

REPORT

January- August 2023

Foodtech



PPORTUNITY

Scenario map by **alinnova**
CNTA

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Contents

- 4.** Science and technology, the basis for the transformation of the food industry
- 7.** Methodology
- 11.** 2023 at a glance. Macro scenario and scenarios
 - 16. Macro Scenario Map
 - 18. Map of All scenarios
- 35.** In depth
 - 36. Alternative proteins, fats and food
 - 48. Sustainability
 - 54. New process technology
 - 62. Healthy food and Personalised nutrition
 - 68. Digitalisation and Food quality and safety
- 75.** Anexes:
 - Opportunity Scenario Map 2022**



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



CNTA, the Spanish National Food Technology and Safety Centre, presents its **2023 Report on the FoodTech Opportunity Scenario Map**, funded by the Ministry of Agriculture, Fisheries and Food (MAPA). This report is the result of an observation and information curation process carried out daily throughout 2022. To do this, the **CNTA Vanguard team** analysed the FoodTech news published in **more than 100 information sources** (both Spanish and international) and identified future scenarios which present transformation opportunities for the food industry.

¿WHAT WE CALL FOODTECH NEWS?

Information that covers innovative **approaches to solving the challenges** faced by society and the food industry which have a **technological component** and the potential to generate a transformative impact. The aim of this report is to present the **FoodTech opportunity scenario map**, a visual tool which shows the situation of the FoodTech industry on a two-dimensional plane. The map can help us understand what is being talked about and how much is being said, and reflects the

stage of innovation or degree of maturity of a specific technology.

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

Where are the opportunities? Given the situation, where should I invest? And the barriers? What is the next technological milestone that will affect my company? What is the market situation? Which ground-breaking startups should I know about? What examples can I find to inspire me?

In these pages, you will find

the maps of both macro scenarios and scenarios so you can navigate with all the detail you need, and a summary of what happened in FoodTech in 2022, with some relevant examples we noticed in the year under analysis. We hope you enjoy reading it and discover a lot of opportunities for the future.



Methodology

Concepts

Stage of innovation

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

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

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

Method of analysis

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

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.

¿WHAT IS FOODTECH FOR CNTA?

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

For **CNTA**, **FoodTech** refers to the **application of technology** for the transformation of the food industry and to resolve the related challenges which our society faces. As a result of this transformation, food will be healthier, more sustainable, safer and more accessible. It should be noted that, with this scope, we do not cover areas such as delivery, e-commerce, supply chain or agritech.

Other sources consulted in this report do include areas that are not covered by what CNTA understands by FoodTech.

One of these sources is Pitchbook, which includes in its FoodTech analysis the categories of **Alternative proteins** (where it bunches together cultivated proteins, fermented proteins, plant-based proteins and edible insects); **Biotechnology-based products** (which covers new ingredients, functional foods, molecular engineering and future forms of food); **Discover and revise** (which addresses discoveries in food and beverages, software for kitchens and personalised nutrition); **Food production** (which covers smart food and development, food waste and traceability, sustainable packaging, freshness control); **e-commerce** (with subcategories such as food kits, online grocery stores and restaurant marke-

tplaces) and **Technology for restaurants and retail** (which includes delivery robots, advanced vending, technology in sales and operations, grocery store tech, ghost kitchens, technology for cooking and robotics).

Another source of reference was **DigitalFoodLab**, which includes in its FoodTech analysis the areas of **Delivery**, **Consumer tech**, **Agritech**, **FoodScience**, **Supply chain** and **Foodservice**. The FoodScience category includes **Alternative proteins**, **Major innovations** in ingredients or in mature beverage or food markets; **New types** of beverages or beverages that promote a healthier lifestyle; **Functional ingredients** and **Pet foods**.

A person wearing a plaid shirt is shown from the chest up, holding a microphone. The image is overlaid with a semi-transparent green gradient that is lighter on the left and darker on the right. The person's face is partially visible, looking towards the microphone.

2023 at a glance

Macro scenarios and scenarios

FoodTech Investment

We are witnessing a slowdown in investment in **FoodTech** in 2023. Globally, investment in FoodTech experienced a notable decrease in number of Venture Capital deals in the first quarter of 2023 (the latest data available at the time of this report), totalling 197, which meant a decrease of 37.6% on the fourth quarter of 2022, when 316 were reached. These deals amounted to a value of \$2.3 billion, a 17.8% drop on the \$2.8 billion registered in the fourth quarter of 2022, according to the consultancy Pitchbook.

Pitchbook explains this drop by reference to the instability of the financial market, which has undermined the confidence of investors, who 'are becoming more discerning and cautious, preferring to invest in ventures that

offer greater stability and potential for growth'. Figure 1 shows how alternative proteins and biotechnology-based products represent, between them, 38.2% of the investment in FoodTech (18.8% in the case of alternative proteins and 19.4% in that of biotechnological foods).

With the definition we provided on page 9 of what CNTA considers FoodTech to be, we have produced this FoodTech opportunity scenario map. 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 1,425 in-

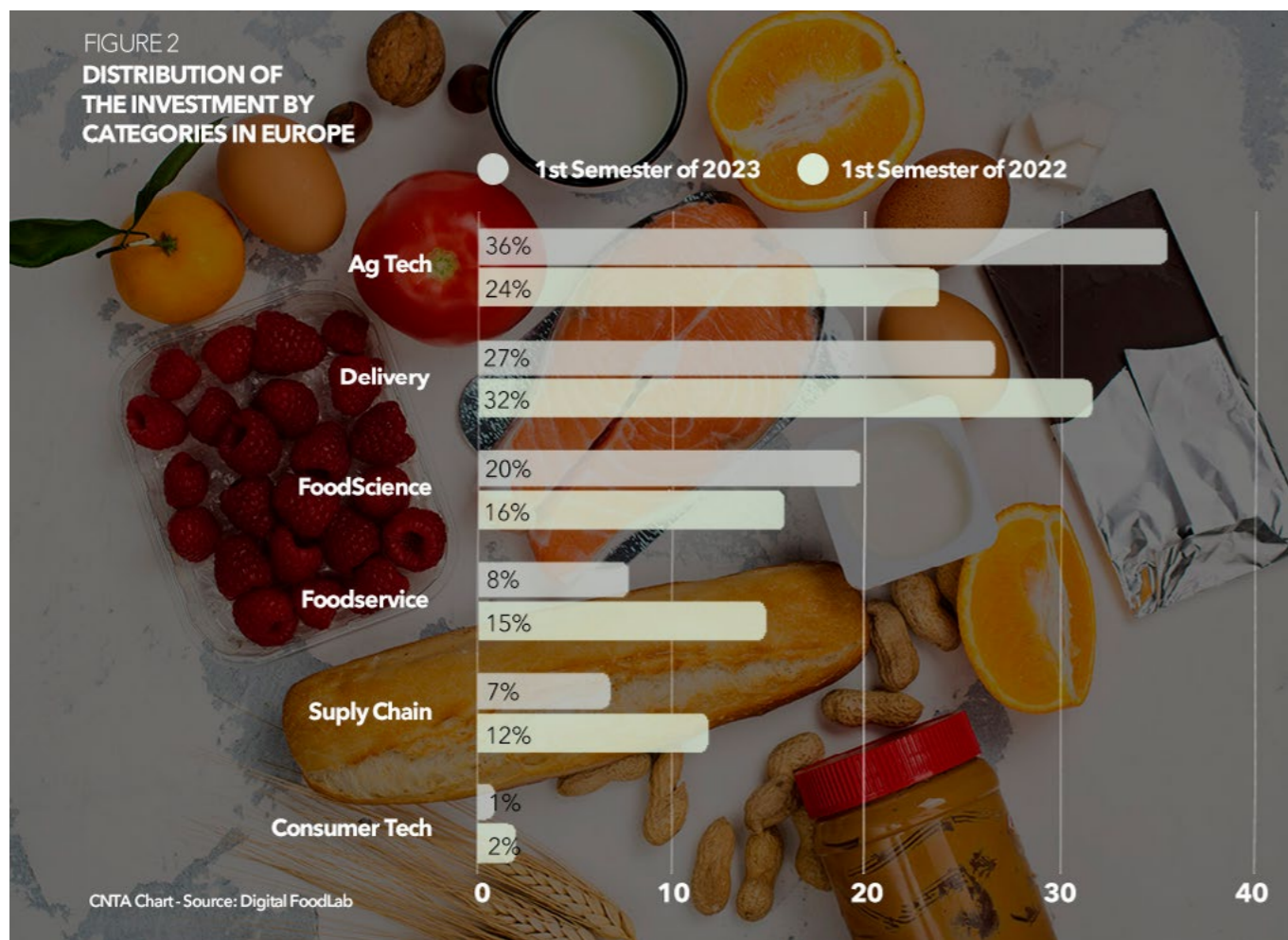
formation items by the CNTA Vanguard team, following the process described in the methodology section, allow us to navigate the current FoodTech scene quickly and simply.

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?

FIGURE 1
FOODTECH INVESTMENT AND SHARE
WORLDWIDE FIRST QUARTER
OF 2023



Figure CNTA - Source: Pitchbook. Data in millions of dollars



FOODTECH IN EUROPE

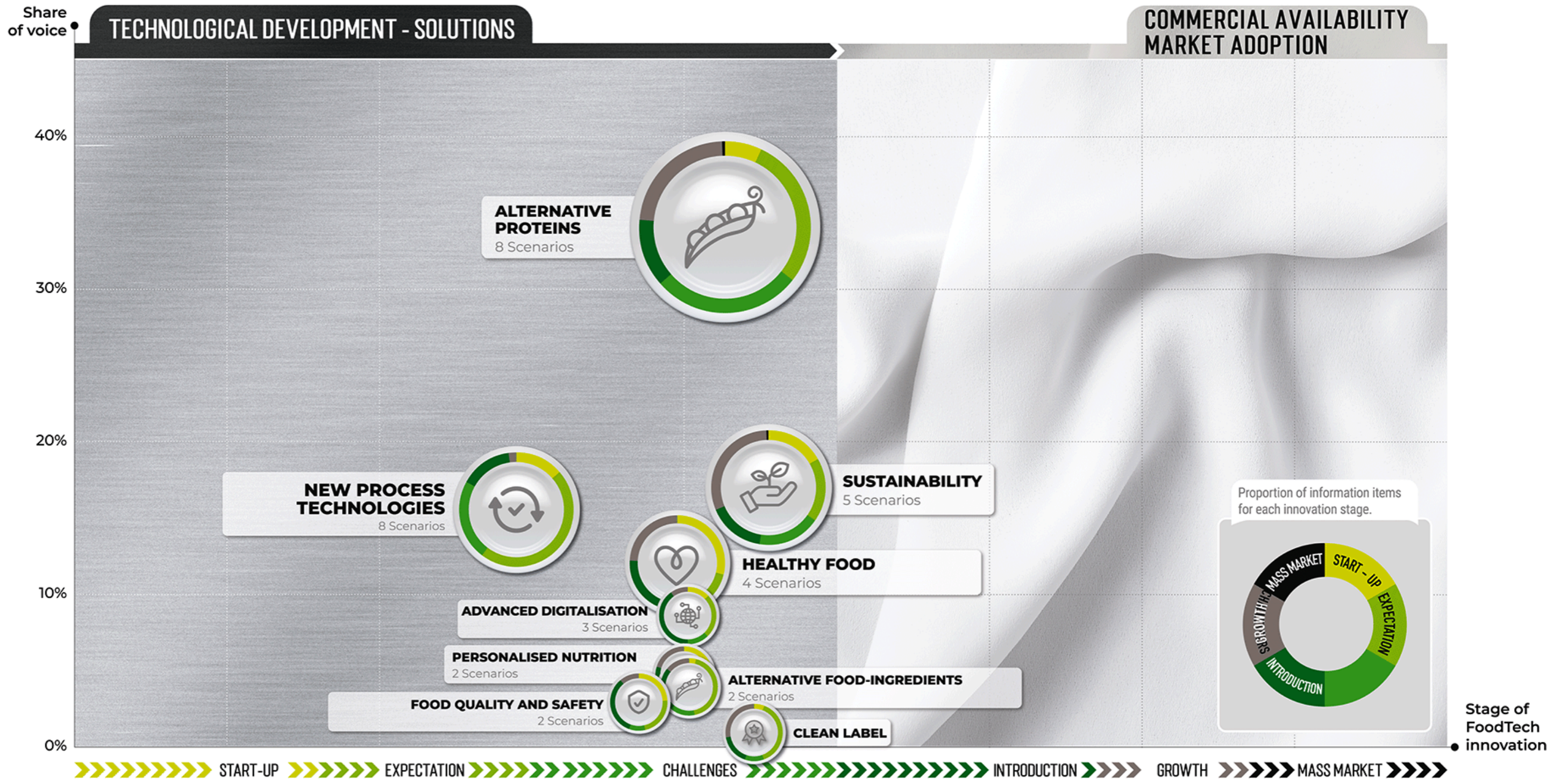
In Europe, investments in FoodTech decreased by 62.5% in the first half of 2023 compared to the same period in 2022, according to the consulting firm **DigitalFoodLab**. In the period analysed, investment in the continent totalled €1.5 billion. However, the figures offered by the firm are not fully comparable with those of other sources consulted because, as mentioned above, they have their own vision of what FoodTech is. In Spain, the latest figures available, found in the re-

port 'The State of FoodTech in Spain 2022' by Eatable Adventures, indicate that investment in food technology in the country stood at €268 million, which represents a 61% decrease compared to 2021. However, it should be borne in mind that of the €695 million invested in FoodTech in 2021, €450 million 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%.



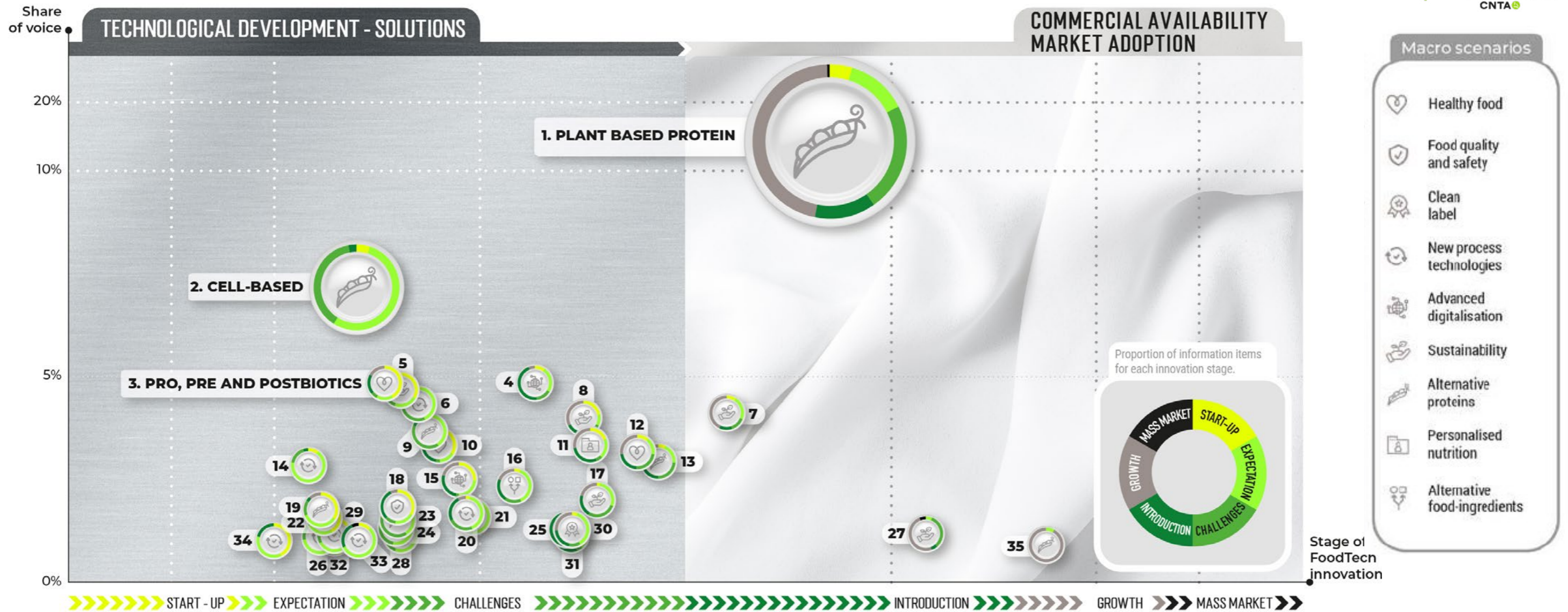
MACRO SCENARIO MAP

JAN/AUG 2023 - 1,425 INFORMATION ITEMS ANALYSED



MAP OF ALL SCENARIOS

JAN/AUG 2023 - 1,425 INFORMATION ITEMS ANALYSED



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

MACRO SCENARIO MAP

We have drafted this **January-August 2023 Report on the FoodTech Opportunity Scenario Map** using CNTA's definition of **FoodTech**, as given on page 9. 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 **35 scenarios**.

On the Macro Scenario Map, we can see that **Alternative proteins** is still the subject generating the most 'noise' in the media, accounting for 33.82% of the news analysed in the period, although there is a drop of 11.15% on 2022.

This fall in media attention is due to the rise in prominence of other macro scenarios. The two macro scenarios which have experienced the greatest growth are: **Food Quality and Safety**, with +88%, to reach 3.16%, and **Advanced Digitalisation**, with a 60.37%

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

increase, to reach 8.49%. Everything suggests that in the future we will hear more about these macro scenarios. Alternative proteins are followed by the **Sustainability** macro scenario, with a share of voice of 17.19%, and the **New Process Technology** macro scenario, with 15.51%. These two macro scenarios show similar numbers to those published in the 2022 Report*.

As for stage of innovation, we have only seen changes in the **Alternative food-ingredients** and **Personalised nutrition** macro scenarios, which in the

2022 Report were in the Expectation stage and are now (January-August 2023) in the Challenges stage. This progress is the result of more proposals reaching the market.

Therefore, and in conclusion, we can see a certain state of continuity in most of the macro scenarios, the main changes coming about for regulatory reasons and due to the challenges faced by each macro scenario and proposals which are reaching the market.

*You can consult the 2022 report map on page 76.

MAP OF ALL THE SCENARIOS

In the **Map of All the Opportunity Scenarios**, we can see **35 opportunity scenarios** which provide the food industry with opportunities for transformation.

