D2.1 Open call tracks

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Revision History

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1.0	24/02/2023	Lorraine Brennan, Aoife O Gorman (UCD)	First draft
1.1	28/02/2023	Ramona Van Gansbeke (GLUON)	Reviewed
2.0	28/02/2023	Lorraine Brennan (UCD)	Final version

Executive summary

An extensive search of the literature was performed to identify the key knowledge with respect to the three trends in “Food As Medicine”. These three trends correspond to the three track topics for the Open Call:
(1) challenges and opportunities in reducing carbon footprint in dietary behaviour,
(2) role of food in holistic wellbeing
(3) rethinking the food chain in our environment.

For each track a detailed literature review, a lay summary and an infographic was produced. Key challenges were identified and opportunities for the future were highlighted. The data was collated in an Airtable which is easy to navigate and all files can be downloaded.

With respect to the three technologies: AI, Wearables and Robotics a detailed review of the available technologies was undertaken and captured in the airtable. Case studies with applications of the technologies to the domain of Food were identified.

A co-design workshop was organised to find a common ground and understanding the potentialities of the selected technologies in relation to the three tracks.

In conclusion, the Airtable produced is easy useable table containing information in relation to the Food Tracks and technology case studies.

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1. Introduction

The focus of the task related to this deliverable was the exploration of the opportunities of AI, Robotics and Wearables for the three trends within the Food as Medicine topic to create the 3 thematic tracks of the first open call.

As part of deliverable D2.1 three trends within the 'Food as Medicine topic' were identified for detailed analysis of the literature. These three trends correspond to the three track topics that are detailed below in this document; (1) challenges and opportunities in reducing carbon footprint in dietary behaviour, (2) role of food in holistic wellbeing and (3) rethinking the food chain in our environment.

These topics are recognised as emerging trends that will require envisioning and developing new innovative technological solutions. To research these topics comprehensive literature reviews were carried out which involved extensive database searching and reviewing of grey literature. In addition to the scientific literature reviews, a non-scientific summary was developed to allow artists to have access to very detailed information but also a more user friendly document. In addition, an infographic for each trend has been produced. All the data was collated in an airtable which is easy to navigate and a link is given below.

A review of available technologies (AI, sensors and robotics) relevant to food was also conducted and case studies collated.

2. **Track 1**: Challenges & opportunities in reducing carbon footprint in dietary behaviour

A comprehensive literature review was conducted using Web of Science and PubMed. The search was conducted using the search terms "environment" or "carbon" AND "footprint" AND "Diet". A total of 122 articles were identified. A number were excluded as they were not relevant to human diet, had an irrelevant title and abstract or focused on specific age groups. After this screening a total of 24 articles were included in the review.

2.1 Overview of Track 1

Recent evidence suggests that 20-30% of all greenhouse gas emissions come from food, with 58% of these emissions coming from animal products. In order to feed the ever growing population there is an urgent need to diversify our diets to reduce animal products and increase plant products; however this is not without its challenges.

Challenge 1: Environmental and health benefits may not always go hand in hand. Scientific evidence shows that shifting to low greenhouse gas diets and reducing meat animal product consumption can lower intakes of nutrients and minerals such as calcium, zinc, potassium, iron, choline, and vitamins A, D, B2, and B12.
Challenge 2: There is currently very little evidence surrounding the land and water footprint of low carbon footprint diets, however existing evidence shows that certain

low carbon footprint diets can have high land and water use, which increases stress on these resources contributing to land degradation and water scarcity.

Challenge 3: With the emphasis on shifting to more sustainable diets there is an increase in the number of meat alternative products on the market. Further work is required to establish the health benefits of such products and to examine the environmental impact associated with their formulation and production.

Opportunities for Sustainable Change to Diets

As societal awareness of the environmental and health benefits of plant-based diets increases, the opportunities to encourage shifts in dietary behaviours also grows.

● Opportunity 1: Encourage consumers to purchase seasonal products from their local markets and to grow some of their own produce.

● Opportunity 2: Diversify current diets such as by consuming a variety of foods – diversification can be achieved through social and behavioural changes.

● Opportunity 3: Food fortification can fill the nutrient gaps associated with low greenhouse gas emission diets; for example, fortification with iron or vitamin B12. This can help maintain nutritional adequacy of sustainable diets.

For further information a detailed review, lay summary can be found here: https://airtable.com/appLTZBZ0xy9kN0EX/tblSWBwVGPQwz0si4/viwhGdzcO26IjBOMg?blocks=hide

3. Track 2: Role of food in holistic human wellbeing

A comprehensive literature review was conducted using Web of Science and PubMed.

3.1 Overview of Track 2

Holistic health refers to the health of the whole person, encompassing five key dimensions - physical, emotional, social, mental, and spiritual wellbeing. There is a large and growing body of evidence which supports the role of certain nutrients, food groups, and dietary patterns to positively influence health and promote the prevention of non-communicable diseases (NCDs).

