

2022 REPORT

Foodtech



OPPORTUNITY

Scenario map by **alinnova**
CNTA

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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 **2022 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 DO 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

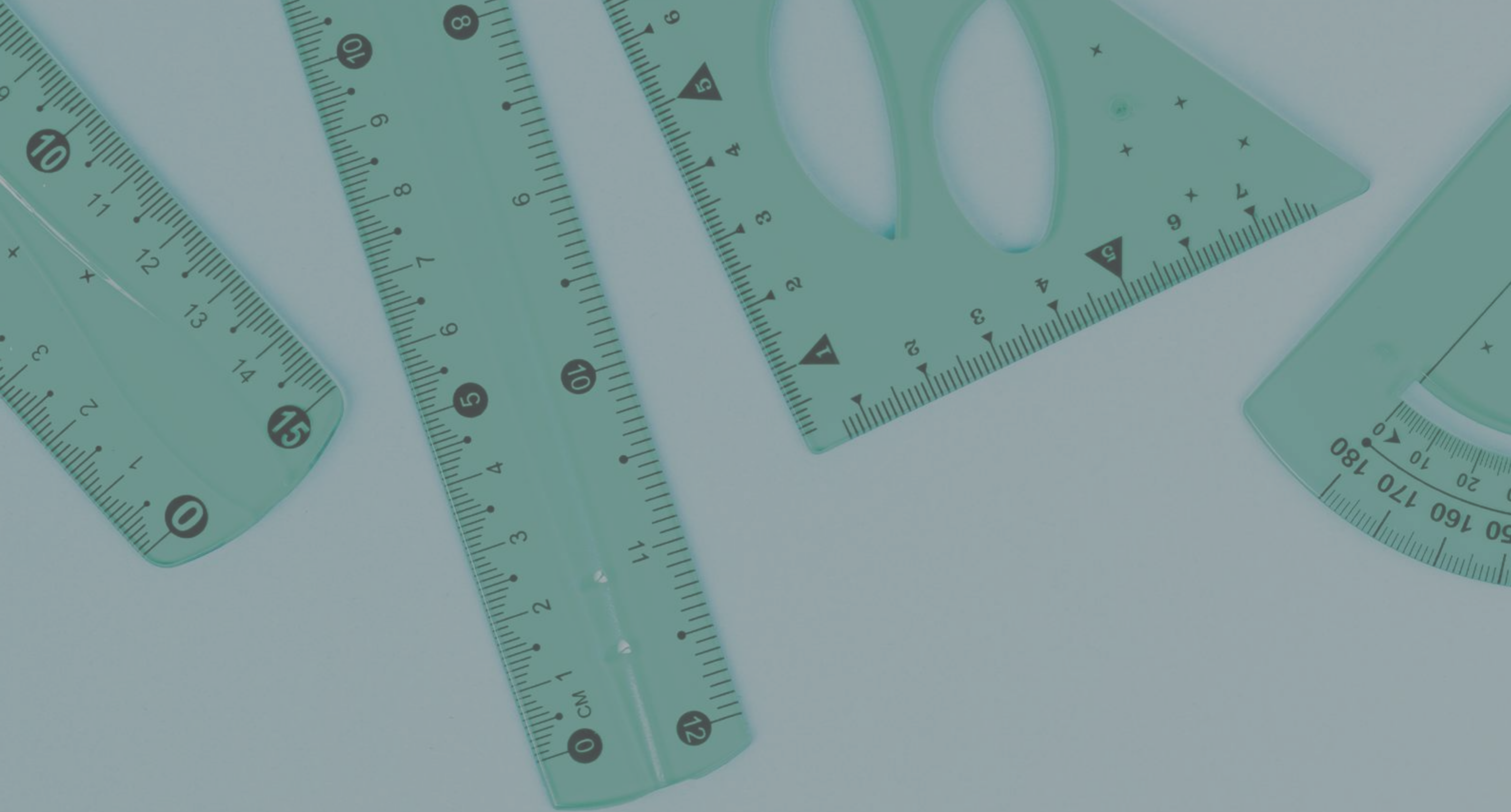
FoodTech industry on a two-dimensional plane. The map can help us understand what is being talked about and how much is being said, and reflects the stage of innovation or degree of maturity of a specific technology.

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 was produced on the basis of the technological monitoring carried out through the CNTA Alinnova platform and the knowledge gleaned by the experts at CNTA from their daily work and the more-than-40 national and international foodtech industry events they attended.

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** to highlight relevant information.
- **Preparation of the report.**

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 2022.

Geographical scope

National (Spain) and international.



2022 at a glance

**Macro scenarios
and scenarios**

2022 was a year in which the inflationary crisis, the war in Ukraine and climate change have played key roles. These factors influenced investment in FoodTech. Here are the main figures on investment in FoodTech worldwide, in Europe and in Spain.

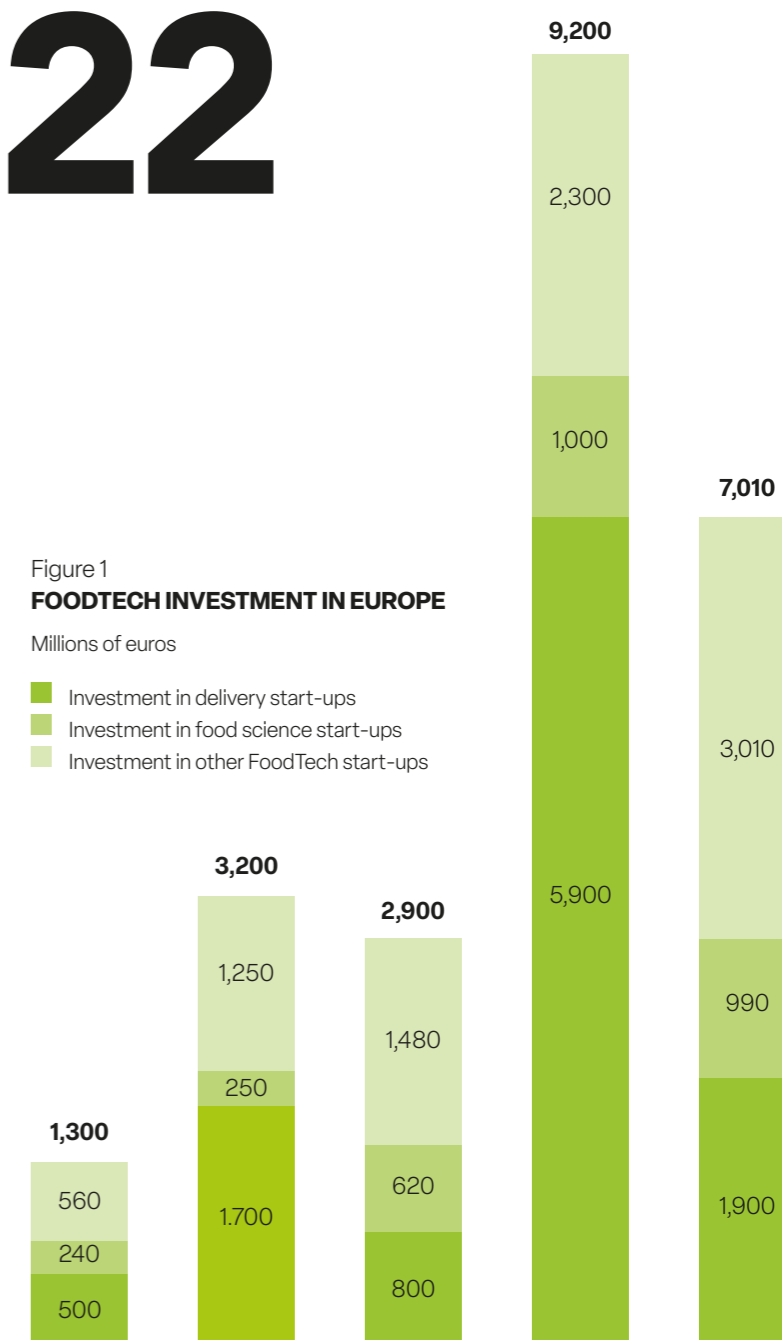
Foodtech investment in 2022

Globally, investment in FoodTech dropped in 2022 compared to 2021, according to sources such as **Pitchbook**. The consulting firm points out that global investments in FoodTech fell by 56%. The reasons provided to justify this decline include the outbreak of the war between **Ukraine and Russia**, and rising inflation.

If we narrow the scope geographically, FoodTech investments in Europe decreased by 36% between 2021 and 2022, to reach a total figure of 5.9 billion euros, according to data from the French consulting firm **DigitalFoodLab**.

Despite these data, DigitalFoodLab notes that the context is still positive for the European FoodTech ecosystem, since the main change in investments took place in the field of delivery. Ignoring this category, investment **grew by 21%**.

These data are shown in Figure 1. The graph also shows how strong what DigitalFoodLab calls Food Science was in terms of investment levels, accounting for almost 25% of the total.



Source: DigitalFoodLab

FOODTECH CATEGORIES

The term FoodTech is very recent and, as such, is constantly evolving. It is a broad term and each organisation interprets its scope in terms of types of technologies and applications. A good illustration of this is the difference between the two sources cited above, although many other examples could also be given.

Pitchbook includes in its analysis the following categories; **alternative proteins, new ingredients, upcycled food, new forms of food, software to equip kitchens, personalised nutrition, food and beverage discovery, molecular engineering, functional foods, e-commerce, food production and retail, and technologies for restaurants.**

Digital Food Lab includes in its analysis the areas of **delivery, consumer tech, agritech, food science, supply chain and foodservice.** The food science category includes alternative proteins, major innovations in ingredients or **mature beverage** or **food markets**; new types of beverages or beverages that promote a healthier lifestyle; **functional ingredients** and **pet foods.**

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. It needs to be noted that, with this scope, we do not cover areas such as delivery, e-commerce, supply chain or agritech. As a result of this transformation, food will be healthier, more sustainable, safer and more accessible.

FOODTECH IN SPAIN



What was the situation of FoodTech in Spain in 2022? The word to define it is 'positive', as stated by Eatable Adventures. Despite the macroeconomic context and global pressures that significantly impacted the agri-food system, the industry enjoyed 'the confidence of investors, companies and governments', they claim.

According to the report 'The State of FoodTech in Spain 2022' by Eatable Adventures, invest-

ment in food technology in the country stood at 268 million euros, which represents a 61% decrease on 2021. However, it should be borne in mind that of the 695 million euros invested in FoodTech in 2021, 450 million euros were thanks to a single round of funding by Glovo. Therefore, ignoring the Catalan start-up, the investment achieved in 2022 meant an increase of 9.38% on the previous year.



CNTA wrote up the report 2022 FoodTech opportunity **scenario map using this scope and focus.**

In it, you can find Macro Scenario Maps and Scenario Maps. A macro scenario consists of a certain number of scenarios. In total in this analysis, there are **9 macro scenarios and 34 scenarios.**

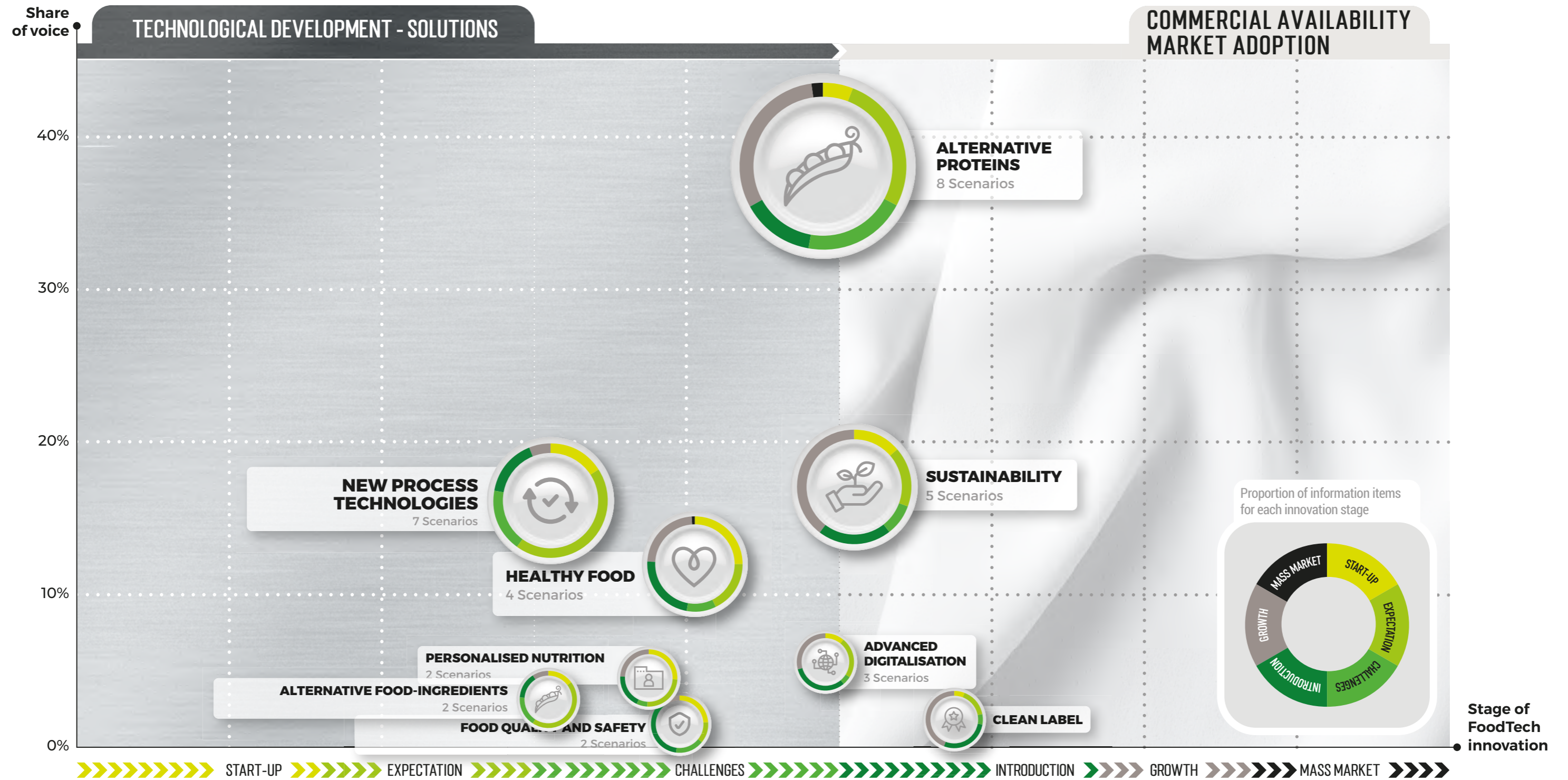
These maps, which we created thanks to the analysis and curation of **1,492 information** items by the CNTA Vanguard team following the process described in the methodology section, allow us to navigate the current FoodTech scene quickly and simply.

