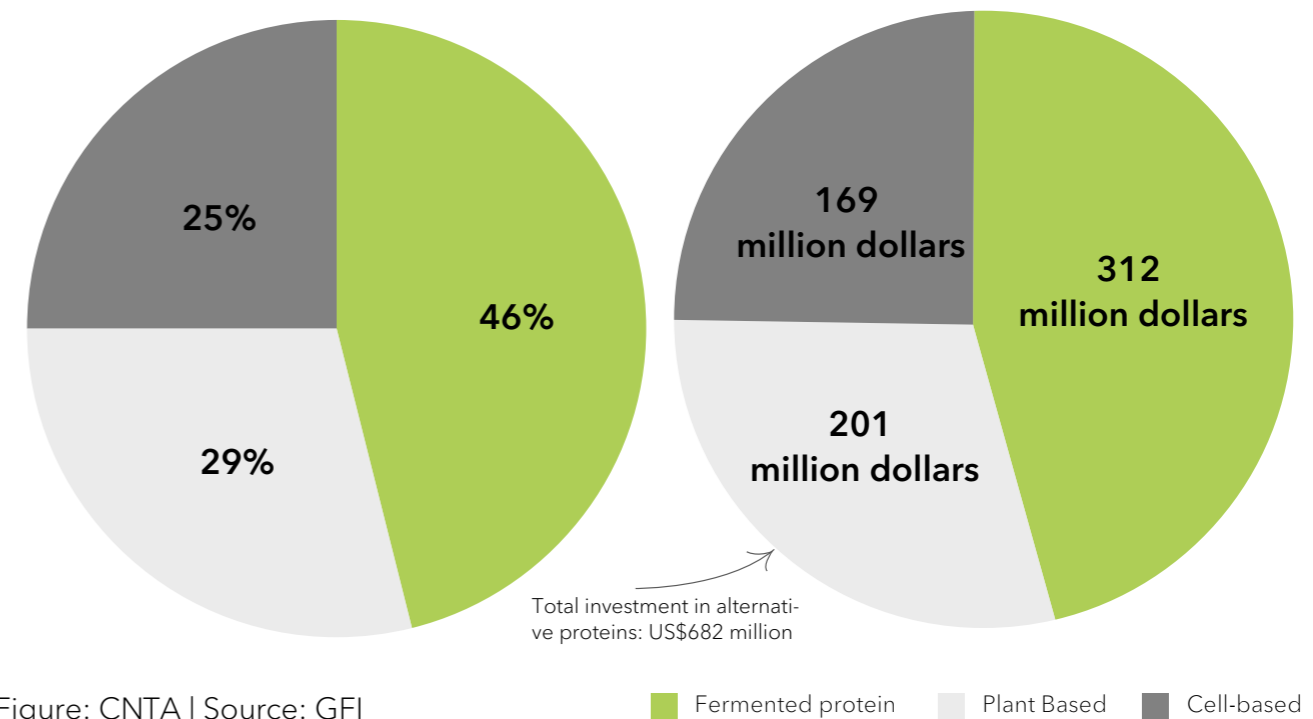


Figure: CNTA | Source: GFI

In the **Alternative proteins** opportunity macro scenario, we analyse news about innovations in proteins whose origin is other than animal. Investment in this macro scenario fell. As can be seen in figure 2, according to The Good Food Institute (GFI), **global investment** in alternative proteins stood at \$682

million in the first three quarters of 2023 (latest data available at time of drafting this report), which meant a decrease of 173% on the same period in 2022.

In more detail, fermented protein was the type of protein which attracted the most investment globally in the first nine months of 2023,

reaching \$312 million, 46% of total investment in alternative proteins, although these figures are a far cry from those registered in the same period of 2022, when this kind of protein drew \$618 million.

On our Opportunity Scenario Map, this kind of protein falls into the **SCP-fermentation** scenario.

Within this scenario, protein made with precision fermentation technology continued to arouse the interest of companies. Some of the challenges it faced in 2023 were: **industrial scaling, lowering the price of foods made using this technology** and **securing more legislative approvals** (in 2023 we learned that **Remilk** received approval from the **Israeli Government** to market its alternative milk proteins produced with precision fermentation and that **TurtleTree** obtained self-affirmed GRAS (Generally Recognized as Safe) status in accordance with FDA regulations for its precision fermentation-produced lactoferrin).

The second alternative protein in terms of investment worldwide, according to GFI, was **Plant protein**. As shown in figure 2, \$201 million were invested in this scenario in the first three quarters of 2023, meaning a decrease of 78% on the same period in 2022.

In 2023, the producers of this type of protein continued

Upside Foods and Eat Just got regulatory approval to sell their cell-based chicken in the United States but only made it available in exclusive restaurants

to look for ways to launch new **clean label** products and improve the **taste, texture, nutritional content** and **value for money** of their products.

Global investment in **Cell-based** alternative proteins was \$169 million in the first nine months of 2023, a 74.4% drop on the same period in 2022, according to GFI. In the year under analysis, this opportunity scenario grabbed attention with one of the most important headlines in FoodTech: regulatory

approval for **Eat Just** (whose cultivated meat subsidiary is **Good Meat**) and **Upside Foods** to market their cell-based cultivated chicken in the **United States**.

Despite approval, the companies only made their cultivated chicken available in exclusive restaurants as they are having a hard time scaling their products and want to test consumer acceptance before launching them onto the market at a larger scale.



Debut of Upside Foods' cultured chicken at Bar Crenn. Photo Upside Foods

There were also moves in **Europe** to progress in the commercialisation of this protein. **Aleph Farms** submitted the first two applications for regulatory approval in Europe in **Switzerland** and the **United Kingdom**. And in 2024, the start-up **The Cultivated B** may become the first biotechnology company in the world to apply for authorisation

for cell-based meat from **the European Food Safety Authority (EFSA)**, the company completing the prior phase in 2023 (an official EFSA process which must be requested at least six months before official presentation).

However, in some specific parts of the European Union, the door has been closed on this type of protein, as has occurred

in **Italy**, where a bill banning the production and marketing of cultivated meat was passed.

The **Fungi** opportunity scenario remained in the Challenges phase. The challenges it faced included managing to be industrially scalable, accelerating the commercialisation of its alternatives and obtaining regulatory approvals.

Regarding this last point, **Myco**technology obtained **Novel Food** status from the European Commission for two of its mycelium-based proteins, the milled and protein powder formats, made with **shiitake mushrooms**.

We saw significant funding in this scenario in this period. One

of the most striking was that of **Meati Foods**, which at the beginning of 2023 raised an extension of \$22 million to the \$150 million round it announced in 2022. According to Axios Pro, the company also managed to raise \$50 million towards the end of 2023.



Innomy mushroom-based haburger. Photo CNTA

As for the **Algae** opportunity scenario, many of the initiatives were start-up projects, the participation of start-ups in different acceleration programmes or different rounds of funding, such as those involving the start-ups **Oceanium** and **HN Novatech**.

Turning to **insects**, at the beginning of 2023, two new types of insect were approved for sale in the European Union: the **lesser mealworm** (*Alphitobius diaperinus*) and the **house cricket** (*Acheta domesticus*).

Despite such progress in regulatory terms, this alternative protein faces certain barriers which hinder its development, such as:

Overcoming **consumer revolution**, mainly in Europe, to eat foods made with insects.

Making products of this kind **more accessible**.

Trying to **increase demand** for this kind of food.

In Spain in the last half of 2023, **Tebrio** began to build what it says will be the largest

insect factory in the world, which will rely on an investment of €80 million and will be located in the province of Salamanca.

An opportunity scenario which grew in prominence in 2023 was **Air**, in which more initiatives began to be seen, some even reaching the market, such as the ice cream made with protein from air that **Solar Foods** launched in **Singapore** in June 2023. This was the first time anywhere in the world that a food made with this type of alternative protein was consumed by the general public.

Finally, in 2023 in the **Hybrid products** opportunity scenario (those in which proteins from two different sources are combined), the combination of **cell-based** and **plant-based protein** began to be acknowledged as a system which offers a more direct way to make products using more commercially viable cells.

If you want to learn more about these scenarios, see page 38.

Solar Foods launched an ice cream made from air protein in June 2023



Solar Foods Air Protein Ice Cream
Photo Solar Foods

Alternative food and ingredients, new ways to enhance flavour and texture

The **Alternative food-ingredients** macro scenario (in which we include everything that is not alternative protein, such as fats or other types of ingredients or food) saw a 33.6% increase in media 'noise' in 2023 when compared to 2022. This macro-scenario contains the following two opportunity scenarios: **Alternative fats**

and oils and **Other alternative food-ingredients**.

Many of the novelties presented in the Other alternative food-ingredients scenario sought to make different types of honey and alternatives to coffee and chocolate, among other products.

In the year under analysis, we saw initiatives in **Alternative fats**

and oils focused on overcoming the flavour and texture challenges faced by the producers of alternative proteins, as in the case with **plant- or cell-based fats**, or proposals seeking a more sustainable alternative, such as some alternative oils.

Find out more about these scenarios on page 38.

Sustainability, more awareness in the food industry

Projects-initiatives which do not harm the environment are significantly changing the face of the food industry. Hence, the considerable focus in the media on the **Sustainability** and its different opportunity scenarios: **Upcycling-food waste**, **Sustainable packaging**, **Carbon neutral**, **Vertical-indoor farming** and **Organic**.

One of the big issues in Sustainability is the fight against food waste. In the European Union, almost 59 million tonnes of food are wasted every year, which amounts to 131 kilograms of waste per person per year. To tackle this problem, one solution that is gaining in importance is upcycling, which we include in **Upcycling-food waste**, the scenario which had the greatest share of voice in the **Sustainability** macro scenario in 2023.

Almost 59 million tonnes of food are wasted in the EU every year

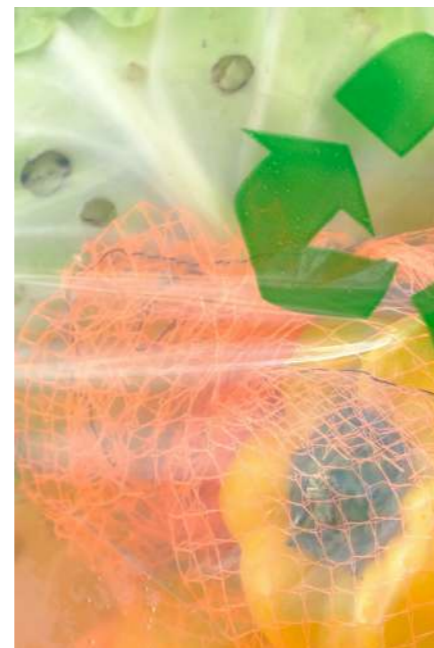
CHALLENGES OF UPCYCLING

To further develop solutions of this kind, a series of challenges need to be overcome:

- Improving **supply chains**.
- Creating a **new narrative** for upcycled ingredients-products.
- Expanding **technological boundaries**.
- Having **clear regulations** in Europe on what is meant by food waste.

The second opportunity scenario with the highest share of voice was **Sustainable packaging**, which in 2023 faced the challenge of the industry adapting to new legislation.

The **use of bioplastics** and other alternative materials, and



ways of **reducing packaging** were two of the main lines of action that companies followed in 2023.

An opportunity scenario that experienced an increase in share of voice of almost 14% on 2022 was the **Carbon neutral** scenario (those industry proposals to decarbonise and pollute less).

In 2023, we saw that the great barrier it faced was the fight against **greenwashing**, unrealistic claims about and

environmental certifications on products and services which are misleading, ineffective or have no scientific basis.

The EU aims to curb greenwashing and a first step was the provisional agreement reached by the Parliament and European Council on new rules to ban misleading advertising and offer consumers better information about products. These standards are expected to be in place by 2026.

The **Vertical indoor-farming/hydroponics** opportunity scenario continued to face two opposing realities. A positive one in the form of the announcement of several investments to build large-scale vertical farming facilities, such as that made by **Hardee Fresh**, which intends to build a 30,000m² vertical farming facility in Georgia (United States). There were also rounds of investment such as that of **Planet Farms**, which raised \$59 million, or that of the Spanish company **Grooots**, which managed to secure €3.5 million.

Another reality was more negative, with data from AG-Funder News reporting that investment in **New Agricultural Models** (which includes everything from indoor crop systems, such as vertical and indoor farms, to insect agriculture or algae production) fell significantly in 2023, generating a total of \$673.2 million in invested funds compared to \$2.92 billion in 2022, a 77% drop from one year to the next.

Furthermore, some relevant players in the sector experienced difficulties, such as **Infarm**, which filed for bankruptcy. These problems were caused by high energy prices and instability in the financial markets.

A special case was that of **AeroFarms**, which received €71 million in funding when it emerged from bankruptcy. The company says it has 'eliminated spending' on all projects not related to the development of its Danville, Virginia farm.

Finally, the increase in prices was the main challenge in the **Organic** opportunity scenario. According to the Spanish Consumers and Users Organisation (OCU), eating organic in Spain is '62% more expensive'. This barrier became the 'main reason for abandonment' for those who consumed organic food on a regular basis, according to the study Connecting with eco-conscious consumers by the **Open University of Catalonia (UOC)**.

Find out about these scenarios on page 52.



New Process Technologies, towards optimisation, scaling and cost reduction

In the **New process technologies** macro scenario, the opportunity scenarios that featured the most in the news in 2023 were: **Precision fermentation**, **Cell-based technologies**, **Biomass fermentation** and **Fermentation**.

As for the Precision fermentation opportunity scenario, the

Precision fermentation was one of the star technologies in FoodTech in 2023

main hindrances to the development of the technology in Europe are: regulations (lack of definition of clear regulations on ingredients produced this way) and the scalability of the processes.

Without leaving the subject of fermentation, **biomass fermentation** continued to generate expectations, as it did in 2022. In this analysis, we saw initiatives such as the new **Aqua Cultured Foods** facility to work on the scaling of its proteins or the new **MicroHarvest** pilot plant in Lisbon.

Meanwhile, in the **Fermentation** opportunity scenario (in which we include techniques which, like traditional fermenta-

tion, are neither precision nor biomass fermentation), we saw **kombuchas**, **bean-based foods**, **plant-based cheese analogues**, **additives** and **fermented legumes** made this way in 2023.

In 2023, the **Cell-based technology** opportunity scenario (in which we include various technologies, such as **culture media**, **scaffolding**, **stem cell lines**, **tissue templating**, **organoids**, etc.), which are used to develop the necessary cells) remained very active, experiencing a growth in share of voice of more than 26% on 2022. Most of the proposals sought to optimise and lower the costs of culture media, the great cha-



CNTA bioreactors. Photo CNTA

llenge facing this scenario.

As for **3D printing**, some launches actually reached the market. One of the most striking was that of **Foodys** and **Cocuu**, who managed to sell what they define as 'the first plant-based bacon made using 3D bioprinting' to the Carrefour supermarket chain.

Turning to **Preservation technologies** (new technologies and research to preserve products and lengthen their shelf life), the opportunity scenario grew in prominence in the media, reaching a share of 9.29% in its macro scenario, while in 2022 it failed to hit 6%.

Some initiatives that we discovered in 2023 were: the develop-

ment of natural antimicrobial coatings for use in packaging; 'active' packaging to absorb moisture; the use of cold plasma technology, or stickers that release plant-based compounds to prevent premature ageing and prolong shelf life.

Equally noteworthy was the **Encapsulation** opportunity scenario, a technology that in 2023 continued to generate research projects due to interest in it for the development of functional products, given that after its application in **bioactives** or compounds, their **functionalities** can be improved and they can be included in **food matrices**.

Finally, **Molecular farming**

appeared as a new opportunity scenario in 2023. With this technology, proteins can be produced using plants as small individual factories. These plants are modified so that their cells produce the desired proteins and then the leaves or other plant tissues are harvested and the proteins of interest are isolated and purified.

In 2023, the impact of this technology in the news and research was great. One of the most striking examples was **Moolec Science's** presentation of 'Piggy Sooy', the soya bean that produces pork proteins through molecular farming.

To find out more about these scenarios, go to page 60.