The scenario with the greatest share of voice is still **Vegetable protein**, although its share is lower, with 14.32% in this period compared to the 18.57% it reached in 2022, and **Cell-based technologies** is still second, with a share very similar to the one it had in the 2022 edition*. **Pro-, pre- and post-biotics** and **Artificial intelligence** came third and fourth, respectively, both with a great increase in share of voice compared to the previous edition.

On this map, the scenario which has grown the most in share of voice compared to 2022 is **Air** and the one which has fallen the most in this section is **Clean label**.

Regarding stage of innovation, we can see progress, compared to 2022, in **Groups with special needs** and **Other alternative food-ingredients**, which have moved from Expectation to Challenges. Scalability and meeting consumer expectations are two of the great challenges to overcome in these two scenarios.

The scenarios **Encapsulation** and **Cell-based technologies** have progressed in this edition from the Start-up to the Expectation stage. This shift is due to the fact that certain initiatives in these scenarios have already reached the market and the companies are working on proposals which have passed the laboratory stage.

The scenarios which have gone backwards in terms of stage of innovation are: **Vegetable protein** and **Vertical-in-**

door farming/hydroponics, which have passed from Introduction to the market to Challenges. In the case of **Vegetable protein**, the producers are trying to find formulas to improve the taste and texture of their products, and also make them clean label. Meanwhile in **Vertical indoor farming/hydroponics**, we can see that leading players in the industry are experiencing financial difficulties.

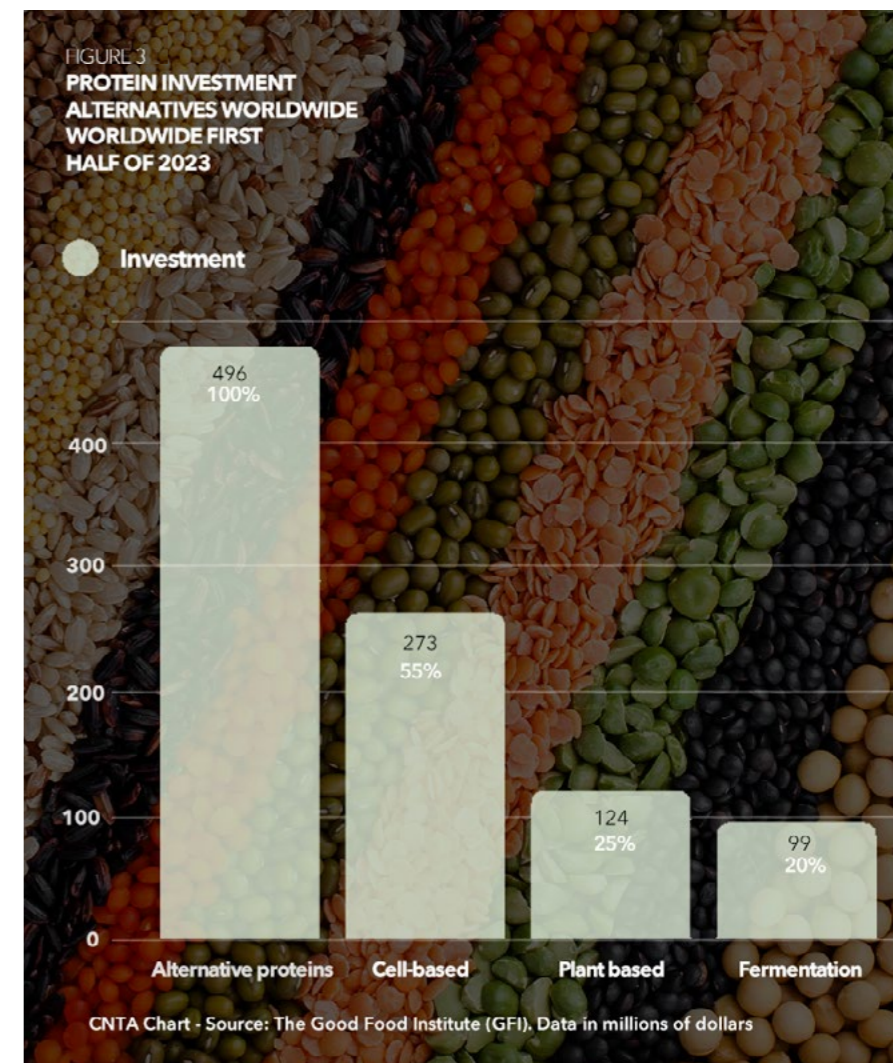
Hybrid products, **Fermentation** and **Other digital technologies** (not AI) have moved from the Challenges stage to Hype. This has happened because research and projects are emerging which need to overcome the challenge of industrial scaling or are facing regulatory barriers to reaching the market. *You can consult the 2022 report map on page 78.

Alternative proteins, the most prominent field of FoodTech

Alternative proteins is the macro scenario which reflects the innovation made in those proteins whose origin is other than that of animal protein. It is still the macro scenario which takes up the most space in the media. And if we delve a little deeper, the three proteins which are most talked about in the news items analysed are: **Plant protein**, with 42.41%, **Cell-based technologies**, with 21%, and **SCP-fermentation**, with 10.8%.

However, as with FoodTech in general, funding has also fallen in this macro scenario. As shown in figure 3, **The Good Food Institute (GFI)** indicates that global investment in alternative protein stood at \$496 million in the first half of 2023, a 70.8% decrease on the same period in 2022.

In its analysis, GFI only takes into account the following alternative proteins: plant-based, cell-based and fermented protein. According to the institute, fermented protein has received the most investment, with \$273 million, 55% of all investment in alternative proteins. The emergence of new players and regulatory approvals has led to backing for this type of protein.





Upside Foods' cultured chicken tasting at Crenn. Photo Upside Foods

On our map, this kind of protein is represented in the **SCP-fermentation** scenario. Within this scenario, protein made with precision fermentation technology continues to arouse the interest of companies.

The main barriers that this alternative protein must address include: industrial scaling, lowering the price of the food made through fermentation and achieving more regulatory approvals.

Remilk has managed to overcome the regulatory barrier in **Israel** after obtaining government approval to market its alternative dairy proteins produced using precision fermentation.

The sale of food made by means of fermentation is expected to grow in the coming years according to **The Hartman Group's** report 'Fermenting the Future: The Growing Opportunity for Products Made with Precision Fermentation'. This study predicts that food of this kind will have a potential market of more than 132 million consumers worldwide by 2027.

According to GFI, the second type of protein with most investment (25% of the total) was **Vegetable protein**. As shown in figure 3, \$124 million was invested in this scenario in the first half of 2023, which means a decrease of 82.7%

Upside Foods and Eat Just can now sell their cell-based cultivated chicken in the United States

on the same period the previous year. The most notable feature of this scenario is that producers are still trying to address the **organoleptic weaknesses** of this type of food, including two aspects which are particularly relevant when it comes to consumer acceptance: flavour and texture.

But consumers do not only take these two factors into account when deciding what to purchase. Colour is also important, as are nutritional content and being clean label. Therefore, companies are striving to improve these characteristics in order to meet consumer expectations.

As for **Cell-based technologies**, this scenario attracted an investment of \$99 million in the first half of 2023, 20% of

the investment in alternative proteins, according to GFI. One of the most significant news stories in the alternative protein industry in a long time came from this scenario: regulatory approval allowing **Eat Just** (whose cultivated meat subsidiary is **Good Meat**) and **Upside Foods** to sell their cell-cultivated chicken in the **United States**.

Upside Foods is already offering its cultivated chicken at **Bar Crenn** by reservation only the first weekend of each month with six-course menus priced at \$150.

Upside Foods and **Eat Just** can now sell their cell-based cultivated chicken in the United States

There are also moves in **Europe** to progress in commercialisation in this scenario. **Aleph Farms** submitted the first two applications for regulatory approval in **Europe** in **Switzerland** and the **United Kingdom**. And in the **Netherlands**, the government has created a code of practice with the start-ups **Meatable** and **Mosa Meat** which will allow cell-based meat tastings in controlled environments, a milestone in the country and in Europe.

The **Fungi** scenario is in the Challenges phase. The challenges it faces include managing to be industrially scalable,

accelerating the commercialisation of its alternatives and obtaining regulatory approvals.

Regarding this last point, **Mycotechnology**, based in the United States, intends to grow in Europe after the European Commission granted **Novel Food** status to two of its mycelium-based proteins, the milled and protein powder formats, made with shiitake mushrooms, at the beginning of 2023.

We have seen significant funding in this scenario in this period. One of the most striking was that of **Meati Foods**, which at the beginning of the year raised an extension of \$22 million to the \$150 million round it announced in 2022. Also noteworthy was that of **Enough**, which raised €40 million to accelerate the production of its mycoprotein product **Abunda**.

We have been talking about **algae**-based alternative protein for years, but this scenario is still in the Expectation stage, with a lot of initiatives in the Hype or Start-up phase, although many others have already reached the market.

The algae cultivation business is expected to grow and reach €9 billion by 2030 according to the European Union. More specifically, the markets for chlorella and spirulina in Europe are expected to accelerate to a Compound Annual Growth Rate (CAGR) of 6.4% and 8.7%, respectively, until 2025.

Solein launches an ice cream made with protein from CO² and air

As for **Insects**, work is being carried out to make products commercially available and regulatory progress is pushing the process along. At the beginning of 2023, two new types of insect were approved for sale in the European Union: the lesser mealworm (*Alphitobius diaperinus*) and the **house cricket** (*Acheta domesticus*).

Also, on 1 June 2023, approval of a powder made from yellow mealworms was published by the **European Food Safety Authority (EFSA)** following a request from the French start-up **Nutri'Earth**, although there is still a long way to go prior to final authorisation as the Member States must vote in favour of its sale. If it is authorised, the Commission will need to establish rules for its sale in a process that could take up to seven months.

Despite this regulatory progress, this protein faces certain barriers that restrain its development, such as: sociocultural reluctance to try this kind of food, the accessibility to products of this type and the low demand existing today.

A scenario which has grown in prominence in the period under analysis is **Air**, in which more initiatives are now

beginning to appear. Some have even reached the market, such as the ice cream made with protein from CO² and air that **Solein** launched in **Singapore** in June 2023.

This is the first time anywhere in the world that a food made with this type of alternative protein has been consumed by the general public.

Finally, the **Hybrid products** scenario (in which proteins from two different sources are combined) is in the Expectation stage, with many of the leading initiatives-projects needing further development or facing regulatory barriers to reaching the market.

During this period, we have seen some hybrid proposals which combine plant protein with fungi, cell-based protein with plant protein and animal meat with plant protein.

Audrey Gyr, specialist in Start-up innovation at GFI, expects 'to see even more of a focus on blended products' in coming years and also points out that 'it's likely that blended products can get to taste and price parity more quickly than 100% alt-protein options'. If you want to learn more about these scenarios, see page 36.



Solein Air Protein Ice Cream. Photo Solein

Alternative food and ingredient, keys to enhancing flavour and texture



The **Alternative food-ingredients** macro scenario (in which we include everything that is not alternative protein, such as fats or other types of ingredients or food) has progressed in terms of innovation stage, passing from the Expectation to Challenges.

Of the news items analysed in this macro scenario, 57.14% have been about Other-alternative food-ingre-

dients and 42.86% about Alternative fats and oils.

Many of the novelties presented in the **Other-alternative food-ingredients** scenario seek to make different types of honey, alternatives to coffee and even caviar.

In the **Alternative fats and oils** scenario, we have seen different initiatives to help overcome the challenges of

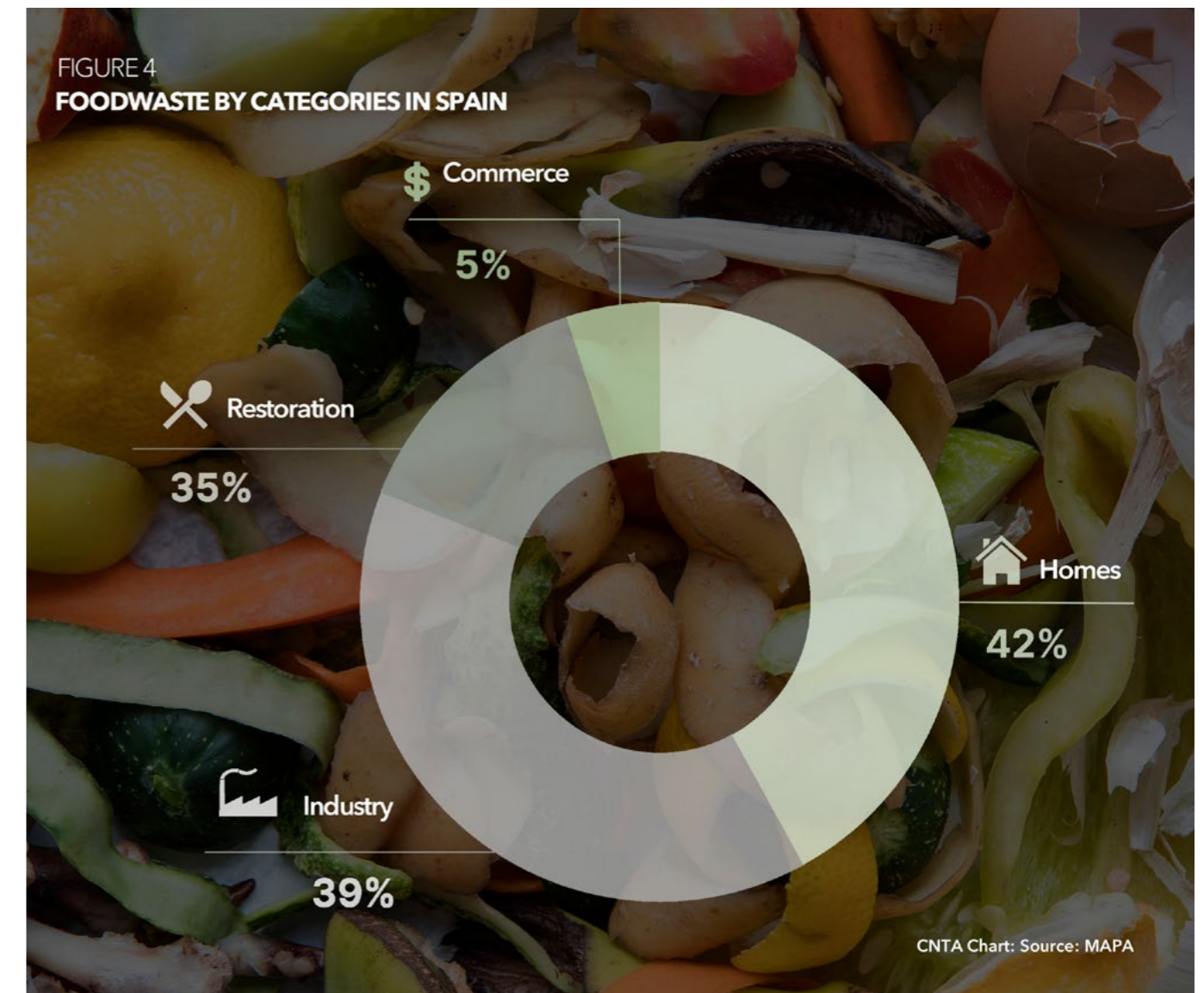
flavour and texture which alternative protein producers face.

An example of this is **Shiru**, which uses an Artificial Intelligence platform to make vegetable fats, or **Cultimate Foods**, which has launched hybrid burgers enriched with its cell-based fat **CultiFat**. Find out more about these scenarios on page 36.

The industry proposes initiatives to encourage sustainability

The promotion of projects-initiatives which do not harm the environment is becoming one of the major issues marking the food industry. Hence the considerable focus on the Sustainability macro scenario in the media. This macro scenario contains different opportunity scenarios: **Upcycling-food waste, Carbon neutral, Sustainable packaging, Vertical-indoor farming and Organic.**

Within sustainability, one of the big issues is the fight against food waste. The European Union wants to make progress in this regard and proposes that the Member States reduce food waste in supermarkets, restaurants and homes by 30% per capita, and manufacturing and processing by a further 10% by 2030.



The Spanish Ministry of Agriculture, Fisheries and Food claims that 39% of all food wasted comes from industry, 5% from trade, 14% from the food-service industry and 42% from households, as shown in figure 4.

Different proposals are being implemented to try to ameliorate and solve this problem. Several of these initiatives converge in one opportunity scenario: **Upcycling-food waste**, which remains stable in share of voice compared to 2022, with 27.25%, the highest share in this macro scenario.

The challenges to overcome in this scenario are: creating a new narrative around upcycled ingredients-products, expanding technological boundaries and improving supply chains.

A scenario which has grown in share of voice, 12.46% on 2022, is **Carbon neutral** (industry proposals to decarbonise and pollute less), now accounting for 23.67% of the news analysed in this macro scenario.

The great barrier it faces is the fight

against 'greenwashing', unrealistic claims about and environmental certifications on products and services that are misleading, ineffective or have no scientific basis.

Meanwhile, the **Sustainable packaging** scenario, with a share of voice of 22.45%, is in the Challenges stage. Because 2023 came with important developments for the packaging industry, one of the challenges to overcome is adaptation by the industry to regulatory restrictions.

New legislation aims to promote more sustainable and recyclable packaging and, in order to adapt, companies are looking for solutions, some of the most prominent of which are bioplastics, other alternative materials and even edible packaging.

The **Vertical indoor-farming/hydroponics** scenario still faces two opposing realities. A positive one in the form of the announcement of several investments to build large-scale vertical farming facilities, such as that made by

the American company **Hardee Fresh**, which intends to build a 30,000m² vertical farming facility in Georgia (United States), or initiatives like the European **LIFE FARMITANK** project, in which CNTA is taking part.

And a more negative one, with certain relevant players experiencing difficulties. One of these is **Aerofarms**, which has filed for bankruptcy. Another example is **Infarm**, which is closing facilities due to 'escalating energy prices and tough financial markets'.

Finally, in the **Organic** scenario, the increase in prices is the main challenge. According to the Spanish Consumers and Users Organisation (OCU), eating organic in Spain is '62% more expensive'. This barrier has become the 'main reason for abandonment' for those who consumed organic food on a regular basis, according to the study Connecting with eco-conscious consumers by the **Open University of Catalonia** (UOC). Find out about these scenarios on page 48.



New process technologies, a key tool in FoodTech

The macro scenario **New process technologies** comes in third in share of voice on our FoodTech Scenario Map with 15.51%. In this macro-scenario, the technologies which have featured the most in the news in the period under analysis are: **Precision fermentation**, **Cell-based technologies** and **Biomass fermentation**.