This information can help us understand and facilitate decision-making on aspects which will affect the future competitiveness

of the industry, offering keys to help answer questions such as: 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 start-ups should I know? Or What examples can I find to inspire me?

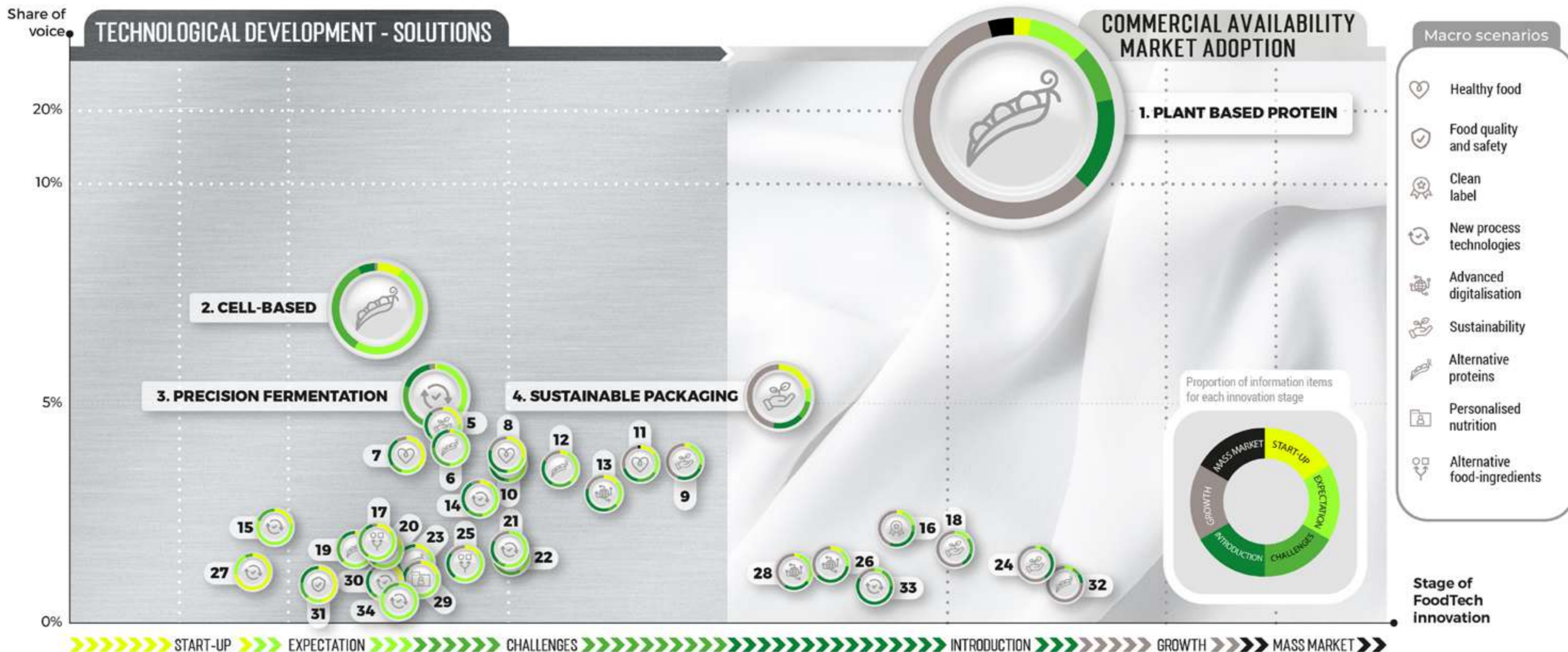
MACROSCENARIOS MAP

JAN/DEC 2022 - 1,492 INFORMATION ITEMS ANALYSED



ALL SCENARIOS

JAN/DEC 2022 - 1,492 INFORMATION ITEMS ANALYSED



- | | | | | | | | |
|------------------------------|--------------------------------------|----------------------------|---------------------------------|--------------------|---------------------------------------|------------------------------|-----------------|
| 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 | |

The first maps presented here are the Macro scenario map and the Scenario map. On the Macro scenario map, you can see that one field dominates the share of voice: the macro scenario of **Alternative proteins** with 38.07%, which is followed by **Sustainability**, with 17.16%, **New process technologies**, with 15.88%, and then **Healthy food** in fourth place, with 12.06%.

A little further away in terms of impact in the media, we find the macro scenarios **Advanced digitalisation**, with 5.29%; **Personalised nutrition**, with 4.56%; **Alternative food-ingredients**, with 3.15%; **Clean label**, with 2.14%, and **Food quality and safety**, with 1.68%.

As for stage of innovation, **Alternative proteins**, **Sustainability**, **Healthy food**, **Advanced digitalisation** and **Clean label** are in the **Challenges** stage. In all these macro scenarios, we found news about different stages of innovation, from research activities to new developments in the market. The reason why they were placed in the Challenges stage is that analysis of all the news gave us a mean and it was that mean which determined the X coordinate.

So, what you can observe in these macro scenarios is that there was a lot of activity in terms of launches, new developments and research trying to help overcome the barriers to marketing. **New process technologies**, **Alternative food-ingredients**, **Personalised nutrition** and **Food quality and safety**, meanwhile, are

Alternative proteins, Sustainability and New process technologies are the macro scenarios with the greatest share of voice. The Plant-based protein, Cell-based technologies and Precision fermentation scenarios attracted the highest percentage of news items on our 2022 FoodTech Opportunity Scenario Map

in the **Expectation** stage, with the information published referring, fundamentally, to the potential of the coming technology and developments, and, above all, expressing expectations about the impact they will have in the future.

For the Opportunity scenario map, **34 Opportunity scenarios** were identified. The scenario with the highest percentage of news items was **Plant-based protein**, reaching 18.57%. In a distant second and third place came the **Cell-based technologies** and **Precision fermentation** scenarios, which accounted

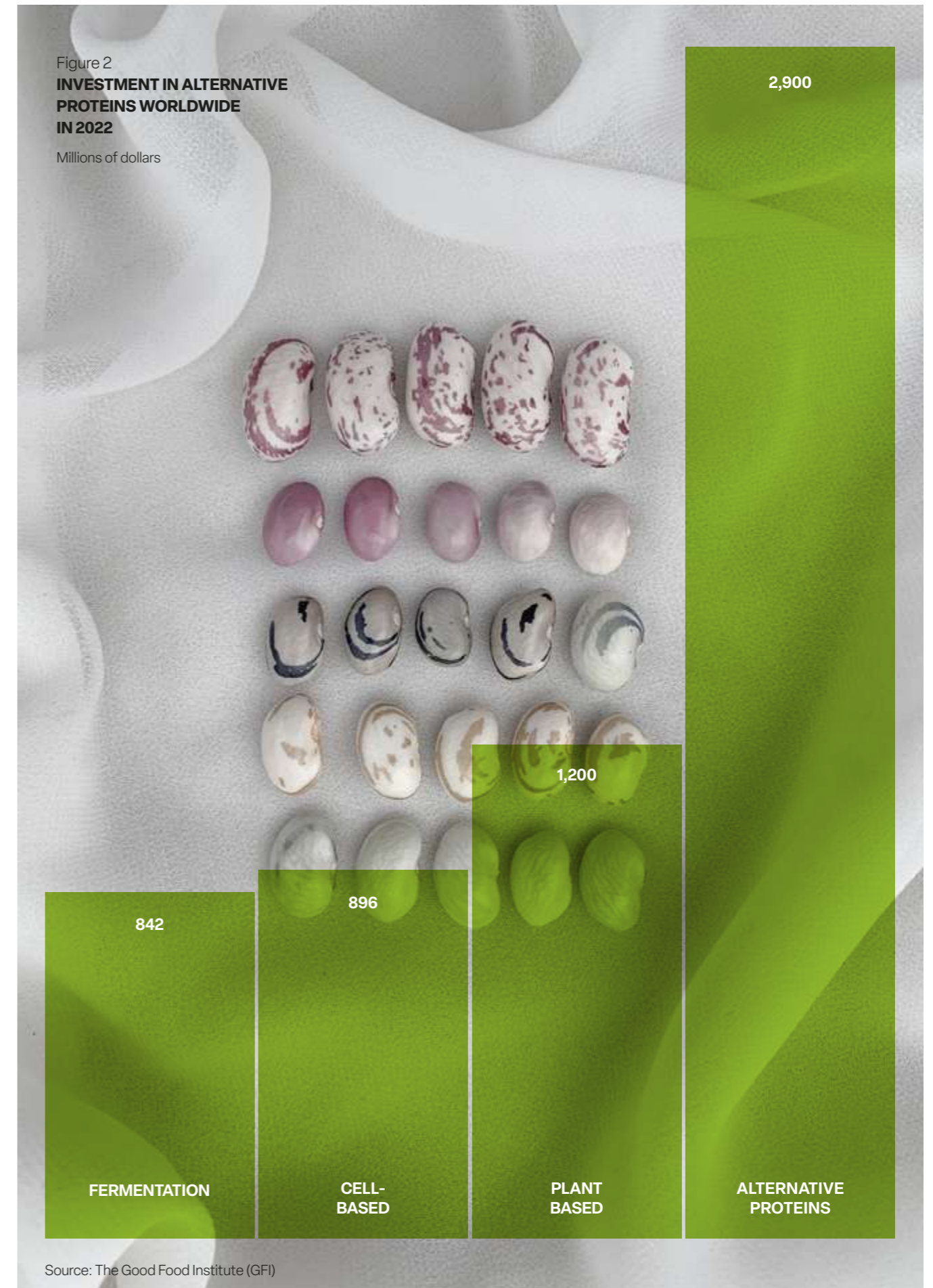
for 7.04% and 5.16%, respectively.

The scenarios at the most advanced stage of innovation in terms of market introduction were **Plant-based protein**, **Organic and Vertical-indoor farming**, where many new products were already available for sale, although we found research and proposals to try to solve the challenges faced in these scenarios as well.

At the other extreme, the scenarios the furthest from the market and more in the **Research**, **Discovery** and **Start** stages were **Encapsulation** and **Cell-based technologies**.

Figure 2
INVESTMENT IN ALTERNATIVE PROTEINS WORLDWIDE IN 2022

Millions of dollars



Source: The Good Food Institute (GFI)

Alternative proteins, the macro scenario par excellence

The 2022 macro scenario par excellence in share of voice was **Alternative Proteins**. It helped that it was one of the **FoodTech** industries which harnessed more investment, generating a lot of activity, which, in the end, led to greater media attention.

The data provided by **GFI** indicate that global investment was worth 2.9 billion dollars in 2022, 42% down on 2021, as shown in Figure 2. In its global investment analysis, GFI only takes into account the following **Alternative proteins**: plant-based, cell-based and fermented protein.

The **Alternative proteins** macro scenario is composed of the following scenarios: **Plant-based protein**, **Cell-based technologies**, **SCP-fermentation** (Single cell protein-fermentation, i.e. developments based on fermentation), **Fungi**, **Algae**, **Insects**, **Air and Hybrid products**.

Within this macro scenario, the **Plant-based protein** scenario is the absolute king in share of voice and its developments are the closest to the market. It is also the scenario that attracted more investment globally, with 1.2 billion dollars

ALTERNATIVE PROTEINS AND THE FUTURE

GFI forecasts “an acceleration of mergers and acquisitions” in alternative proteins in 2023. Looking further ahead, the outlook is even more positive. Some of the findings of the report by Blue Horizon and Boston Consulting Group, ‘The Untapped Climate Opportunity in Alternative Proteins’, indicate that alternative proteins will account for 11% of all protein consumption by 2035, while noting that “with the help of technology, investors and regulators, alternative proteins could capture 22% of the global market in that timeframe”.

(a downturn of 42% on 2021), according to GFI, which includes all plant-based meat and dairy analogues in terms of flavour, texture and appearance in the category

The most salient characteristic of this scenario in 2022 was the market slowdown it suffered. Attempting to reverse this trend, plant-based protein producers tried to find **formulas** to offer products with the same texture, flavour and organoleptic characteristics as their analogues, and create less processed **Clean label** products.

The prospects for 2023 in this scenario involve continuing looking for tastier products with better textures and **cleaner labels**.

Cell-based technologies was another prominent scenario in **Alternative proteins** in 2022, grabbing attention with one of the most important news items of the year when the **FDA** granted **UPSIDE Foods GRAS** status for its cultivated chicken product, bringing the marketing of cultivated meat for the first time ever in the United States a step closer.

In order to market it, **UPSIDE Foods** also needs approval from the US Department of



Upside Foods facilities. Photo Upside Foods

Agriculture’s Food Safety and Inspection Service (**USDA-FSIS**).

The third major Alternative proteins scenario was **SCP-fermentation** (Single cell protein-fermentation, i.e. developments based on fermentation), currently in the **Expectation** stage.