The link between food and health grows stronger



Another of the pressing challenges facing today's society is the developing link between health and food. As a result, the **Healthy food** macro scenario throws up many opportunities. In this macro-scenario, most of the news analysed centred on the **Pre-, pro- and postbiotics** opportunity scenario, with 39.88%.

In the **Pre-, pro- and postbiotics** scenario, we saw novelties which focus on achieving an **optimal microbiome** and research on the therapeutic potential of the use of probiotic ingredients to go beyond gut health and treat diseases such as **depression, migraines or neurodegenerative diseases**. 2023 also saw a boom in the launch of food with **postbiotics** (preparations of inanimate microorganisms or their components that confer a health benefit on the human body).

Regarding **Functional foods**, this opportunity scenario continued to reveal initiatives focused on **cognitive health** and **improving nighttime rest**.

The **Improving the nutritio-**

nal profile scenario generated information on solutions or research seeking to reduce the content, above all, of sugar and salt in food.

In 2023, increasing social pressure, and also pressure from investors, led multinationals such as **Nestlé, Danone** and **Mars** to announce investments and pro-

posals to make their products healthier in the medium term.

Finally, in the **No-Lo** opportunity scenario (low-alcohol or non-alcoholic drinks), new developments were presented in drinks such as vermouth, beer, wine, rum and gin. Part of the growth of this scenario can be explained by the fact that

'people are looking for healthy drinks, especially young shoppers', according to **Renata de Moura**, author of the study 'Shopping for Beverage Alcohol' and senior director of shopper and category insights at **Kantar**.

You can find more detailed information on this macro scenario on page 68.

Women, seniors, children and sportspeople, groups grabbing the attention of the industry



Personalized nutrition is being focused on different groups. Photo CNTA

The **Personalised nutrition** macro scenario (healthy food developments focused on personal nutrition or groups with special needs) is made up of the **Groups with special needs** and **Personal nutrition** opportunity scenarios.

Most of the research and launches in this macro scenario were aimed at **Groups with special needs**. Some groups on which the companies focussed were: **women, seniors, sportspeople and children**.

In **Personal Nutrition**, we saw the potential that artificial intelligence may have in this opportunity scenario when it comes to giving nutritional recommendations.

You can find out more about these scenarios on page 68.



Digitalisation, artificial intelligence begins to show its potential in the food industry

The **Artificial intelligence** (AI) opportunity scenario was one of the big stars of 2023. In the year under analysis, this scenario accounted for a large part of the news on FoodTech, taking third place in overall share of voice.

A number of food companies began to try out AI in their processes and there were cases where it was used for crop monitoring, sales forecasting, food

quality and safety control, bio-reactor management and the creation of customised plans, among other applications.

Another use given to AI was as an aid to design-formulate foodstuffs. Some companies relied on what we define as **Smart formulation**, an opportunity scenario in which we include initiatives where AI is used to discover new ingredients or

design novel products.

In the **Other digital technologies** (not AI) scenario, we saw progress towards the digitalisation of factories, chiefly featuring robotisation, process automation-digitalisation, the use of artificial vision and digital twins.

You can learn more about these scenarios from page 76 onwards.

Food quality and safety 4.0, technologies to enhance efficiency and reduce risks

In the **Food quality and safety 4.0** macro scenario, we saw research-initiatives so that new analysis techniques can be developed to reach the market.

Food quality and safety 4.0 is a step forward in food quality and safety because it combines vision and digital technologies with data science to generate significant advantages such as time savings, the ability to generate predictive models, the non-destruction of samples and data-based decision-making which can potentially improve the food production process.

This macro scenario consists of two opportunity scenarios: **Rapid analysis technologies** (called Rapid methods of analysis in 2022), in which we include those technologies that open the way to the efficient, speedy improvement of food quality and safety controls, and **Traceability**.

In the first scenario, we continued to observe proposals in **NIR** and **hyperspectral imaging** (to **measure quality, predict shelf life, detect foreign bodies or food fraud**), as was the case with **OneThird**, which raised €2.75 million to boost its

AI-driven Near Infrared (NIR) Scanning technology to predict the shelf life of fresh products.

In **Traceability**, hopes were still pinned on **blockchain** technology although some compa-

nies are leaning towards other systems, such as **Oritain**, which uses forensic methods to trace products.

Find out more about these scenarios on page 76.



CNTA Food Quality and Safety 4.0 Laboratory. Use of hyperspectral technology in cereal bars. Photo: CNTA

Clean label, an increasingly important concept

To conclude our review of all the macro scenarios, we need to look at **Clean label**, which is in the Challenges stage, **inflation** being the greatest challenge to overcome.

In this analysis we saw several launches with a focus on the clean label concept (i.e. production based on simplicity and transparency, using as few

6,9%

ingredients as possible and with components known to the consumer).

The future of this scenario looks promising. According to **Meticulous Research**, it is estimated that the clean label ingredient market will grow at a CAGR (Compound Annual Growth Rate) of 6.9% over the period 2023-2030.





In depth

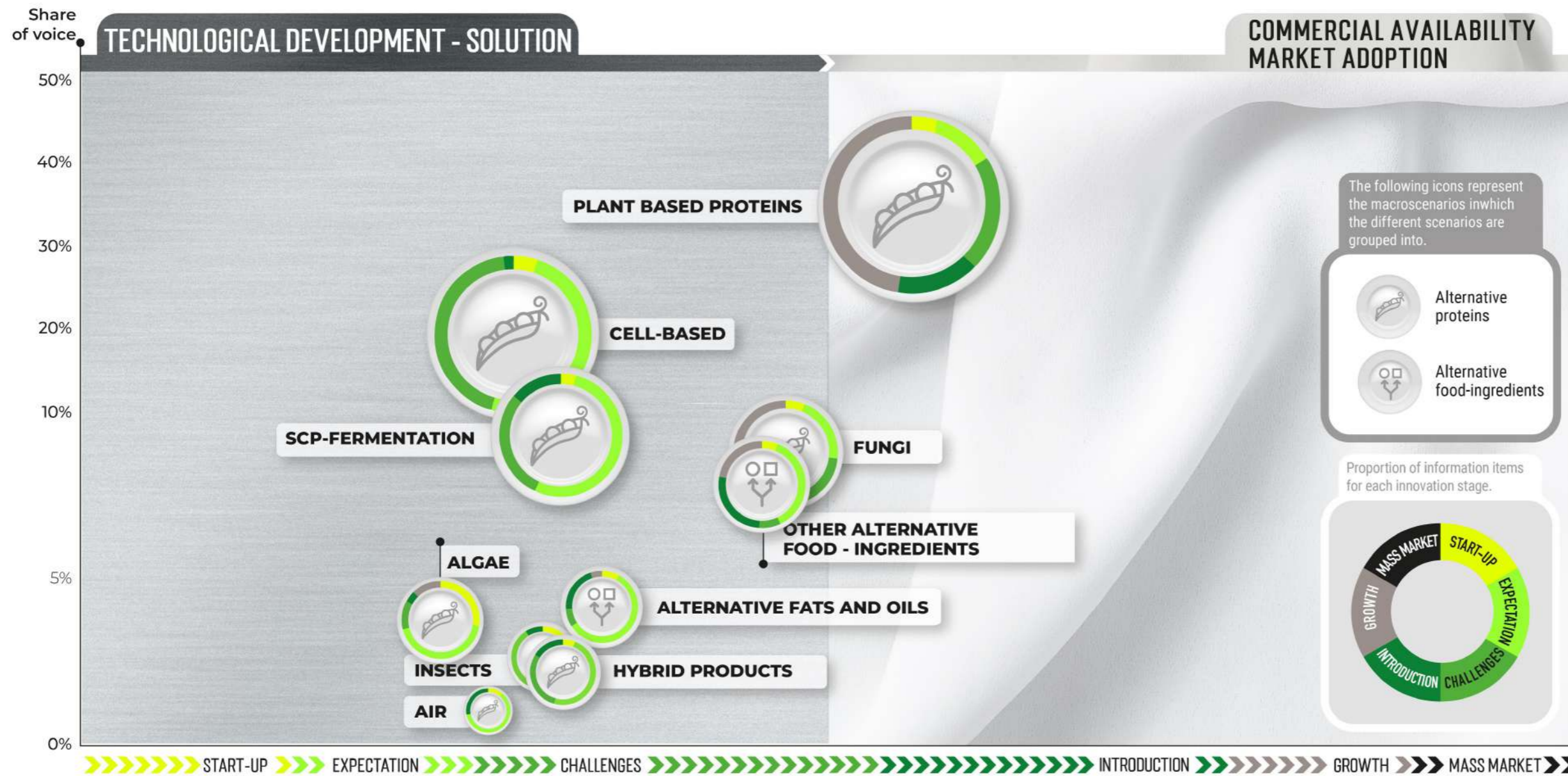
In the following pages, we would now like to offer you a more in-depth exploration of the opportunity scenarios featured in it.

The following pages contain some reflections, launches, data, start-ups, technologies, etc., that led the way in the FoodTech industry in 2023 and

5 macro-scenario maps are presented with their respective scenarios (**Alternative proteins, fats and foods; Sustainability; Healthy food and Personalised nutrition; New process technologies and Advanced digitalisation and Quality and safety 4.0**).

FOODTECH OPPORTUNITY SCENARIO. PROTEINS, FATS AND ALTERNATIVE FOODS

JAN / DEC 2023 - 902 INFORMATION ANALYSED



The first map is the **Alternative proteins, fats and food map**. **Plant protein** was the scenario with the highest share of voice, registering 37.69%, although this was lower than the figure in the 2022 Report*, when it hit 45%. It is followed by **Cell-based technologies, SCP-fermentation and Fungi**.

On this map, the largest increases in share of voice were seen in the **Other alternative food-ingredients** and **Air** opportunity scenarios, which went from a share of 3.25% and 0.98% in 2022 to 6.98% and 2% in 2023, respectively. This was due an increase in the number of proposals and launches, chiefly in **Other alternative food-ingredients**.

On this map, we can also observe how the Innovation stage of **Plant protein** passed from Introduction to the market in 2022 to Challenges in 2023. The challenges that it must overcome include finding formulas to improve the flavour and texture of plant-based foods, and making them clean label.

The other scenarios in which we saw a change in Innovation stage were **Other alternative food-ingredients**, which went from Hype to Challenges, and **Hybrid Products**, moving from Challenges to Expectation.

The other scenarios remained in the same stage of innovation as in 2022.

*You can consult the 2022 report map on page 88.

Stage of Food Tech innovation

Plant protein to meet consumer expectations

In the **Plant protein** opportunity scenario, most of the news (54.4%) focused on launches by and growth in the market of companies working with this technology. Nevertheless, a lot of the news (20.3%) focused on the barriers faced by this alternative protein, such as **crises in start-ups, slowdown in consumption, product recalls, consumer expectations**, etc.

According to GFI, a total of \$201 million were invested in plant protein in the first three quarters of 2023, meaning a decrease of 78% on the same period in 2022.

In 2023, we continued to see how producers were persevering to meet the **expectations of consumers**, who demand plant-based products that are tasty, clean label and good value for money, have good texture and nutritional content, and exhibit freshness.

Certain voices also began to criticise the plant-based market. The controversy which arose in early 2023 with the article published by Bloomberg accusing plant-based meat of not meeting up to expectations and with

critical words for such leading companies in the industry as **Impossible Foods** and **Beyond Meat**, a start-up which reported a drop in sales in 2023, attracted a great deal of attention.

This alternative protein also encountered certain legislative barriers. In **Italy**, a bill was passed to ban the use of meat-related terms such as 'salami' or 'steak' for plant-based meat alternatives; in **Chile**, a bill very similar to the Italian one was passed, and in **France**, a project to ban the use of meat terms for products that do not actually contain meat saw progress.

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Despite these barriers, in 2023 different companies-institutions received large investments, such as **Ripple Foods'** \$49.2 mi-

llion financing round to expand its pea milk; the promise of the German company **Nordzucker** to invest €100 million to develop in the plant protein market over the next few years or the undertaking of the **Government of Denmark**, which will invest \$180 million to promote the transition to a plant-based food system.

In Spain, **Heura** began to market its plant-based version of York ham, made using a novel thermo-mechanical technique, which uses heat and mechanical energy to shape or modify material properties.

Better flavour, texture and nutritional content, and clean label among the consumer demands for plant-based products



In the first nine months of 2023, Beyond Meat had net revenues of \$269.7 million, -20.4% than in the same period of 2022. Photo Beyond Meat

Cell-based technologies, legislative progress and setbacks

Most of the news from the **Cell-based** scenario was about start-ups announcing technology projects which still need to be developed further, with 43.5% of all the information analysed, followed by the barriers faced by this alternative protein, with 40%.

THE FOUR MAJOR CHALLENGES TO OVERCOME FOR CELL-BASED:

- Consumer **acceptance**.
- **Lower production costs**.
- Better industrial **scalability**.
- A more favourable **regulatory environment**.

In June 2023, we saw one of the biggest news stories of the year in FoodTech: the regulatory approval allowing **Upside Foods** and **Eat Just** (whose cultivated meat subsidiary is **Good Meat**) to sell their cell-based cultivated chicken in the **United States** (the second country in the world where the sale of products of this type is now allowed after **Singapore**).

But approval did not mean that their products appeared on the shop shelves, because **Eat Just** and **Upside Foods** only made their cultivated chicken available in exclusive restaurants

as they are having a hard time scaling them and want to know if their products are accepted by consumers before broad market introduction.

The United States, the second country in the world to permit the sale of cell-based products

Steps were also taken in **Europe** for the future sale of this alternative protein. The Israeli start-up **Aleph Farms** submitted the first two applications for regulatory approval in **Europe** in **Switzerland** and the **United Kingdom**.

In September 2023, **The Cultivated B** (TCB) initiated the phase prior to application for regulatory authorisation for the sale of hybrid cultivated meat products in Europe. The company explained that it had entered the initial phase, an official European Food Safety Authority (**EFSA**) process which needs to be requested at least six months before official presentation. When its application is submi-



Chef José Andrés cooking Good Meat's cultured chicken. Photo Good Meat

tted, TCB will become the first biotechnology company in the world to apply for EFSA certification for cultivated meat if there are no further applications in the period.

Such progress stands in contrast to what happened in other European countries, such as **Italy**, where a bill was passed to ban the production and sale of cultivated meat. **Romania** intends to follow the same path and ban cell-based food, and some parliamentarians also called for a ban in **France**.

Other initiatives seen in 2023 included: **Clever Carnivore** raising \$7 million to scale its cell-based meat production; the start of construction of a \$62 million innovation facility for cultivated meat by meat giant **JBS** in Brazil and **Meatable** raising \$35 million to accelerate the launch of its cell-based sausage and meatball products.

But not everything is meat in the cell-based world. In 2023, we saw projects focussing on other types of food made from cultured cells, such as that of

Blue Nalu, which signed a Memorandum of Understanding with NEOM (a sustainable regional development initiative in northwestern Saudi Arabia) to

promote cell-based seafood in Saudi Arabia or the French start-up **Nūmi** to develop cell-based breast milk.

PROGRESS IN AUSTRALIA TO COMMERCIALISE CELL-BASED PRODUCTS

In Australia, **Food Standards Australia New Zealand** (FSANZ) concluded in late 2023 that **Vow's** cell-based quail was safe to use as an ingredient in other products, such as hamburgers or sausages. FSANZ also said that this food was genetically stable and bacteria-related risks were 'very low'. This assessment is the first step

towards selling this type of food (under the conditions indicated) in Australia.

We also learnt in 2023 that the French start-up **Vital Meat** had submitted a pre-market dossier to the Singapore Food Agency (SFA) seeking approval to launch its cultivated chicken in the country.



Chicken breast grown from stem cells from Upside Foods. Photo Upside Foods

Single-cell protein-fermentation leading investment in Alternative proteins

The third major Alternative proteins scenario is **SCP-fermentation** (Single-cell protein fermentation, i.e. developments based on fermentation). In the first three quarters of 2023, this scenario led world investment in alternative proteins, totalling \$312 million according to GFI, which accounts for 55% of all investment in alternative proteins, as shown in figure 2 on page 21.