Precision fermentation faces the challenges of achieving industrial scalability and infrastructure, and obtaining further regulatory approval. Overcoming these challenges will be helped by support such as that of the US Government for biotechnology, which aims to build more biomanufacturing facilities for food production, including precision fermentation plants.

Also interesting is the opening of the new **Imagindairy** headquarters, which will serve to accelerate the production of its alternative dairy products. This site has state-of-the-art laboratories, a test kitchen for culinary and ingredient applications, and an operational pilot line that allows testing under conditions similar to those in large-scale fermentation processes. The start-up obtained GRAS (Generally Recognized

Precision fermentation is the scenario with the highest share of voice in the New process technologies macro scenario

As Safe) status in the **United States**, becoming the third precision fermentation company to do so after **Perfect Day** and **Remilk**.

Continuing with the subject of fermentation, **biomass** fermentation remains, as in 2022, in the Expectation stage. In this analysis, we have seen initiatives such as the new **Aqua Cultured Foods** facility so it can work on scaling the production of its proteins or how **Enough** wants to go from producing 10,000 tonnes of its mycoprotein to making 60,000 by 2027.

The **Fermentation** scenario (in which we include techniques which, like traditional fermentation, are neither precision nor biomass fermentation) has taken a step backwards in terms of stage of innovation, passing from Challenges in 2022 to Expectation. We have seen **kombuchas**, **bean-based foods**, **plant-based cheese analogues** or **fermented legumes** made using this type of technology in this period.

The **3D Printing** scenario is also in the Expectation stage. Various start-ups working with 3D printing continue with research to break through the barrier between technological development and the market. One example is the alliance between the Navarrese companies **Cocuus** and **Foodys** to set up a plant to produce and sell 3D printed food.

Given the great barrier of scaling up and achieving an affordable price, it is noteworthy that various cell-based technologies (**culture media**, **scaffolding**, **stem cell lines**, **tissue templating**, **organooids**) are being developed to push on with cells which can be used.



Use of precision fermentation technology. Photo CNTA

From January to August 2023, the **Cell-based technologies** scenario remained very active, experiencing growth in share of voice by 80% in its macro scenario compared to 2022. Most of the proposals in the news items analysed focused on trying to 'optimise the means of growth to maximise production', as discussed at **The Future of Protein Production Summit**.

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

Over this period, we have seen ini-

tiatives that have reached the market, such as **TopGum's** line of **high-dose caffeine gummies**, which uses microencapsulation technology.

And we should not overlook the **Preservation technologies** scenario (new technologies and research to preserve products and lengthen their shelf life). This scenario continues to feature in different research projects and has grown in prominence in the news items analysed, reaching a share of 10.86% in its macro scenario, when in 2022 it barely exceeded 5%.

These new technologies are not yet consolidated in the market although their potential is evident. Some initiatives that we have learnt about in this period are: the development of natural antimicrobial coatings for inclusion in packaging; the use of 'active' packa-

ging to absorb moisture and mould inhibitors for bread.

Finally, a new scenario appears in this report, **Molecular farming**, a technology which produces proteins using plants as small individual factories. These plants are modified so that their cells produce the desired proteins. Then their leaves or other plant tissues are harvested and the proteins of interest are isolated and purified.

In the first part of 2023, the impact of this technology in the news and research was great. An example of this was the presentation by **Moolec Science** of 'Piggy Sooy', the soya bean that produces pork proteins through molecular farming. To find out more about these scenarios, go to page 54.

Consumers seek health in food

Health is one of consumers' greatest concerns and, consequently, the **Healthy food** macro scenario presents many opportunities. In this macro scenario, most of the news analysed has been on the **Pre-, pro- and postbiotics** scenario, with 39.88%; followed, in order, by **Functional foods; Improving the nutritional profile and No-Lo**.

In the **Pre-, pro- and postbiotics** scenario, we have seen novelties which focus on achieving an optimal microbiome, children and research on the therapeutic potential of the use of probiotic or postbiotic ingredients to go beyond gut health and treat diseases such as depression, migraines or neurodegenerative diseases, as highlighted at IPA World Congress + Probiota 2023.

Regarding **Functional foods**, this scenario continues to reveal initiatives focused on cognitive health. The growth of these proposals is helped by results such as those of **MMR Research**, which says that brain health ranks second among the health concerns of consumers in **France, Germany** and the **Netherlands**.

The **Improving the nutritional profile** scenario has generated information on solutions or research seeking to reduce the content, above all, of sugar and salt in food.

Now not only consumers demand that the industry work on this aspect, but investors are also demanding that their companies make healthier products. The pressure is strong on manufacturers as the social trend has led to investors in multinationals such as **Unilever, Nestlé** or **Kraft Heinz** asking



for healthier food.

More specifically, in April 2023 a group of 26 Nestlé investors, responsible for just over \$3 trillion in assets, issued a statement calling on the company to commit to setting targets to improve its impact on the health of the population.

Finally, new developments in vermouth, beer, wine and gin have been announced in the **No-Lo** scenario (low-alcohol or non-alcoholic drinks) in this period. Part of the growth of this scenario can be explained by the fact that 'people are looking for healthy drinks, especially young shoppers',

The social trend of wanting healthier food means that investors are also asking to improve the nutritional profile of their offerings

according to **Renata de Moura**, author of the study 'Shopping for Beverage Alcohol' and senior director of shopper and category insights at **Kantar**. You can find more detailed information on this macro scenario on page 62.

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



Cocoa cream for people with dysphagia. Photo CNTA

The **Personalised nutrition** macro scenario (healthy food developments focused on personal nutrition or groups with special needs), which is made up of the **Groups with special needs** and **Personal nutrition** scenarios, is in the Challenges stage, when in 2022 it was in the Expectation phase.

Most of the research and launches in this macro scenario are aimed at the scenario **Groups with special needs**.

Some of the groups that are attracting the attention of companies when it comes to their developments are: women, seniors, children, athletes and people with swallowing difficulties.

In the **Personal nutrition** scenario, we are observing the potential of artificial intelligence to launch tools or apps to offer personalised nutritional advice or proposals. You can find out more about these scenarios on page 62.

Digitalisation, Artificial Intelligence grows in the food industry

In **Advanced Digitalization**, the **Artificial Intelligence (AI)** scenario has been one of the main focuses of this period, featuring in 56.2% of the news analysed in the macro-scenario. It is now the fourth scenario with the highest share of voice of all the scenarios, accounting for 4.77% when it only totalled 2.88% in the 2022 Report.

According to the study 'Uso de inteligencia artificial y big data en las empresas españolas' (Use of artificial intelligence and big data in Spanish companies) by red.es, '7% of food companies use artificial intelligence'.

Some of those companies are: **Unilever**, a multinational where AI is used to reformulate products, and the Israeli start-up **Mamay**, which has developed an AI-driven algorithm capable of determining the sweetness of a food or drink.

One of the uses given to AI is as an aid to design-formulate foodstuffs. Some companies already rely on **Smart formulation** to find new or the most suitable ingredients for their products.

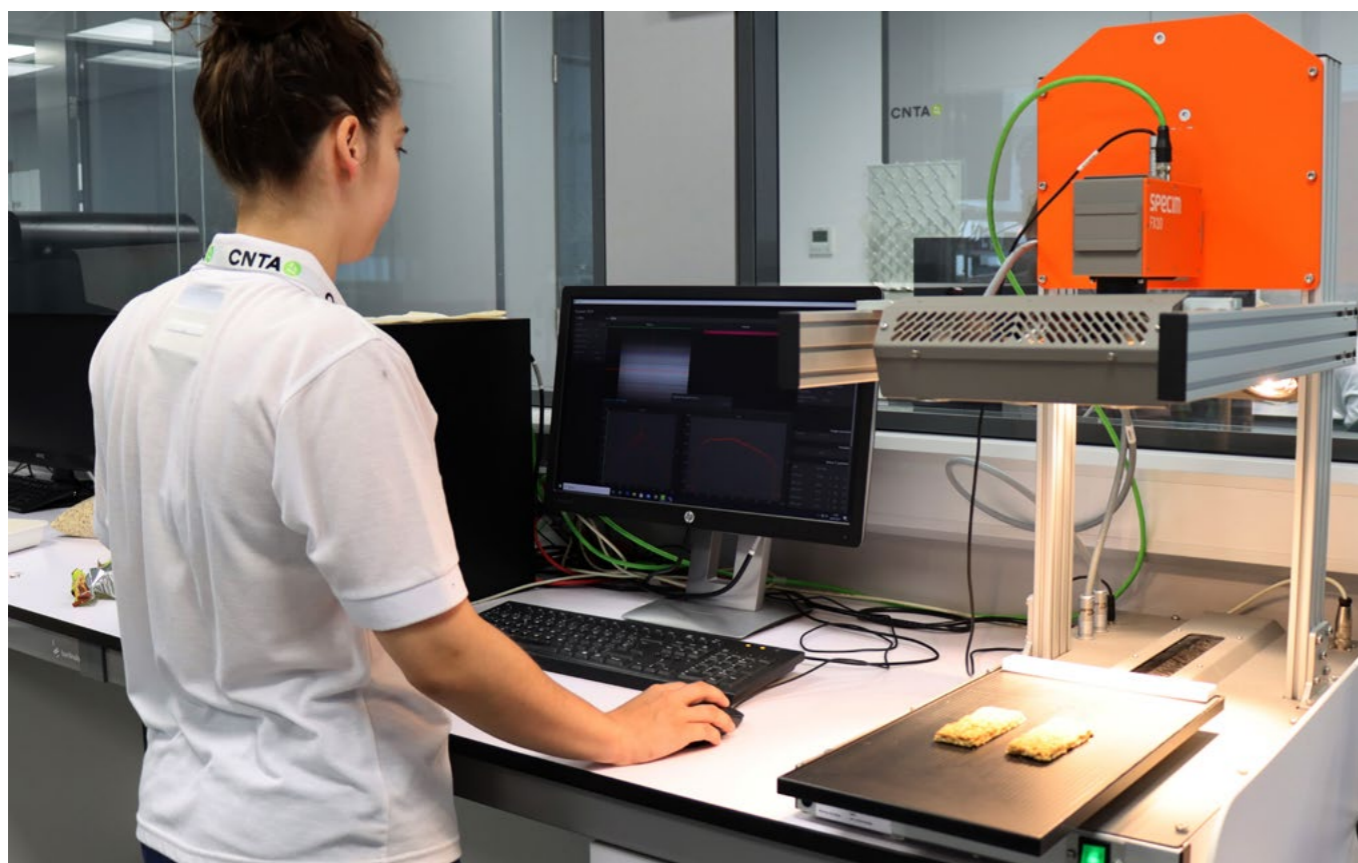
There are various examples of this, such as the new **AI Palette** tool **FoodGPT**, which harnesses the power of

generative AI to augment data-backed innovations and increase the success rate of product launches; the cases of **Hell Energy Drink** and **Vivi Kola**, which have designed different beverages through AI, or **Shiru**, which used AI to make its vegetable fat Oleopro.

In the **Other digital technologies** (not AI) scenario, we have seen different advances towards the digitalisation of factories, chiefly featuring robotisation, process automation-digitalisation, the use of artificial vision and digital twins. You can learn more about these scenarios from page 68 onwards.



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



Use of hyperspectral technology in cereal bars. Photo CNTA

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

The food quality and safety 4.0 concept can be defined as the application of new technologies and digital advancement to improve food quality and safety controls and analysis; enabling the reduction of risks and waiting times; expanding sampling or, in some cases,

sampling production in its entirety; making decisions based on data without destruction of the sample and with a minimum of processing, and developing predictive models.

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

In the first scenario, we have seen more proposals in the fields of NIR, hyperspectral and the use of sensors to see how fresh food is or to detect pathogens in real time.

In **Traceability**, hopes are still pinned on **blockchain** technology although some companies are leaning towards other systems, such as **Ortain**, which uses forensic methods for product traceability. Find out more about these scenarios on page 68.

Clean label, consumers prepared to pay more for clean label products

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

Despite the rise in prices we are currently seeing, more than 75% of consumers worldwide are prepared to pay a bit more for Clean label products, according to the data from **Ingredion's Atlas 2023** research.

Food is considered clean label when it is made based on simplicity and transparency, using as few ingredients as possible and with components known to the consumer. In the period under analysis, we have seen a number of companies launch new clean label products, such as **Kerry**, **Heura**, **Bioveritas** and **Hevo Group**.





In depth

After taking a quick look at the January-August 2023 Report on the FoodTech Opportunity Scenario Map, we would now like to offer you a more in-depth exploration of the opportunity scenarios featured in it.

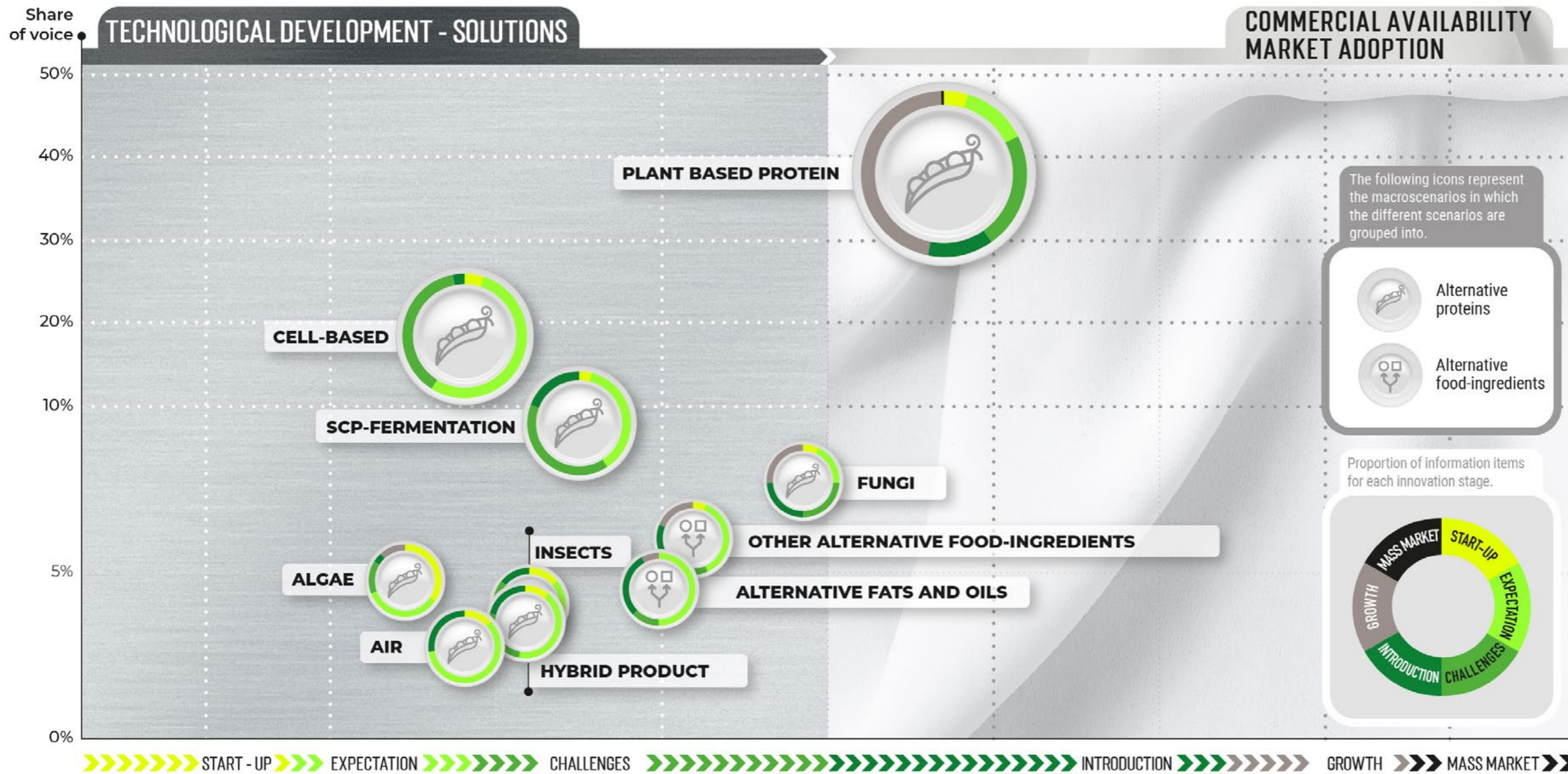
The following pages contain some of the reflections, laun-

ches, data, start-ups, technologies, etc. at the forefront of the FoodTech industry in the first eight months of 2023 and we also present 5 macro scenario maps with their respective scenarios.

ALTERNATIVE PROTEINS, FATS AND FOOD SCENARIOS



JAN/AUG 2023 - 537 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 because they showcase the most prominent research and initiatives focusing on products made using alternative proteins and ingredients, and how food of this kind has been developed.

This map is made up of **10 opportunity scenarios**. **Plant-based protein** is the scenario with the highest percentage of news, reaching **37.92%** of share of voice within the **Alternative proteins, fats and food map**, although this figure has dropped compared to the 2022 report* when it accounted for **45%**. It is followed by **Cell-based technologies, SCP-fermentation** and **Fungi**.

On this map, the largest increase in share of voice has been in the **Air** scenario, which has gone from a share of **0.98%** in 2022 to **2.79%** in the period under analysis. This is because there have been a greater number of proposals in this period, some of which have even reached the market.

The map also shows that **Plant protein** is the scenario at the most advanced stage of innovation, **Challenges**, a stage back from where it was in 2022, when it was in **Introduction** to the market. The challenges that this scenario must overcome include finding formulas to improve the flavour and texture of plant-based foods, and making them clean label.

The other scenarios in which a change in the stage of Innovation has been observed are **Other alternative food-ingredients**, which has passed from **Hype** to **Challenges**, with some proposals reaching the market while others still need to overcome the challenge of scalability; and **Hybrid products**, which has moved from **Challenges** to **Expectation**, with cell-based technology initiatives leading the field.

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

*You can consult the 2022 report map on page 80.

Stage of FoodTech innovation

Plant protein, the need to address organoleptic weaknesses



Beyond Meat's hamburger analogues. Photo Beyond Meat

In the **Plant protein** scenario, most of the news (56%) has focused on launches by and growth in the market of companies working with this technology. Nevertheless, a lot of the news (22%) has focused on the barriers faced by this alternative protein, such as crises in start-ups, slowdown in consumption, product recalls, etc.