Within this scenario, protein made with precision fermentation technology aroused more interest in the media in 2022 than in previous years, as reflected in the news items focusing on this type of **alternative protein**.

The large number of initiatives was one of the most notable aspects in this scenario, which in 2022 saw the **FDA** (the US Food and Drug Administration) give **GRAS** status to Remilk’s milk proteins, allowing it to market its products in the United States. **GRAS** status indicates that **Remilk’s** protein is considered safe for consumption in food and drinks, meaning it can be used by manufacturers in a range of popular consumer products, such as ice cream, yoghurt and cream cheese.

Other initiatives in this scenario were led by **Perfect Day**, including its partnership with **Onego Bio** to accelerate the launch of

The FDA granted UPSIDE Foods GRAS status for its cultivated chicken product

animal-free eggs or its alliance with Nestlé, thanks to which the multinational launched its **Cowabunga Animal-Free Dairy Beverages**.

The **Fungi** scenario is in the **Challenges** phase. 2022 was a great year for mycelium due to the number of initiatives seen during the year, some of which were led by **Quorn** and **Mycorena**, leaders in the business.

One of the main barriers it faced was the inflation affecting this type of protein, as Judd Zusel, president of Quorn Foods USA, pointed out.

However, the future looks promising for the scenario, with **Future Market Insights** estimating that the value of the mycopro-

tein market will reach 976 million dollars by 2032, growing at a Compound Annual Growth Rate (CAGR) of 12.6%.

Algae have a scenario all of their own within this macro scenario. For years we have been talking about this type of alternative protein, but it is still in the **Expectation** stage, where a lot of initiatives remain, although many others have already reached the market.

Global sales of this type of protein are expected to grow at a Compound Annual Growth Rate of 14.1% until 2027, according to **Markets and Markets**.

The **Insects** scenario is also in the Hype stage, although progress is being made in the commercial availability of this protein. This is being helped by regulatory development, as more and more insects are recognised as safe for human consumption by EFSA (European Food Safety Authority).

In 2022, four had EFSA approval: the **European migratory locust** (*Locusta migratoria*); the **yellow mealworm beetle** (*Tenebrio molitor*); the **lesser mealworm** (*Alphitobius diaperinus*) and the **house cricket** (*Acheta domestica*). They can all be marketed in the European Union.

the last two to obtain this authorisation being the **lesser mealworm** (*Alphitobius diaperinus*) and the **house cricket** (*Acheta domestica*), regulations for which were published in early 2023.

Future approvals and investments will lead to more launches involving this type of protein which will reach the market in the coming years.

As for the **Air** scenario, the initiatives based on this protein are generating more expectations and promises than certainties. However, one solid development witnessed in 2022 was regulatory approval by the **Singapore Food Agency of Solein**, the Solar Foods protein grown with CO₂ and air, allowing the sale of this type of alternative protein in the country, although there is still some way to go before we see food with this protein on the supermarket shelves.

Finally, the **Hybrid products** scenario (in which proteins from two different sources are combined) is in the Challenges phase

In 2022, Solein, the protein grown by Solar Foods with CO₂ and air, was granted regulatory approval by the Singapore Food Agency

The most promising feature of this scenario is that the food industry is seeing in these products an excellent opportunity to develop food which can help introduce consumers to **alternative protein** without giving up on the flavour and texture of their analogues, as discussed in the webinar organised by CNTA: 'Will hybrid products lead the next generation of alternative protein?'

During 2022, we saw, fundamentally, the launch of products that combined fungi and meat of animal origin with plant-based protein. If you want to learn more about these scenarios, see page 34.

WATCH THE WEBINAR



Alternative food and ingredients, a booming macro scenario

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) really took off in 2022. Technologically, this macro scenario is growing fast, mainly in the scenario of Alternative fats and oils, where we saw a lot of initiatives and research during the year under analysis.

The most notable features of this scenario in 2022 were initiatives to help overcome and solve the flavour and texture challenges faced by alternative protein producers.

During the year, we learned about a number of start-ups focusing on developments of

this kind, such as Nourish, Mission Barns and Hoxton Farms, and others which are investigating the production of alternative oils, as is the case of C16 Biosciences, a start-up that announced the launch of an alternative to palm oil for 2023.

In the Other alternative food-ingredients scenario, many of the new developments presented in 2022 sought to create different types of chocolate, either without cocoa, such as that of the company Planet A Food, or cultivated, like those of the start-ups Fazer and California Cultured, among others.

Find out more about these scenarios on page 34.



Sustainability, one of the major focuses of the industry

The change in the food production model to reduce environmental impact and combat food waste is marking the food industry.

The 'No Time to Waste' report by **Feedback EU** estimates that 153.5 million tonnes of food are wasted in the **European Union** every year, which represents about 143 billion euros per year for European companies and households and is why many activities are being carried out in the area of sustainability. This macro scenario contains the following scenarios: **Sustainable packaging, Upcycling-food waste, Carbon neutral, Vertical-indoor farming and Organic.**

Sustainable Packaging has the greatest share of voice in this macro scenario. The food industry is coming up with more and more initiatives to become more environmentally friendly. One way to do this is by making more sustainable packaging. The trend is being pushed along by increased consumer awareness of the environment and legislation incentivising the manufacture and/or use of recyclable and sustainable packaging.

The industry is working on different sustainable and recyclable materials, such as bioplastics or other alternatives. Other strategies the industry is pursuing include increasing the use of recycled materials, reducing and eliminating packaging, designing packaging for recycling or reuse, and working on single-material packs.

Another scenario growing in relevance in this macro scenario is **Upcycling-food waste**, which is in the **Expectation** stage. Upcycling solutions or the valorisation of by-products rose in importance both in Spain and internationally in 2022, in the case at hand as a solution to food waste.



This scenario is expected to grow thanks to the initiatives undertaken by public institutions to encourage people not to waste food. One step forward in this regard will be the entry into force in Spain of the **Act on the Prevention of Food Loss and Waste** in 2023.

In the **Carbon neutral** scenario (industry proposals that seek to decarbonise and pollute less) in 2022, we saw growth in initiatives to develop the decarbonisation of the industry and others which encouraged environmental improvements. Investments in **solar energy** or the launch of products made with **neutral CO₂ emissions** were some of the proposals.

Meanwhile, the **Vertical indoor-farming/hydroponics** scenario faced two realities in 2022. One was more positive, driven by a boost in the market for this type of facility with the global Vertical Farming market reaching sales of 5.89 billion dollars in 2022, which represented growth of 6.41% on 2021 according to the consulting firm **Grand View Research.**

However, we also observed how the cost of energy turned into a barrier to be overcome and led to lay-offs and reductions in operations in some companies in the industry.

Finally, the **Organic** scenario was the one with the greatest number of initiatives in the market and this market saw growth. **Juices, fresh fruit and vegetables, oils and cereals** were the product categories with the greatest presence in the scenario, in which consolidated brands and producers already existed, while other companies began to follow the trend.

Find out more about these scenarios on page 44.

153.5

'No Time to Waste' estimates that 153.5 million tonnes of food are wasted in the European Union every year, which represents about 143 billion euros per year for European companies and households

New process technologies: the quest to produce new foodstuffs



Researcher using precision fermentation. Photo: CNTA

Process technologies are attracting more and more attention in **FoodTech**, so this macro scenario sits on the lower step of the podium in share of voice on our **FoodTech** Scenario Map.

In this macro scenario, **Precision fermentation** and **Biomass fermentation** are the two most prominent scenarios.

Different experts indicate that **Precision fermentation** technology has a promising future for use in the production of alternative proteins. But to fulfil these predictions, it will have to overcome challenges in terms of scalability and industrial infrastructure, without forgetting regulatory matters.

Some initiatives seen in 2022 sought to overcome those barriers. One of these was led by **Perfect Day**, which in September launched a biotechnology business called

nth Bio to help its partners use precision fermentation technology.

If we look at the **Biomass fermentation** scenario, we can see that it truly burst onto the scene in 2022, becoming an increasingly used technique thanks to companies such as **Quorn** or **Meati Foods**. However, like **Precision fermentation**, it is still in the **Expectation** stage.

The **Fermentation** scenario (in which we include techniques which are neither precision nor biomass fermentation, such as traditional fermentation) is currently the most developed as far as stage of innovation is concerned and is in the **Challenges** stage. With this type of technology, in 2022 we saw the production of fermented beans as alternatives to more commonly used plant ingredients, chocolate or functional drinks.

The **3D Printing** scenario is in the **Expectation** stage. Different start-ups were working with 3D printing and continued with investigations to get beyond the frontier between technological development and the market. Such was the case of the Navarrese company **Cocuu**, which in 2022 presented the world's first industrial 3D food printing line.

Given the challenge which scale-up and offering an affordable price represent, novel technological developments are being seen in the **Cell-based** field. All of these have been included in the scenario **Cell-based technologies**, which includes all the different types of process technology (**scaffolding, culture media organoids, tissue templating, cell lines, etc.**) which serve to develop cells of this kind.

Precision fermentation and biomass fermentation were the two most prominent scenarios in process technologies

Equally noteworthy is the **Encapsulation** scenario, a technology that in 2022 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. This scenario is in the **Start-up** stage, since the vast majority of publications that we saw in 2022 focused on research, although a few solutions are already on the market.

Finally, let's turn our attention to the **Preservation technologies** scenario, which involves all the new **technologies and research** to preserve products and increase their shelf life.

The different preservation technologies are widely known and used in the food industry, but high-potential research activity can be observed looking for ways to improve existing solutions: longer shelf lives, reducing the effects of using technology, etc.

These new technologies are not yet consolidated in the market although their potential is evident. A few we learnt about in 2022 were the incorporation of **probiotic microorganisms**, the use of **plant-based preservatives** to inhibit bacterial growth and the use of **Crispr** (a gene editing technique) to increase the shelf life of melons.

To find out more about these scenarios, go to page 50.

Increased demand for healthy products

Healthy food is a macro scenario brimming with opportunities because consumers are becoming increasingly aware of their health.

Functional foods; Pro-, pre- and post-biotics, Improving the nutritional profile and No-Lo (low-alcohol or non-alcoholic drinks) are the four scenarios that make up this macro scenario.

The **Functional Food** scenario came first equal with Pro-, pre- and postbiotics in terms of share of voice in 2022.

In the year under analysis, we began to see initiatives that not only focused on the concept of physical health but also on mental well-being, with proposals to aid memory or concentration.

Like Healthy food, the **Pro-, pre and post-biotics** scenario was one of the major players, thanks to growing consumer interest in gut health and maintaining a healthy microbiome. In 2022, we observed new developments in this field aimed at children and research trying to take things further on to learn how the microbiome affects the nervous system, skin and brain.

The scenario of Improving the **nutritional profile** grew in share of voice in 2022 compared to previous years, with most of the news focusing on solutions or research to try to reduce the sugar and salt content in food to make it healthier.

In 2022, we saw major multinational companies such as **Danone and Nestlé** make plans to reformulate some of their products to make them healthier.

Another growing scenario was **No-Lo (low-alcohol or non-alcoholic drinks)**, which released new wines, ciders and beers, and, according to IWSR, is expected to grow at a CAGR of 7% in volume terms over the period 2022-2026. If you want to see how 2022 went in these scenarios in more detail, go to page 56.



In the **Advanced digitalisation** macro scenario, initiatives in which the **Artificial intelligence (AI)** played a leading role stood out. In 2022, we saw an increase in start-ups with their own software to make food with the help of AI and many that even relied on **Smart formulation** to find new or the most appropriate ingredients for their products.

Examples of the use of Artificial Intelligence included **Equii's** developments, with its bioinformatics platform, and the new launches from the Chilean start-up **NotCo**, which uses its AI software **Guiseppé**.

Digitalisation, Artificial Intelligence steals the show

In the **Other digital technologies** (not AI) scenario, the progress made by companies to develop factory 4.0, with an emphasis on **robotisation**, process **automation** and the use of **artificial vision**, was notable.

You can find more detailed information on this macro scenario on page 62.

The healthy food industry turns to groups with special needs

The **Personalised nutrition** macro scenario (healthy food developments focused on personal nutrition or groups with special needs) was in the **Expectation** stage.

Most of the launches and research in this macro scenario were aimed at **Groups with special needs**. The groups that most captured the attention of company developers included women and children, people with swallowing problems, the fructose intolerant and people with visual and cognitive disabilities



Burger for people with dysphagia

The **Personal Nutrition** scenario, meanwhile, remained in the **Expectation** phase, facing the challenge of developing 'a rigorous set of standards and best practices for designing and assessing the efficacy of personalized interventions', given that current 'statistical modeling approaches are limited in that they do not necessarily provide detailed mechanistic insights and they rely upon a training cohort' according to a 'Perspective' study.

You can find out more about these scenarios on page 56.



Food quality and safety 4.0, in search of speed and efficiency

The **Food quality and safety 4.0** macro scenario highlights developments for new analysis techniques to advance along the path to commercial availability. This macro scenario is in a stage of expectation and consists of two scenarios: **Traceability and Rapid methods of analysis**.

Within the **Traceability** scenario, **block-chain** technology, to better and more transparently control the traceability of the product, gained the most attention and is expected to continue doing so in 2023.

In the **Rapid methods of analysis** scenario, we saw that **hyperspectral** technologies, to de-

termine the freshness and shelf life of food, and **Vis-NIR** technology, with which different parameters in various foods can be controlled in real time, are making headway, and the forecast is that further developments will be observed in 2023.

You can learn more about these scenarios from page 62 onwards.

Clean label, time to overcome challenges



To conclude our review of all the macro scenarios, we need to turn our attention to the **Clean label** macro scenario, currently in the Challenges stage. One of the challenges it faced, as **Mintel** pointed out, was that of better communicating its proposals. Furthermore, another feature of 2022, according to the market Intelligence agency, was ‘opportunities for brands to link “clean” with “green”’.