The main barriers that this alternative protein needs to overcome include:

- Industrial **scaling**.
- **Lowering the price** of food made using fermentation.
- Possible **health** risks associated with these products.
- Reluctance and **lack of consumer confidence**.
- Securing **more regulatory approvals**.

Concerning regulatory approvals, in 2023 we learned that **Remilk** received approval from the **Israeli Government** to mar-

ket its alternative milk proteins produced with precision fermentation and that **TurtleTree** obtained self-affirmed GRAS (Generally Recognized as Safe) status in accordance with FDA regulations for its precision fermentation-produced lactoferrin.

Self-affirmed GRAS status does not legally require FDA review; companies only need to receive safety approval from a scientific panel. This can be done without notifying the FDA or publicly disclosing safety data. This is an easier, cheaper and quicker way to get products on the market because full FDA approval can take anywhere from six months to a year.

Other proposals seen were: **Danone's** investment in the start-up **Imagindairy**, which could pave the way for joint collaboration in the development of animal-free dairy products and collaboration between **Vi-vici** and **Ginkgo Bioworks** to

expand and scale their dairy protein alternative production process.

However, **Perfect Day**, one of the leaders in dairy protein production through precision fermentation, also made the news by announcing the dismissal of approximately 15% of its staff by closing its D2C (Direct to Consumer) brand, **The Urgent Company**, in order to focus exclusively on B2B (Business to Business) operations.

Remilk received approval from the Israeli Government to market its dairy alternatives and TurtleTree obtained self-affirmed GRAS status

FIGURE 3
2023 QUOTA FOR FOODS PRODUCED WITH PRECISION FERMENTATION TECHNOLOGY

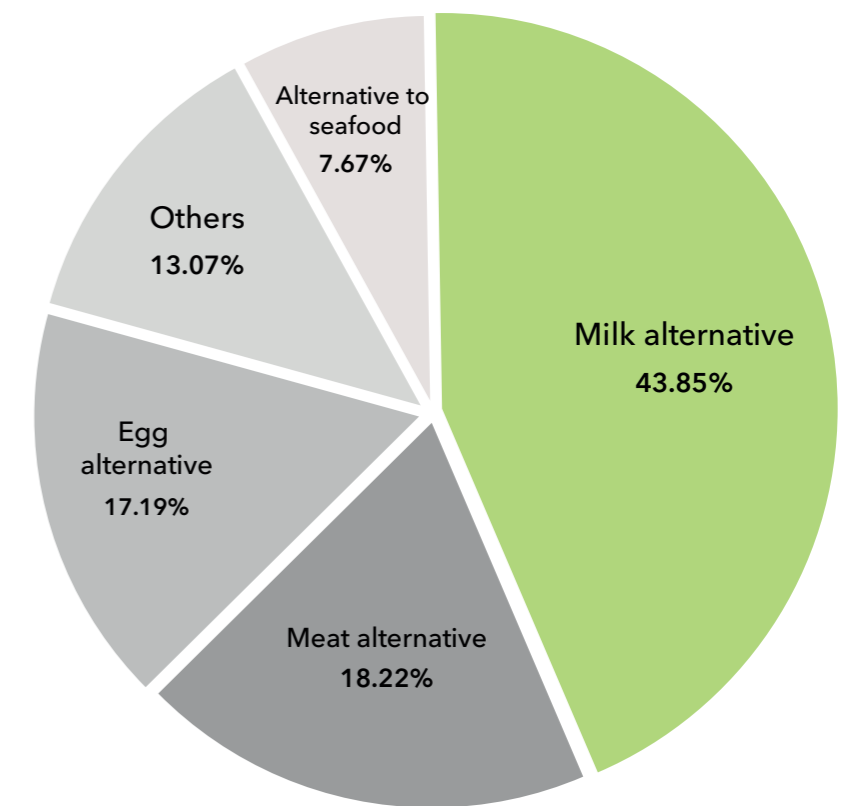


Figure: CNTA | Source: Precedence Research

INTEREST IN PROTEINS DEVELOPED USING PRECISION FERMENTATION

In this opportunity scenario, protein made using precision fermentation technology continues to arouse interest, as can be seen in all the news in which it featured in 2023.

According to **Precedence Research's** forecasts, dairy alternatives were the type of food sought most intensively through precision fermentation, with a 43.85% share, as can be seen in figure 3.

The ingredients most searched for in 2023, according to the consultancy, were whey protein and casein, with 36.1%, as shown in figure 4.

FIGURE 4
2023 QUOTA OF INGREDIENTS ELABORATED WITH PRECISION FERMENTATION TECHNOLOGY

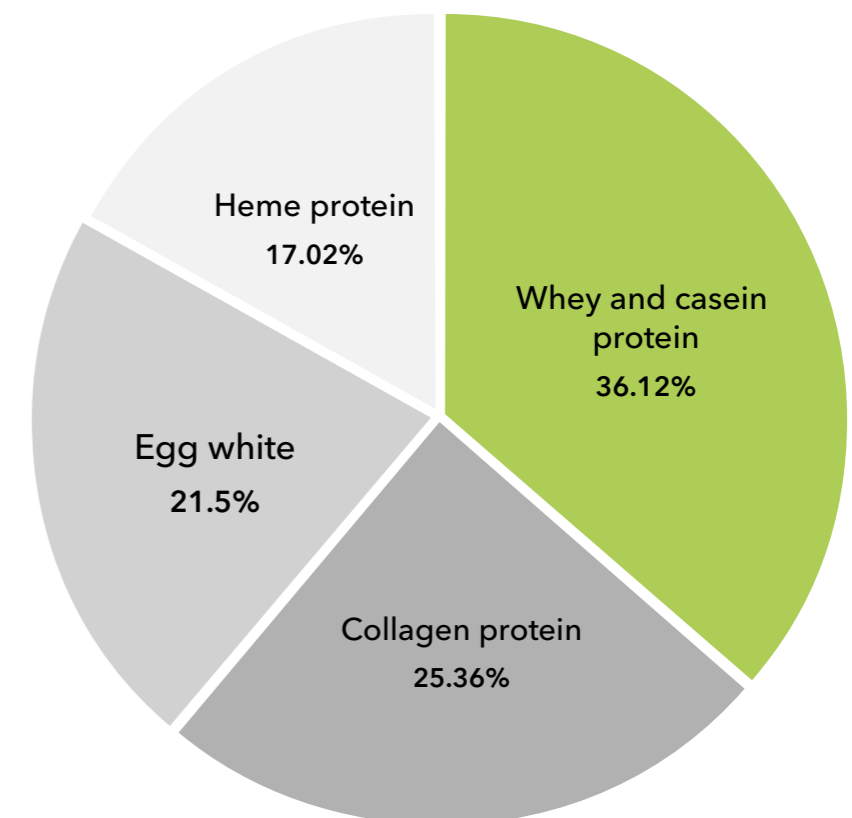


Figure: CNTA | Source: Precedence Research

Different challenges to overcome for fungi protein

In the **Fungi** opportunity scenario, the main themes in the information analysed were: launches or initiatives for start-ups to expand their products, projects with great expectations and barriers to overcome.

Some of the challenges it faces are **increased costs** and **stagnating sales**, achieving **industrial scaling**, accelerating **commercialisation** and obtaining **legislative approvals**.

Regarding this last point, the European Commission granted

Mycotechnology Novel Food status for two of its mycelium-based proteins, the milled and protein powder formats, made with shiitake mushrooms.

Significant investments were secured in this scenario in 2023. According to Axios Pro, **Meati Foods**, for example, managed to raise \$50 million in the last quarter of 2023, adding to the \$22 million extension it obtained at the beginning of the year on the \$150 million round announced in 2022.

Other major investments were

the €40 million that **Enough** raised to accelerate the production of its mycoprotein product Abunda and the €11 million that **Eniferbio** received to develop its mycoprotein powder Pekilo.

Finally, in Spain, we learnt about **Libre Foods'** fungi-based bacon and collaboration between **Innomy** and **Grupo Ausolan**, the purpose of which is to validate the scaling of the former's mycelium fermentation technology and investigate the production of final and intermediate products.



Innomy mushroom-based hamburger. Photo CNTA

Algae, an opportunity scenario with prospects

In 2023, we learned about projects with future potential and a wide range of ongoing research in this scenario.

Examples included: the expansion plans into Europe and Southeast Asia of **WTH Foods** with its new microalgae-based products; **SimpliiGoods'** smoked

salmon alternative made with *spirulina*; **Poseidona's** idea of using the invasive seaweed **Rugulopteryx okamurae** as a source of protein ingredients and the new line of seaweed seasonings from the Spanish start-up **Mediterranean Algae**.

We also learned about diffe-

rent rounds of funding involving start-ups such as **HN Novatech**, which raised \$4 million to market its ACOMS, a heme-based seaweed ingredient for plant-based meat applications, and **Oceanium**, which announced the \$2.6 million it had raised for its seaweed processing technology.



Protein algae extract with coloring power. Photo CNTA

Insects, working on breaking down barriers

Focussing on insects, the main topic in 2023 was the challenges the scenario faces, accounting for 47% of the information analysed.

Regulatory approval is significant when it comes to overcoming the challenges the scenario faces and in this regard we saw approval for the sale in the EU of two new types of insect at the beginning of 2023: the **lesser mealworm** (*Alphitobius diaperinus*) and the **house cricket** (*Acheta domesticus*), which now join the **European migratory locust** (*Locusta migratoria*) and the **yellow mealworm beetle**

(*Tenebrio molitor*).

However, despite these regulatory breakthroughs, this type of protein encounters several barriers to further development. Some of these are:

Making products of this kind more **accessible**.

Increasing demand for the consumption of this kind of food.

Overcoming **consumer revulsion**, mainly in Europe, to eat foods made with insects.

To overcome these challenges, some industry experts advocate for positive communication: highlighting the virtues of insect protein, combating misinforma-

tion surrounding insect-based foods, and informing consumers about food safety in these products.

Despite these difficulties, there were still initiatives such as **Tebrio's**, which began building a 90,000m² factory in the province of Salamanca in the second half of 2023 to produce 100,000 tonnes of **Tenebrio molitor** products.

Ynsect also announced the creation of a genotyping chip for insect breeding, which means 'a significant step of selection of larvae lines to produce more insect-based proteins', the company states.



Cricket flour. Photo CNTA

First air protein-based ice cream brought out

In 2023, we saw air protein grow in prominence. This opportunity scenario went from having a share within this macro scenario of 1% in 2022 to 2.24% in 2023.

With any doubt, the most striking news from this scenario was that of **Solar Foods**, which launched ice cream made from air protein on the menu at the Italian restaurant **Fico** in **Singapore** in June 2023. This was the first time anywhere in the world that a food made with this type of al-



Solar Foods Air Protein Ice Cream

Photo Solar Foods

ternative protein has been made available to the general public. The start-up also completed an **€8 million** funding round, which will help it build a new factory in 2024, in Vantaa, Finland.

Another noteworthy story in 2023 was the partnership between the **Bill and Melinda Gates Foundation** and the **Novo Nordisk Foundation** to support a consortium that plans to use CO² for food applications.

Hybrid products, a possible solution to promote alternative proteins

In Hybrid Products (in which proteins from two different sources are combined), in 2023 we began to see different initiatives that aimed to combine **cell-based** and **plant protein** as what could be a simpler way to com-

mercialise cell-based products, since producing meat made completely from cells at reasonable costs is not yet viable.

Such was the case of **SciFi Foods**, which experimented with 10-20% cultured proteins

mixed with plant-based proteins (mainly soya beans) to produce hamburgers. Along the same lines, **Mane** and **NewForm** joined forces to develop and scale hybrid products in which cell-based and plant protein are mixed.

Alternative fats, looking towards precision fermentation and cell culture

Fat is a key macronutrient in creating the flavour, mouthfeel and nutritional value of food. Currently, around 50% of global fat production is derived from soyabean and palm oils, followed by other vegetable oils (25%), fat derived from animal meat (13%) and fat from dairy (12%).

A growing number of companies are progressing towards the production of fats and oils which can serve as alternatives to these, and **precision fermentation** and **cell culture** are increasingly seen as the best technological solutions to produce them.

An example of progress in cell culture was **Hoxton Farms**

opening what it claims to be the UK's first pilot production facility for cultivated animal fat.

Meanwhile, **Nourish** relied on precision fermentation to make its Tastilux fat alternative and **Yali Bio** also opted for this technology to make its milk fat alternative.

Cargill and the Spanish start-up **Cubiq Foods** announced their intention of accelerating the large-scale commercialisation of **Cubiq's** novel alternative fats, including its innovative **Go!Drop**, for plant-based meats and dairy, among other products.

Likewise, in the **Other alternative food-ingredients** scenario,

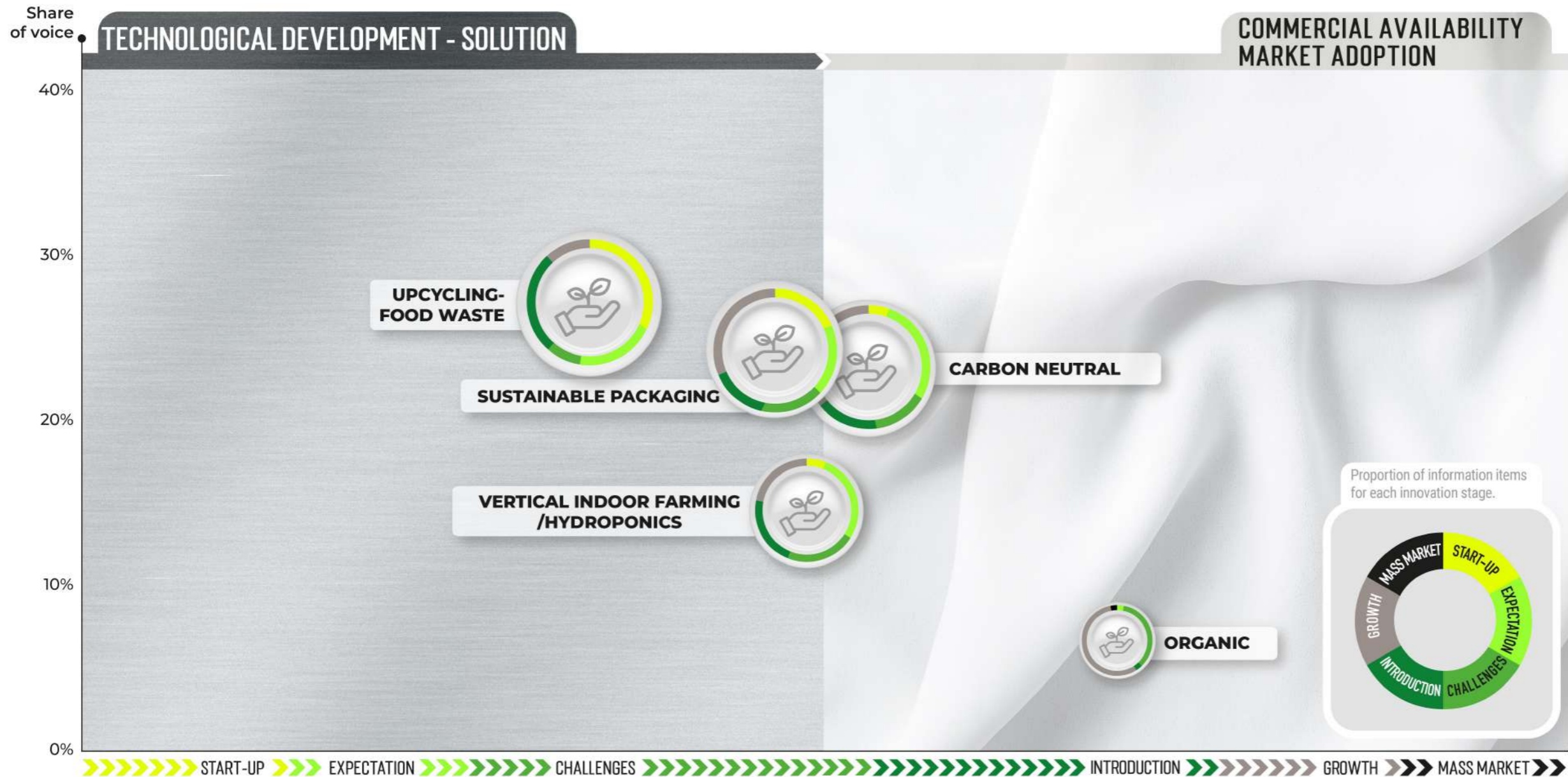
most of the proposals had to do with new products arriving on the market. Some of these were rather sweet in nature since in 2023 we learnt of initiatives to make different types of honey analogues, such as those from **Melibio** and **Fooditive**, and cocoa-free chocolate analogues, such as the ones by **WNNW** and **Nomo**.