As shown in figure 3 on page 21, we have seen a slowdown in investment in this type of alternative protein in the period analysed. According to **The Good Food Institute** (GFI), global investment stood at \$124 million in the first half of 2023 (a decrease of 82% on the same period in 2022).

The reason behind this sharp drop in investment is that the category is not fulfilling its growth expectations.

CoBank's latest **Knowledge Exchange** report indicates that sales of plant-based meat alternatives fell steadily in the United States from 2021 onwards and then more sharply in 2023. The bank states that volume sales decreased by 20.9% over the 52-week period ending 2 July 2023.

CoBank comments that this fall is the result of the higher prices in the plant-based meat analogue category compared to its animal counterpart, leading many consumers to reduce their purchases.

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

words for such leading companies in the industry as **Impossible Foods** and **Beyond Meat** attracted a great deal of attention.

In Europe, the latest figures provided by GFI, based on data from **NielsenIQ**, speak of a slowdown in the growth of sales of plant-based foods. If in 2021, the market value increased at a rate of 15%, in 2022 growth fell by more than half, stabilising at 6%.

To try to attract more consumers, plant-based protein needs to overcome different challenges, including:

- Improving product **flavour** and **texture**.
- Taking **colour** into account in food of this kind.
- Making food with rich **nutritional content**.

GREATER INTEREST IN PLANT-BASED EGGS



Omelet made with Zero Egg's egg analog.
Zero Egg's egg analog. Photo Zero Egg

In the period, we have seen various egg alternative proposals and this market is expected to grow worldwide at a CAGR of 6.6% until 2030, according to **Prophecy Market Insights**.

In the first months of 2023, bird flu and higher operating costs saw the price of eggs reach unprecedented heights and some plant-based egg alternative start-ups (such as **Zero Egg** or **Eat Just**) saw increased interest in their products.

However, like many emerging enterprises, the challenges that the alternative egg industry needs to address are slowing down its growth. The most significant of

these, as **Proveg** points out, are:

- **High prices:** plant-based egg analogues are expensive and, despite inflation, price parity still does not exist with egg products of animal origin.
- **Lack of capacity and accessibility.**
- **Poor product flavour, texture and sensory qualities.**
- **Minimal consumer awareness, acceptance and food neophobia** (not wanting to try new things).

- Producing **clean label** products.
- Striving for **price parity** with animal analogues.

Regulatory barriers are also curbing the growth of plant-based options. In Italy, there are plans to pass a bill which could prohibit the use of meat-related terminology in reference to plant-based food and a bill very similar to the Italian one was passed in Chile.

Despite the challenges and barriers facing the industry, in this period we have continued to see launches in the scenario, including new products from **Nestlé**, **Beyond Meat**, **Impossible Foods** and **Juicy Marbles**, with their ribs with edible bones.

In Spain, **Heura** announced the use of a new technology, pending the patent. The company claims that this techno-

logy is based on thermomechanics, which uses heat and mechanical energy to shape or modify the properties of materials and will allow them to enter new food categories such as sausages, whole cuts of meat and fish, and dairy products.

Also in this time, **Pascual** has expanded its plant-based catalogue with the launch of the **Bifrutas** with oat drink; **Better Balance** has brought out its 'Veggiebradas' and **Sanygran** has bought the plant-based food company **Obrador Sorribas**.

The sales growth of plant-based foods in Europe has slowed down

Cell-based products, the chance to sell in the United States

Most of the news on the **Cell-based technologies** scenario (cultivated meat) has been about start-ups announcing projects-technologies which require further development before they can be launched onto the market: 52.47% of all the information analysed.

The major challenges facing this scenario are: industrial scaling, reducing costs and regulatory approvals.

Regarding this last challenge, the period has seen one of the biggest news stories in this scenario and FoodTech in general: the regulatory approval allowing **Upside Foods** and **Eat Just** (whose cultivated meat subsidiary is **Good Meat**) to sell their cell-based cultivated chicken in the **United States** (the second country in the world where the sale of products of this type is now allowed after **Singapore**).

Upside Foods is already offering its cultivated chicken at **Bar Crenn** by reservation only the first weekend of each month with six-course menus priced at \$150.

There are also initiatives in this scenario in **Europe**. The Israeli start-up **Aleph Farms** submitted the first two applications for regulatory approval in Europe in **Switzerland** and the **United Kingdom**. And in the **Netherlands**, the government has created a code of practice with the start-ups **Meatable** and **Mosa Meat** which



Good Meat cell-based nugget.
Photo Good Meat

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

will allow cell-based meat tastings in controlled environments, a milestone in the country and in Europe.

These steps forward stand in contrast to what is happening in other European countries, such as **Italy**, where a bill was announced at the end of March 2023 to ban laboratory foods, including cell-based products.

And what is the situation in the European Union as a whole? 'So far, no company has asked EFSA to evaluate any cell-based food,' said **Wolfgang Gelbmann**, EFSA's senior scientific officer, at the 'Cell culture-derived foods and food ingredients' colloquium.

Other initiatives that we have learnt about in this period include the one led by **Vow**, which presented a cultivated meatball made using the DNA sequence of the extinct woolly mammoth to draw attention to this type of alternative protein, and that of **BlueNalu**, which continues to advance towards the launch of its first commercial product: cultivated bluefin tuna toro.

Jimi Biotech developed a deer antler stem cell line; **Re:meat** announced the construction of a cell-based beef pilot plant in Sweden; and **Meatable** secured \$35 million in funding to accelerate the launch of its cell-based sausage and meatball products.

SCP-fermentation, the fermentation protein leading investment

The third big Alternative proteins scenario is **SCP-fermentation** (Single Cell Protein-fermentation, i.e. developments based on fermentation). In the first half of 2023, this scenario led global investment in alternative proteins, totalling \$273 million according to GFI.

The sale of food made using fermentation is expected to grow in the coming years, according to The Hartman Group's report 'Fermenting the Future: The Growing Opportunity for Products Made with Precision Fermentation'. The study predicts that food of this kind will have a potential market of more than 132 million consumers worldwide by 2027.

However, most of the news analysed in this scenario, 51%, has focussed on the barriers to be overcome by this alternative protein.

The main barriers that it faces are:

- **Industrial scaling.**
- **Lowering the price of food** made using fermentation.
- **Achieving more regulatory approvals.**

This protein has featured in a large number of launches onto the market and proposals which have been authorised for sale, accounting for 19.6% of the news analysed. One of the most prominent stories centred on **Remilk**, a start-up which received approval from the **Israeli Government** to sell its alternative milk proteins produced with precision fermentation.

Other proposals seen were the launch of **TurtleTree's** precision fermentation-produced lactoferrin and **Danone's** investment in the start-up **Imagindairy**, which could pave the way for joint collaboration in the development of animal-free dairy products.

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

Remilk has received approval from the Israeli Government to sell its dairy alternatives

CASEIN, THE HOLY GRAIL OF DAIRY PROTEINS

One of the proteins most sought-after through precision fermentation is casein. In this period, we have observed several initiatives to produce this type of protein as an alternative to dairy protein by start-ups such as **New Culture** and **Fermify**.

Casein is seen as the holy grail to develop 'animal-free' dairy analogues and we can see how large dairy

companies such as **Nestlé**, **Fonterra**, **Unilever**, **Bel Group** or the Spanish company **Pascual** are already investing in precision fermentation technology through alliances with start-ups like **Perfect Day**, **Standing Ovation**, **Zero Cow Factory** and **De Novo Dairy**.

Fungi faces different challenges



Innomy mushroom-based hamburger. Photo CNTA

The main themes of the **Fungi** scenario have been: market launches and initiatives which can now be sold, which accounted for 35% of the news analysed, and the barriers and challenges to overcome that exist in this scenario, which took up 20% of the information.

We have also seen significant funding operations. One of these was that of **Meati Foods**, which at the beginning of the year raised an extension of \$22 million to the \$150 million round it announced in 2022. Other major investments were that of **Enough**, which raised €40 million to accelerate the production of its mycoprotein product **Abunda**, and the €11 million raised by **Eniferbio** to technologically develop its powdered mycoprotein **Pekilo**.

The chief challenges facing this scenario are achieving industrial scalability, accelerating the marketing of the alternatives it offers and obtaining regulatory approvals

Achieving industrial scalability, accelerating the marketing of the alternatives it offers and obtaining regulatory approvals are some of the barriers that this scenario must overcome

Regarding the regulatory issue, **Mycotechnology**, based in the United States, intends to expand in Europe after getting the European Commission to grant Novel Food status to two of its mycelium-based proteins (using shiitake mushrooms): its milled and protein powder formats.

Another start-up which managed to overcome a regulatory barrier was **Nature's Fynd** when it received approval from **Health Canada** to sell alternative products made with its **Fy** fungi-based protein.

In Spain, we learnt about fungi-based bacon by **Libre Foods** and collaboration between **Innomy** and **Grupo Ausolan**, the purpose of which is to validate the scaling of the former's mycelium fermentation technology and investigate the production of final and intermediate products, such as textured products or minced meat analogues, with different functionalities.



Protein algae extract with coloring power. Photo CNTA

Algae, a scenario to cultivate

This scenario is in the Expectation stage and the main topics which have grabbed attention in the news analysed have been: projects which need to be developed, 38.4%; research, 34.6%, and launches or growth plans, 15.4%.

Examples of initiatives which have reached the market include the expansion plans into Europe and Southeast

Asia of **WTH Foods** with its new micro-algae-based products; **SimpliiGoods'** smoked salmon alternative made with spirulina; Akua's partnership with the children's entertainment brand **Nickelodeon** to launch kid-friendly kelp patties, and the new line of seaweed seasonings from the Spanish start-up **Mediterranean Algae**.

Looking ahead, the European Union expects the algae cultivation sector to hit €9 billion by 2030. Two species which are expected to grow are chlorella and spirulina, at annual growth rates of 6.4 and 8.7%, respectively, until 2025.

Insects, EU approvals

Focussing on insects, this scenario aims to develop the commercial availability of its products. To do this, it needs to break down barriers, the big issue in the news analysed in this scenario, accounting for 45.45% of the information published.

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

And it seems that in a few months a

Novel Food made with insect protein may also appear, with the announcement on 1 June 2023 that the **European Food Safety Authority** (EFSA) was approving a powder made from yellow mealworm beetles by the French start-up **Nutri'Earth**.

The EFSA concluded that the powder, made from the larval form of **Tenebrio molitor**, is both nutritional and safe to use according to the company's proposed applications. After passing this requirement, the European Commission will present the EFSA's opinion to the EU Member States to discuss whether to authorise this novel food and the conditions for its use. If it is authorised, the Commission will establish rules for its sale in a process which could take up to seven months.

However, despite these regulatory breakthroughs, this type of protein encounters several barriers to further development. Some of these are: 'sociocultural issues when it comes to trying this kind of food; accessibility to this type of products and the low demand existing today,' the industry indicates.

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

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



Solein Air Protein Ice Cream. Photo Solein

THE FIRST AIR PROTEIN ICE CREAM

In 2023, we can see how air protein is growing in prominence. This scenario has gone from having a share within this macro scenario of 1% in 2022 to 3.11% in the January-August period of 2023.

Without doubt, the most striking news from the scenario was that of **Solein**, which launched ice cream made from CO² and air in **Singapore** in June 2023. This is the first time anywhere in the world that a food made with this type of alternative protein has been made available to the general public.

Another noteworthy story that highlights the importance that this

alternative protein is gaining is the partnership between the **Bill and Melinda Gates Foundation** and the **Novo Nordisk Foundation** to support a consortium that plans to use CO² for food applications.

Also of interest are the proposals from **Calysta**, which has developed Positive Protein for use in human food and uses a patented fermentation platform to produce what it describes as 'protein without limits', and **Arkeon Biotechnologies**, which announced the opening of a pilot plant in Vienna in order to commercialise CO² proteins.

Hybrid products, possible solution for price parity in alternative proteins



The **Hybrid products** scenario (in which proteins from two different sources are combined) is in the Expectation phase.

Audrey Gyr, specialist in Start-up innovation at GFI, expects 'to see even more of a focus on blended products' in the market in coming years. She believes that 'it's likely that blended products can get to taste and price parity more quickly than 100% alt-protein options'.

The start-up **Momentum Foods**, on seeing that '[plant-based] products were too expensive and didn't taste good enough', has decided to launch blended products. To do this, they use 90% plant-based ingredients (such as rice or soya beans) in their products

Audrey Gyr, from GFI, expects hybrid products to 'get to taste and price parity more quickly than 100% alt-protein options'

but also include ingredients of animal origin, such as collagen and fat.

In this scenario, most of the news in this period has been about initiatives-projects which require further development before they can be released into the market: 42.1%. These proposals include **Mewery's** burger made by combining pork and microalgae cells; the one from **Scifi Foods**, which is developing a product that combines cell-based meat with plant-based ingredients, or **Millow's** initiative, which is pursuing the possibilities of another type of combination: mycelium with oats.



Alternative fats, technological solutions to improve flavour

Fat is a key macronutrient in creating the flavour, mouthfeel and nutritional value of food. Every year, 221.5 million tonnes of fats and oils are produced worldwide.

Currently, around 50% of global fat production is derived from soyabean and palm oils, followed by other vegetable oils (25%), fat derived from animal meat (13%) and fat from dairy (12%).

For a few years now, a growing number of companies have been moving towards production with minimum agricultural alternative fat and oil inputs. Precision fermentation and cell culture are increasingly seen as technological solutions in this area.

In the period, most of the news concerning the Alternative fats and oils scenario has focused on initiatives-pro-

jects which need to be developed more before reaching the market, 43.4%, and launches which can now be sold or are already on the market, 30.4%.

One example of a new product is CultiFat, **Cultivate Foods'** cell-based fat, which the company says will help replace certain flavourings, coconut oil and methylcellulose in plant-based meat.

As for plant-based fats, we have seen how **Shiru** uses an Artificial Intelligence platform to make fats and **Lypid's** Phytofat plant-based fat, which is available in the US foodservice and B2B markets.

Meanwhile, **Cargill** and the Spanish start-up **Cubiq Foods** announced its intention of accelerating the large-scale commercialisation of **Cubiq's** novel alternative fats, including its innovative

Go!Drop, for plant-based meats and dairy, among other products.

Likewise, in the **Other alternative food-ingredients** scenario, most of the proposals have to do with new products which are arriving on or are close to the market.

Some of these are rather sweet in nature since in recent months we have learnt of initiatives to make different types of honey analogues, such as those from **Melibio** and **Fooditive**.

Also noteworthy was the initiative from **Chosen Foods** with its avocado oil caviar with pumpkin spices; and those of different start-ups (**Atomo**, **Minus Coffee**, **Northern Wonder**, **Prefer**, **Voyage**, **Cult food science** and **Stem**) with their ideas for alternatives to coffee.

SUSTAINABILITY SCENARIOS

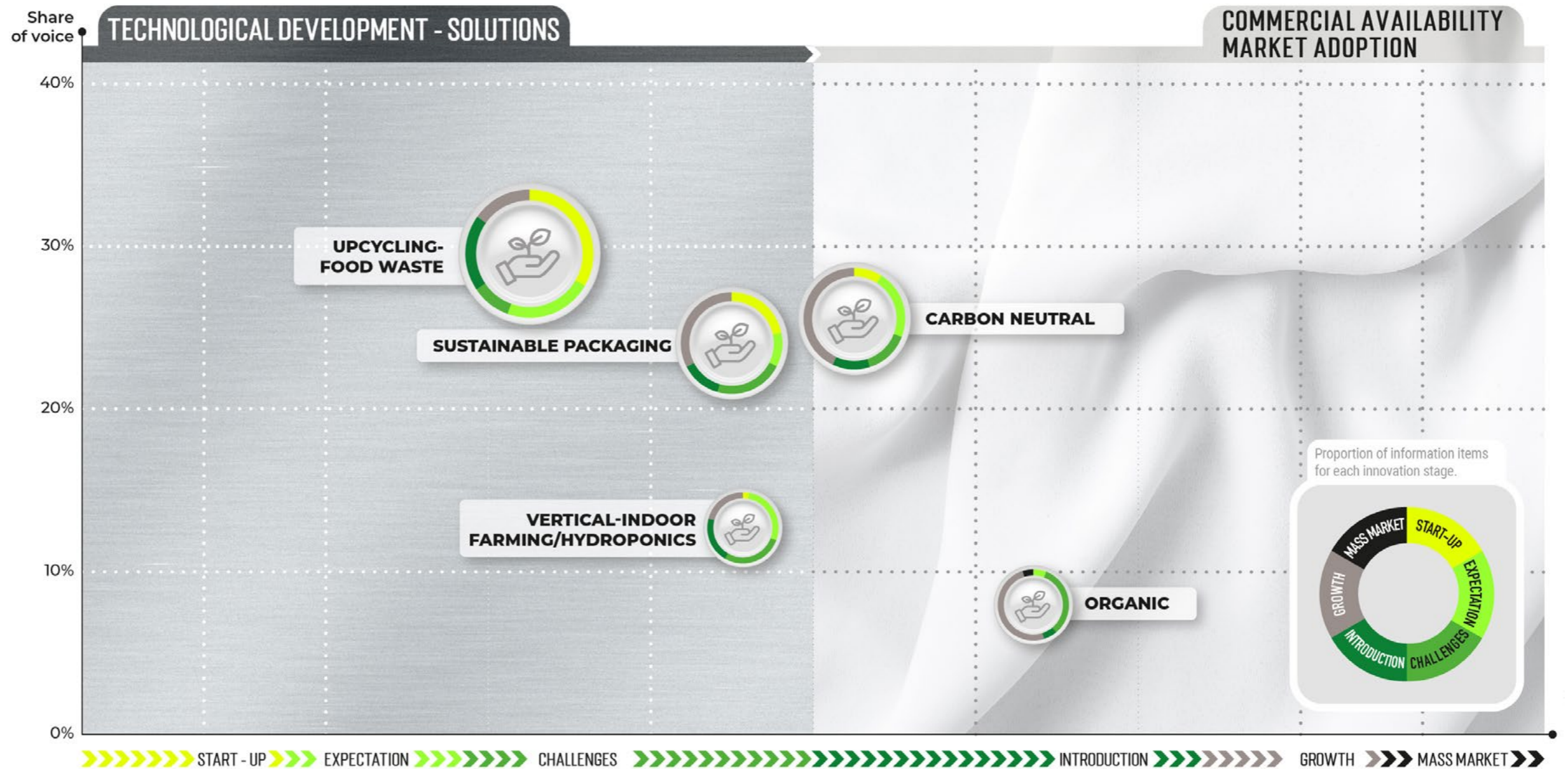
JAN/AUG 2023 - 227 INFORMATION ITEMS ANALYSED



The second map is **Sustainability**. On this map, we find 5 opportunity scenarios, **Upcycling-food waste** having the highest share of voice, 27.35%, followed in second and third place by **Carbon neutral** and **Sustainable packaging**.