In the Clean label scenario (i.e. production based on simplicity and transparency, using as few ingredients as possible and with components known to the consumer), we saw multinationals, such as **Barry Callebaut**, with the launch of **Second Generation Chocolate**, which has a short list of ingredients (only cocoa and sugar, plus milk in the case of milk chocolate), and **Kerry**, with its emulsifier made from acacia, get initiatives off the ground.

Start-ups like **Sunscoop**, with its plant-based clean label ice cream, and **Good Culture**, with its clean label cheese, launched other products and solutions.

As for the future of this macro scenario, it looks **promising**, **Mintel** forecasting that the clean label trend will be worth 42.5 billion dollars worldwide by 2030, with a CAGR of 17,5% by the end of the decade.



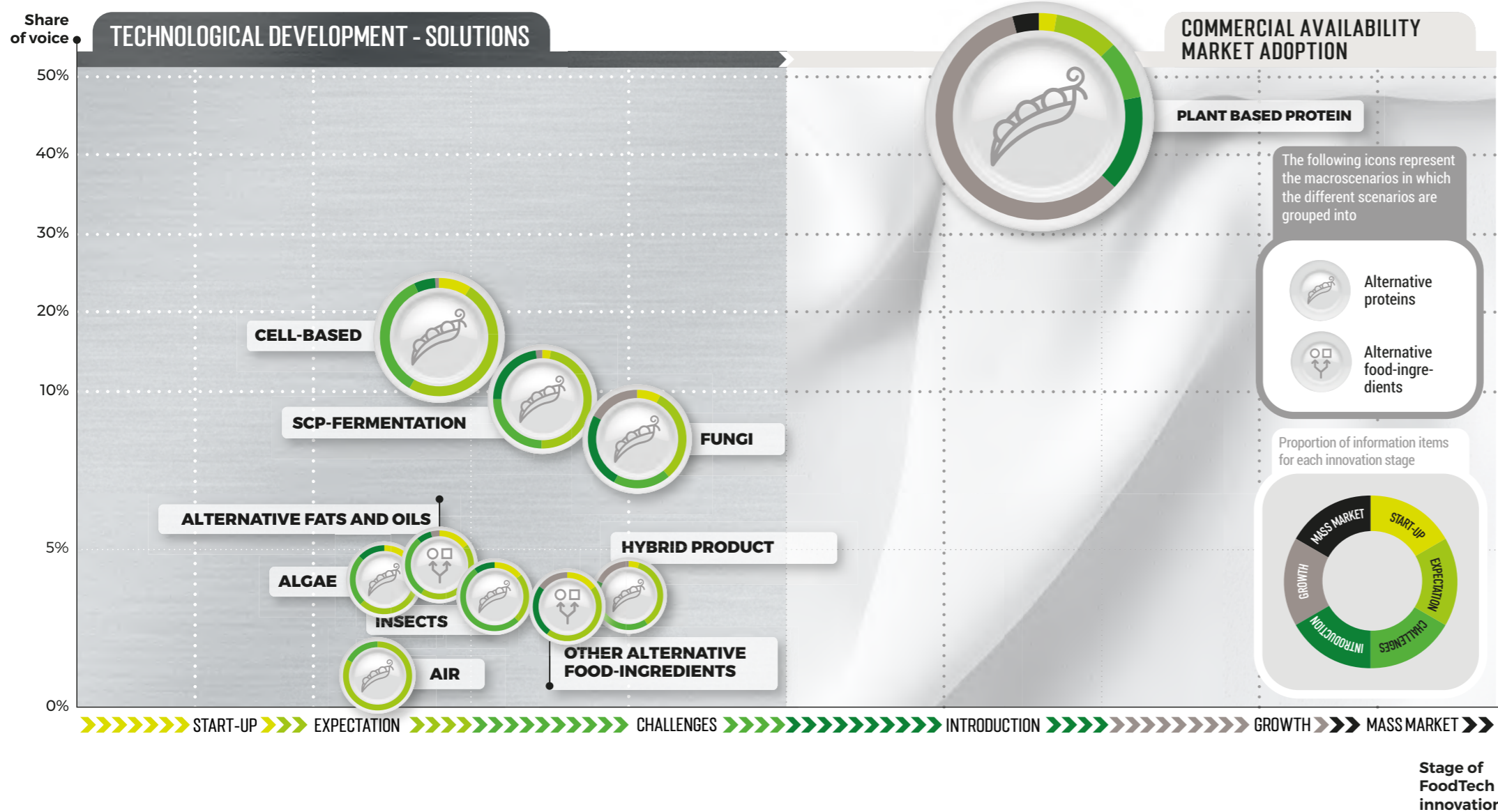
In depth

The following pages offer you a more in-depth exploration of the opportunity scenarios featured in this report. On this journey, you will find discover some of the reflections, news, data, start-ups, technologies, etc., that led the way in FoodTech in 2022. We also present

5 macro scenario maps (Protein, fats and alternative foods; Sustainability; Healthy food and personalised nutrition; New process technologies and Digitalisation and Quality and safety 4.0), each with all its respective scenarios.

ALTERNATIVE PROTEINS, FATS AND FOOD SCENARIOS

JAN/DEC 2022 - 615 INFORMATION ITEMS ANALYSED



The first map is the **Alternative proteins, fats and food map**. This map analyses **Alternative proteins** and **Alternative food-ingredients**, two macro scenarios which are closely linked, since they showcase the most prominent new proposals, research and initiatives focusing on products made using alternative proteins and ingredients, and how food of this kind has been developed.

There are **10 Opportunity scenarios** on this map. Plant-based protein is the scenario with the highest percentage of news, reaching 45% of share of voice. At some distance come the **Cell-based technologies, SCP-fermentation and Fungi** scenarios, with 17%, 9.9% and 8.45%, respectively.

And a long way from those, the other featured scenarios: **Alternative fats and oils** (4.4%), **Algae** (3.9%), **Hybrid products** (3.67%), **Insects** (3.41%), **Other alternative food-ingredients** (3.25%) and **Air** (0.9%). The map shows us that **Plant-based protein** is the scenario in the stage of **innovation** closest to the market. The rest are in other stages. **Fungi and Hybrid products** are in the **Challenges** stage and the others (**Cell-based technologies, SCP-fermentation, Algae, Insects, Air, Alternative fats and oils, and Other alternative food-ingredients**) are still in the **Expectation** stage.

Plant-based protein, the need to go one step further



Plant-based product by Impossible Foods. Photo: Impossible Foods.

SPAIN AND THE PLANT-BASED INDUSTRY

Examples of launches in Spain included Campofrío Vegalia's plant-based Fingers and Nuggets; Vall Company and El Pozo's new plant-based meat analogues; voie gras, a kind of vegan foie gras produced by Nestlé; and Goikoa's plant-based chorizo alternative.

The sale of plant-based food grew by 4% in 2022, hitting 447.4 million euros, according to GFI and as shown in Figure 3. The category which came out the best was plant-based milk, with growth of 5%, reeling in 352.8 million euros. Plant-based product by Impossible Foods.

According to GFI, **Plant-based protein** is the scenario which generated the most investment worldwide, harnessing 1.2 billion dollars in 2022 (a 42% drop on 2021).

In 2022, this type of protein found that the market did not grow at the desired speed and failed to generate new consumers. Attempting to reverse this trend, producers endeavoured to find **formulas** to offer products with the same texture, flavour and organoleptic characteristics as their analogues, and create less processed, **clean label** products.

The rise in food prices also affected the market, leading to a return to cheaper food

products, to the detriment of other more expensive options, such as plant-based food.

Legislative barriers also curbed the growth of plant-based products. In 2022, France banned plant-based meat from being marketed as steak, bacon or sausage. South Africa passed a similar law and Turkey banned the sale and production of dairy-free cheese.

According to **Innova Market Insights**, this slowdown in the market is the result of consumers not buying products of this kind because they consider them highly **processed** and expensive, and because they fail to meet expectations in terms of value for money.

According to eToro, this downturn in the market saw ten of the biggest vegan stocks fall in value by an average of 51% in 2022.

Faced with this problem, several companies (**Impossible Foods, Oatly and Beyond Meat**, among others) announced redundancies. To try to overcome these barriers, some start-ups reacted to reverse the situation. Such were the cases of **Beyond Meat**, which brought out new products of this kind in 2022, **Juicy Marbles**, with its whole-cut loin; and **Kraft and Notco**, with their plant-based mayonnaise.



Cell-based products, closer to the market in the United States

The **Cell-based** (cultivated meat) scenario has been one of the great protagonists of 2022, thanks to the **FDA** granting **GRAS** status to **UPSIDE Foods'** cultivated chicken, bringing the sale of cell-cultured meat for the first time in history in the United States closer.

In order to market it, **UPSIDE Foods** will also need approval from the US Department of Agriculture's Food Safety and Inspection Service (**USDA-FSIS**). Approval is expected by 2023 or 2024.

The **FSIS** is responsible for verifying that the facilities of all manufacturers that use products of animal origin are suitable for the production and sale of their products. And as the start-up uses **animal cells**, it will have to go through the approval process before it can sell cultivated chicken in the US market.



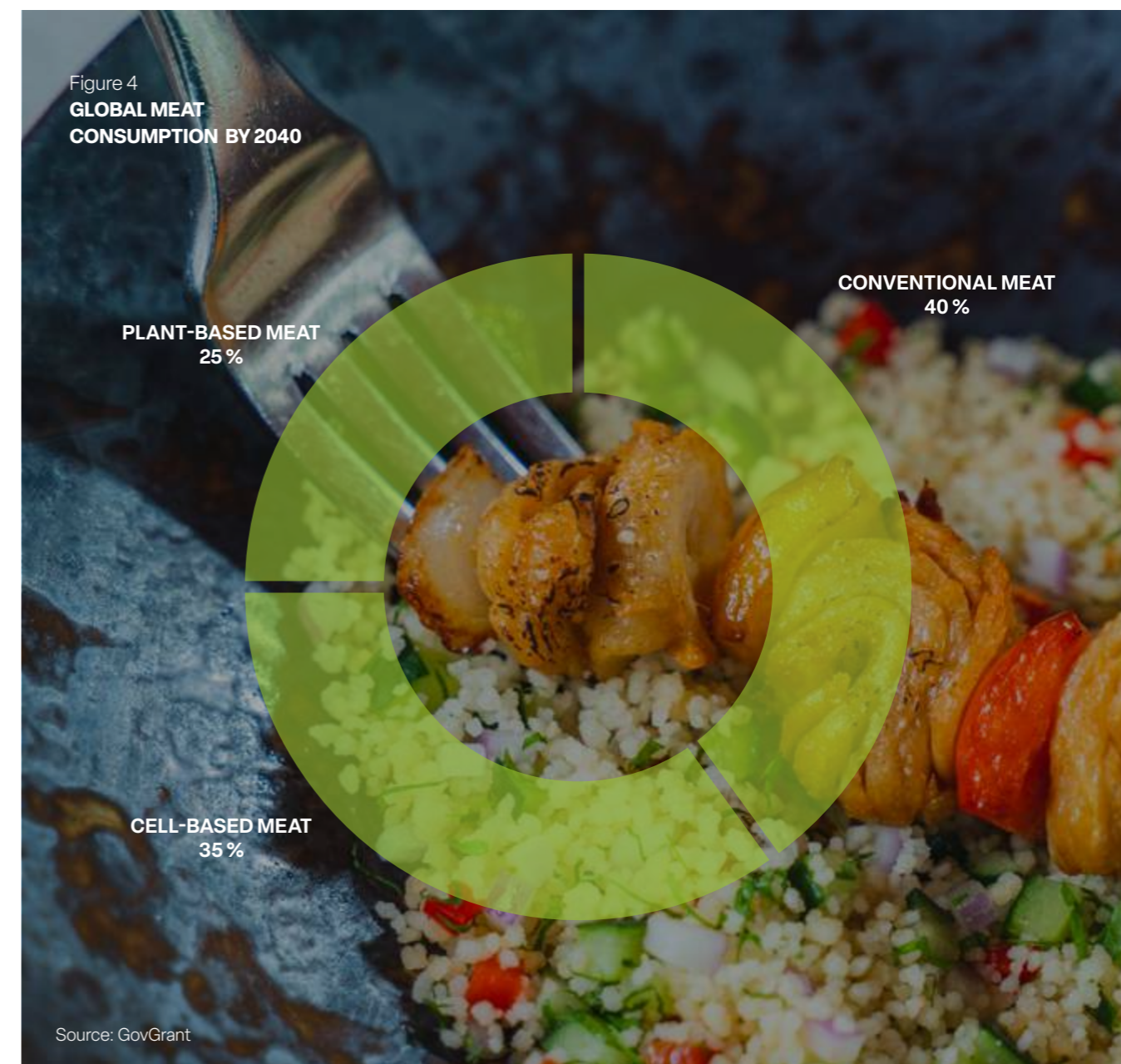
Upside Foods facilities. Photo of the Upside Foods media kit.

In order to market its cultivated chicken, UPSIDE Foods also needs approval from the USDA, which it expects to obtain in 2023 or 2024

Another sign of progress in the **Cell-based** scenario is that, for the first time, the **FAO** held a meeting to analyse cell-based food. The experts attending concluded that these food products did not pose any more risks than their conventional counterparts. Other experts, however, prefer to err on the side of caution and warn that it has not yet been proven how this type of meat may affect human health.

As for global investment, **GFI** claims that in 2022 this type of protein attracted 896 million euros (31% of the investment in **Alternative proteins**). The countries where the most investment was made in this type of protein were: **The United States, Israel, the Netherlands, Singapore and the United Kingdom**, according to **GovGrant** data.