Also noteworthy were the initiatives of **Chosen Foods**, with its pumpkin spice avocado oil caviar and those of different start-ups (**Atomo**, **Minus Coffee**, **Northern Wonder**, **Prefer**, **Voyage**, **Cult food science** and **Stem**) which proposed alternatives to coffee.



FOODTECH OPPORTUNITY SCENARIOS. SUSTAINABILITY

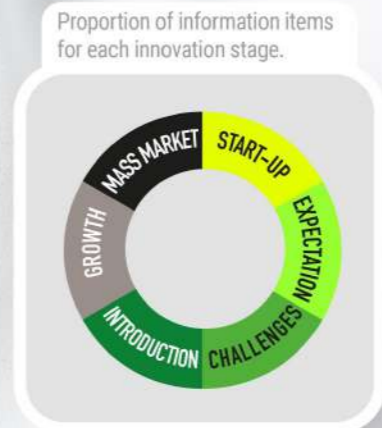
JAN/DEC 2023 - 382 INFORMATION ANALYZED



The second map is **Sustainability**. On this map, we find 5 opportunity scenarios, **Upcycling-food waste** having the highest share of voice, 25.55%, followed in second and third place by **Sustainable packaging** and **Carbon neutral** with very similar shares of just over 24.5%.

As for innovation stage, we can only see any change in the **Vertical-indoor farming/hydroponics** scenario, going from the **Introduction to the market** stage in the 2022 Report* to **Challenges** in 2023. This was because some relevant players in this scenario experienced financial difficulties.

* You can consult the 2022 report map on page 90.



Stage of Food Tech innovation

Upcycling, a solution to fight against food waste

Sustainability is marking the food industry and the fight against food waste is one of the great issues in this field.

In the **European Union**, almost 59 million tonnes of food are wasted every year, which amounts to 131 kilograms of waste per person per year. To tackle this problem, one solution that is gaining in importance is upcycling, which we include in the **Upcycling-food waste** scenario.

Upcycling is becoming a key strategy in by-product management and, **Innova Market Insight** informs us, companies are coming up with more and more innovations to implement it. The latest figures from the consultancy firm indicate that from the first quarter of 2022 to the first quarter of 2023, a total of 674 upcycled products were launched, 18.6% more than the previous period.

Some of the challenges that this

Upcycling is becoming a key strategy in by-product management and companies are coming up with more and more innovations to implement it.

scenario needs to overcome are:

- Improving **supply chains**.
- Creating a **new narrative** for upcycled ingredients-products.
- Expanding **technological boundaries**.
- Having **clear regulations in Europe** on what is meant by food waste.

Some of the initiatives that sought to solve these challenges were led by **Kern Tec**, which clo-

sed a €12 million funding round to continue developing its dairy alternatives from fruit pits, and the partnership between the Chilean company **Done Properly** and **AB InBev** to make a sodium substitute from beer by-products.

In Spain, we heard about **El Corte Inglés** partnering up with **Cervezas Mica** to sell beer made using excess bread; **Bread Free**, which is investigating the incorporation of waste from the brewing industry to make gluten-free barley flour, and **Väcka**, which launched plant-based cheese analogues made with melon seeds and olive oil at the beginning of 2023: *Mözza* and *Pumpkin Chxdar*.

Another initiative of interest was that of **Impact Upcycled Foods**, which, together with CNTA, developed a new instant drink rich in caffeine from coffee husks in the third edition of Food (Tech)² Challengers.

Sustainable packaging, the aim is to reduce plastic

The packaging industry is still working to accelerate along the path to sustainability. Since the end of 2022, different governments have been promoting standards to push sustainable packaging.

In 2023, it was announced that the **European Parliament** was endorsing the Commission's proposed targets to reduce packaging (5% by 2030, 10% by 2035 and 15% by 2040) and add specific targets to reduce plastic packaging (10% by 2030, 15% by 2035 and 20% by 2040). MEPs also want EU countries to ensure that 90% of the ma-

terials contained in packaging (plastic, wood, ferrous metals, aluminium, glass, paper and cardboard) are collected separately by 2029.

This has led different companies to look into and come up with solutions to make packaging more sustainable. Consequently, it should come as no surprise that launches and range expansions were the number one topic in the **Sustainable packaging** scenario, with a share of 42%

In 2023, we saw packaging solutions using bio-based plastics and other alternatives to

petroleum-based plastics, and the implementation of ways to reduce packaging. Some of the proposals seen were led by **Tetra Pak**, which expanded its range of packaging solutions using recycled polymers; **Lactalis Nestlé**, plumping for bio-based plastic for its ready-to-go coffee container, and **Maderight**, which managed to raise \$2 million to develop its fungi-based solutions.

Curious too was the case of **Cabreiroá** with its 100% biocompostable sugarcane-based **PLA** (polylactic acid) container, which is not yet on sale.

PACKAGING TRENDS, ACCORDING TO INNOVA MARKET INSIGHTS

The market intelligence consultancy firm **Innova Market Insights** detected certain trends in the packaging sector in 2023, which included:

- **Plastics circularisation.**
- **Transparency and truthfulness.** Consumers want to know the environmental impact of specific packaging.
- **A commitment to renewable packaging**, mainly made from paper and bioplastics.
- **Packaging** connected with digital interaction.
- **The reusable is gaining ground.**



Carbon neutral, companies set ambitious targets

In the **Carbon neutral** opportunity scenario, many of the news stories were about proposals being put in place to pollute less. One of the companies involved was **Mars**, which as part of its strategy to reduce greenhouse gas (GHG) emissions is optimising its product recipes to include more environmentally friendly ingredients. The multinational announced a roadmap in which it will invest \$1 billion to reach zero GHG emissions

across its value chain by 2050.

Towards the end of 2023, **Lactalis USA, General Mills, Kraft Heinz, Bel Group, Danone** and **Nestlé** announced an alliance to encourage transparency and accountability on methane emissions from their dairy supply chains.

Meanwhile, the **IAN Group** undertook a decarbonisation project for its business with the help of Edison Next to reduce its emissions by 29% by 2027,

42% by 2030 and 90% by 2050.

Another interesting initiative was that of **Eroski**, which added its Planet Score environmental label (a way to easily communicate the global impact of a foodstuff on the environment) to 29 food products.

Some companies also undertook to move towards 'Net zero', which is achieved when a company eliminates more Greenhouse gases (GHG) than it produces.

CAREFUL WITH 'GREENWASHING'

One of the major challenges faced by this opportunity scenario is the fight against 'greenwashing', unrealistic claims and environmental certifications on products and services that are misleading, ineffective and have no scientific basis.

Faced with this situation, in 2023 the **European Commission** presented a provisional agreement that aims to provide consumers with clear, truthful and reliable information, that is, when they buy food or drink with environmental claims, they can be sure that these statements are truthful.

Even so, the **European Consumer Organisation** (BEUC) called for a 'ban' on 'carbon neutral' claims on food and beverages in Europe, even when offsetting projects are funded to achieve it.



Vertical-indoor farming/hydroponics, reasons to be optimistic and pessimistic

In 2023, the **Vertical indoor-farming/hydroponics** opportunity scenario followed the path it set off on at the end of 2022, when we saw investments and projects to scale vertical-indoor farming technology. However, we also saw that some relevant companies in the industry were having a hard time due to the high price of energy and the instability of the financial markets.

The more positive side of things featured several funding rounds, such as **Planet Farms**, which raised \$40 million to expand in Italy and the United Kingdom, or the Spanish company **Groots**, which managed to raise €3.5 million.

We also learnt about several investment projects, such as **Hardee Fresh's**, which intends to build a 30,000m² vertical farming facility in Georgia (United States); **Ekonoke's**, which grows hops hydroponically indoors and plans to complete a 1,000m² pilot plant in Chantada (Lugo) early in 2024, and the

European **LIFE FARMITANK** project, in which CNTA is taking part, where a vertical agriculture prototype was installed at **Florette Ibérica's** facility

A special case was that of **AeroFarms**, which received €71 million in funding when it emerged from bankruptcy. The company says it has 'eliminated spending' on all projects not related to the development of its Danville, Virginia farm.

The uglier side of this scenario featured companies such as **In-farms**, which filed for bankruptcy, or **Bowery Farmin**, where there were multiple layoffs.

Furthermore, according to data from AGFunder News, investment in **New Agricultural Models** (which includes everything from indoor crop systems, such as vertical and indoor farms, to insect agriculture or algae production) fell significantly in 2023, generating a total of \$673.2 million in invested funds compared to \$2.92 billion in 2022, a 77% drop from one year to the next.



Vertical Farming Farmitank installation. Photo CNTA



Organic, increase spending on these products

In the Organic scenario, the two main topics in the news analysed were: launches, 62%, and challenges to overcome, 34.5%.

The big challenge facing this scenario was the rise in prices. According to the **Spanish Consumers and Users Organisation (OCU)**, eating organic in Spain was '62% more expensive'. This factor became the 'main reason for abandonment'

for those who consumed organic food on a regular basis, as shown in the study Connecting with eco-conscious consumers by the **Open University of Catalonia (UOC)**.

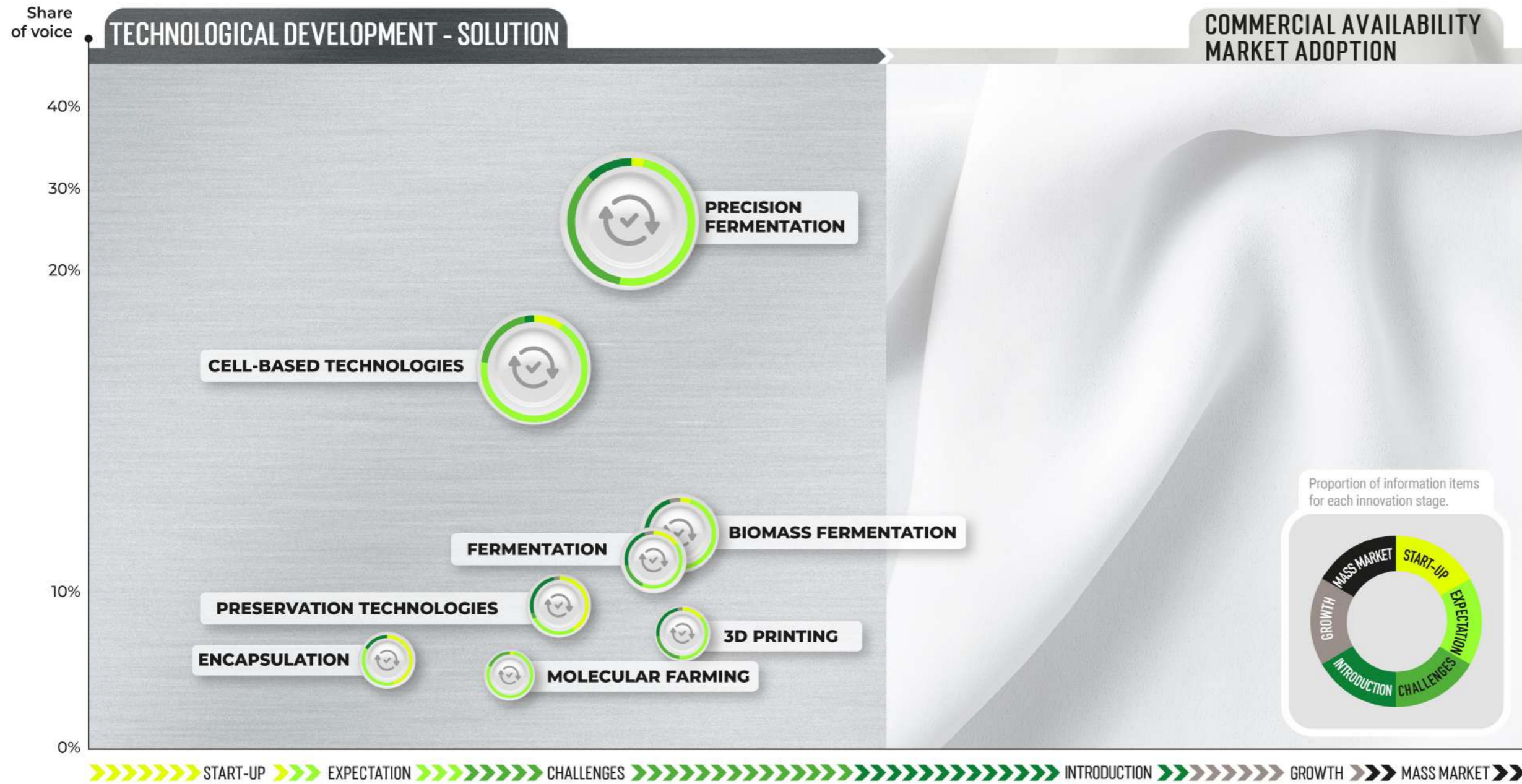
However, the data show that more and more people are turning to this type of product. The latest **Ecovalia** data indicate that spending on **organic products in Spain** stood at €2,856

million in 2022, 13% more than in 2021.

The new proposals we saw included **Delicatalia's** cereals, creams, biscuits, baked goods and eco cereals; the new line of organic soft drinks 'Organic' with adaptogens and functional ingredients from **Relash**, and the expansion of **Aldi's** organic range.

FOODTECH OPPORTUNITY SCENARIOS. NEW PROCESS TECHNOLOGIES

JAN/DEC 2023 - 364 INFORMATION ANALYZED



The third map we bring to you is the **New process technologies** map, which focuses on the technologies that are modifying the way food products are made.

This map consists of 8 opportunity scenarios, **Precision fermentation** leading the others in terms of share of voice with 29.51%, followed by **Cell-based technologies**, **Biomass fermentation** and **Fermentation**.

Almost all the scenarios here are in the stage of innovation Hype, except **Encapsulation**, which is in the Start-up phase but very close to Expectation.

The only scenarios that changed their stage of Innovation were **Fermentation** and **Cell-based technologies**. Fermentation went from Challenges in the 2022 Report* to Expectation due to the increase in research and number of projects which need to be scaled up. For its part, Cell-based technologies passed from the Start-up stage to Expectation because companies were working on ideas which had moved out of the laboratory.

* You can consult the 2022 report map on page 92.

Stage of Food Tech innovation

Precision fermentation, the technology stealing the limelight



CNTA bioreactor. Photo CNTA

In the **Precision fermentation** opportunity scenario, the most repeated themes in the news analysed in 2023 were projects with future potential and the challenges that this technology needs to overcome before it can be developed further.

In 'The Green Revolution edition 2023', **Raquel Virto**, head of the Microbiology Research Department in the R&D+innovation section of CNTA, stated that: 'The main obstacles to the development of the European precision fermentation industry are: regulation (definition of clear rules on the ingredients produced in this way) and process scalability.'

Start-ups launched initiatives to try to improve process sca-

lability. **Liberation Labs**, for instance, secured a \$25 million loan, backed by the US Government, to build a commercial-scale precision fermentation facility in the United States.

**BEYOND PLANT BASED:
DATA, FOCUS
AND FUTURE**



See the article of the event in the CNTA website

Similarly, **LiDestri Foods and Drinks** and **Fermentum** began to work on a precision fermentation plant to scale the proteins made using precision fermentation technology and **Pow.bio** raised \$9.5 million to expand its developments at a pilot plant in Alameda (California).