As for innovation stage, we only see regression in the **Vertical-indoor farming/hydroponics** scenario, going from the Introduction to the market stage in the 2022 Report* to the Challenges stage in the January-August 2023 period. This is because we have learnt how relevant players in the scenario are going through hard times.

*You can consult the 2022 report map on page 82.



Upcycling, an alternative in the fight against food waste

Sustainability is one of the major issues affecting the food industry and, within the field of sustainability, the fight against food waste is one of the main topics.

To try to reduce this problem, one solution which is gaining in importance is **upcycling**.

Most of the news analysed in the **Upcycling-food waste** scenario has been about initiatives which have arrived on the market, 35.8%, and research, 34.32%.

The challenges to overcome in this scenario include: creating a new narrative

around upcycled ingredients-products, expanding technological boundaries and improving supply chains.

Some initiatives that seek to solve these challenges have been led by the Chilean firm **Done Properly**, which has joined forces with **AB InBev** to generate a sodium substitute from beer by-products, and **Nordic Umami Company**, which uses vegetable and cereal by-products to make umami ingredients through fermentation.

A different narrative, and a different

approach to addressing food waste, is that of **Hungyroot**, which uses AI to help consumers make healthier and more sustainable food purchases through a digital platform.

In Spain, we have heard about **El Corte Inglés** partnering up with **Cervezas Mica** to sell beer made using excess bread and **Bread Free**, which is investigating the incorporation of waste from the brewing industry to make gluten-free barley flour.



VÄCKA AND ITS CHEESE ANALOGUES

At the beginning of 2023, **Väcka** presented plant-based cheese analogues made with melon seeds and olive oil: **Mözza** and **Pumpkin Cheddar**. This start-up was one of the winners of the second edition of **Food (Tech)² Challengers** and, during the programme, CNTA and Väcka worked on the selection of microorganisms and the definition and optimisation of the fermentation process to make these new analogues possible.

Varieties of queso analogues from Väcka. Photo CNTA



Carbon neutrality, claims that are clear, truthful and reliable

The **Carbon neutral** scenario is facing several challenges. One of these is the fight against 'greenwashing', unrealistic claims about and environmental certifications on products and services that are misleading, ineffective or have no scientific basis.

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

The **European Consumer Organisation (BEUC)** is also calling for a 'ban' on 'carbon neutral' claims on food and beverages in Europe, even when offsetting projects are funded to achieve it.

Given the situation, some companies are committed to moving towards 'Net zero', which is achieved when a company eliminates more Greenhouse gases (GHG) than it produces. In this direction, **Huch Ventures** has launched a **Net Zero** technological innovation project which focuses on promoting proteins and innovative technologies in food production that reduce carbon emissions.

However, the largest proportion of the news analysed in this scenario, 46.55%, has focussed on initiatives to expand proposals to become carbon neutral, with different companies backing solar energy or the new **Reewild** application, which helps users track the carbon footprint of their diets.

One of the challenges facing the carbon neutral scenario is the fight against greenwashing



Sustainable packaging, backing bioplastics

The packaging industry is still working to accelerate along the path to sustainability. The second study by **Ceresana** 'Food Packaging - Europe' indicates that **sustainable packaging**, such as bioplastics, is growing the most in Europe, while paper bags and packaging made from recycled plastics are also experiencing growth.

Since the end of 2022, different governments have been promoting standards to push sustainable packaging. This has led the food industry to look into and come up with solutions to make packaging more sustainable. Consequently, it should come as no surprise that launches onto the market or range expansions are the number

one topic in the sustainable packaging scenario, with a share of 43.6%.

Some of the proposals seen in recent months have been pioneered by **Tetra Pak**, which has expanded its range of packaging solutions using recycled polymers, and **Lactalis Nestlé** with its commitment to bioplastic for its ready-to-drink coffee packaging.

Curious too are the cases of **Agari**, which proposes a water bottle made from agar, a substance extracted from red seaweed which disintegrates after the contents are drunk, or **Cabreiroá** with its 100% biocompostable sugar-cane-based **PLA** (polylactic acid) container, not yet on sale.

PACKAGING TRENDS FOR 2023 - TOP FIVE

The market intelligence consultants **Innova Market Insights** have detected certain trends in the packaging sector for 2023, which include:

- **Plastics circularisation.**
- **Transparency and truthfulness.**
- **A commitment to renewable packaging**, mainly made from paper and bioplastics.
- **Packaging connected** with digital interaction.
- **The reusable is gaining ground.**

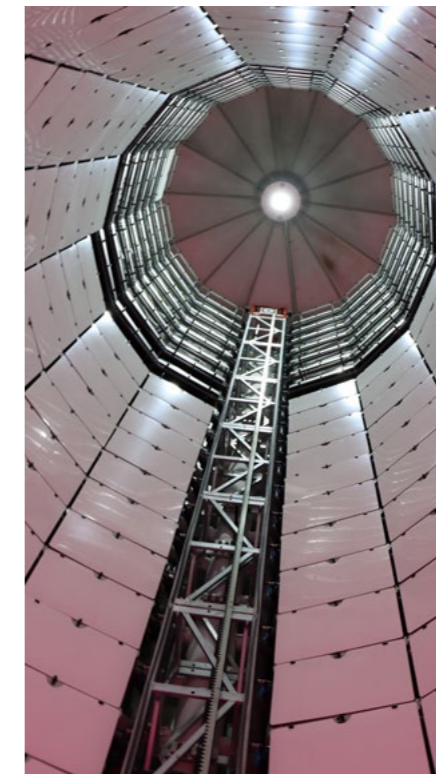
Vertical-indoor farming/hydroponics, two opposing realities

Vertical indoor-farming/hydroponics is the only scenario in this macro scenario which has changed its stage of innovation, moving from Introduction to the market in 2022 to Challenges now.

The predominant theme in the news analysed in this scenario has been the barriers to development, 27.5%. Among these challenges are the price rise in products of this kind and the financial problems that relevant players in the industry are facing.

Two paradigmatic cases are **Aero-farms**, which has declared bankruptcy, and **Infarm**, which is abandoning its operations in Europe due to 'escalating energy prices and tough financial markets'.

Other stories which we have seen in the period under analysis have centred on the investments made by different companies, accounting for 17.24% of the information. One of these was



Vertical Farming Farmitank installation. Photo CNTA

about the American company **Har-dee Fresh**, which intends to build a 30,000m² vertical farming facility in Georgia (United States), and another centred on the British company **Vertical Future**, which aims to develop controlled environment agricultural technology for future space exploration missions.

In Spain, we have also learnt that **Ekonoke**, which grows hops hydroponically indoors, is to build a 1,000m² pilot plant in Chantada (Lugo); about the partnership between Madrid-based **Vertical Green** and the US-based **OnePointOne** to promote vertical agriculture, and the European **LIFE FARMITANK** project, in which CNTA is taking part, where a vertical agriculture prototype has been installed at **Florette Ibérica's** facility.

Organic, inflation bears an influence

In the Organic scenario, the two main topics in the news analysed have been: launches, 61.1%, and challenges to overcome, 33.3%.

The big challenge facing this scenario is the rise in prices. According to the **Spanish Consumers and Users Organisation (OCU)**, eating organic in Spain is

'62% more expensive'. This factor has become the 'main reason for abandonment' for those who consumed organic food on a regular basis, as shown in the study Connecting with eco-conscious consumers by the **Open University of Catalonia (UOC)**.

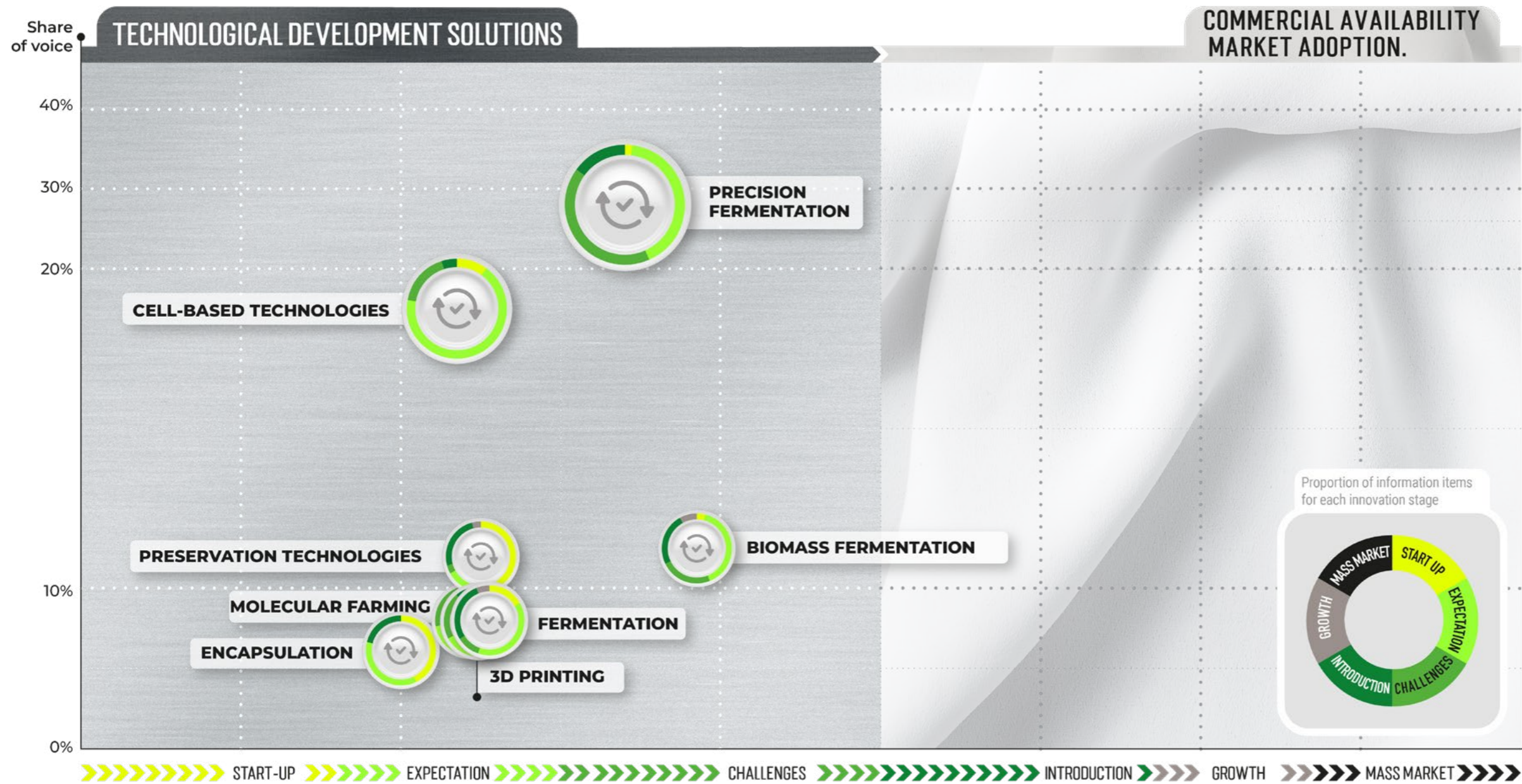
The foods with the highest market

share are **eggs, fruits, fresh vegetables, juices, cereals** and **oils**, for which there are already established brands and manufacturers.

The new proposals in this period have featured **Smileat**, a Spanish organic baby food company, which started up a jar factory in Jerez; **Naturgreen**, with the launch of its plant-based, organic Bifidus, and **Biosabor**, with its organic vegetable and cream range.

NEW PROCESS TECHNOLOGY SCENARIOS

JAN/AUG 2023 - 220 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.

This map consists of 8 opportunity scenarios, **Precision fermentation** leading the others in terms of share of voice with 28.05%, followed by **Cell-based technologies**, **Biomass fermentation** and **Preservation technologies**.

All the scenarios are in the stage of innovation **Hype**. The only scenarios that have changed stage are **Encapsulation** and **Cell-based technologies**, which have progressed from the Start-up stage in the 2022 Report* to Expectation, with some initiatives having arrived on the market and companies working on ideas that have passed the laboratory stage. And **Fermentation**, which has gone from Challenges in 2022 to Hype as a result of the greater prominence of research and projects which need to be scaled up or face regulatory barriers.

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

Stage of FoodTech Innovation

Precision fermentation, big companies set their sights on this technology

In the **Precision fermentation** scenario, the most repeated theme in the news analysed in this period has been the different challenges that this technology faces, 32.36%.

The challenges to overcome include achieving greater industrial scalability and infrastructure, and obtaining more legislative approvals.

However, we are seeing progress in the evolution of this technology. Multinationals such as **Nestlé**, **Danone** and **Unilever** have already set their sights on it. In April 2023, Danone, through Danone Manifesto Ventures, announced investment in Imagindairy; in October 2022, **Perfect Day** and **Nestlé** reached an agreement to explore the development of products made with dairy protein alternatives, and in the same month, **Unilever** declared its interest in

including protein of this kind in one of its major global ice cream brands, possibly in North America.

The **US Government** is also backing biotechnology and intends to build more biomanufacturing facilities for food production, including precision fermentation plants.

The creation of the European association **Food Fermentation Europe (FEE)** at the beginning of 2023 marks further progress in this field. This alliance, made up of **Better Dairy**, **Formo**, **Onego Bio**, **Thorse Vegan Cowboys** and **Imagindairy**, seeks to pave the way to allow innovative solutions to reach the market in a more agile fashion, since, in their opinion, the current regulatory processes are 'far too lengthy and opaque'.

In this period, **Imagindairy** also opened its new headquarters, which will

serve to accelerate the production of its alternative dairy products. The site has state-of-the-art laboratories, a test kitchen for culinary and ingredient applications, and an operational pilot line that allows testing under conditions similar to those in large-scale fermentation processes. The start-up obtained GRAS (Generally Recognized As Safe) status in the United States, becoming the third precision fermentation company to do so after **Perfect Day** and **Remilk**.

As for investment, we have learnt that **Liberation Labs** obtained \$30 million to develop its first commercial-scale biomanufacturing facility in **Indiana** (United States), which will have a fermentation capacity of 600,000 litres, and about the funds the Dutch company **Vivici** has secured to bring its precision fermentation animal-free dairy proteins to the market.

Multinationals such as Nestlé, Danone or Unilever have already set their sights on precision fermentation technology



CNTA's bioreactor. Photo CNTA

Biomass fermentation, technology to make analogues

Continuing with the theme of fermentation, biomass fermentation is still a technology used by start-ups to make alternative foods in 2023, as corroborated by the fact that 32% of the news in this scenario has featured projects or initiatives to be developed before being released into the market.

In the period under analysis, we learnt that **Aqua Cultured Foods** was building a new facility to scale up the production of its seafood analogues through biomass fermentation.

The start-up **Enough** also received €40 million to scale up its mycoprotein, made using biomass fermentation, from 10,000 tonnes a year to 60,000 by 2027.

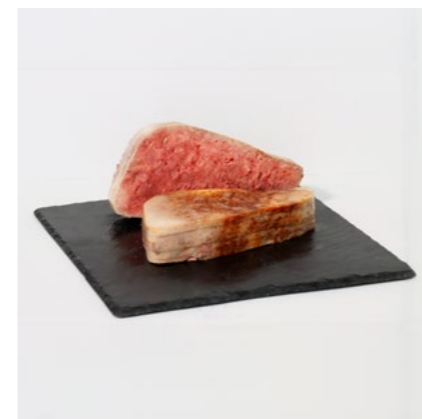
Fermentation other than biomass and precision fermentation is covered in the Fermentation scenario, which is in the Expectation phase, one step back in terms of stage of innovation compared to the 2022 edition.

In this scenario, we can see different proposals, such as **WNWN's** cocoa-free

chocolate, which is made by fermentation and won the 'Best Demo' award at the **Häagen-Dazs Start-Up Innovation Challenge**; a meat analogue made from beans from **Eighth Day Foods** and a plant-based cheese replicate from **Daiya**.

Also noteworthy is the initiative from the Spanish start-up **Miwi**: a new range of kombucha made by fermenting green tea and organic cane sugar, which is completely consumed in the fermentation process.

3D printing, moving from technological development to the market



Coccus 3D printed steak. Photo CNTA

3D printing technology is in the Expectation phase although the future looks positive, with **Vantage Market Research** indicating that the global 3D printed food market will grow at a CAGR of 49.9% until 2028.

There are various start-ups working with 3D Printing which continue with research to break through the barrier between technological development and the market.

Examples of start-ups working with and researching this technology are:

Steakholder Foods and **Umami Meats**, which aim to develop 3D printed cell-based fish products; **Revo Foods** and **Mycorena**, which received €1.5 million to develop a 3D printable mycoprotein, and **SavorEat**, which launched a robot capable of producing meatless hamburger analogues using 3D printing technology.

In Spain, we saw how **Coccus** and **Foodys** have joined forces to launch a facility to produce and sell 3D printed food.

Cell-based technologies. Mission: to optimise culture media



Upside Foods control center. Photo Upside Foods

SPAIN AND CELL-BASED TECHNOLOGIES

In Spain, we have also heard about proposals concerning culture media, such as that of **Cocoon Bioscience**, which completed a funding round of €15 million to build a new manufacturing plant located in the Bizkaia Technology Park in Zamudio (Bilbao). One of the specialities of this start-up is the development of high-performance growth factors for the cultivated meat industry.

Likewise, we have learnt that the Spanish molecular agriculture specialist **Agrevenc** is making progress designing its portfolio of proteins for culture media, to be launched in 2024.

Everything related to cell-based technologies continues to arouse interest in the media, as seen in the rise in share of voice from 13.5% in 2022 to 18.55% now.

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

One of the main challenges in this scenario, which is in the Expectation stage, is 'optimising the culture media to maximise production', as pointed

out at **The Future of Protein Production Summit**.

In this period, we have seen proposals to make progress in this direction, such as that of the Los Angeles start-up **Omeat**, which has already made the first commercial sales of Plenty, its affordable alternative to foetal bovine serum.

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

Dyadic International also indicated that its animal-free bovine serum albumin is structurally identical to commercial animal albumin, opening up new commercialisation opportunities.