Scalability, cost reduction and regulatory issues are the main



barriers this type of protein needs to overcome. Beyond these challenges, other obstacles to advancing development include having appropriate facilities and equipment, and adequate processes.

On the subject of scalability, in 2022 we learnt that **Good Meat**, the cultured meat division of **Just Eat** (the only company in the world that has received approval to sell its cultured chicken nuggets, specifically in **Singapore**, the only country so far to approve the marketing of

35% OF THE MEAT CONSUMED WILL BE CULTIVATED

The growing interest in Cell-based products makes it one of the up-and-coming stars of the Alternative Protein industry. **Barclays** predicts that this market will hit \$450 billion globally by 2040 and **GovGrant** forecasts that the cultured meat market will account for 35% of global meat consumption, with conventional meat totalling 40% and vegan meat 25%, as shown in Figure 4.

a cell-based product), signed an agreement with the bioprocess equipment specialist **ABEC** to develop in the United States the "largest known" bioreactors for cell culture production of bird and mammal meat'.

We also saw **Prolific Machines** raise \$42 million to open a 2,300 m² facility in California.

Spain is no stranger to this alternative protein. In 2022, **Biotech Foods** announced an investment of 30 million euros to open the first factory in San Sebastian by 2024.

Growing interest in Single cell protein-fermentation

The third major **Alternative proteins** scenario is **SCP-fermentation** (Single cell protein-fermentation, i.e. developments based on fermentation), which remains in the **Expectation** stage.

The large number of initiatives was one of the most striking aspects observed in 2022. One of the most noteworthy was GRAS recognition from the FDA of **Remilk's Alternative milk proteins**, which will allow it to market its products in the United States. Many of the developments observed in this scenario were led by **Perfect Day**, such as its partnership

GRAS status for Remilk's Alternative milk proteins will allow the start-up to market its products in the United States

Onego Bio to accelerate the launch of its egg analogues; its agreement with **Mars** to launch a chocolate bar alternative (100% animal free), and its alliance with **Nestlé**, through which the multinational launched its **Cowabunga Animal-Free Dairy Beverages**.

There was also a relevant agreement between the French cheese and snack manufacturer **Bel Group** and the precision fermentation start-up **Standing Ovation** to 'face the challenge of the proteins of the future'. In Spain, start-ups working with this type of protein include the Barcelona-based company **Real Deal Milk** or the Navarre-based firm **Moa Foodtech**.

One scenario in which we saw growth in initiatives in 2022 was **Fungi**, which is in the **Challenges** stage.

One of the main challenges this scenario faced was inflation, as **Judd Zusel**, president of **Quorn Foods USA**, pointed out. In an interview with Food Navigator, he stated that 'we're going through a difficult economic time when [...] shopping behaviors are changing,' adding that 'because the [fungi] category is still at an early stage [...] there's a massive amount of competition. [...] and not all of the food is meeting the expectations of consumers'.

Despite these difficulties, the outlook for this protein is positive. According to **Future Market Insights**, the value of the mycoprotein* market is expected to reach \$976 million by 2032, growing at a CAGR (Compound Annual Growth Rate) of 12.6% over the next decade.



Fungi multiplies

The Basque start-up Innomy closed a \$1.3 million investment round to boost fungi-based food processing

Regarding the news and movements we saw in 2022, the most relevant were the opening of **ENOUGH's** 15,000 m2 plant in Sas van Gent in the **Netherlands**; the expansion of **Mycorena's** facility and it's receiving \$150 million funding; the launch of Meati's Steak Filet by **Meati Foods**; and different launches from **Quorn**.

There is also support for this protein in Spain, as shown by the fact that the start-up **Innomy** raised 1.3 million euros in a first round of investment to promote the creation of fungi-based food.

*Some sources and consultants include mycoproteins in plant-based protein. The Future Market Insights data refer specifically to the mycoprotein market."



Nutrinsect cricket flour. Photo: CNTA

Algae and Insects, two scenarios of interest

Algae and insects are two **Alternative protein** sources of great interest for the future demand of the population. These two **Alternative proteins** are having a hard time getting off the ground, although future forecasts are positive for both.

Focusing on the **Algae** scenario, according to **Markets and Markets**, the global algae-based* protein market was worth \$585 million in 2022 and is estimated to hit \$1.131 billion by 2027, growing at a Compound Annual Growth Rate (CAGR) of 14.1%.

In 2022, one investment in this protein we learnt about was the 8.4 million dollars obtained by the Israeli company **Brevel** to develop its algae-based protein. We also saw examples of new products, such as the ice cream alternative made from chlorella microalgae by **Sophie's BioNutrients**; and the seaweed burger analogues from **Atlantic Sea Farms**.

In Spain, there are different companies working with this type of protein. Two examples are: **Neoalgae**, which celebrated its tenth anniversary in 2022; and the start-up **Isauki Seafoods** which aims to launch products onto the market in 2023.

As for the **Insects** scenario, work is being carried out to make products commercially available and regulatory progress is pushing the process along. In the European Union (EU), **EFSA** (European Food Safety Authority) now recognises four insects as safe for human consumption: the **lesser mealworm** (*Alphitobius diaperinus*); the **European migratory locust** (*Locusta migratoria*); the **house cricket** (*Acheta domesticus*), and the **yellow mealworm beetle** (*Tenebrio molitor*). They can all be marketed in the European Union, the last two to obtain authorisation being the **lesser mealworm** (*Alphitobius diaperinus*) and the **house cricket**

(*Acheta domesticus*), regulations for which were published in early 2023.

Despite this regulatory progress, for some industry players it is still 'slow', leading to a 'slowdown in investments'. This type of protein also faces other barriers to accelerating its sale: the industry cites 'sociocultural issues when it comes to trying this kind of food; accessibility to this type of products; ignorance of their allergenic effects; and the low demand existing today'.

If these difficulties are overcome, we will see more launches of products using this kind of protein reaching the market in the coming years.

Some Spanish companies which believe in this alternative protein are: **Insekt Label**, a start-up which develops insect protein and hopes to be able to offer it to the food industry by 2024; and **Ausolan**, which has a new project to develop new insect-based foods.

*Some sources and consultants include algal protein in plant-based protein. The Markets and Markets data refer to the algae-based food, animal feed, additive, cosmetics and personal care markets.

Hybrid products, opportunity in response to demand for new foodstuffs



Consumers are looking for healthier and more sustainable products with fewer ingredients of animal origin and more of plant origin. According to an **OpinionWay** survey, 58% of the Spanish population have decreased their meat consumption in recent years and 38% have brought vegetable options into their diet.

In view of this reality, **hybrid products** (in which proteins from two different sources are combined) are now becoming an opportunity for the food industry to develop food to help introduce consumers to **alternative protein** without sacrificing the taste and texture of their analogues.

In the webinar ‘Will hybrid products lead the new generation of alternative protein?’ organised by CNTA in November 2022, **David Guarch**, Head of Business Development – South Europe at **Cubiq Foods**, explained that entering this business comes with its ‘its complexity’ and that, at his company, they try to elaborate their alternative fats in a way which is ‘easy to use for our customers’. He went on to add that the hybrid industry is ‘something new and we need to give it time’ for companies to better understand its potential.

In 2022 we also saw that several start-ups and companies chose to launch a range of

hybrid products. One example was **Peas of Heaven**, which brought us hybrids made by combining pea and mushroom protein.

Interesting too, although in a more incipient phase, was Dutch start-up **Meatable’s** intention of combining **cell-based** with plant-based protein.

Meanwhile, other companies preferred to bring out mixes between traditional meat and plant-based protein, as was the case of the Spanish company **El Pozo** with its **Flexiterráneo** (Flexiterranean) range.

Hybrid products are becoming an opportunity for consumers to try new products without sacrificing the taste and texture of their analogues



Air Protein Meat.

Air protein approved in Singapore

CO₂-based protein developments generate more expectations and promises than certainties, and their share of voice is low compared to other **Alternative proteins**. However, one solid development seen in October 2022 was regulatory approval by the Singapore Food Agency of **Solein**, the **Solar Foods** protein grown with CO₂, allowing the sale of this type of alternative protein in the country. The Finnish start-up’s commercial launch is scheduled for 2024.

Other start-ups working on air protein are: **Air Protein**, which continues to make progress with its meat analogue developed using hydrogenotrophs, a kind of airborne microbe, and managed to raise 32 million dollars at the beginning of 2022; and **Arkeon Biotechnologies**, which obtained more than 10 million euros to convert CO₂ into food in the same year.

Arkeon’s technology uses gaseous fermentation to transform CO₂ into protein and the process, according to the company, generates the 20 essential amino acids through a micro-organism that produces them in a single fermentation process.



Alternative fats, allies for flavour and texture

In the **Alternative fats and oils** scenario, we saw different initiatives featuring alternative fats whose goal was to help overcome and solve the challenges of **flavour and texture** that **Alternative protein** producers face. In the second part of 2022, we detected an increase in the impact of this scenario in the media.

We discovered start-ups committed to developments of this kind, such as **Nourish**, which secured 28.6 million dollars in funding to promote the development of fats and oils for the **Alternative protein** industry. Other major investees included **Mission Barns**, which raised €28.3 million to produce cultured fat, and **Hoxton Farms**, which raised \$22 million to build a pilot plant for the same purpose.

We also discovered various proposals for alternative oils. An example of this was **C16**

Biosciences, a start-up which announced the launch of an alternative to palm oil by 2023; or **DSM’s** announcement that the European Commission had approved its Omega-3 algae-based oil for use in meat and fish alternatives.

Alternative fats are becoming increasingly important to help overcome taste and texture challenges

CHOCOLATE OR HONEY, EXAMPLES OF OTHER ALTERNATIVE FOOD

In 2022 we saw new developments in the Other alternative food-ingredients scenario, many of which had a very sweet component. There were initiatives to produce different types of chocolate analogues, made without cocoa, such as Planet A Food’s; or cultivated chocolate as proposed by Fazer, California Cultured and Celleste Bio, which has the support of companies like Mondelez International, Barrel Ventures, Regba Group and Trendlines. Also noteworthy was the initiative led by Fooditive, which produces an alternative to honey using precision fermentation.

SUSTAINABILITY SCENARIOS

JAN/DEC 2022 - 244 INFORMATION ITEMS ANALYSED



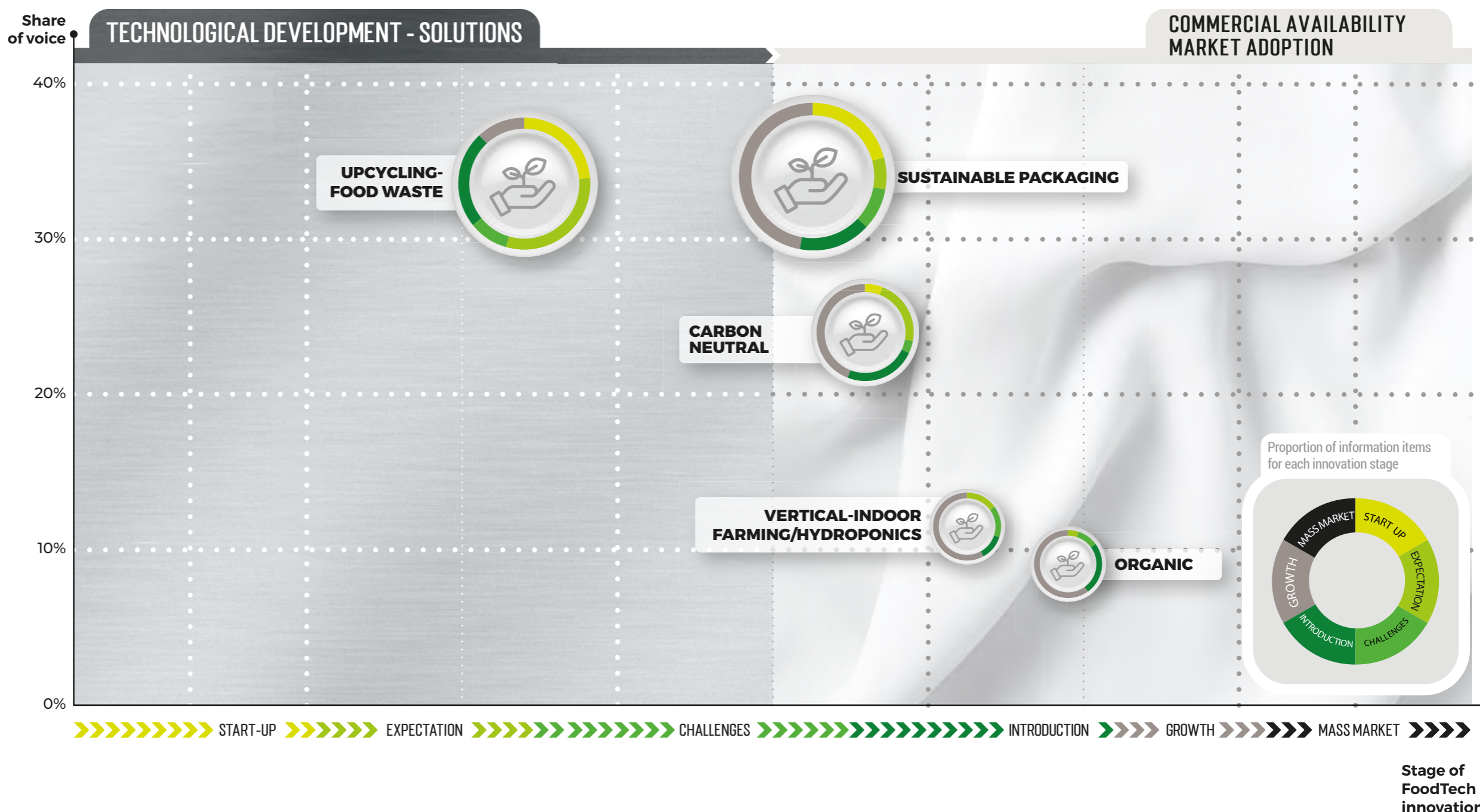
The second map we bring you is the **Sustainability** map, which is the second-placed macro scenario in terms of share of voice on our FoodTech opportunity scenario map. On this map, we show the most representative scenarios that worked on solutions or new developments to help improve the environment in 2022.