The most recent worldwide data indicates that poor diet quality has been linked to an increased risk of many chronic diseases as well as premature mortality. Poor diet quality is indicated by low intake of wholegrains, fruits, and vegetables, and high intakes of sodium.

(1) Dietary risk factors
   a. Interventions for increasing fruit and vegetables
   b. Interventions for increasing wholegrains
   c. Interventions for salt reduction
   d. Personalised approaches

(2) Diet and cardiometabolic diseases
   a. Strong evidence supports the role of the Mediterranean diet in protection against CVD & diabetes
   b. The Mediterranean diet is high in vegetables, fruits, legumes, nuts, beans, grains, fish & olive oil

(3) Diet and mental health
   a. Lifestyle changes such as an improved diet in addition to mental health care can improve mental health outcomes.
   b. Strong evidence exists between Mediterranean diet & mental health

(4) Diet and sleep
   a. Diet quality may be associated with sleep quality
   b. Recent data shows that high intake of fruits, vegetables, wholegrains & legumes was associated with better sleep quality

Conclusion

The scientific evidence has emerged in recent years to support the role of good quality diet in the prevention of diseases. Innovative approaches to enable people to make healthy food choices are needed in conjunction with new approaches to communicate the benefits of food. Development of personalised approaches to enable people to make healthier choices should be developed further.

For further information a detailed review, lay summary and infographic can be found here:

https://airtable.com/appLTZBZ0xy9kN0EX/tblSWBwVGPQwz0si4/viwhGdzcO26IjBOMg?blocks=hide

4. Track 3: Rethinking the food chain in our environment

A comprehensive literature review was conducted using Web of Science and PubMed. The search was conducted using the search terms “food chain”, “food system”, “revise”, “redesign”, “transform”, “change”, “food security”, “food waste”, and “food production”. Following screening for duplicates and articles that were not relevant, a total of 16 articles were included in the final review.

4.1 Overview of Track 3

The food chain involves stages of production, processing, packaging, distribution, retail, consumption, and waste. As the current global food chain faces environmental, political, and economic challenges; it has been suggested how food chains operate should be changed.

The global population is set to grow to approximately 9.7 billion people by 2050. This calls for more food to be produced in order to meet the nutritional needs of the world and maintain food security. For people to be considered food secure, they must have food available to them, have physical and financial access to it, and are able to use the food products.

Challenges Related to Rethinking the Food Chain.There are a number of challenges facing the current global food chain:

Challenge 1: Risks - Risk to the food chain include climate change, depletion of natural resources, conflict, emerging disease, and food safety scares.

Challenge 2: Food insecurity - Globally ~193 million people acutely food insecure in 2022. Rising populations require an increase in food production to meet demands, which may be a struggle. Likely Covid-19, climate changeand conflict are worsening the number of individuals affected.

Challenge 3: Price increases - Cost of living has increased in recent years and this is reflected in rising food prices. Increasing energy and fertiliser costs, supply chain disruptions following the pandemic, conflict (including the war in Ukraine) have all contributed. Food inflation can negatively affect food insecurity.

Challenge 4: Shorter food chains – Have been suggested as a option for food chain reform. Benefits include: increased traceability and transparency, increased consumer trust, greater autonomy and resource utilisation for producers Barriers: highly localised and seasonal and viewed as expensive and difficult to access by consumers.

Challenge 5: Food Waste - One third of all food produced is wasted. Household waste per capita appears similar in high, uppermiddle, and lower-middle income countries. Negative

environmental impacts associated with waste, and waste contributes to food insecurity. Change needed at all points of food chain and needs to consider all actors in the food chain from producers to consumers.

For further information a detailed review, lay summary and infographic can be found here: https://airtable.com/appLTZBZ0xy9kN0EX/tblSWBwVGPQwz0si4/viwhGdzcO26IjBOMg?blocks=hide