And **Good Meat** took things one step further in early 2023 when it received regulatory approval from the **Singapore Food Agency** to use serum-free media for the production of its cultivated meat, allowing it to sell cultivated chicken meat without using animal serums there.

Using another approach, the British start-up **Uncommon** says that it has developed a new, more efficient and cheaper way (patent pending) of introducing RNA into cells (an idea similar to that used for COVID vaccines) so that, with that RNA, it can then direct the differentiation of cells towards fat or muscle and thus be able to develop cell-based products.

Encapsulation: technology to improve the functionalities of different food matrices

Encapsulation is a technology which has 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**.

It should come as little surprise, therefore, that new research projects have popped up and take up a large part of the news analysed, 34.32% of the scenario. Some of the most striking have been the microencapsulation process to make probiotic-based products in unrefrigerated conditions or the encapsulation of carotenoids (natural pigments that give colour to

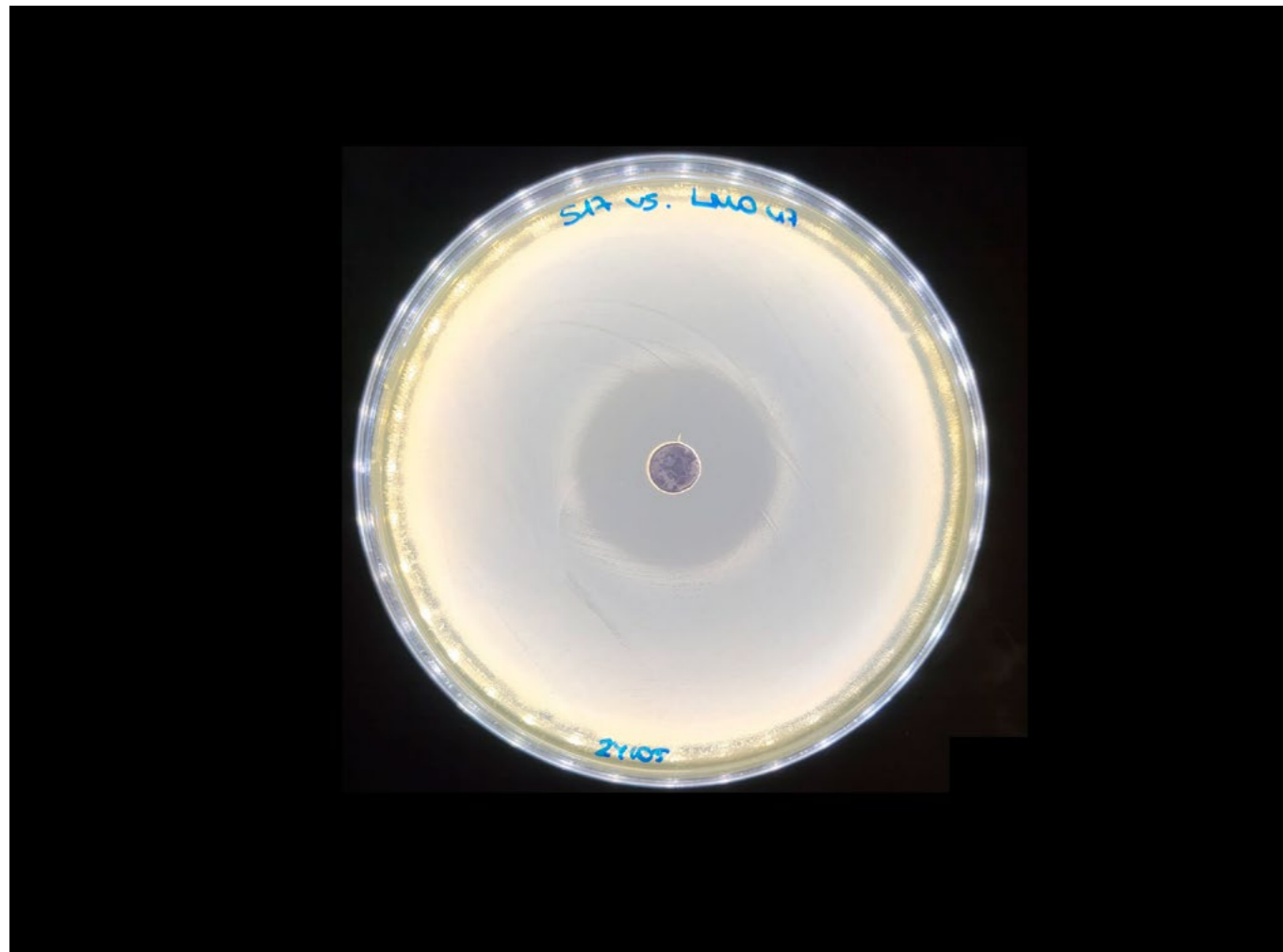


many fruits and vegetables) based on microalgae.

We have seen initiatives which have reached the market, such as **TopGum's** line of high-dose caffeine gummies, which uses microencapsulation technology.

In Spain, we have the encapsulated food ingredient developments by **Nucaps Nanotechnology**, which is developing PROCAPS, microencapsulated probiotics which can be incorporated into food while maintaining their functionality after industrial processing.

Preservation technologies, new approaches to improve existing solutions



Antimicrobial substance. Photo CNTA

All 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. Consequently, 41.67% of the news analysed was about research.

Some of the most prominent projects use pulsed electric fields technology as an alternative to freezing in order to kill anisakis in fish. Also of interest is **Evercase's** smart storage container, which uses magnetic and electric fields to keep food below 0 degrees without crystallising to preserve it in a soft, pliable condition.

Different preservation technologies are also being researched in Spain. An example of this is **Florette**, which as part of the European **Co-fresh** project has started looking into a new active form of packaging that absorbs the moisture from packaged foods to extend product shelf life.



Molecular farming, the power of plants

Finally, the new feature of the **New process technologies** macro scenario is **Molecular farming**, through which plants are used to produce proteins.

This technology has been around for some time, but it appears as a scenario in its own right now due to the great impact it has had in information and research so

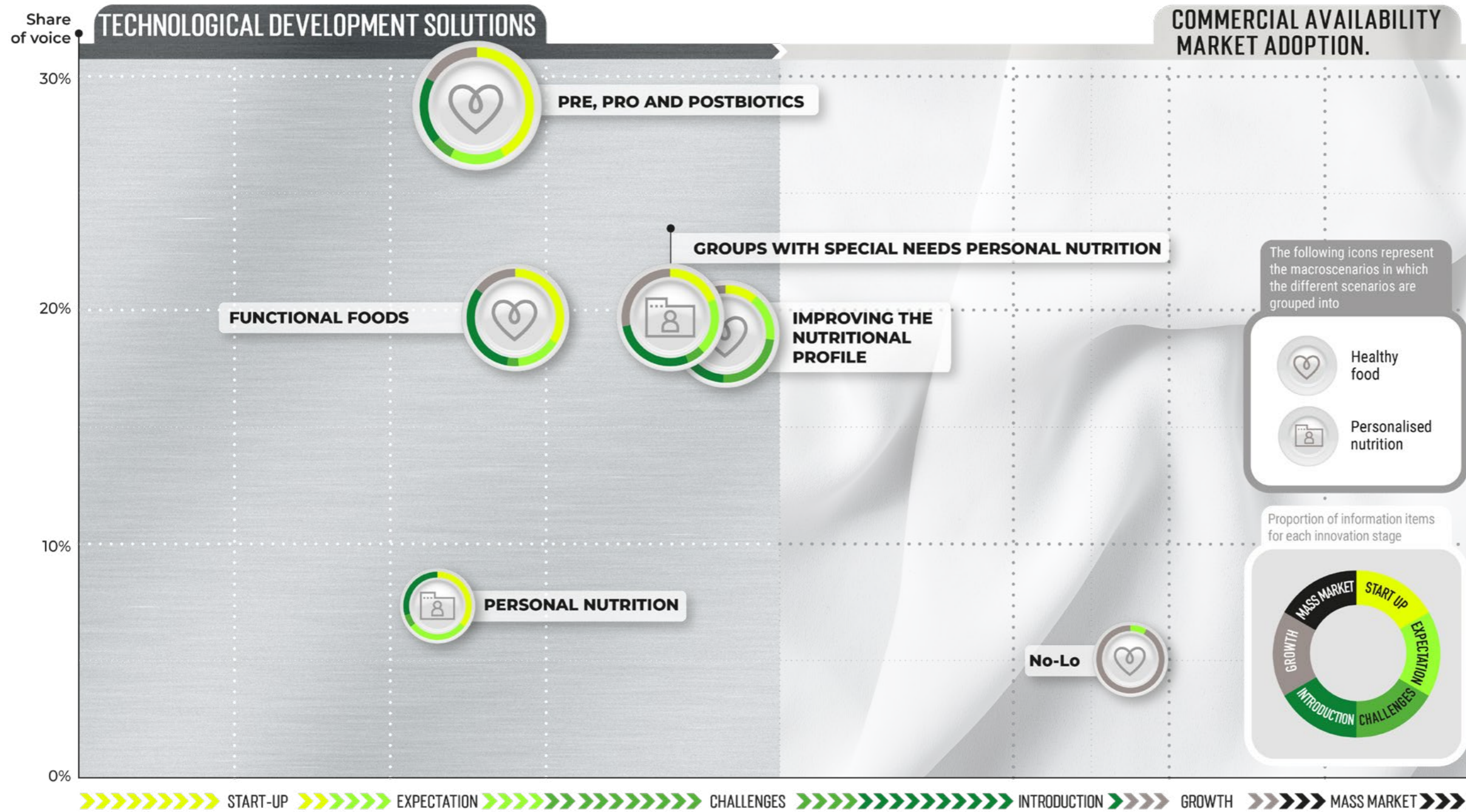
far in 2023. Examples of this have been the presentation of 'Piggy Sooy', the soya bean that produces pork proteins through molecular farming by **Moolec Science**; the **IngredientWerks'** initiative by which it produces heme protein through genetically modified corn, or the alliance between **KBio** and **ZERO** to

build a molecular farming network.

As for funding, one of the largest investments in this field was the \$24.5 million round closed by **Elo Life Systems** to develop a new natural sweetener, made through molecular farming with genetic information from monk fruit.

HEALTHY FOOD AND PERSONALISED NUTRITION SCENARIOS

JAN/AUG 2023 - 237 INFORMATION ITEMS ANALYSED



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

This map contains 6 scenarios. The one with the largest share of voice is **Pre-, pro- and postbiotics**, 29.11%, followed by **Functional foods**, **Groups with special needs** and **Improving the nutritional profile**.

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

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

Stage of FoodTech Innovation



Different varieties of kombuchas. Photo: CNTA

Pre-, pro- and postbiotics, with a focus on the relationship of the gut with other parts of the human body

Consumers are showing growing interest in their gut health and maintaining a healthy microbiome. According to the consultancy firm **Euromonitor**, the global human microbiome market is expected to reach \$9.1 billion by 2026.

This interest means that probiotics, along with their counterparts, prebiotics and postbiotics, are receiving increasing attention.

But science wants to go further and study the relationship between the gut and other parts of the human body. At the **IPA World Congress + Probiota 2023**, we discovered that more and

more studies support the benefits of probiotics, prebiotics, symbiotics and/or postbiotics for health beyond the digestive tract, including **oral, liver, skin, vaginal, urinary tract and cognitive health**.

In this analysis, we have seen how companies are looking into the benefits that pre-, pro- and postbiotics can bring. For example, **Unilever** is using artificial intelligence to analyse hundreds of food ingredients and identify which ones are capable of feeding (prebiotics) the probiotics that produce **GABA** (an acid that is known to

produce calming effects and is thought to have an impact on anxiety, stress and fear).

If we turn to launches, we have seen **Mayawell** and **Asarasi** launch prebiotic soda and a lemon drink with probiotics, respectively, and **Pressed Juicery** present juices with probiotics.

As for investments, in 2023 **Archer-Daniels-Midland**, an ingredient supplier, invested more than \$30 million in a Spanish facility that produces probiotics.

Functional foods, cognitive health in the spotlight

An important scenario in the health field is **Functional foods**. Many of the initiatives proposed in this scenario focus on cognitive health. According to data from **MMR Research** collected from consumers in France, Germany and the Netherlands, brain health ranks second in their health concerns behind cardiovascular health.

In the arena of cognitive health, we saw **Rarebird** run a campaign to fund its coffee alternative for mental well-being and **Puleva** presented its skimmed and lactose-free milk enriched with **Naturalcalm**, a combination of tryptophan and Tilia and Lemon balm plant extracts which help attain optimal relaxation and facilitate sleep.



No-Lo, younger consumers demand drinks of this kind



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

In terms of launches, which is the big subject in this scenario, accounting for 75% of the news analysed, we have seen the release of low and non-alcoholic wine by **Bodegas Peñascal**; **La Casera's** cider and **vermouth aperitifs**; **Martini's** alcohol-free **vermouth**, and **Seagram's 0.0% gin**.

Also relevant was **AB InBev's** €31 million investment in technology for non-alcoholic beers.

Consumers and investors push for food to have a better nutritional profile

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

More specifically, a global survey by **Kerry**, presented in June 2023, shows that people are looking for alternatives

to replace sugar in order to preserve their long-term health and increasingly want natural solutions.

Investors of the companies themselves are demanding that progress be made in this regard. An example of this is **Nestlé**, whose investors are pushing for the multinational to produce healthier foods.

The corporation is working on mea-

sures to produce foods with a better nutritional profile and in this period has presented technology which, through an enzymatic process, reduces the sugar in ingredients such as malt, milk or fruit juices by up to 30%.

On a similar note, **Gran Via** has brought out sugar-free beer and **Campofrío** has reduced the salt and fat in 170 of its products.



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

Most of the research and launches in the **Personalised nutrition** macro scenario are aimed at **Groups with special needs**. The groups that are capturing the attention of company developers include **women, seniors, children, athletes, people with swallowing problems** and the **visually impaired**.

One of the opportunities in this scenario, as pointed out by **Sagentia Innovation**, is 'to target holistic nutrition for women'. The consultants indicate that, at present, multinationals such as **Nestlé, Kellogg's, Danone** and **Abbot** already sell products aimed at women, including snacks, breakfast cereals and

specialised dairy products, but that it expects to see 'a new wave' of food and beverage products, combined with services that diagnose women's nutritional needs to offer tailored support.

Likewise, the **senior** segment has great potential in this scenario, with older people representing an increasingly large proportion of the population pyramid in, chiefly, Western societies. In view of this, food companies are working to offer products aimed at this group. An example of this was the launch of **Alcampo's** new range of products for seniors, aimed at meeting their nutritional needs.

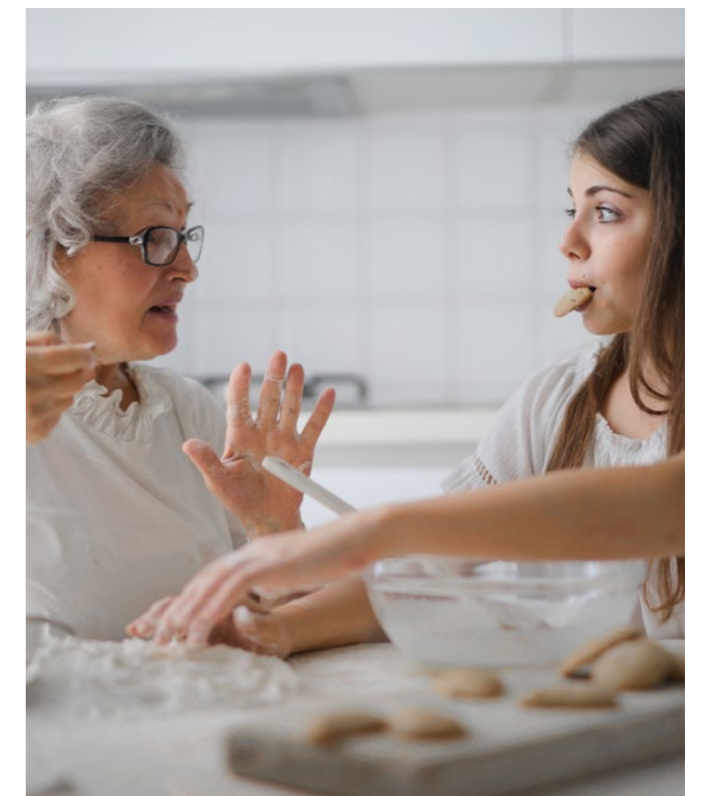
Related to this segment, we have learnt how **Campofrío Health** has started a project, in which **CNTA** is taking part, through which it intends to improve and expand its product catalogue for **people with swallowing difficulties**.

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

PERSONAL NUTRITION, COMPLEXITY TO INDIVIDUALISE PROPOSALS

The **Personal nutrition** scenario faces several challenges. One of the key problems in developing personalised meal plans is the sheer complexity of human nutrition. Our bodies require a delicate balance of nutrients, including protein, carbohydrates, fats, vitamins and minerals, to function optimally. Each person's nutritional needs can vary significantly depending on factors such as age, sex, weight, activity level and genetic makeup.

Yet despite such complexity, in this analysis we have seen research and proposals to offer individualised solutions or recommendations in nutritional matters such as those from **Elo Smart Protein**, which offers recommendations for protein dosing after training, and **4GOLD**, which obtained €1.3 million to expand its DNA testing service and then offer personalised supplements.