In all, there are 5 opportunity scenarios on this map, the most significant in terms of share of voice being **Sustainable packaging**, with 29.69%.

Not far behind are the **Upcycling-food waste** and **Carbon neutral** scenarios, with 26.56% and 21.09%, respectively. Just above the 10% mark, we find **Vertical-indoor farming/hydroponics** and below this, **Organic** with 7.81%.

Continuing to analyse the map, we find that both the **Organic** and the **Vertical-indoor farming/hydroponics** scenarios are in the **Introduction** stage, a good percentage of the developments and market technologies in them being at the Introduction point and with much of the news featuring these two scenarios belonging to the Growth stage.

Looking at the x-axis of the map, to the left of the **Organic** scenario sit the **Carbon neutral** and **Sustainable packaging** scenarios, which are in the **Challenges** stage, and even further to the left is **Upcycling-Food waste**, which is in the **Expectation** area.



Stage of FoodTech innovation



The path towards more sustainable packaging

The packaging industry is increasingly working to accelerate along the path to sustainability. The trend is being pushed along by increased consumer awareness of the environment and legislation incentivising the manufacture or use of more sustainable packaging.

In the **sustainable packaging** scenario, we can see that work continues along the line of manufacturing 'more environmentally friendly' packaging. One way to achieve this is to make more sustainable packaging.

A number of legislative proposals are helping in this regard, such as the revision of the Packaging and Packaging Waste Directive (PPWD) released on 30 November 2022, which modifies the 2019/2020 European Union Regulation (EU) and the 2019 Directive, and which the Spanish government supported on 27 December 2022 by passing a new royal decree, the tax on non-reusable plastic packaging coming into force in the country a few days later, on 1 January 2023.

If fully adopted, the proposed revision will accelerate the EU's goal of making all packa-

TRENDS IN PACKAGING

As discussed at events such as **Vitafoods, Hispack or Meeting Pack**, the food industry is intent on using more sustainable packaging. To this end, some of the main trends are:

- Increasing the use of recycled materials.
- Reducing and eliminating packaging.
- Replacing of plastic with bioplastics or alternative materials.
- Designing packaging for recycling or reuse.
- Switching to single-material packs.

ging reusable or recyclable by 2030.

All this is encouraging companies to commit themselves to sustainable packaging and seek ways to develop it. To achieve this, certain expectations are placed on the development of new materials, particularly of plant origin. Examples include the Magical Mushroom Company, which combines agricultural waste with mycelium to create biodegradable containers; and **Tetra Pak**'s development of a new container made using a biopolymer-based material to replace the aluminium layer.

Other interesting ideas include research to create smart packaging, such as the work being carried out by the **Canadian Food Innovation Network (CFIN)** to extract the biopolymer from lobster shells to give packaging antimicrobial properties.

In Spain, an illustrative example noticed in this scenario was that of **Nomen**, which presented a 100% sustainable, reusable glass container for its 1 Minute Rice range.

Upcycling, an opportunity for the industry



One scenario which is growing in **relevance** is **Upcycling-Food waste**. It helps that public institutions are trying to encourage less and less food waste. One step towards this objective will be the entry into force in **Spain** of the **Act on the Prevention of Food Loss and Waste** in 2023.

This law establishes a priority hierarchy for the use and exploitation of food waste, supporting reuse for human consumption, and can be seen as 'an opportunity', although for that to be so it is necessary to 'rethink business models, study new markets, develop new technology, research'.

According to **FactMR**, the global market for food products made from ingredients obtained from by-products was worth \$275.3 million in 2022, registering year-on-year growth of 5.9%.

Barclays, however, warns of the risk of increased competition for by-products as technology develops, which, if supply chains are not improved, could lead to higher input prices and additional pressure on business margins.

Concrete proposals in 2022 included a number of Spanish initiatives in this scenario. One was the purchase of 5% by the Santander Group of the Almeria biotechnology

firm **Kimitec**, whose plans within the field of agribusiness include the valorisation of different by-products.

Pascual led another initiative by presenting in Navarra the **MKare** brand, which specialises in harvesting egg shell membrane and is working on its valorisation. Other examples of Spanish start-ups working on the valorisation of by-products are: **Ingredalia, Agrosingularity, Moa Food Tech and Eggnovo**.



MULTINATIONALS AND UPCYCLING

Several multinationals used up-cycling solutions to develop new products. One example was the American brewing giant **Molson Coors**, which transformed its upcycled barley into a new ingredient to create its Golden Wing barley milk. Another was the Swiss multinational **Bühler**, which created a joint venture with **Circular Food Solutions Switzerland**. The new company will produce an ingredient intended for use in meat alternatives based on up-cycled barley by-products.

'No Time to Waste' estimates that 153.5 million tonnes of food are wasted in the European Union every year, which represents about 143 billion euros per year for European companies and households

Carbon neutral, the industry is working on polluting less

The Spanish are increasingly aware of the importance of caring for the environment. In its study 'The Changing Climate of Sustainability', **Nielsen IQ** reports that 73% of Spanish consumers consider sustainability to be 'more important' than in 2020. However, 49% point out that the cost of these options prevents them from adopting a sustainable lifestyle, as shown in Figure 5.

76% of Spanish consumers believe that companies should be forced to show full transparency regarding their supply chain. On this matter, 77% say they would stop buying products from a company found guilty of 'greenwashing' (publicly claiming that their activities are sustainable when actually they are not).

Patricia Daimiel, Managing Director South Europe at **NielsenIQ**, states that: 'Companies that have been proactive about climate action will have a huge advantage because the industry is taking pains to fulfil sustainable requirements and efforts.' These requirements include advancing in the decarbonisation of processes and trying to be **carbon neutral**.

In 2022, we saw different initiatives in the **Carbon neutral** scenario (industry proposals that seek to decarbonise and pollute less). One of these was led by **Neutral Foods**, which made a \$12 million investment to expand its carbon-neutral dairy products.

We also saw some proposals focused on this scenario in Spain. Among others, we can highlight **Heineken**, which has the first 100% renewable solar thermal power generation plant in Spanish industry; **Coca-Cola Europacific Partners** (CCEP), which aims to transform CO₂ into raw material to incorporate it into its supply chain; the beer company **Cervezas Ambar**, with its 'Triple Zero' product, made with neutral CO₂ emissions; or **Europastry**, with its 'Carbon Neutral' production line.

Figure 5
THE CHANGING CLIMATE OF SUSTAINABILITY

% of Spanish consumers who

77
State that they would stop buying products from a company found guilty of 'greenwashing'

76
Believe that companies should be forced to show greater transparency in their supply chain

73
Consider that sustainability is more important than in 2020

49
State that the cost of sustainable options prevents them from adopting a sustainable lifestyle

Source: Nielsen IQ 2022

Vertical-indoor farming/hydroponics, barriers to overcome

The **Vertical indoor-farming/hydroponics** scenario faced two realities in 2022. On the one hand, it reached global sales of 5.89 billion dollars in 2022, which meant a growth of 6.41% on 2021, and is expected to have a Compound Annual Growth Rate (CAGR) of 20.1% over the period 2023-2030, according to **Grand View Research**,

which points out that this is due to 'the growing adoption of the environment-friendly production of fruits and vegetables'.

Staying on the positive side, in 2022, we learnt that **Plenty unlimited** plans to build the largest Vertical Farming campus in the world in **Virginia** (United States) and that **Emirates Crop One** opened what **Crop One**

Holdings and Emirates Flight Catering described as 'the world's largest vertical farm'.

In Spain, one news item that stood out was the investment round of 4.2 million euros led by **Corporación Hijos de Rivera**, which created the start-up **Ekonoke** to help develop indoor hydroponic hop cultivation.

The flipside in the scenario is the great barrier it faces in the form of the high cost of energy, which will be its great challenge to overcome in 2023.

Proof of this difficulty was the announcement by the German vertical agriculture specialist **Infarm** of the dismissal of more than 50% of its workforce and the reduction of its operations in the **United Kingdom, France and the Netherlands**.

The cost of energy is one of the great challenges facing the Vertical-Indoor farming industry

Organic, green is growing

The **Organic** scenario is consolidated and product launches are the order of the day. In Spain, organic consumption accounted for 2.856 billion euros in 2022, compared to the 2.752 billion registered in 2021, according to **Ecovalia's** figures.

The average per capita expenditure was 60 euros per year, a figure that also rose compared to 2021 when it was 58.15 euros, although still lower than in other countries, such as France, with an average expenditure of 187 euros per year per person, **Ecovalia** points out. **Juices, fresh fruit and vegetables, oils and cereals** were the product categories with



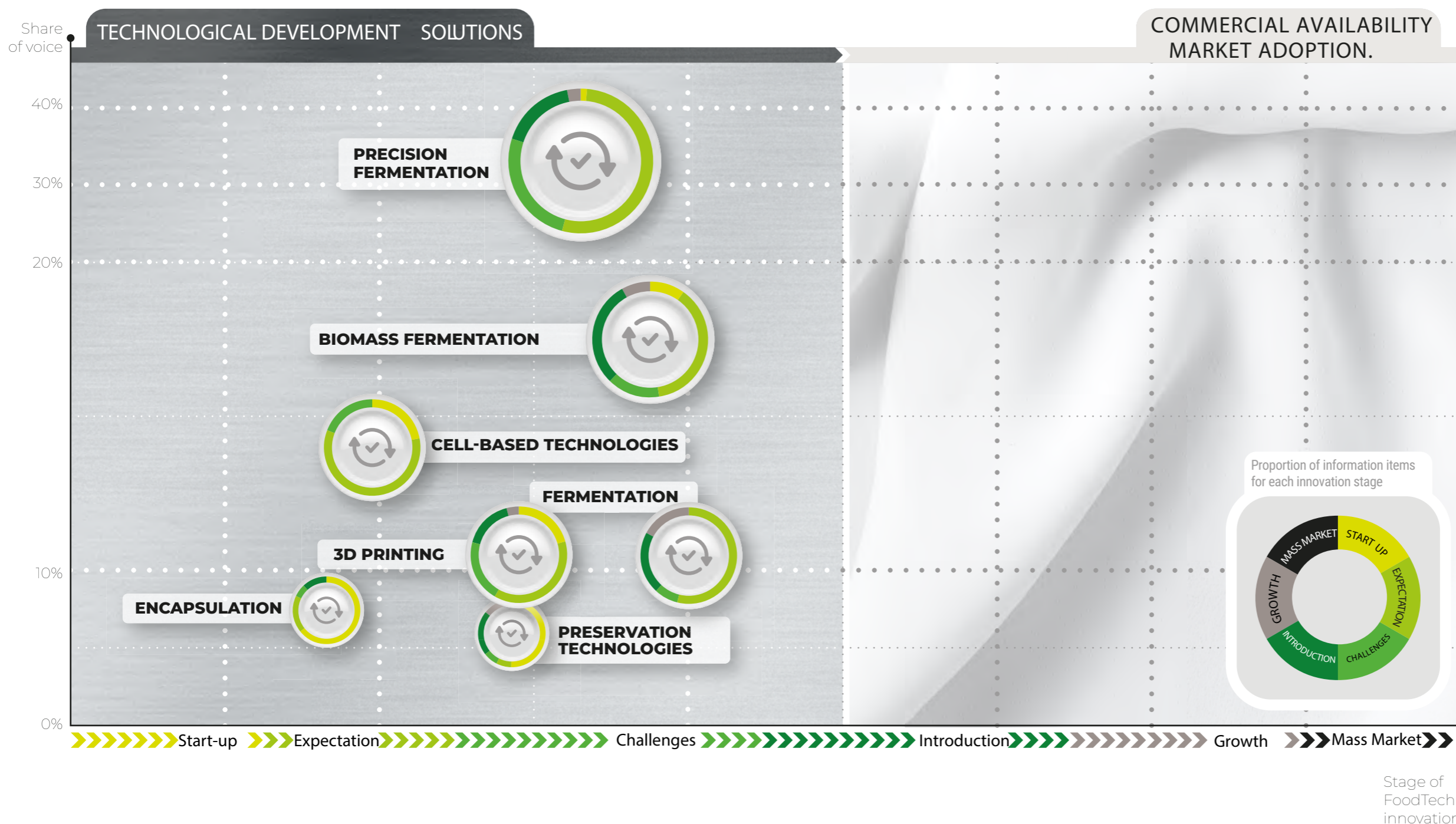
Juices, fresh fruit and vegetables, oils and cereals are the product categories with the greatest presence in the organic food business

the greatest presence in the scenario, in which consolidated brands and producers already existed, while other companies began to follow the trend

In the period under analysis, some proposals that we heard in this field were: **Roquette's** new organic pea protein line; **Soli Organic** raising some 125 million dollars to expand production of its organic culinary herbs in the United States, and advancement of **Food Sourcing Specialists** in its positioning in organised distribution with its organic sports nutrition brand **Win It**.

NEW PROCESS TECHNOLOGY SCENARIOS

JAN/DEC 2022-228 INFORMATION ITEMS ANALYSED



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.

On this map, we find 7 opportunity scenarios and leading the macro scenario in terms of share of voice is **Precision fermentation**, with 32.49%.

Another type of fermentation, **Biomass fermentation**, is the scenario beneath it, reaching 16.88%, closely followed by **Cell-based technologies** (13.5%), **3D printing** (10.13%) and **Fermentation**, the scenario which covers fermentation that is neither precise nor biomass, such as traditional fermentation (10.13%). And beneath double figures are **Encapsulation** (7.17%) and **Preservation technologies** (5.91%).