Other proposals included the announcement of **Danone's** investment in the start-up **Imagindairy** and the creation of the European association **Food Fermentation Europe (FEE)**. This alliance, made up of **Better Dairy, Formo, Onego Bio, Those Vegan Cowboys** and **Imagindairy**, seeks to pave the way to allow innovative solutions to reach the market in a more agile fashion.

Biomass fermentation, investments to develop the technology

Start-ups continued to look towards biomass fermentation technology to make alternative foods in 2023. Most of the information analysed centred on the future projects or expectations of companies, with 34.9%, and investments or funding rounds, with 20.9%.

One recipient of such investments was the German start-up **Kynda**, which secured a grant from the German Government to advance in the production of mycelial protein using its biomass fermentation platform.

Also noteworthy were the new single-cell protein sample pilot

plant that **MicroHarvest** opened in Lisbon, **Aqua Cultured Foods'** plans for new facilities which will allow it to scale up the production of its seafood analogues and the €6 million raised by **Farmless** to build a pilot plant and speed up the research and development of its microbial protein.

Other types of fermentation, which are neither biomass nor precision fermentation, are included in the **Fermentation** opportunity scenario.

We heard about **MycoTechnology's** Fermentation as a Service (FaaS) platform to help companies ensure fermentation capacity. We also saw proposals such as **WNWN's** cocoa-free chocolate, developed through fermentation, or the natural additives from **Mmmico**, a Spanish start-up which took part in the second edition of the 'Spain Foodtech start-ups Program' acceleration programme and relied on the technological support of **CNTA**.



CNTA bioreactor. Photo CNTA

Cell-based technologies, working on reducing the cost of growth media

In the **Cell-based technologies** opportunity scenario, most of the news centred on initiatives which seek to optimise and lower the costs of growth media, the great challenge facing this scenario.

Given the great difficulty of scaling up this alternative protein and achieving an affordable price, several technologies are being designed (**scaffolding, culture media, organoids, stem cell lines** and **tissue templating**, among others) to develop cells of this type. We cover these in the **Cell-based technologies** scenario.

To move closer to such optimisation, in 2023 we saw pro-

posals such as **Novel Farms'**, which uses scaffolding, microbial fermentation techniques and tissue engineering to try to optimise growth media, or **Omeat's**, which made the first commercial sales of **Plenty**, its affordable alternative to foetal bovine serum.

In a similar vein, **Multus** proposed outsourcing culture media instead of producing them internally to reduce costs and presented a foetal bovine serum (FBS) substitute called Proliferum M.

Dyadic International also announced that its animal-free bovine serum albumin is structurally identical to commercial

animal albumin. And **Good Meat** took things one step further when it received regulatory approval from the **Singapore Food Agency** to use serum-free media for the production of its cultivated meat, allowing it to sell cultivated chicken meat without using animal serums there.

Using another approach, the British start-up **Uncommon** said that it had developed a more efficient way of introducing RNA into cells (an idea similar to that used for COVID vaccines) so that, with that RNA, it could then direct the differentiation of cells towards fat or muscle and develop cell-based products.



Good Meat pilot plant. Photo Good Meat

€17 MILLION FOR COCOON BIOSCIENCE

In Spain, we also heard about proposals concerning culture media, such as that of the start-up **Cocoon Bioscience**, which in 2023 secured funding worth €17 million to build a new

manufacturing plant located in the Bizkaia Technology Park in Zamudio (Bilbao) and continue developing its high-performance growth factors for the cultivated meat industry.

Likewise, we learnt in 2023 that the Spanish molecular agriculture specialist **Agrevent** is making progress designing its portfolio of proteins for culture media for launch in 2024.

3D printing, some new products reach the market



Bacon plant based by Foodys and Cocuus. Photo Foodys

3D printing is in the Expectation stage although in 2023 we did actually see novelties reaching the market. One example of this featured **Foodys** and **Cocuus**, who managed to sell

what they define as 'the first plant-based bacon made using 3D bioprinting' to the Carrefour España supermarket chain.

Internationally, **Redefine Meat** launched several 3D-printed

meat analogues in the British supermarket chain Ocado and Austrian start-up **Revo Food** unveiled The filet, a mycoprotein-based salmon fillet, at an Austrian vegan store.



Bioprotective crop. Photo CNTA

In the **Preservation technologies** opportunity scenario, we continued to see a great deal of research activity in 2023 to improve existing solutions and achieve longer shelf lives, lessen the effects of using technology, etc.

Some of the research looked into **pulsed electric fields** technology as an alternative to freezing in order to kill anisakis in fish, **cold plasma** to eliminate microorganisms and preserve food, and the use of bioprotective cultures with antimicrobial activity.

Other solutions we saw were: **Evercase's** smart storage containers, which use magnetic and electric fields to keep food below 0 degrees without crystallising to preserve it in a soft, pliable condition, and **stickers** (which release plant-based compounds to prevent premature ageing and prolong shelf

Preservation technologies, new ideas to extend shelf life

life) by the company **Ryp Labs**, which raised funding to the tune of \$8.1 million.

Different preservation technologies are also being researched in Spain. Examples of this were **Florette**, which as part of the European **Co-fresh** project started looking into a new active form of packaging that absorbs

the moisture from packaged foods to extend product shelf life, and the start-up **Bio2coat**, which took part in the Spain FoodTech programme, in which CNTA acted as technological partner, and developed 100% natural coatings that increase the shelf life of foods such as fruit and vegetables.

Encapsulation: research to find new uses



Encapsulated pomegranate extract. Photo CNTA

Encapsulation was a technology which continued to generate research projects due to interest in it for the development of functional products, given that after its application in **bioactives** or compounds, their **functionalities** can be improved and they can be included in **food matrices**.

Different research projects were the subject of most of the news analysed in this opportunity scenario, with 45.2%. Some

dealt with the **microencapsulation of phenolic compounds, propolis extract nanocapsules** and the application of different **encapsulation strategies for probiotics**.

We also saw initiatives reaching the market, such as **TopGum's** line of high-dose caffeine gummies, which uses microencapsulation technology. In Spain, we saw **Nucaps Nanotechnology's** encapsulated food ingredient developments.

Molecular farming, plants for protein production

The new feature of the **New process technologies** macro scenario in 2023 was the opportunity scenario **Molecular farming**, through which plants are used to produce proteins.

This technology has been around for some time, but it appears as a new opportunity scenario due to the great impact it had in information and on research in 2023.

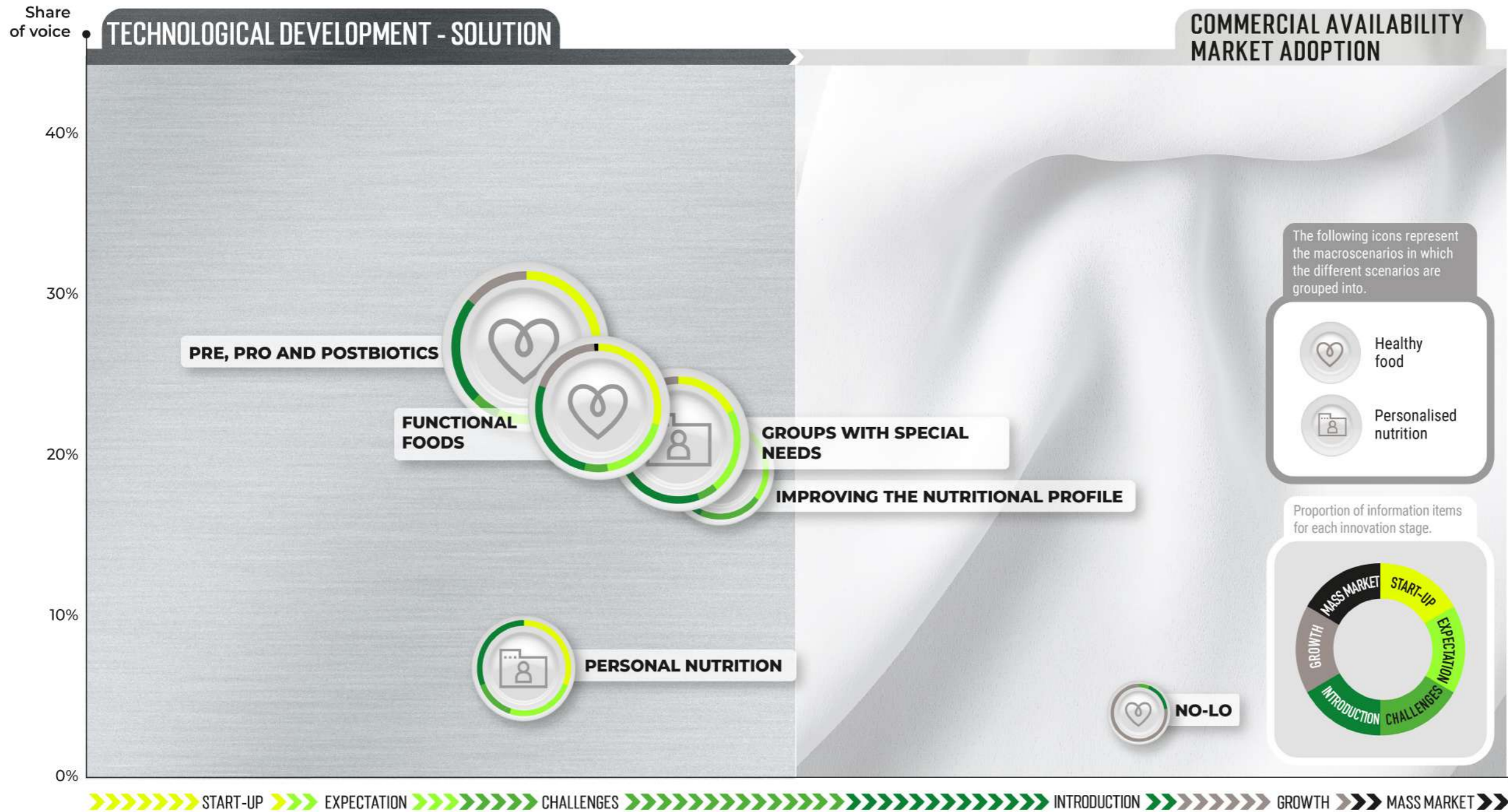
Examples of this were the presentation of 'Piggy Sooy', the soya bean that produces pork proteins through molecular farming, by **Moolec Science**; the **Ingre-dientWerks'** initiative by which it produces heme protein through genetically modified corn, or the alliance between **KBio** and **ZERO** to build a molecular farming network.

As for funding, the largest investments in this scenario were made in **Moolec Science**, which raised \$30 million to strengthen its financial position and accelerate its business model, and in **Elo Life System**, which obtained \$24.5 million to develop a new natural sweetener made through molecular farming with genetic information from monk fruit.

FOODTECH OPPORTUNITY SCENARIOS. HEALTHY FOOD AND PERSONALISED NUTRITION



JAN/DEC 2023 - 390 INFORMATION ANALYZED



The fourth map we are going to analyse is **Healthy food and Personalised nutrition**. This map is composed of two macro scenarios closely linked to each other, both focusing on health: **Healthy food** and **Personalised nutrition**.

The map contains 6 opportunity scenarios. The one with the largest share of voice is **Pre-, pro- and postbiotics**, 28.97%, followed by **Functional foods**, **Groups with special needs** and **Improving the nutritional profile**.

In this graphic representation, we can see that virtually all the scenarios are in the same stage of innovation as in the 2022 Report*. The only exception is **Groups with special needs**, which advanced from the Expectation stage in 2022 to Challenges in 2023. The challenges to overcome for this scenario include scaling up industrially and making progress with solutions that meet consumer expectations.

*You can consult the 2022 report map on page 94.

Stage of Food Tech innovation

Pre-, pro- and postbiotics, beyond gut health



Consumers are showing growing interest in their gut health and maintaining a **healthy microbiome**. This interest means that probiotics, along with their counterparts, prebiotics and postbiotics, are receiving increasing attention.

But science wants to go further and study the relationship between the gut and other parts of the human body. At the last **IPA World Congress + Probiota**, we discovered that more and more studies support the benefits of probiotics, prebiotics, symbiotics and/or postbiotics for health beyond the digestive tract, including **oral, liver, skin,**

vaginal, urinary tract and cognitive health.

This analysis showed us that companies are continuing to look into the benefits that pre-, pro- and postbiotics can bring. For example, **Unilever** is using artificial intelligence to analyse hundreds of food ingredients and identify which ones are capable of feeding (prebiotics) the probiotics that produce **GABA** (an acid that is known to produce calming effects and is thought to have an impact on anxiety, stress and fear).

We also saw actual launches: **Nestlé's** new proprietary blend for infants that combines a pro-

biotic strain with human milk oligosaccharides and juices with probiotics from **Pressed Juicery**.

2023 also saw more launches featuring postbiotics (preparations of inanimate microorganisms or their components that confer a health benefit on the human body). Inalpi cheese protein slices enriched with postbiotics by **Tetra Pak** and **AB Biotek Human Nutrition & Health** were just one example.

As for investments, in 2023 **Archer-Daniels-Midland** (ADM) invested more than \$30 million in a Spanish facility that produces pro- and postbiotics.



Functional foods, aiming to improve mental health and rest

An important opportunity scenario in the health field is **Functional foods**. Many of the initiatives proposed in this scenario focused on **cognitive health** and aiding **better nighttime rest**.

Rarebird ran a campaign to fund its coffee alternative for mental well-being; **Puleva** presented its skimmed and lactose-free milk enriched with Naturcalm, and **BeverageScouts** released the Dreams range, which includes melatonin and magnesium, and in which the functional ingredients are stored dry in the product and are activated by pressing the cap and mixing them with the drink when you are about to have it.

Improving the nutritional profile, targeting sugar and salt



One consumer preference is for foods that have a **better nutritional profile**. Consumers are more aware and value the sugar, salt and fat content of a product more in their purchase decisions.

According to the report 'Food tensions in relation to health', carried out for Spain by the consultancy firm **Across The Shopper**, 24.1% of participants acknowledged that they avoid buying products that contain sugar, 20.7% will eliminate it in the future and 8.1% will reduce it. In the case of salt, 13% already avoid buying foods that contain it, 18.4% will exclude it in the future and 6.8% will reduce it.

Given this increased social pressure, and also pressure from investors, in 2023 multinationals such as **Nestlé**, **Danone** and **Mars** announced objectives, investments and proposals to make their products healthier.

Danone said it invests more than €5 million a year in research and development to improve the nutritional profiles of its products. **Nestlé** promised to sell 50% more products with a better nutritional profile by 2030 compared to 2022. And **Mars** announced research into an allulose alternative to sugar, also known as D-picolose.

As for technological solutions,

in the third edition of the Food (Tech)² Challengers technology catalyst programme, run by CNTA, **Levprot** sensorially characterised brazein to validate it as a solution for sugar reduction in dairy matrices.

Nucaps has a product to reduce the use of salt called 'Nucla', a technological solution developed by CNTA and transferred to the start-up, whose controlled release means that the consumer experiences a longer salty taste although the presence of salt has actually been reduced by up to 40% in the final product without losing organoleptic qualities.

No-Lo, consumers are on the lookout for these drinks

Another prominent opportunity scenario on this map is **No-Lo** (low-alcohol or non-alcoholic drinks). The reason for the rise of this scenario is that 'people are looking for healthy drinks, especially young shoppers', according to **Renata de Moura**, author of the study 'Shopping for beverage alcohol' and senior di-

rector of shopper and category insights at **Kantar**.

Some launches (the big subject in this scenario, accounting for 83.3% of the news analysed) we saw were: **Bodegas Peñas-cal's** low and non-alcoholic wine, **La Casera's** cider and vermouth aperitifs, **Martini's alcohol-free vermouth**, **Captain Morgan's**

alcohol-free rum and **Seagram's 0.0%** gin.

Also relevant was **AB InBev's** €31 million investment in technology for alcohol-free beers and **Pernod Ricard's** \$5 million investment in US non-alcoholic beverage retailer **Boisson**.



The food industry targets women, seniors, children and sportspeople

Most of the research and launches in the **Personalised nutrition** macro scenario were aimed at the opportunity scenario **Groups with special needs**. The groups that the companies most focussed on were: **women, seniors, sportspeople and children**.