SCENARIOS IN DIGITALISATION AND FOOD QUALITY AND SAFETY

JAN/AUG 2023 - 166 INFORMATION ITEMS ANALYSED



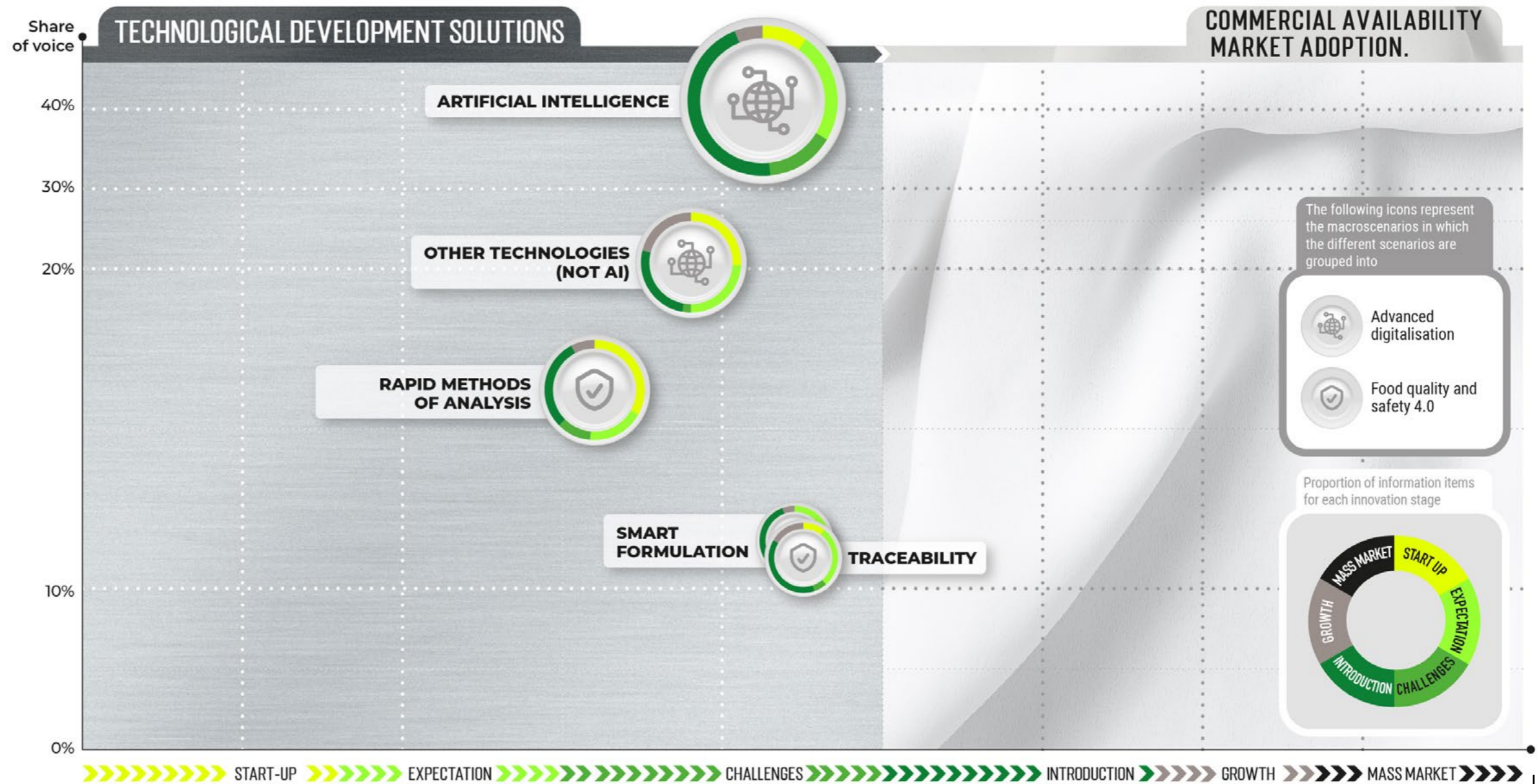
The last map in this section is **Advanced digitalisation and Food quality and safety 4.0**, and it shows the situation of the scenarios included in the two macro scenarios that feature in its title, in which technologies are developed to progress in efficiency to make food or check its quality and safety.

The map features 5 opportunity scenarios, the **Artificial intelligence** scenario standing out a long way from the rest in terms of share of voice with 40.96%. It is followed, in this order, by **Other technologies (not AI)**; **Rapid analysis technologies**; **Smart formulation** and, finally, **Traceability**.

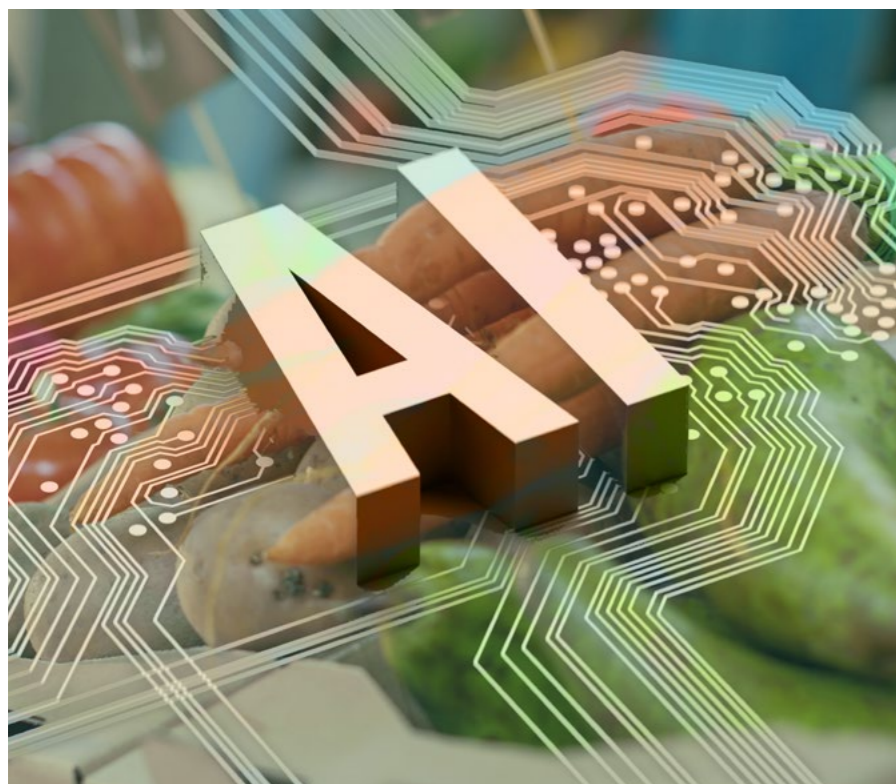
As for stage of innovation, only **Other digital technologies (not AI)** has changed, passing from Challenges in the 2022* Report to Expectation in the period January-August 2023, with companies trying out different technologies to advance in the digitalisation of different processes in their businesses.

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

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



The food industry begins to use Artificial intelligence



The main focus in the **Advanced digitalisation** macro scenario is everything to do with Artificial Intelligence (AI). AI has great potential in the food industry, with the study 'Uso de inteligencia artificial y big data en las empresas españolas' (Use of artificial intelligence and big data in Spanish companies) by red.es stating that 'only 7% of food companies use artificial intelligence'.

Some of those companies are: **Unilever**, a multinational where AI is used

to reformulate products, and the Israeli start-up **Mamay**, which has developed an AI-driven algorithm capable of determining the sweetness of a food or drink.

Tastewise uses generative AI (a branch of artificial intelligence which focuses on generating original content from existing data) to help its customers validate new product ideas, generate market research reports and discover new ingredients.

DRINKS THROUGH SMART FORMULATION

Of great interest in Advanced Digitalization is the use of smart formulation (through AI) by companies to find new or the most suitable ingredients for their products.

In this time, we have seen how some start-ups have used this technology to make different types of drinks. One example is the Hungarian company **Hell Energy Drink**, which has designed an energy drink using AI. Meanwhile, the Swiss firm **Vivi Kola** claims that it took just two days to develop a soft drink using **ChatGPT**, **Midjourney** and **Unreal Engine**.

In this scenario, we also learnt about other initiatives such as that of **Shiru**, which used AI to make its vegetable fat **OleoPro**, or the development of **Food-GPT** by **Ai Palette**, a tool which harnesses the power of generative AI and natural language processing to increase the success rate of product launches.



Other digital technologies, towards the digitalised factory

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

Advances of this type are being made in the **DTWine** project, in which a pilot plant has been set up to apply **digital**

twin technology in the wine industry. Other examples in this scenario include **Gorbit**, which is applying its machine vision software to develop various applications for food distribution, and **Florette**, which has adopted the digital tool **MyMediaConnet**, allowing it to accelerate and optimise its packaging development processes.

Also noteworthy is **Nueva Pescanova's** commitment to moving towards the factory 4.0, foreseeing the incorporation of technologies such as **artificial intelligence**, the **internet of things**, **cloud computing**, **big data**, **machine vision**, **blockchain** and **machine learning**, among other innovations, at all its facilities in Galicia.

Rapid analysis technologies, new ideas to improve food quality and safety controls

There has also been movement in the two scenarios (**Rapid analysis technologies and Traceability**) associated with **Food quality and safety 4.0**, a concept which can be defined as the application of new technologies and digital advancement to improve food quality and safety controls and analysis; enabling the reduction of risks and waiting times; expanding sampling or, in some cases, sampling production in its entirety; making decisions based on data without destruction of the sample and with a minimum of processing, and developing predictive models.

Regarding **Rapid analysis technologies**, we have continued to see initiatives in NIR and hyperspectral technologies, and the use of sensors to check freshness or detect pathogens in food.

One example is that of the Dutch start-up **OneThird**, which raised €2.75 million to boost its AI-driven Near Infra-red (NIR) Scanning technology, which allows producers, food distributors, retailers and consumers to accurately predict the shelf life of fresh products and minimise food waste.

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

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

The Israeli start-up **Neolithics** has also patented a remote sensing system that combines Artificial Intelligence, hyperspectral technology, machine learning and food science to facilitate the instant and accurate evaluation of fruit and vegetable quality, and **Deep Detection** aims to launch its X-ray inspection technology onto the market.

Finally, **Sensifi's** initiative, which uses an 'artificial nose' for the rapid and local detection of pathogens such as E.Coli and Salmonella, stands out in the crowd.



NULAB portable NIR device. Photo CNTA.



The use of blockchain reaches more sectors


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.

Examples of blockchain use are **Rujamar**, which thanks to this technology manages its production cycle, guaranteeing transparency, traceability, safety and sustainability in its organic eggs,

Blockchain is one of the most widely used technologies in the traceability scenario

and Leche Rio's **Milkchain**, a traceability system which integrates different kinds of devices (sensor systems, machine vision, laser printing and blockchain, among others) and certifies the origin of milk until it reaches the final consumer.

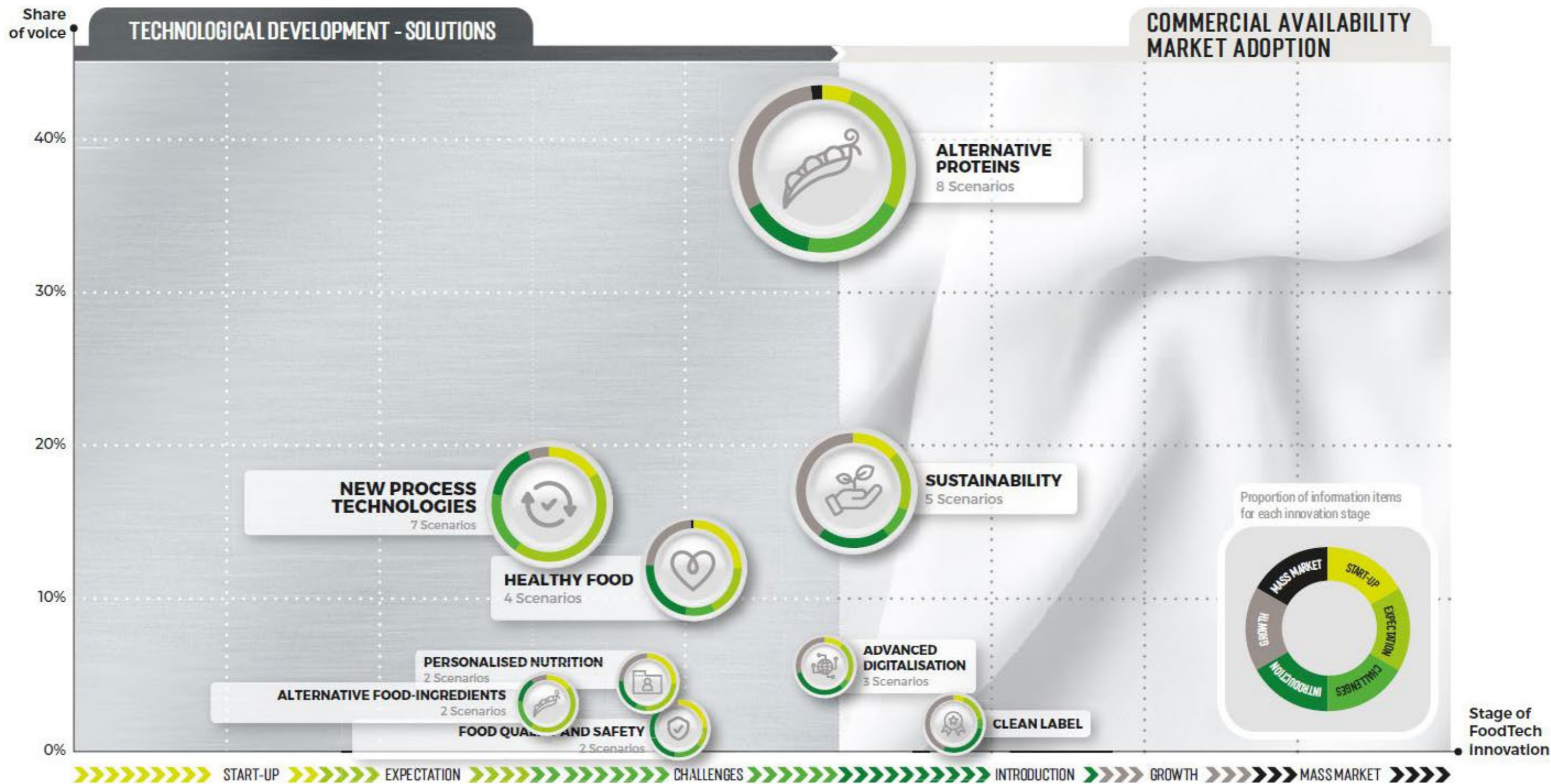
Apart from blockchain, other companies are looking towards other methods, such as **Oritrain**, which uses forensic analysis to verify the origin of products ranging from cocoa to coffee.



**Anexes:
Opportunity
Scenario Map
2022**

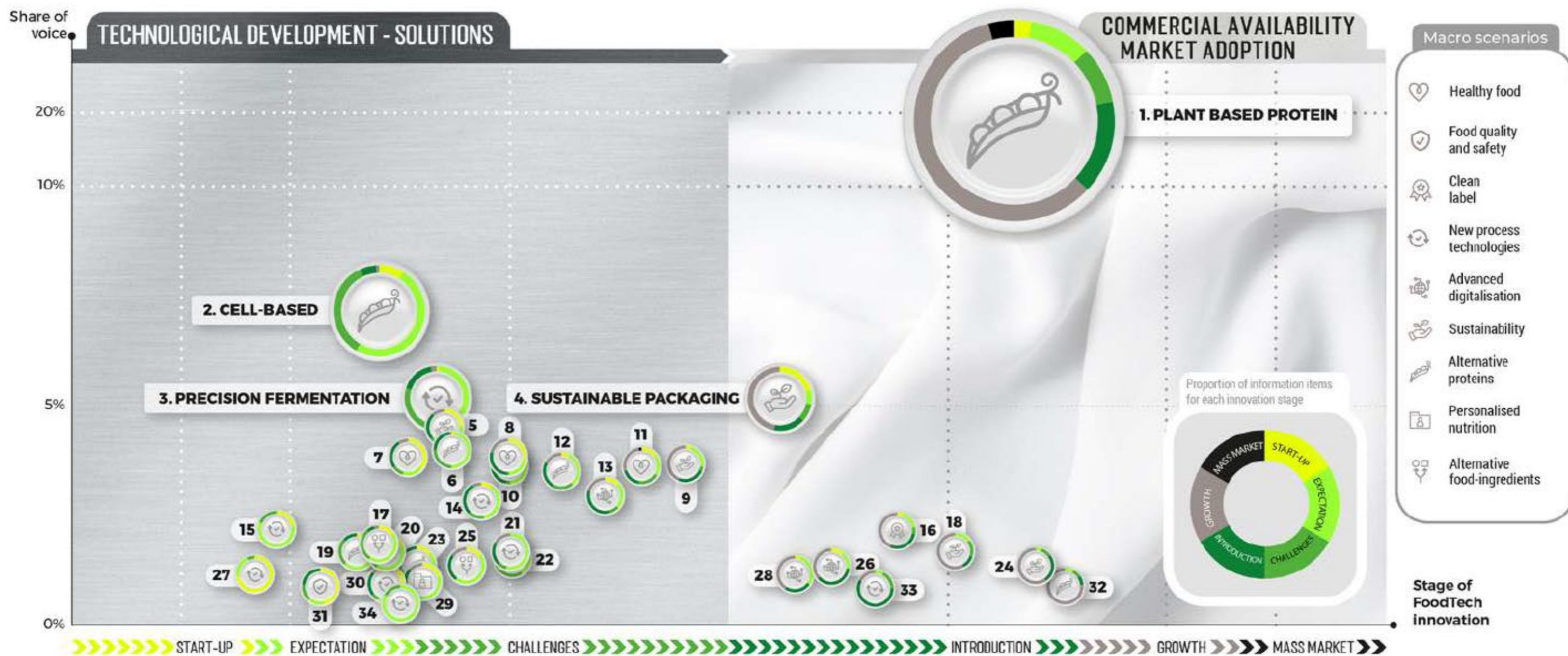
MACRO SCENARIO MAP

JAN/DEC 2022 - 1,492 INFORMATION ITEMS ANALYSED



MAP OF ALL SCENARIOS

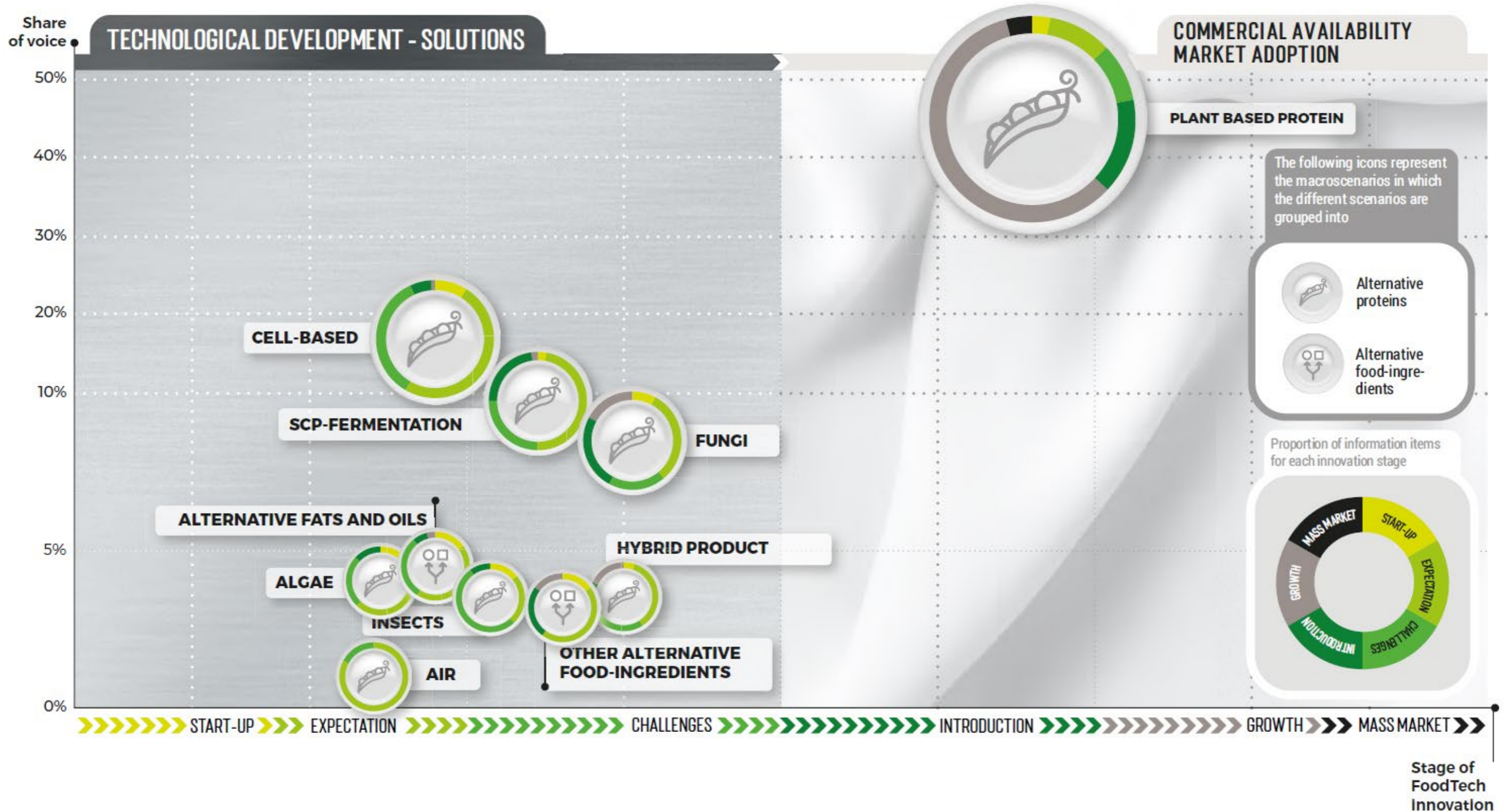
JAN/DEC 2022 - 1,492 INFORMATION ITEMS ANALYSED