In these scenarios, we found news about different stages of **Innovation**, from research activities to new developments in the market. The reason why they were placed at one point or another on the map is that analysis of all the news gave us a mean and it was that mean that determined the X coordinate.

So, what we can observe on this map is that the most advanced scenario in terms of innovation is **Fermentation**, which is in **Challenges**. The **Biomass fermentation**, **Precision fermentation**, **3D printing** and **Preservation technologies** scenarios are in the **Expectation** stage. Finally, those which are still in a more fledgling and research state are: **Cell-based technologies** and **Encapsulation** (in the latter scenario, the news published refers to information on scientific studies).



CNTA bioreactor

Precision fermentation reigns supreme

The ingredients or proteins obtained through **precision fermentation** are expected to reach a sales value of 36.3 billion dollars worldwide by 2030, with a Compound Annual Growth Rate (CAGR) of 48.1% in terms of value, according to a study by **ResearchandMarkets.com**.

In the period analysed, we discovered initiatives by multinationals such as **Nestlé**, which began to explore the development of products using animal-free dairy protein alternatives; and **Unilever**, which announced research into the development of 'cow-free' ice cream.

We also learnt about the partnership between **Fermify and Bilfinger** to address the issue of producing 'animal-free' dairy protein analogues on a large scale and making them profitable.

+48.1%

The sales value of ingredients or proteins obtained from precision fermentation is expected to grow at a CAGR of 48.1% according to ResearchandMarkets.com.

PERFECT DAY, ONE OF THE LEADERS



Perfect Day, which is looking beyond its whey protein, which is already used by several companies, deserves special mention. In September 2022, it launched a biotechnology business called nth Bio to help its partners use precision fermentation technology.

In the same month, we also learnt that the start-up allied with One-go Bio to accelerate the launch of 'animal-free' eggs.

Biomass fermentation continues to boom

In 2022, **Biomass fermentation** grew in importance and is expected to continue to develop technologically in 2023. This technology is used by companies like **Quorn and Meati Foods** to make their filamentous fungi-based meat analogues.

In the period under analysis, some interesting initiatives we heard about included one led by **Nextferm**, which reached an agreement for the production of Protevin, its vegan alternative based on **Biomass fermentation**, or one by **Oceanium**, a Scottish start-up that develops an algae-based methylcellulose replacement.

Other types of fermentation, which are neither biomass nor precision fermentation, are included in the **Fermentation** scenario. We saw different proposals here in 2022, such as the development of Fabea+, an ingredient made from fermented beans by the **Finnish start-up Foodiq**; the launch of the cocoa-free brand **WNWN**; and **Pulp Culture's** fermented functional non-alcoholic drinks.



3D printing, facing the challenge of scalability



Cookie made by 3D printing

3D printing is a technology in the Expectation stage. Various start-ups working with 3D Printing are continuing with research to overcome the frontier of moving on from technological development to the market.

One of these is the Navarrese firm **Cocuus**. In November 2022, it presented the world's first industrial 3D food printing line, which, they claim, 'is ready to be incorpo-

rated at any food company'. The line can produce up to 1,000 tonnes of bacon analogues per year.

Other examples of start-ups that work with this technology are: the Austrian company **Revo Foods**, which develops 3D printed plant-based seafood, or the Spanish firm **Novameat**, which in 2023 closed a funding round of 7.1 million euros to scale up its 3D printed meat.

Cell-based technologies, helping to develop cells



With the increase of everything related to **Cell-based technologies** in 2022, process technologies such as **scaffolding**, **culture media**, **organoids**, **stem cell lines** or **tissue templating** which help develop cells had a great impact in the media over the period.

The **cell-based** industry has many challenges to overcome, such as: reducing the economic cost of processes and achieving industrial scale-up. To overcome them, production technology must evolve. There are many aspects involved in progress of this kind and all these technologies are included in the **Cell-based technologies** scenario.

In 2022, one term that gained prominence in share of voice was **scaffolding** (creating structures that develop cells). During the year analysed, we saw various initiatives that use this technology. Among them were: the research being conducted at the **University of Vermont** (United States) on the use of alginate to create **scaffolding** and **Bluu Seafood's** research into cultivation with **3D scaffolding** made of plant material.

Culture media and scaffolding were two of the key terms on the Cell-based Technologies stage in 2022

Another term heard a great deal in this scenario was **Culture media** (growth media to feed cells). The progress being made is multifaceted and **Culture media** (due to their price and animal origin) play a critical role in development.

NEW IDEAS FOR CELL-BASED FOOD

In 2022, we learnt of a number of new technologies to develop **Cell-based** food production. **Umami Meats** filed a patent for its stem cell technology using **mesenchymal stem cell** (MSC) lines from fish. The cultured seafood start-up explains that this kind of technology is 'unique' because it only requires one type of cell and one production line to grow both muscle and fat. Other start-ups proposed different approaches to scale up **cell-based** production without using **scaffolding**. For example, **3D Bio-Tissues (3DBT)**, which uses its tissue templating platform to create structured, functional and scalable tissues, and **Forsea Foods**, which claims to be the first company to use **organoid** technology for its seafood cultivation process, which requires 'fewer bioreactors'.

To try to overcome the barriers, some of the proposals we saw were led by: the Israeli start-up **BioBetter**, which offers culture media at competitive prices made with **insulin**, **transferrin** and **FGF2** (Fibroblast Growth Factor); and **Opalia**, which replaced its culture medium (foetal bovine serum) with an animal-free alternative.

There are also proposals of this kind in Spain. One of these is **Agrenvec**, which positions itself as a supplier of recombinant plant-based proteins for cultured meat growth media. Another example is **Algenex**, which was acquired by the pharmaceutical group Insud Pharma at the end of 2022, although the operation included the segregation (through a spin-off) of Algenex's bio-component unit, the development of which will continue independently in a newly created company, **Cocoon Bioscience**.

Preservation technologies, new approaches to extend shelf life



Bioprotective culture

The development of new preservation technologies allows progress to be made in preserving and increasing the shelf life of food products and thus reducing food waste.

The different preservation technologies are widely known and used in the food industry, but high-potential research activity can be observed in search of ways to improve existing solutions: longer shelf lives, reducing the effects of using technology, etc.

Such new preservation technologies are not yet consolidated in the market, but their potential is evident. In 2022, we heard about a number of propo-

sals. We found one in Italy, where a group of experts from the University of Bari, the National Research Council of Italy (CNR) and the private Italian Food Safety Lab managed to extend the shelf life of fresh pasta by up to 30 days by incorporating probiotic microorganisms.

Other ideas we saw in 2022 in this scenario were the use of **Prinova's** plant-based preservative, which inhibits the growth of specific bacteria, yeasts and moulds, and can stop the formation of *Listeria Monocytogenes*; and the **Cronogard** system, which introduces functional molecules into packaging materials to better protect and preserve food

Encapsulation: a technology of interest for functional products



Encapsulation is a technology that in 2022 continued to generate research projects, due to the interest it arouses in the development of functional products. After use in bioactives or compounds, not only do these gain in functional properties that make their inclusion in food matrices possible, but these food matrices gain in value and functionality as well.

In 2022, we discovered research into the

microencapsulation process which preserves high antioxidant and polyphenol content from passion fruit peels; or **co-encapsulation** by spray drying lactic acid bacteria and lipids.

In Spain in 2022, we learnt about the progress in **encapsulated food ingredients** being developed by **Nucaps Nanotechnology**, which is also involved in the preparation of

caramel with probiotics at **El Caserío de Tallalla** in which encapsulation technology is used; and in **NuCla**, a salt alternative, which, when it dissolves in the mouth, brings a salty taste without harming the health.

HEALTHY FOOD AND PERSONALISED NUTRITION SCENARIOS

JAN/DEC 2022 - 180 INFORMATION ITEMS ANALYSED



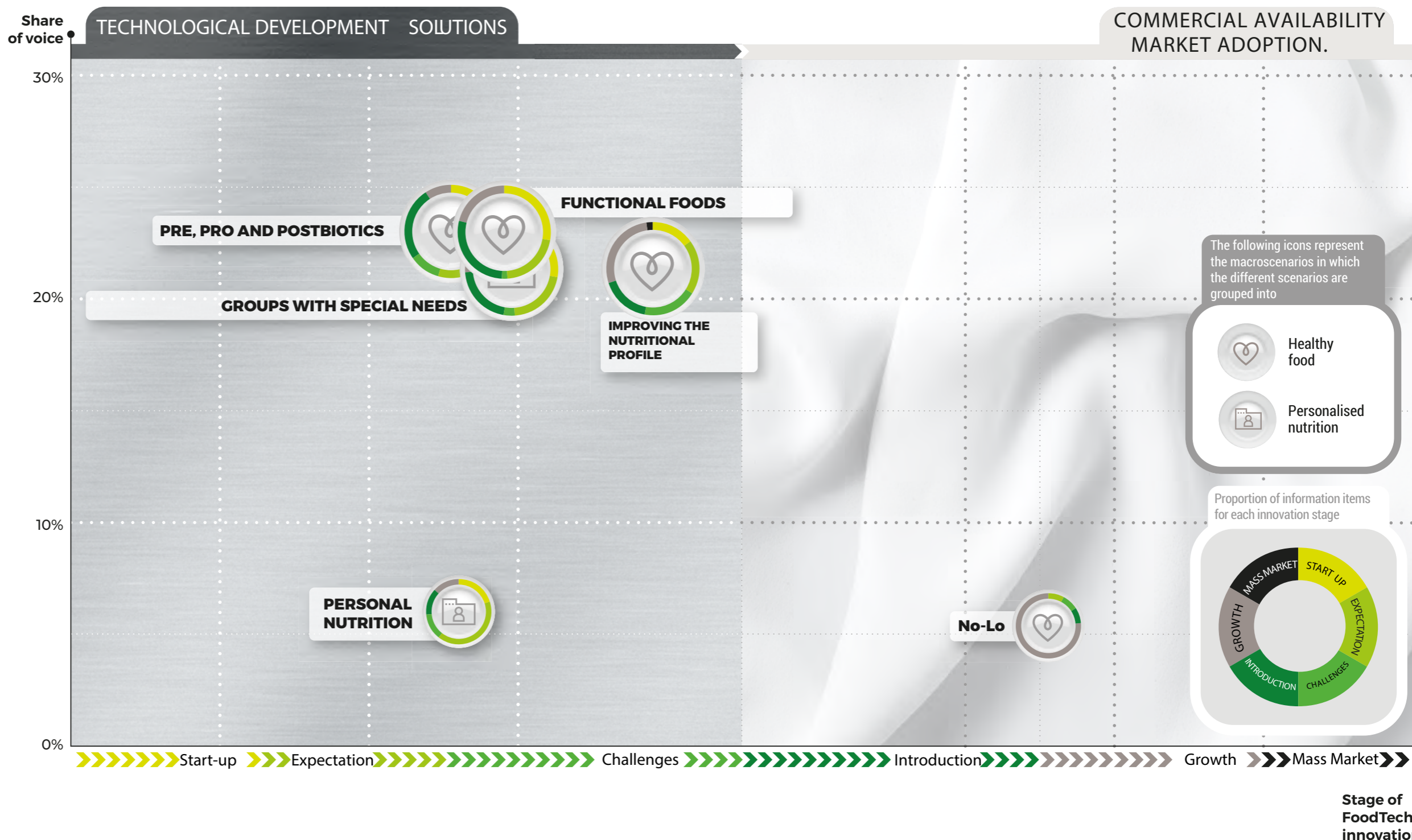
The fourth map we are going to analyse is **Healthy food and Personalised nutrition**. This map is composed of the scenarios from two macro scenarios closely linked to each other, both focusing on health: **Healthy food and Personalised nutrition**.

On it, there are 6 opportunity scenarios, with **Functional foods and Pro-, pre- and postbiotics** in joint first place in terms of share of voice, both with 22.89%.

Improving the nutritional profile and Groups with special needs also tie, both with 21.37%. Finally, we have **Personal nutrition**, with 6%, and **No-Lo** (low-alcohol or non-alcoholic drinks), with 5.24%.

On this map, we can see that the **No-Lo** scenario is already in the market stage (approaching the growth point) and that **Improving the nutritional profile** is in the stage in which it needs to overcome **Challenges**.

All the other scenarios (**Functional Foods, Pre-, pro- and postbiotics, Groups with special needs and Personal nutrition**) remain in the Expectation stage.



Stage of FoodTech innovation

Functional foods, looking at cognitive health



An important scenario in the health segment is **Functional foods**, a product category which, according to **ICEX**, reached a global value of 189.5 billion dollars in 2022 and is expected to grow to 285 billion by 2030.

In the year under analysis, we saw initiatives that not only focused on the concept of physical health but also on mental well-being. Examples included the one led by **Megmilk Snow Brand**, with its drink that helps maintain memory, and the vitamin supplements to accompany coffee, smoothies or juices Super Good Drinks by **GoodNews** and **Baia Food**, which enhance such things as concentration or luminosity of the skin.

Improving the nutritional profile, healthier food to prevent diseases

To prevent diseases, it is essential to have foods with a better nutritional profile. For this reason, the **Improving the nutritional profile** scenario was relevant in 2022 and the trend is expected to continue in 2023 with research and launches reaching the market.

News in this scenario included the sugar substitute developed by **Resugar** and the research by the **National Food Institute - Technical University of Denmark** which shows that lactase derived from lactic acid bacteria can be used to produce sweet **yoghurt** naturally.



Multinationals are also deciding to offer proposals to improve the nutritional profile of their products. Steps forwards in this regard are the initiative of **Danone North America**, which plans to reformulate 70% of its dairy alternatives to make them healthier, and that of **Nestlé**, which intends to push on with a catalogue that has a better nutritional profile.