One of the opportunities in this scenario, as pointed out by **Sagentia Innovation**, is 'to target holistic nutrition for women'. It expects 'to see a "new wave" of food and beverage products combined with services that diagnose female nutritional needs to offer tailored support' in quite a short space of time.

Likewise, the **senior** segment has great potential, with older people representing an increa-

singly large proportion of the population pyramid in, chiefly, Western societies. In view of this, food companies are working to offer products aimed at this group.

An example of this was **Alcampo's** new range of products for seniors, aimed at meeting their nutritional needs, and the launch of three varieties of milk powder formulations for healthy ageing by **Arla Foods**.

Related to this segment, we learned how **Campofrío Health** started a project in 2023, in which **CNTA** is taking part, through which it intends to improve its product catalogue for **swallowing difficulties**.

Also interesting were the movements to develop products

aimed at the child population. Some of the most striking were **Danone's** \$2 million investment in the Israeli start-up **Wilk** to make cell-based breast milk for inclusion in infant formulas and the launch of **Plezi Nutrition**, a company co-founded by **Michelle Obama** that focuses on healthier foods and drinks for children.

Finally, companies are also focusing on athletes or people who do sport. In 2023 we saw novelties such as the isotonic drink **Sportyeti Electrolytes**, which helps replenish 5 key electrolytes (sodium, chlorine, potassium, magnesium and phosphorus) which are lost when you sweat, and **Equii's** high-protein, low-carb bread.

PERSONAL NUTRITION, AI SUPPORT AND DIFFERENT CHALLENGES TO OVERCOME TO ARRIVE AT 'TOTAL PERSONALISATION'

The **Personal nutrition** scenario needs to overcome several challenges before it will be able to achieve 'total personalisation', including:

- **Consumer confusion** when filling out the different questionnaires that some companies need in order to offer their personalised products.

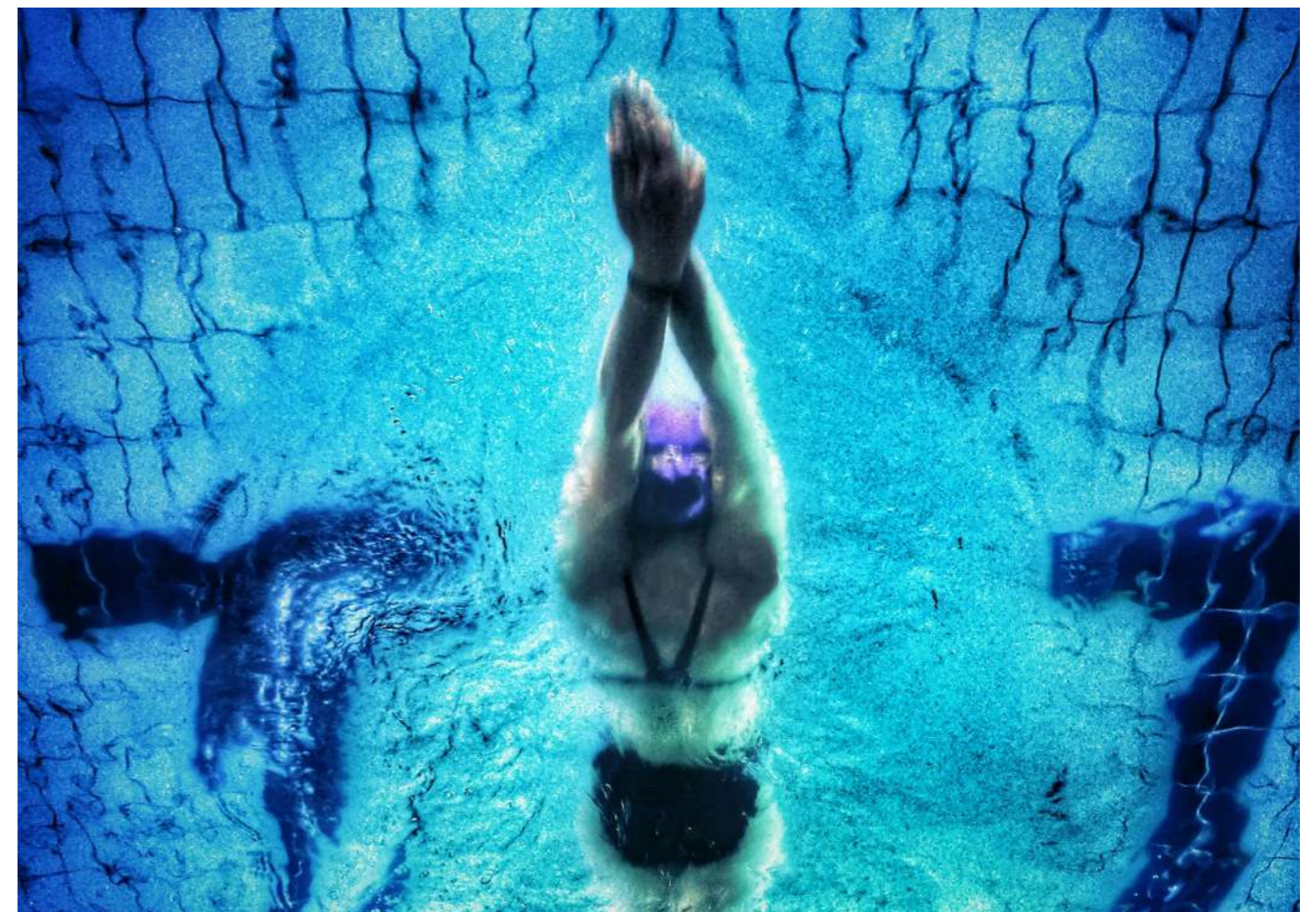
- There is no way to know the **optimal number of**

combinations a brand has to offer to satisfy all consumers.

- **Immediate production is challenging** and it takes time before consumers can receive their personalised food, so it all comes down to how long they are willing to wait for their products.

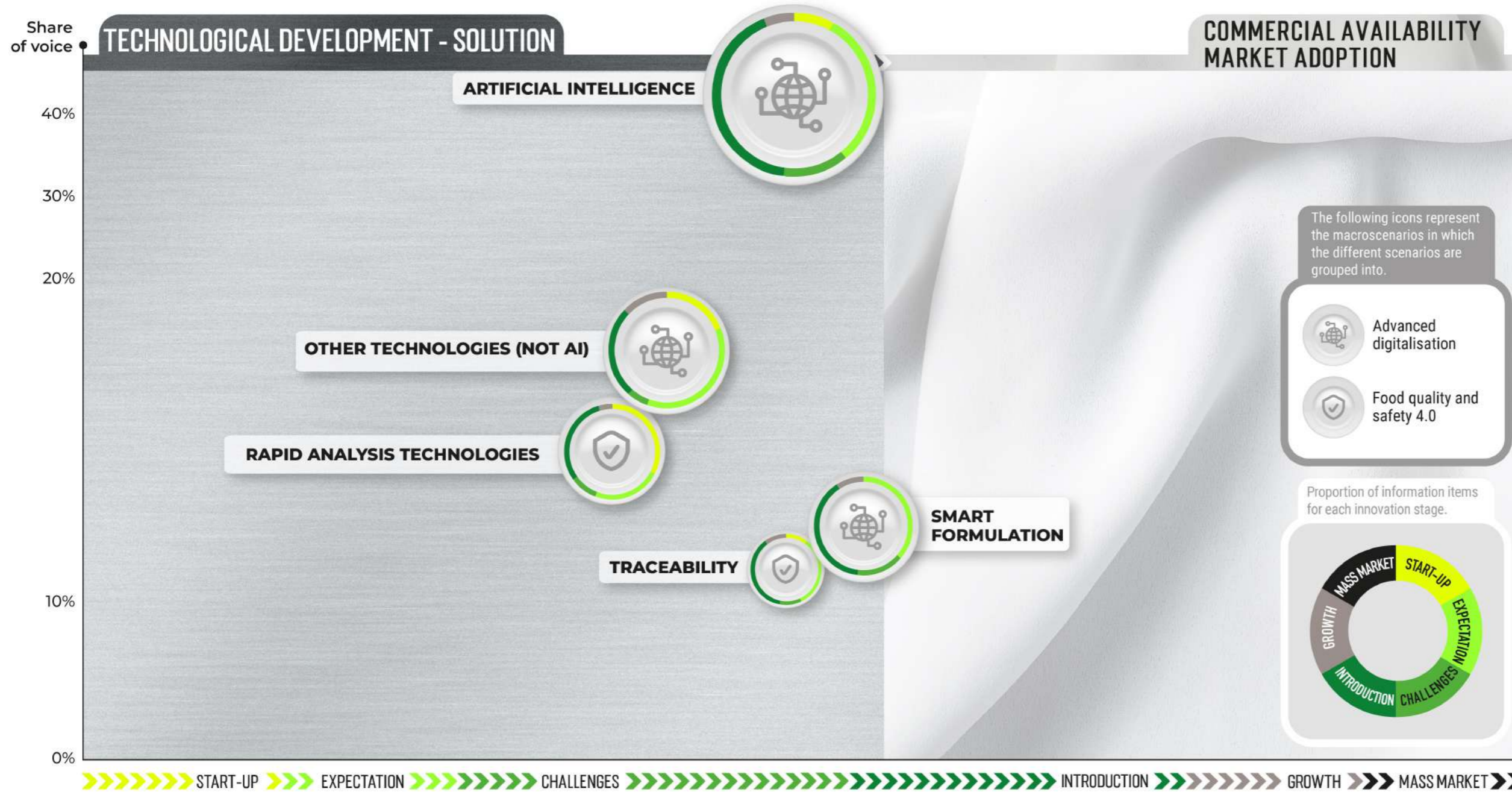
But despite this complexity, during the year analyzed there were research and

proposals for individualised solutions or recommendations in nutritional matters, many supported by Artificial Intelligence. One of these was that of **Elo Health**, a start-up that partnered up with **Nourished** to offer its customers the option of taking their personalised supplements in the form of gummies.



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

JAN/DEC 2023 - 291 INFORMATION ANALYZED



The last map in this section is **Advanced digitalisation and Food quality and safety 4.0**, two macro opportunity scenarios in which technologies are developed to progress in efficiency to make products and check food quality and safety, among other things.

This map features 5 opportunity scenarios, the **Artificial intelligence** scenario standing out a long way from the rest in terms of share of voice with 45%.

As for stage of innovation, only **Other digital technologies (not AI)** changed, passing from Challenges in 2022 to Expectation in 2023, with companies trying out different technologies to advance in the digitalisation of different processes in their businesses.

The other scenarios remained in the same stage as in the 2022 edition.

You can consult the 2022 report map on page 96.

Stage of Food Tech innovation

Artificial intelligence, an increasingly prominent opportunity scenario in FoodTech



The great focus in the macro scenario of **Advanced digitalisation** was everything that had to do with **Artificial intelligence** (AI), which in 2023 was the third opportunity scenario with the highest share of voice in our analysis.

In 2023, a number of food companies began to try out AI in their processes and there were cases where it was used for crop monitoring, sales forecasting, food quality and safety control, bioreactor management and the creation of customised plans, among other applications.

An example of this was the

multinational **Unilever**, which announced plans to open up its first laboratory dedicated to AI, where the areas of focus will include: forecasting, modelling complex data relationships through graph technology and generating information on trends, patterns and predictions.

We also learnt that some start-ups have solutions to integrate AI into the food industry. Some of these were: **AI Palette**, which is working on a market trend monitoring platform to help food and beverage manufacturers improve their success rate in product launches; **LogMeal**,

which has a tool based on Computer Vision and AI which can scan products or dishes and immediately obtain their nutritional information and ingredients, and **Factic**, whose solution helps agri-food companies improve demand management and decision making in their processes.

Tastewise introduced TasteGPT, it generative AI to help users at companies such as **Nestlé**, **Campbell's**, **Mars**, **Givaudan** and **PepsiCo**, discover dish concepts, validate new product ideas, and generate market research reports.

SOME CHALLENGES FOR AI



You can read the Byte to Bites article series by **Peakbridge VC** by scanning the QR code

For AI to continue to develop in the food industry, it needs to overcome several challenges. Some that Peakbridge VC lists include:

- Abundant high quality data is needed to achieve adequate algorithm performance.
- Insufficient processing power.
- Limited and insufficient historical data.
- High cost of AI implementation.
- The challenge of data protection and security.

- Consumer acceptance and environmental impact.
 - Consumer Behaviour and Sustained Adherence
 - Limited Evidence Base
 - Regulatory compliance
 - Reliability of Wearables
 - Ethical considerations.
- Ethical considerations and fear of the potential of AI led the EU to propose an **Artificial Intelligence Act** in the EU in 2023, the first of its kind in the world. This act will not come into effect until at least 2026.

Smart formulation to find new ingredients

Of great interest in the Advanced digitalisation scenario is the use of smart formulation (through AI) by companies to find new ingredients or design novel products

In the **Smart formulation** opportunity scenario, we saw initiatives such as that of **Maolac**, which thanks to its Maoreka algorithm and generative AI was able to identify specific protein combinations to launch its Maolactin bars for Gut Support and Maolactin for Anti-Inflammatory Activity. Another proposal was from the multinational **Kraft** and the Chilean start-up **NotCo** with their vegan version of mac and cheese, using Notco's AI technology Guiseppe.

We also saw companies use this technology to make different types of beverages. One example was **Coca-Cola 3000**, a new limited-edition Zero Sugar flavour co-created with AI.



Other digital technologies, towards the automated and digitalised factory

There were also movements in the two opportunity scenarios (**Rapid analysis technologies** and **Traceability**) linked to **Food quality and safety 4.0**.

Food quality and safety 4.0 is a step forward in food quality and safety because it combines vision and digital technologies with data science to generate significant advantages such as time savings, the ability to generate predictive models, the non-destruction of samples and data-based decision-making which can potentially improve the food production process.

In **Rapid analysis technologies**, we continued to learn

NIR and hyperspectral technologies are two of the most used in this scenario.

about **NIR** and **hyperspectral** initiatives to measure quality or shelf life and detect foreign bodies or food fraud.