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

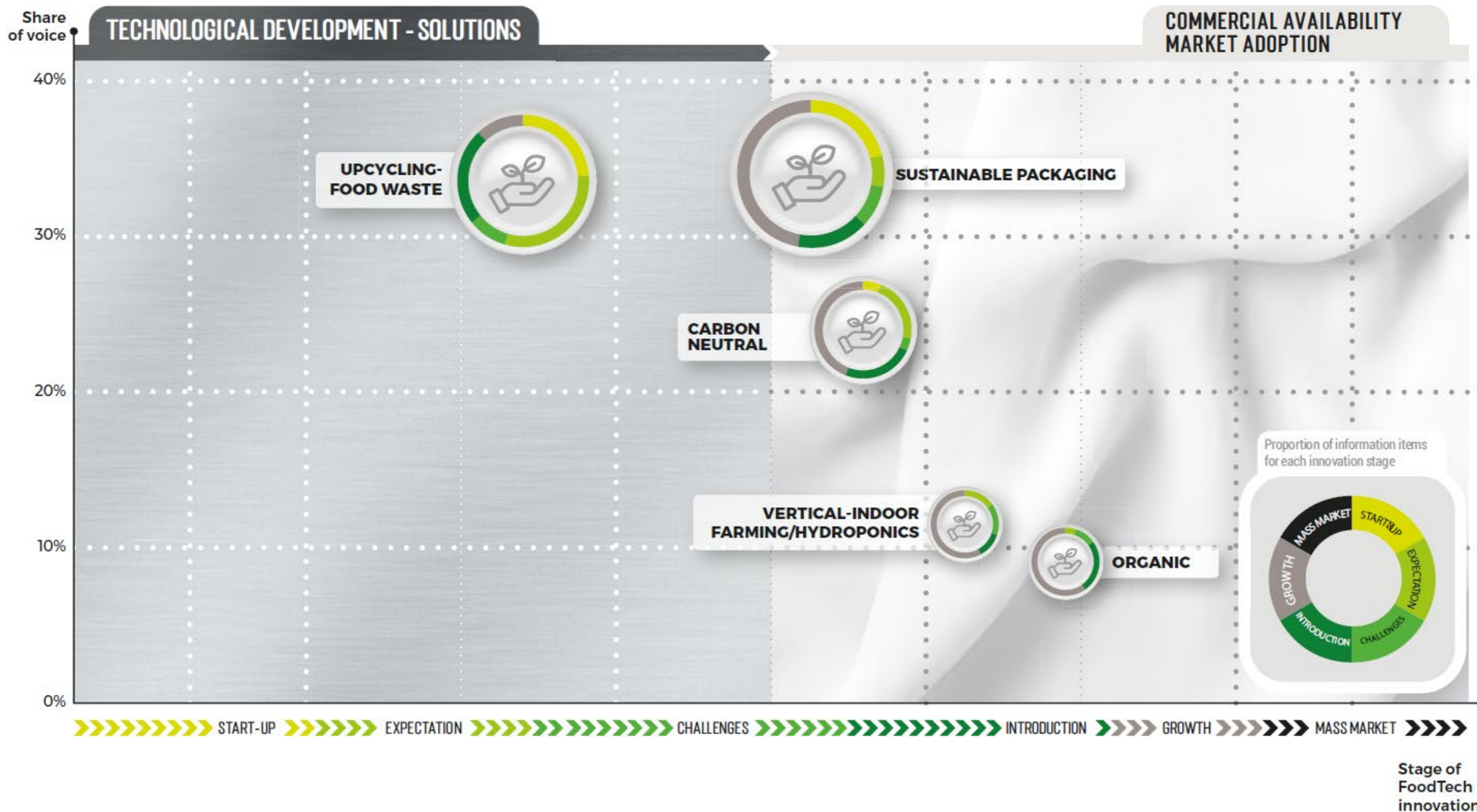
ALTERNATIVE PROTEINS, FATS AND FOOD SCENARIOS

JAN/DEC 2022 - 615 INFORMATION ITEMS ANALYSED



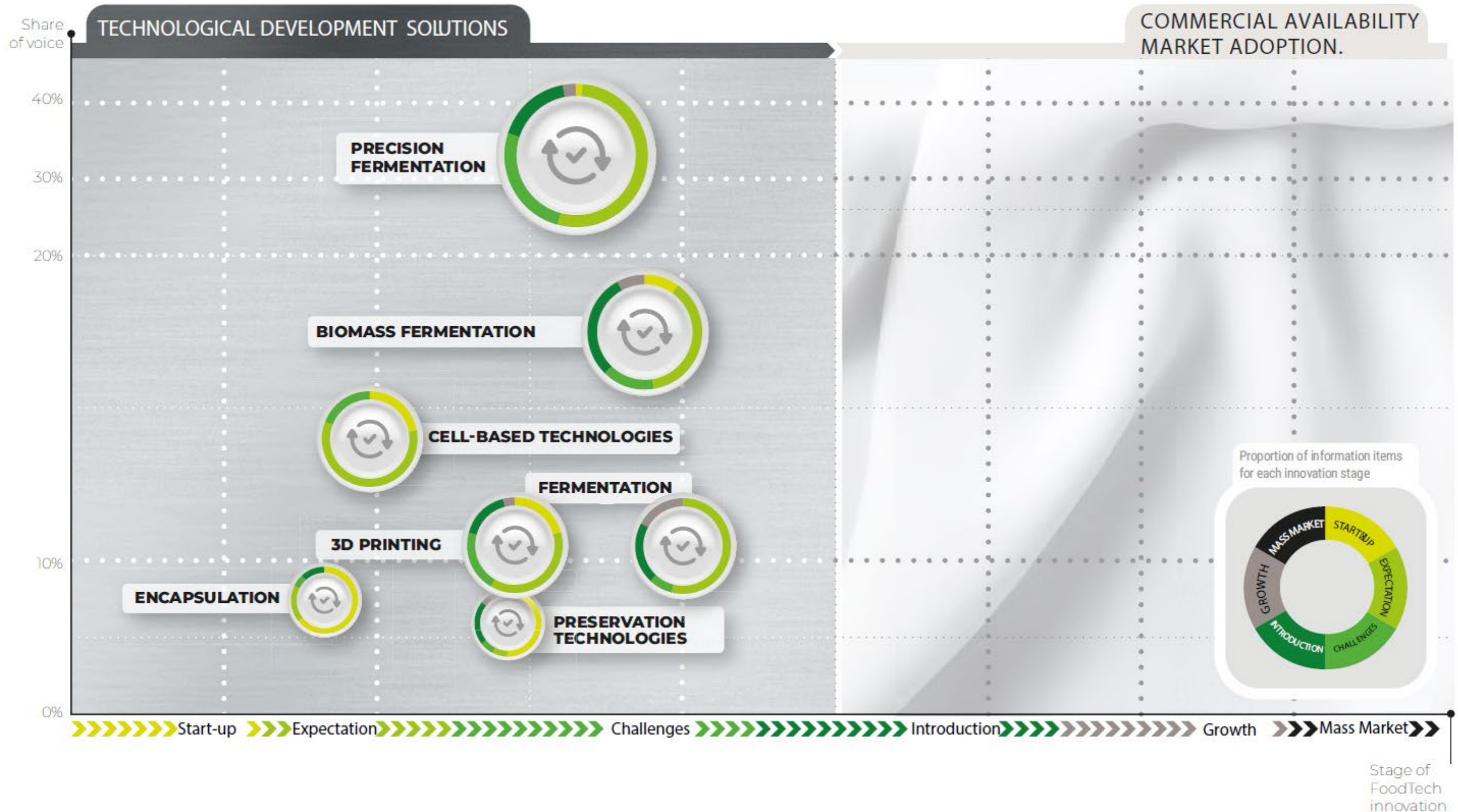
SUSTAINABILITY SCENARIOS

JAN/DEC 2022 - 244 INFORMATION ITEMS ANALYSED



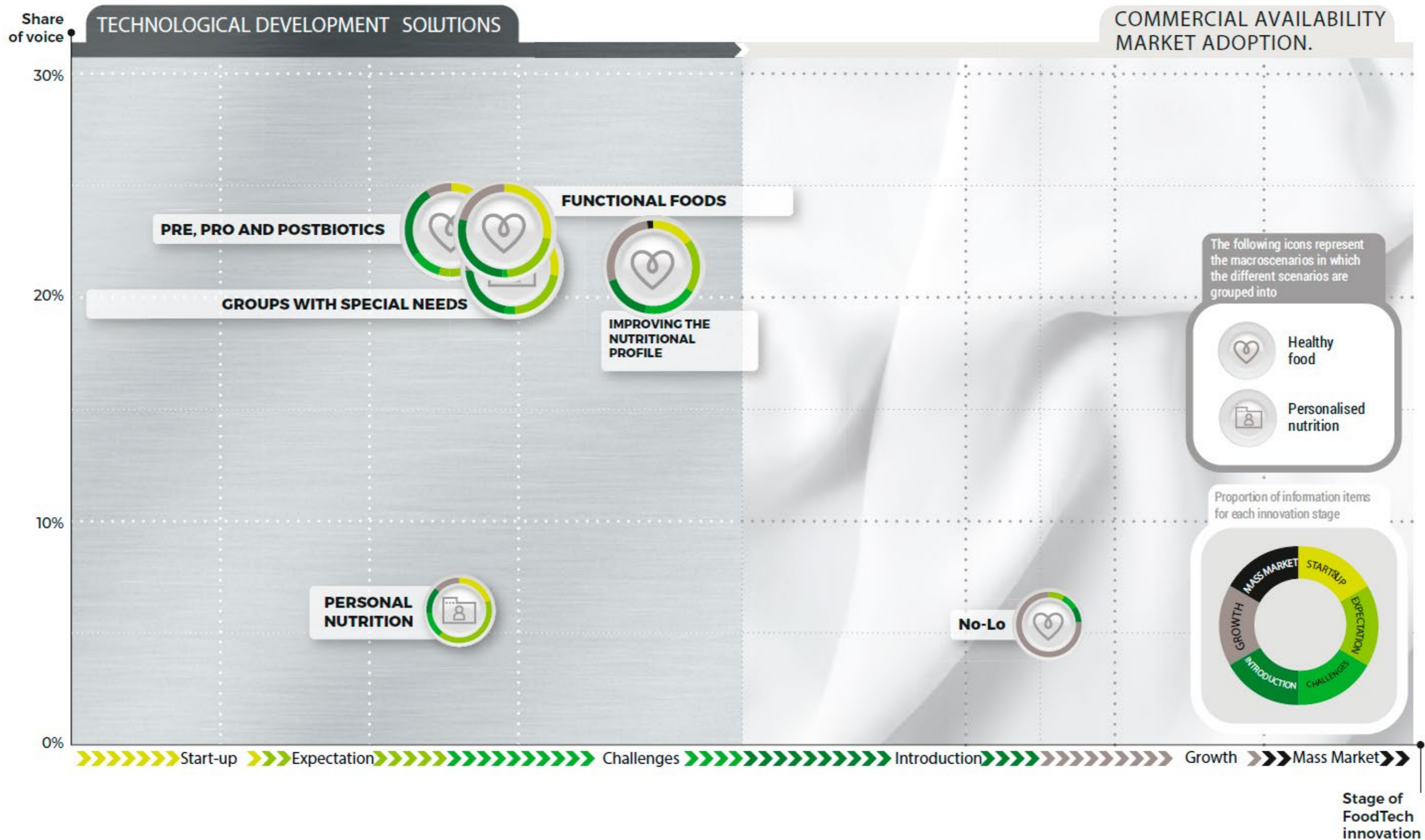
NEW PROCESS TECHNOLOGY SCENARIOS

JAN/DEC 2022-228 INFORMATION ITEMS ANALYSED



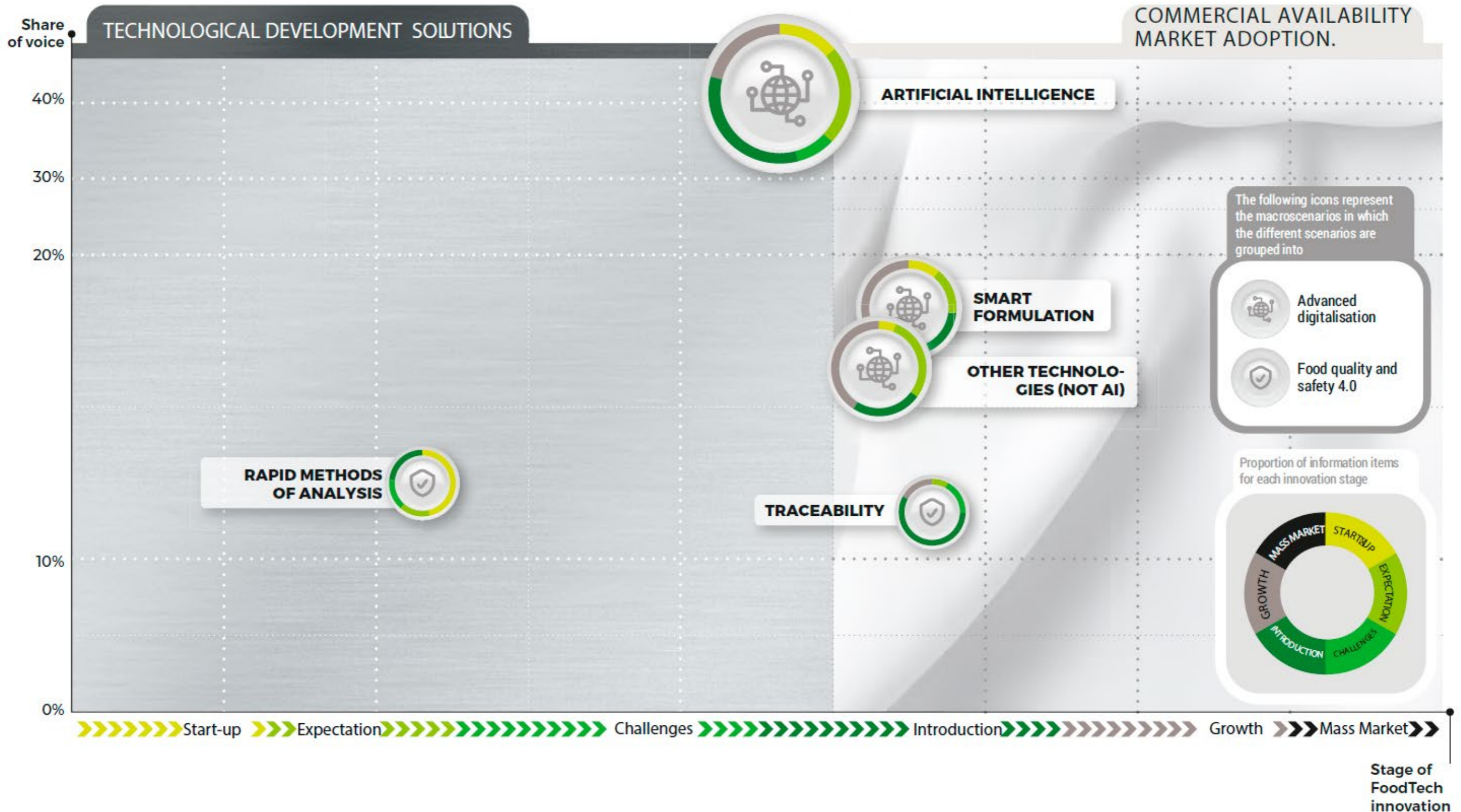
HEALTHY FOOD AND PERSONALISED NUTRITION SCENARIOS

JAN/DEC 2022 - 180 INFORMATION ITEMS ANALYSED



SCENARIOS IN DIGITALISATION AND FOOD QUALITY AND SAFETY

JAN/DEC 2022-104 INFORMATION ITEMS ANALYSED



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