We also learnt of new ways to reduce salt in food in 2022. One of the most notable was **Nucla**, a salt reduction solution marketed by **Nucaps**, which maintains the perception of tasting salt in food without adding strange flavours.



Pro, prebiotics, postbiotics, a business sector with great potential

With growing consumer interest in gut health and maintaining a healthy microbiome, probiotics, prebiotics and postbiotics are receiving more and more attention.

The probiotic ingredients industry is expected to reach a global level of 6.06 billion dollars by 2028, when in 2021 it totalled 3.49 billion dollars, according to **Research and Markets**.

We saw a few new products launched in this scenario in 2022. Examples were two new probiotics aimed at children's growth and immune health from **Nestlé Health Science's Garden of Life**; and the psychobiotic to aid relaxation and sleep by **Bened Biomedical**.

We also saw a number of initiatives in Spain. Two were led by the **University of Navarra with CNTA**, which developed probio-

tics that can help fight obesity, and **El Caserío de Tafalla**, which is working on the first caramel with probiotics on the market, with plans for market launch in 2023.

Breaking down the barrier posed by the technical difficulty of achieving the industrial scale-up of some types of probiotics and continuing to investigate the potential of certain microorganisms are some of the challenges this scenario faces.

BEYOND INTESTINAL HEALTH

On the subject of pre-, pro- and postbiotics, Smriti Sharma, Program Manager of the Nutrition & Wellness Practice Area of Frost & Sullivan, said at Vitafoods 2022 that the industry is focusing on 'regulating the microbiome and improving the immune system'. But she supported continuing research in this field to be able to go further and discover just how microbiota affect 'the nervous system, the skin and the brain'.

No-Lo, a growing scenario

In 2022, the **No-Lo drinks** scenario (low-alcohol or non-alcoholic drinks) surpassed 11 billion dollars in sales in terms of value and grew in volume by 7% on 2021 in the ten markets analysed by **IWSR** (Australia, Brazil, Canada, France, Germany, Japan, South Africa, Spain, the United Kingdom and the United States).

The consulting firm predicts that its volume will grow at an Annual Compound Growth Rate (CAGR) of 7% in the 2022-2026 period, as shown in Figure 6. 'No-alcohol will spearhead this growth, expected to account for over 90% of the forecast total category volume growth,' it indicates.

It goes on to state that 'improved taste, production techniques, and a diversification of consumption occasions are driving no-alcohol's dominance over low-alcohol in many markets' and that innovation in this product category is focusing 'on packaging, functional benefits, and flavour'.

In terms of launches, some of the new products that we began to hear about in Spain were: the low alcohol wine by **Bolle**, **El Progreso's** de-alcoholised white wine; **Ambar's** 'Triple Zero' beer; and **El Gaitero's** 0% cider, made by the traditional method and then de-alcoholised.



Personal nutrition, in the expectation phase

The **Personal nutrition** scenario (healthy initiatives customised for each individual) is still in the **Expectation stage**. **Research and Markets** indicates that the global **Personal nutrition** market was worth \$11.3 billion in 2022 and forecasts growth at a rate of 15.5% CAGR until 2027.

One example of a solution we saw in 2022 in this scenario was that of **myAir**, which uses personalised nutrition (through the data it collects from an online questionnaire) to help consumers reduce their stress levels. After completing the questionnaire, the respondents get snacks with adaptogens that specifically target their needs.

Another example was **Inside Tracker's** \$15 million funding round for its lifestyle and eating tracking and personalisation platform.

15.5%

Research and Markets indicates that the global Personal nutrition market was worth \$11.3 billion in 2022 and forecasts growth at a rate of 15.5% CAGR until 2027.

According to the experts behind a 'Perspective' study published in the **Oxford Academy**, one of the great challenges for this scenario is 'to develop a rigorous set of standards and best practices for designing and assessing the efficacy of personalized interventions' that work.

SOLUTIONS AIMED AT GROUPS WITH SPECIAL NEEDS



In the **Personalised nutrition** macro scenario, we detected a rise in research and proposals focused on the **Groups with special needs** scenario. These groups included **women, children and people with dysphagia, fructose intolerance and visual and cognitive disabilities**.

In this field, **Food Scouting** points out, the proliferation of products that improve the different stages of the menstrual cycle, pregnancy, lactation or menopause is remarkable. An example of this is **Girl Tribe's** cereal bars, which 'support the two most important phases of the menstrual cycle,' according to the consulting firm. Also of interest is **Me&S's** development of cell-based breast milk for use in infant formulas. Another example of interest was the initiative led by **Mimica and United Caps**, which proposes an inclusive cap for people with visual and cognitive disabilities so that this group can know how fresh food is and when it expires, or **FreeShakes's** initiative to research the development of fructose-free products.

SCENARIOS IN DIGITALISATION AND FOOD QUALITY AND SAFETY

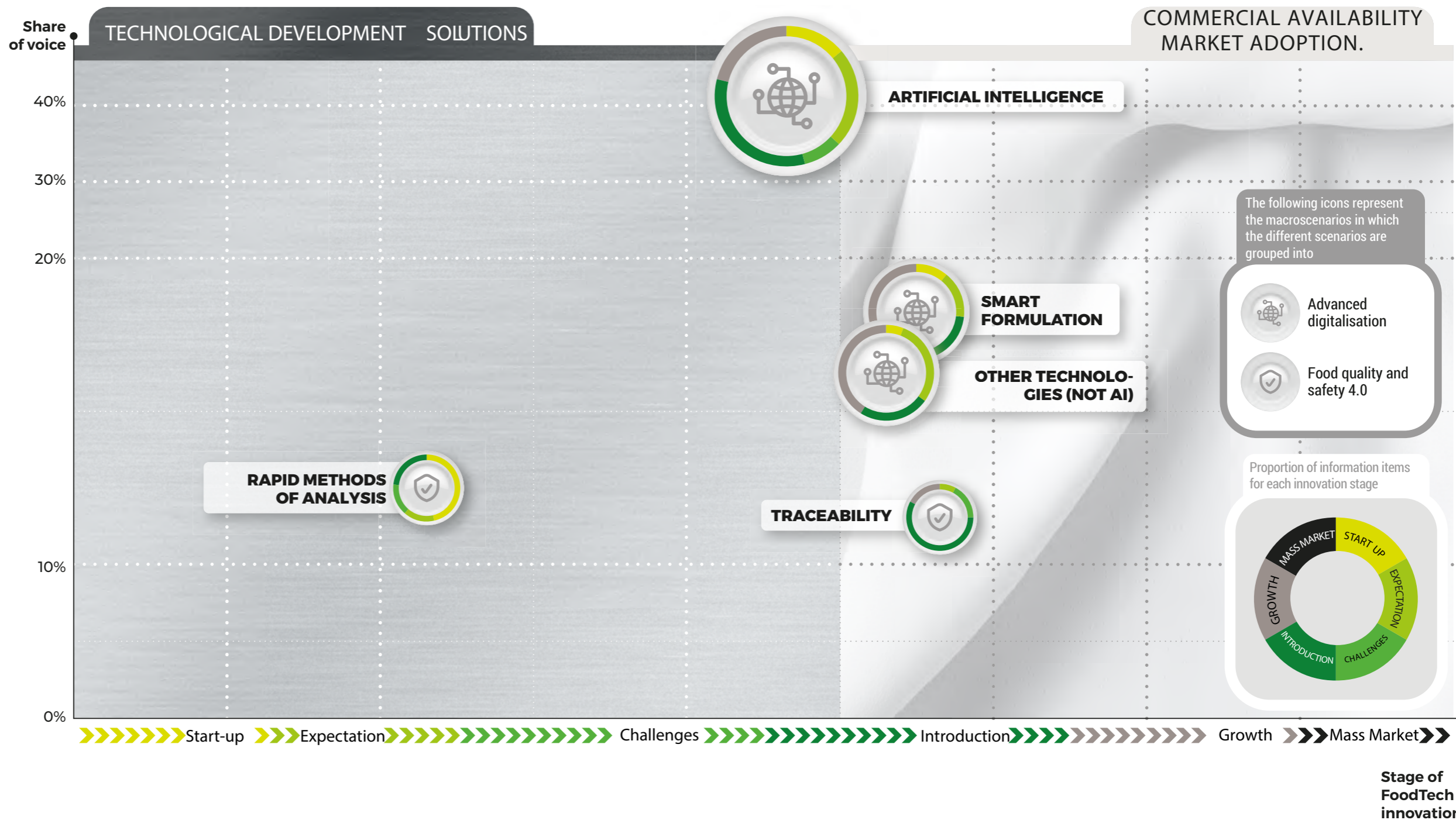
JAN/DEC 2022-104 INFORMATION ITEMS ANALYSED



The fifth and last map in this section is **Advanced digitalisation and Food quality and safety 4.0**. This graph shows the situation of the scenarios included in the macro scenarios of **Advanced digitalisation and Food quality and safety 4.0**, two macro scenarios in which technologies are developed to progress in efficiency to make food or check its safety and quality.

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 41.35%. A good way below, we find the other four scenarios: **Smart formulation**, with 18.27%; **Other technologies (not AI)**, with 16.35%; **Rapid methods of analysis**, with 12.5%, and **Traceability**, with 11.54%.

As for stages of **Innovation**, it is notable that four (Artificial Intelligence, Other technologies (not AI), Smart Formulation and Traceability) out of the five scenarios are in the stage where they need to overcome barriers. The odd one out is **Rapid methods of analysis**, which is one step behind in the **Hype** stage.



Artificial Intelligence, backing digitalisation for FoodTech

In digitalisation, technological developments based on **Artificial Intelligence (AI)** are stealing the show. In 2022, one of the trends we observed was the increase of start-ups with their own software to make food with the help of AI.

An example of this was **DSM**, which created its Delvo One range of cultures through its **AI platform Culture Co-Creation Platform**, designed specifically for fermented dairy, although as the firm indicated 'the Culture Co-creation Platform could be used for plant-based applications'.

In the realm of Artificial Intelligence, new releases in 2022 included the Swedish company **Stravitto's** Atlas tool, which aims to help food and beverage manufacturers manage the data they receive from consumers.



SMART FORMULATION TO FIND NEW INGREDIENTS

A scenario that rose strongly within the **Advanced digitalisation** macro scenario was **Smart formulation**, a concept used by start-ups to find new or more suitable ingredients for their products. Using this system, we saw **Equii**, which has a bioinformatics platform with which it predicts the quality of the microbial protein from a fermentation process, and **NotCo** (Chilean start-up), which formulates ingredients with its Artificial Intelligence program **Giuseppe**.

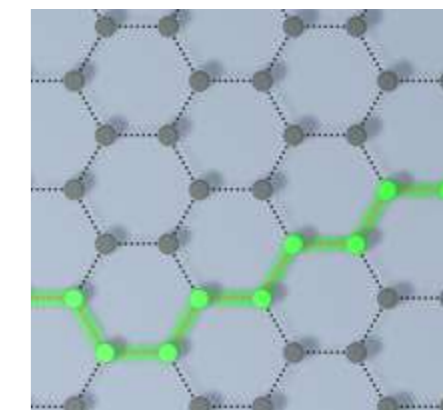
In late 2022, NotCo raised \$70 million to boost its AI platform. This will enable other companies to use the platform for their own innovations, while the company itself will continue to operate its branded business, NotCo Food, offering its products and new launches through retailers and food services across the United States.

Traceability, blockchain the most used solution

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

An example of the use of blockchain is **Origin**, created by **Trazable**, the start-up backed by the owner of the **Mercadona** supermarket chain Juan Roig's Lanzadera business accelerator. This project aims to help wine companies with the EU labelling standard and show the history of their product through **blockchain** certification.

In Traceability, interest in blockchain-based solutions is still rife



Rapid methods of analysis, more efficient and accurate predictions

In the **Rapid methods of analysis** scenario, we saw that **hyperspectral** technology was making headway. An example of this was **Apeel**, which launched an avocado freshness scanning system based on hyperspectral images to predict the freshness of avocados and their shelf life.

We also learned about research into more precise methods for **detecting allergens** using more sensitive **molecular biology** analytical techniques capable of recognising these substances more quickly.

Equally interesting was the proposal we heard about from Canadian scientists to increase the safety of frozen and preserved vegetables through pulsed light during the final stage of processing as an additional step to ensure that the vegetables are free of Listeria.

SUREFISH AND MEDITOMATO, TO DETECT FRAUD IN FISH AND TOMATO QUALITY

In 2022, we saw progress in this field thanks to a few projects in which CNTA took part, such as **Surefish**, which centres on detecting two types of fraud in fish: frozen bluefin tuna being sold as fresh, and knowing the origin of anchovies through VIS-NIR and hyperspectral imaging in conjunction with AI.

Another project in which CNTA collaborated was **Meditomato**, which uses VIS-NIR devices to measure up to seven parame-



ters of tomato quality, such as °Brix, acidity, colour or firmness, in real time. And if we look at products which have reached the market in 2022, Nulab launched its portable NIR device, which can determine food quality and safety parameters in real time wherever the product is. So, tests that once took days now only take seconds.

Other digital technologies, towards factory 4.0

In the **Other digital technologies (not AI)** scenario, in 2022 we saw a number of developments bringing companies closer to factory 4.0, in which robotisation, process automation and the use of artificial vision are major features, as was the case at **Patatas Meléndez**, which invested more than 36 million euros to bring in **optical selectors**, which classify potatoes by size, shape and quality in

a single process; **anthropomorphic robots**; a smart warehouse; enhanced energy exploitation and optimisation of the water cycle.

Another example is **Mars**, which has reached an agreement with **Accenture** to transform and modernise its manufacturing operations with artificial intelligence (AI), cloud, edge technology and digital twins at its factories all around the world.



TECNOLOGÍA Y CONOCIMIENTO
PARA LA COMPETITIVIDAD DE
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