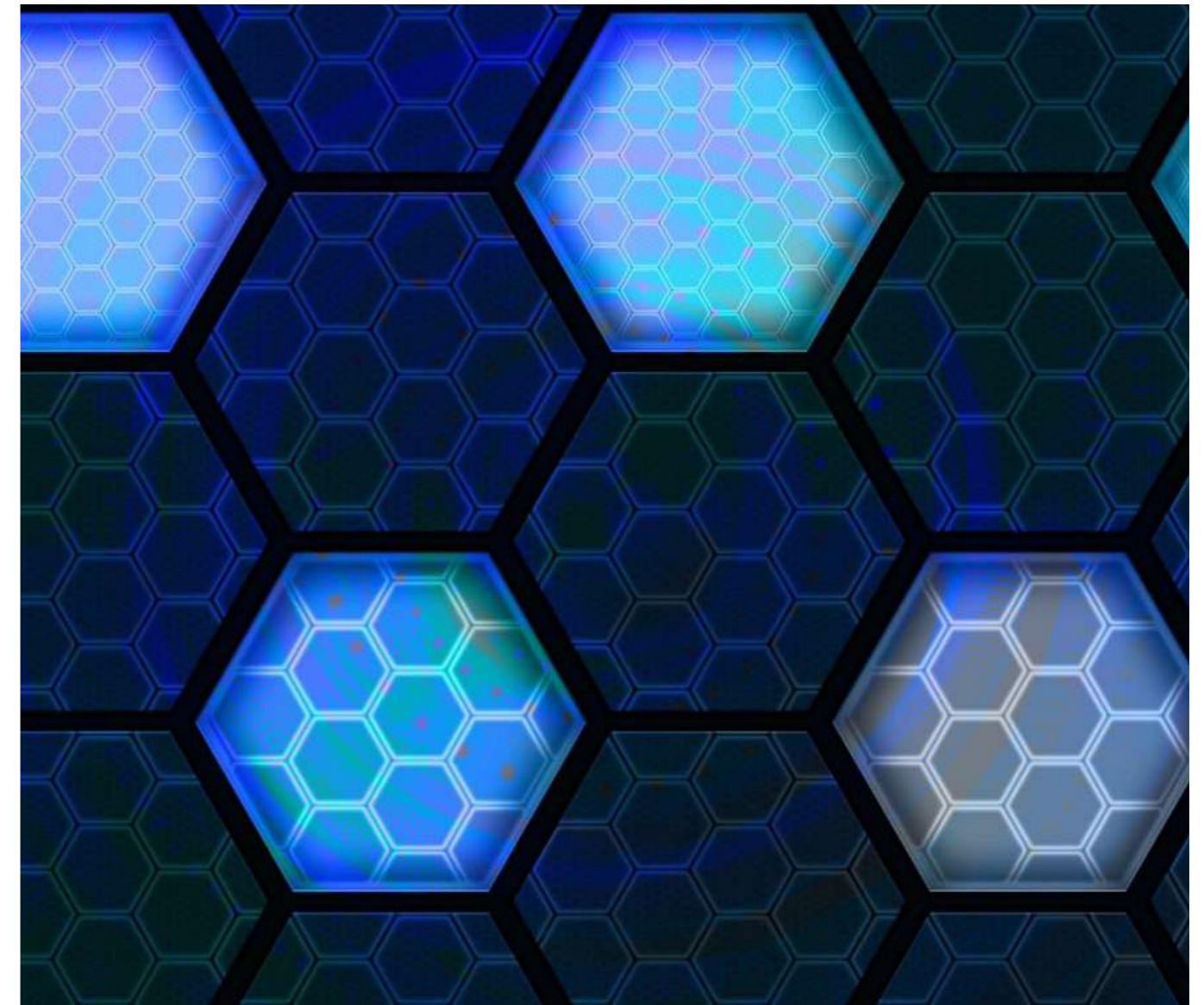
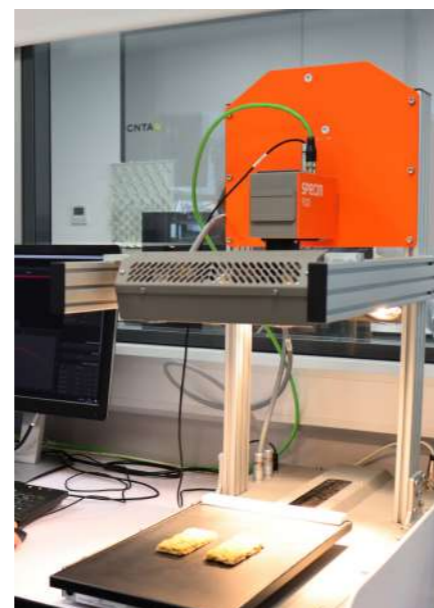
Summary: NIR and hyperspectral technologies are two of the most used in this scenario.

One example was that of the start-up **OneThird**, which raised €2.75 million to boost its AI-driven Near Infrared (NIR) Scanning technology, which allows the shelf life of fresh products to be predicted accurately and food waste to be minimised.

Further important funding was that obtained by **Evigence**, which raised \$18 million to develop its sensors, which, combined with data analysis, allow the freshness of perishable food to be monitored in real time.

The Israeli start-up **Neolithics** also patented a remote sensing system that combines Artificial Intelligence, hyperspectral technology, machine learning and food science to facilitate the instant and accurate evaluation of fruit and vegetable quality.

Using other types of technology, we saw the cases of **Positive Carbon**, which raised €2.3 million to boost its patented automated sensor technology to monitor food waste; **Scentian Bio**, which secured \$2.1 million to further its technology based on virtualising insect olfactory receptors (iOR), and **Sensifi**, which uses an 'artificial nose' for the rapid and local detection of pathogens such as *E.Coli* and *Salmonella*.



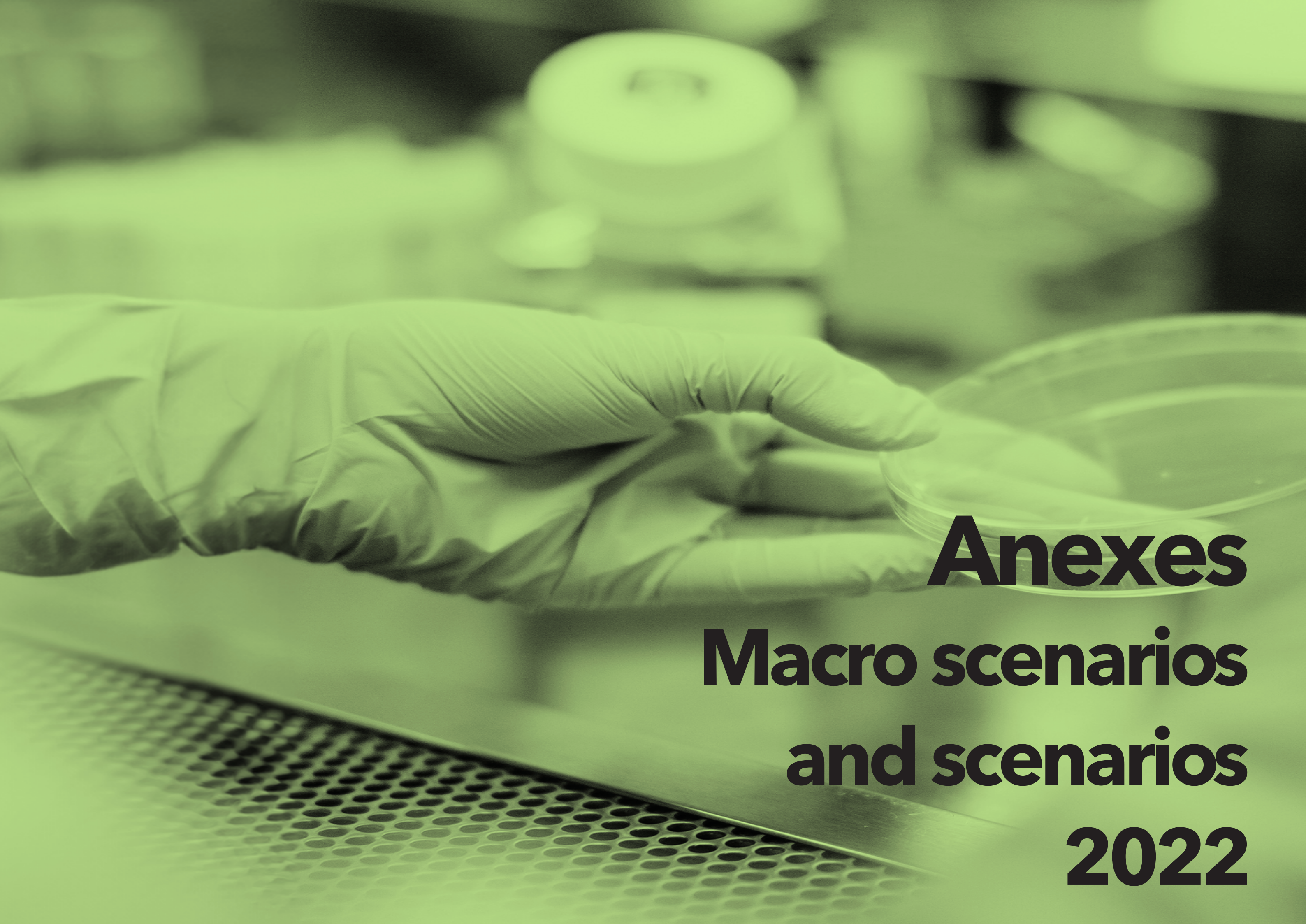
Blockchain technology dominates Traceability

Blockchain technology, which joins forces with production cycle management innovation to ensure transparency, safety and sustainability to better control product traceability, was one of the most widely used types of technology in the **Traceability** opportunity scenario in 2023.

Examples of blockchain use

were **Rujamar**, which manages its production cycle with this technology, guaranteeing transparency, traceability, safety and sustainability in its organic eggs, and **Blue Room Innovation**, which started a pilot project with several restaurants in Mallorca to offer their customers guarantees of origin for fish.

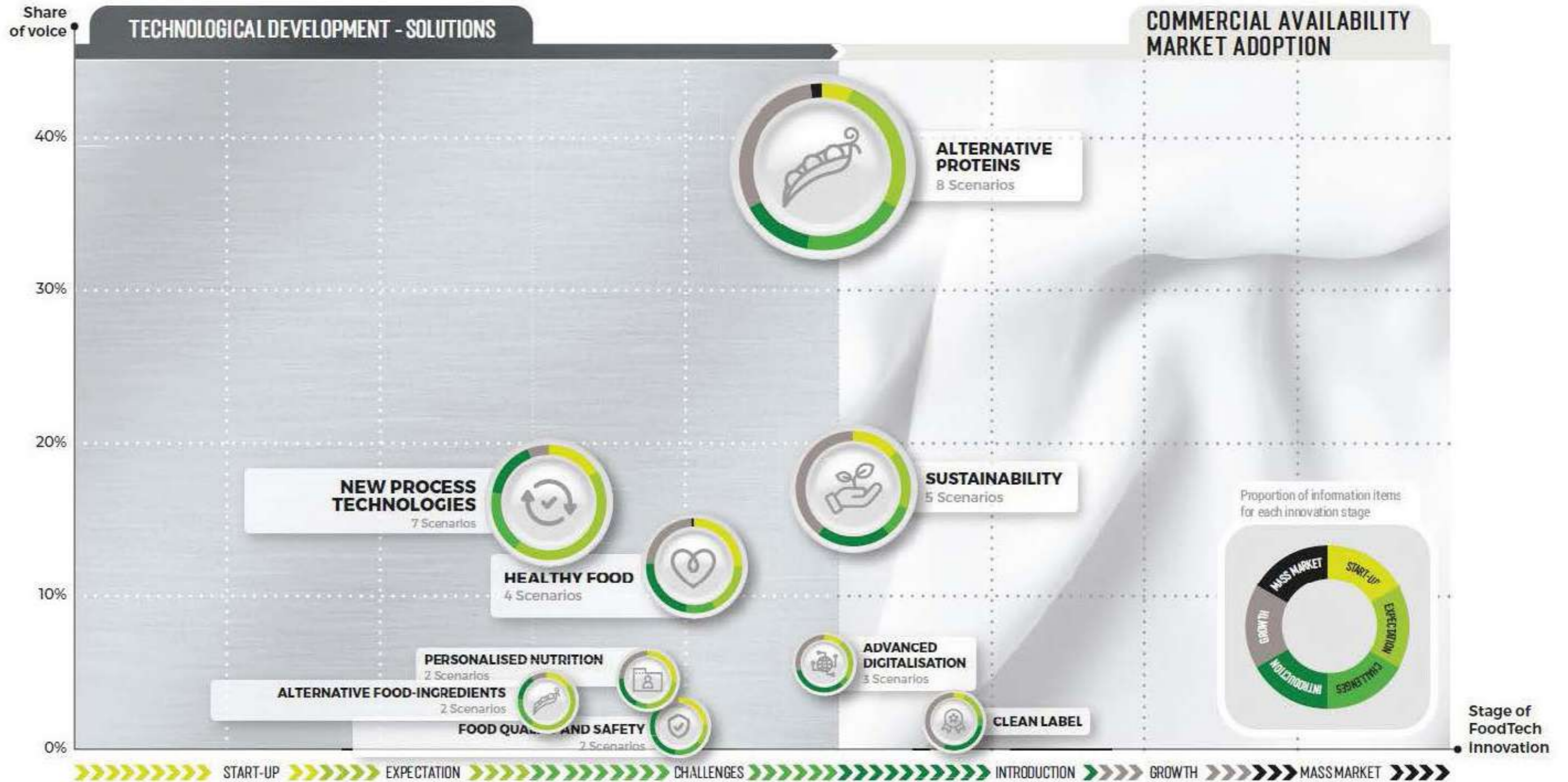
Other companies looked towards methods other than blockchain, such as **Oritrain**, which uses forensic analysis to verify product origin, and **Consorzio Parmigiano Reggiano**, which aims to combat food fraud by incorporating silicon chips to trace its cheese and verify its authenticity.

A photograph of a laboratory setting, overlaid with a green tint. A hand wearing a white nitrile glove is holding a clear petri dish. In the background, there are several white containers, possibly vials or bottles, on a surface. The foreground shows a metal tray with a perforated grid pattern.

Anexes
Macro escenarios
and escenarios
2022

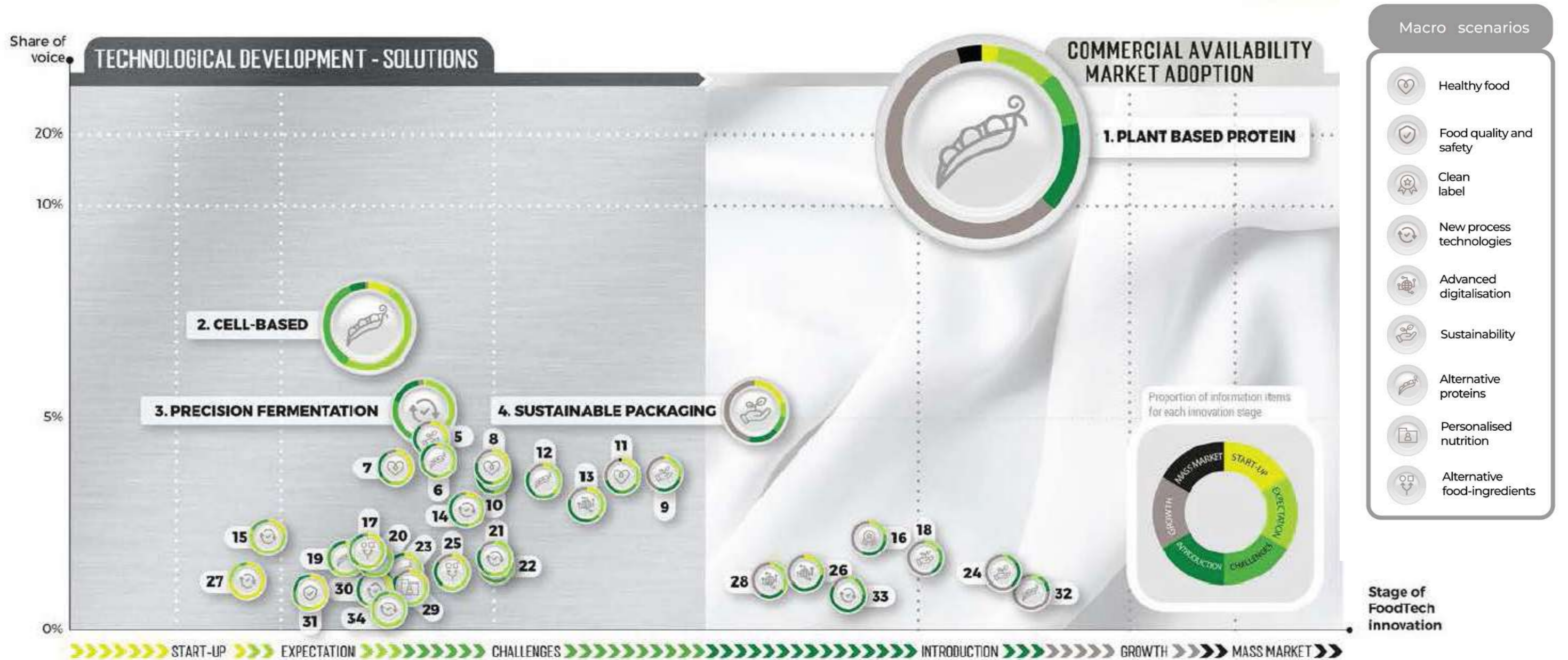
MAP OF MACRO-SCENARIOS OF FOODTECH OPPORTUNITY

JAN/DEC 2022 - 1.492 INFORMATION ANALYZED



MAP OF ALL FOODTECH OPPORTUNITY SCENARIOS

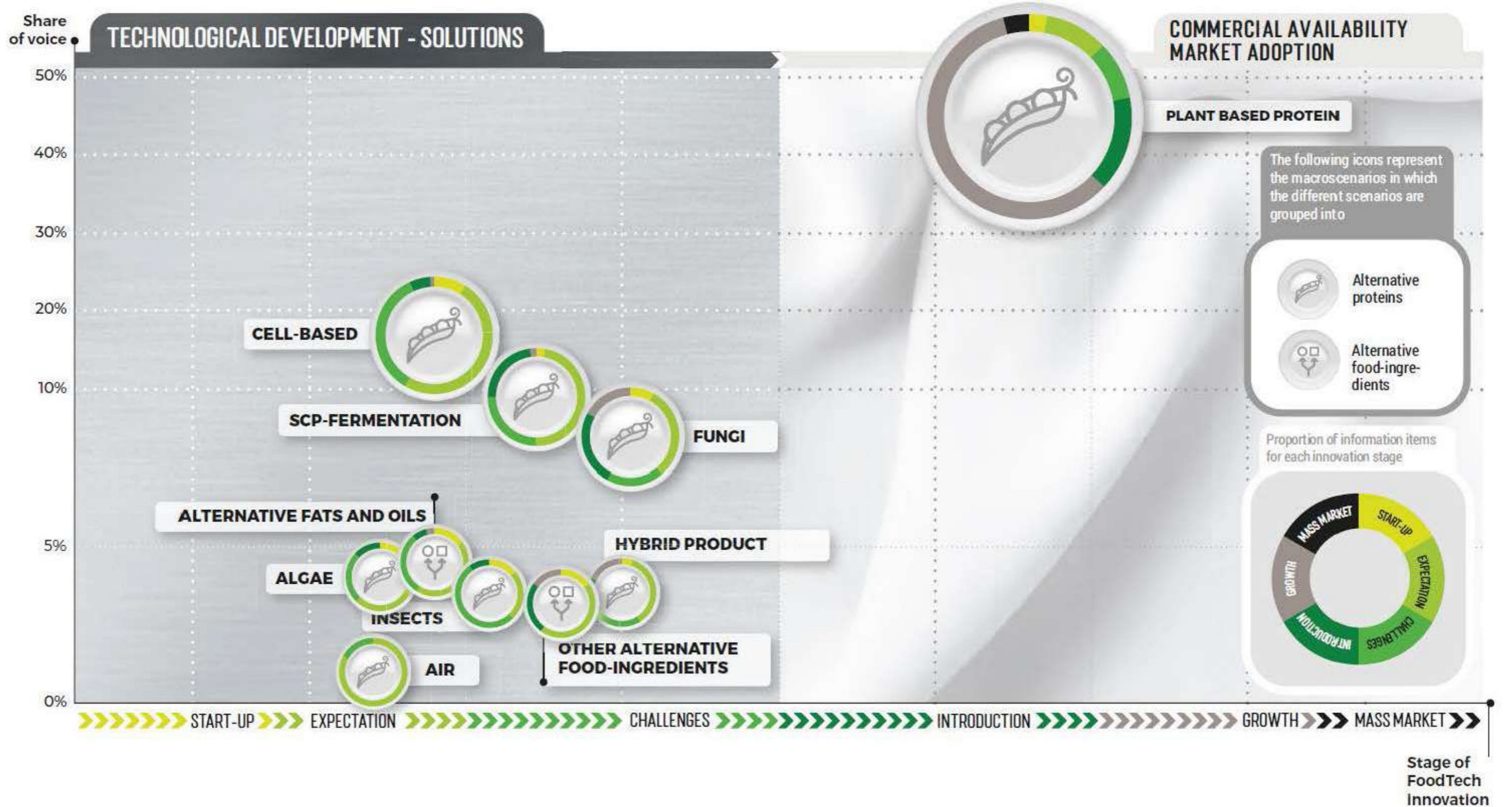
JAN/DEC 2022 - 1.492 INFORMATION ANALYZED



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

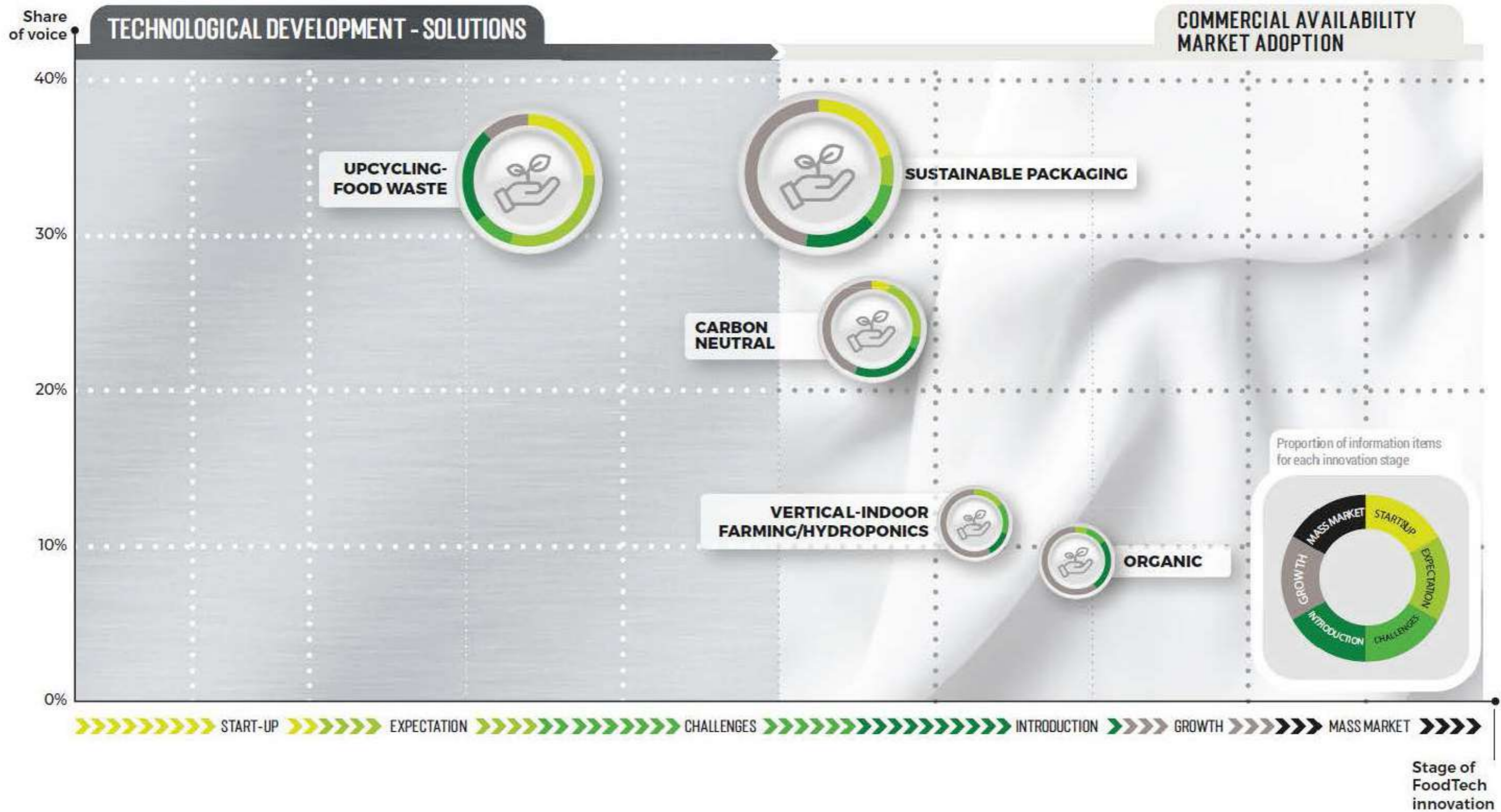
FOODTECH OPPORTUNITY SCENARIO. PROTEINS, FATS AND ALTERNATIVE FOODS

JAN/DEC 2022 - 615 INFORMATION ANALYZED



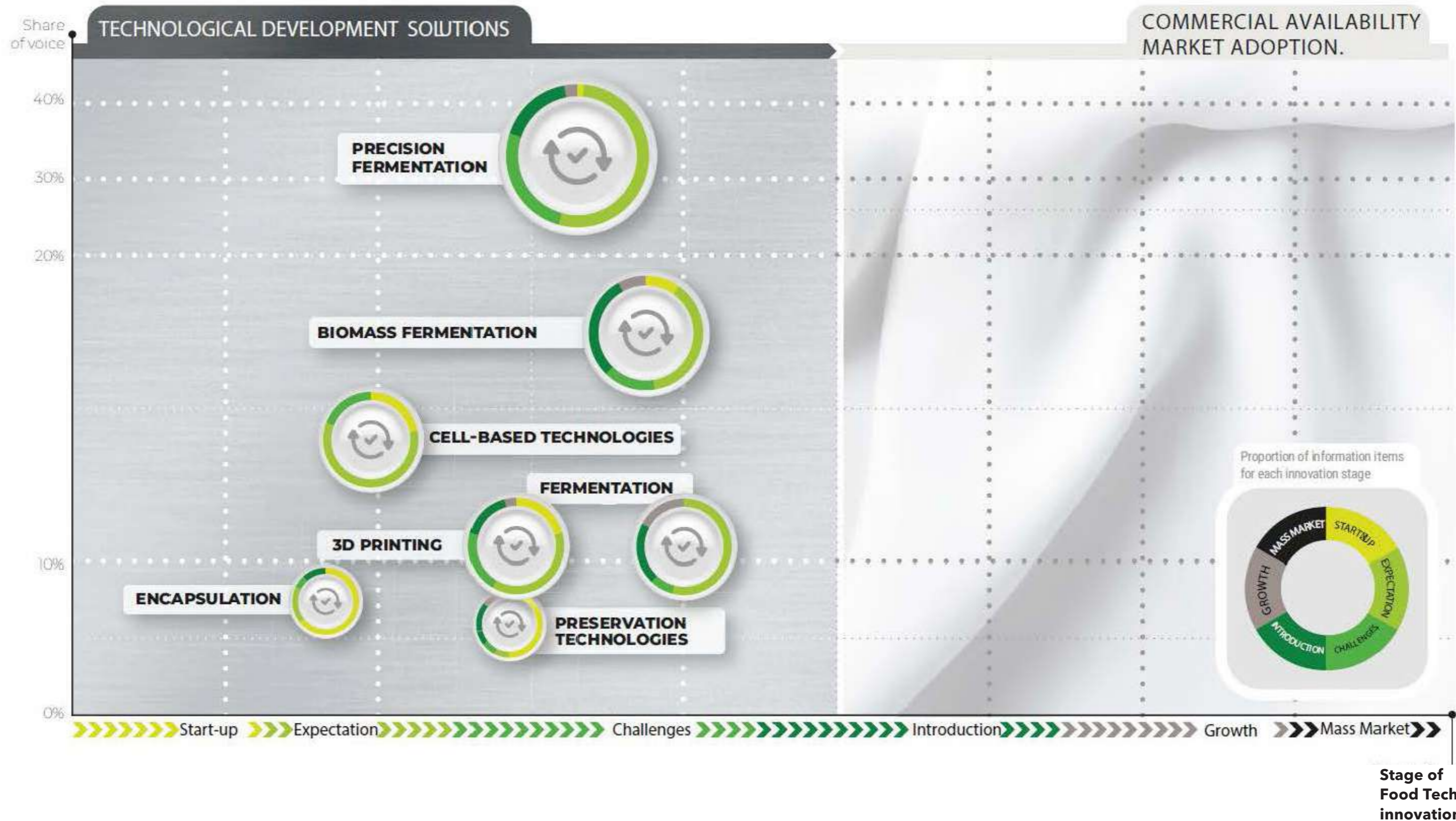
FOODTECH OPPORTUNITY SCENARIOS. SUSTAINABILITY

JAN/DEC 2022 - 224 INFORMATION ANALYZED



FOODTECH OPPORTUNITY SCENARIOS. NEW PROCESS TECHNOLOGIES

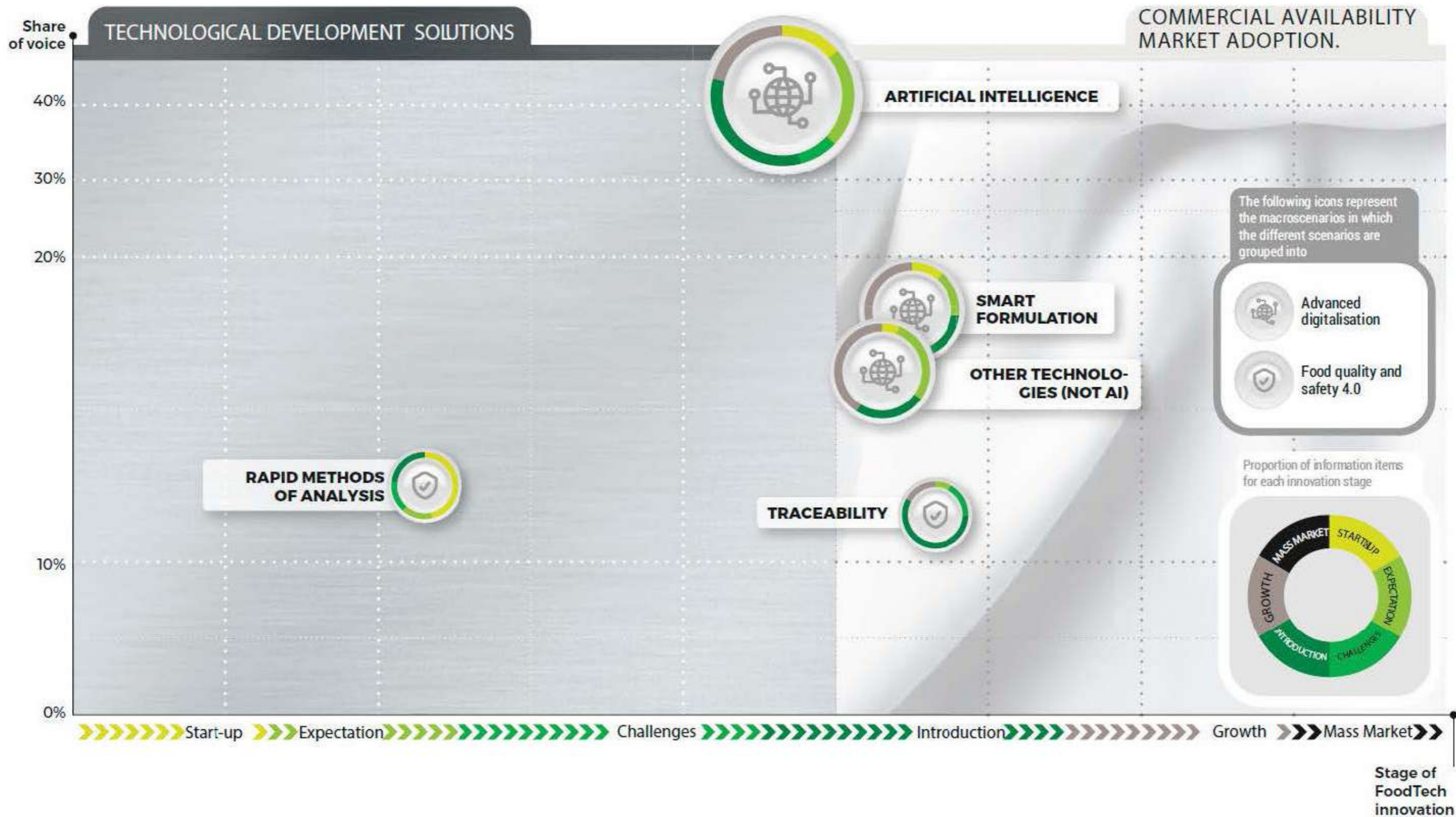
JAN/DEC 2022 - 228 INFORMATION ANALYZED



FOODTECH OPPORTUNITY SCENARIOS ADVANCED DIGITALIZATION AND QUALITY AND FOOD SAFETY 4.0



JAN/DEC 2022 - 104 INFORMATION ANALYSED



TECNOLOGÍA Y CONOCIMIENTO
PARA LA COMPETITIVIDAD DE
LA INDUSTRIA ALIMENTARIA

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RESEARCH & TECHNOLOGY
FOR THE COMPETITIVENESS
OF THE FOOD INDUSTRY