5. Technologies that could be used to develop future scenarios

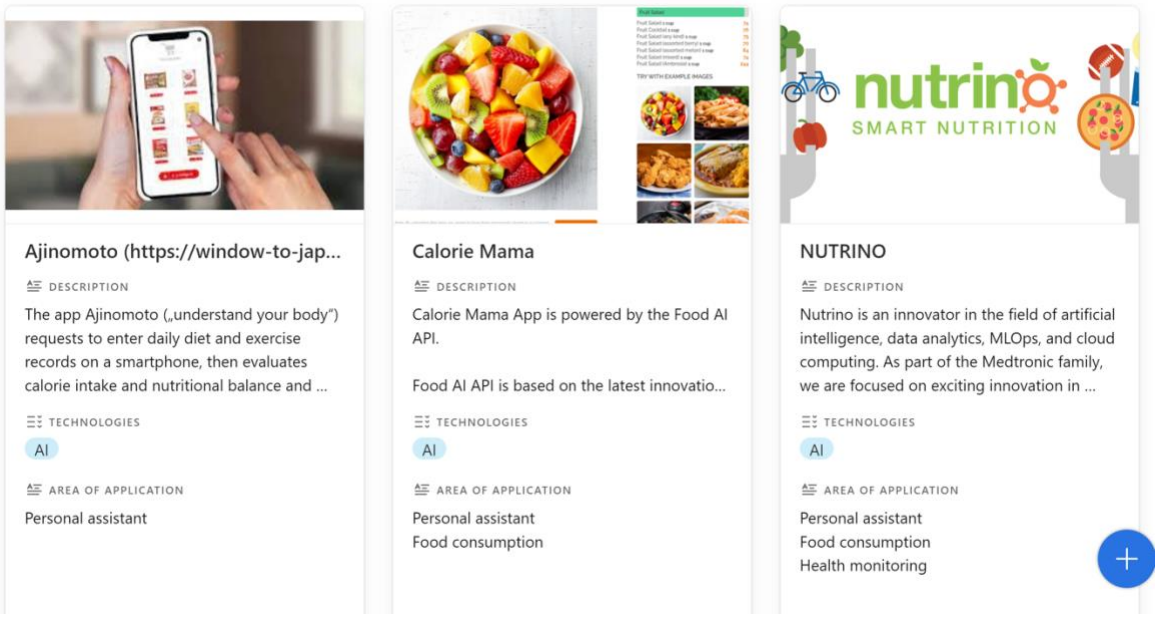
Technology exploration was undertaken by UB, ABACUS, PAL and UoM to identify examples of tech case studies that could be applied to the three tracks outlined above under the theme 'Food as Medicine' to understand the opportunities their technologies have in these areas. A total of 68 case studies were identified

5.1. AI

AI is a powerful tool to interpret data from the person as well as from the environment and to transform them in usable information in healthcare and nutrition.

Case study example: Calorie mama – the app is powered by the Food AI API, which is based on the latest innovations in deep learning and image classification technology to quickly and accurately identify food items.

For more technology case studies – https://airtable.com/appLTZBZ0xy9kN0EX/tblc8oUUvC05jtlLg/viwScGL6kyRlgUQzO?blocks=hide



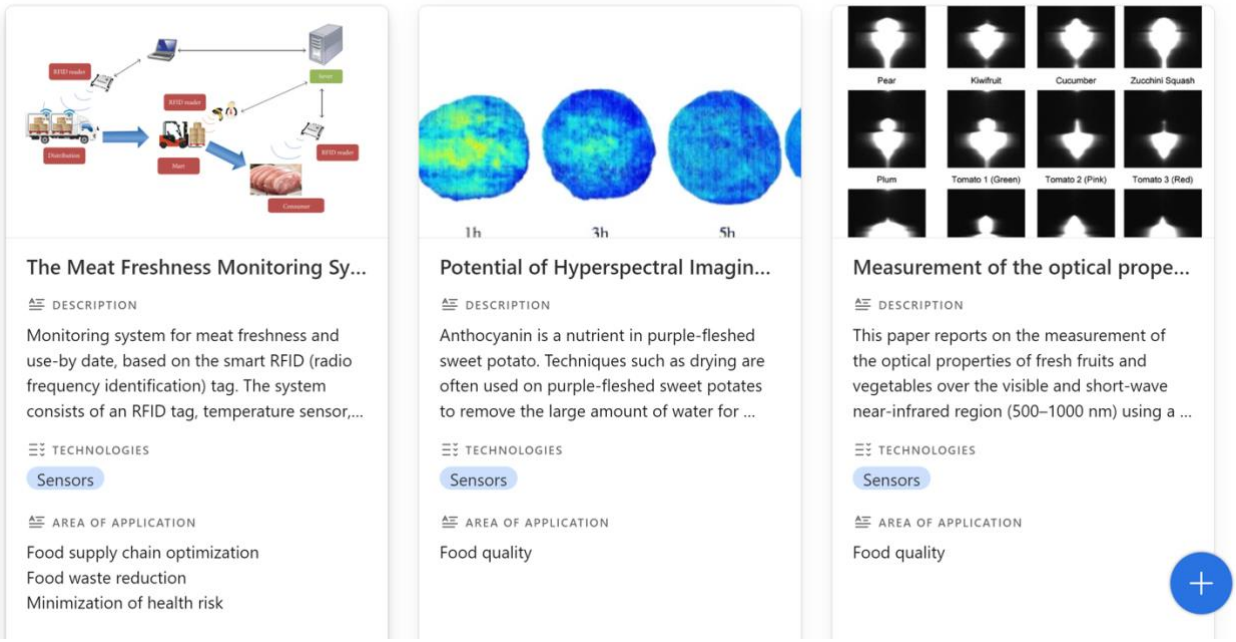
Example AI Technologies – more available at the above link.

5.2. Wearable sensors

Wearable technology is gaining increasing interest in the digital society mainly because of mainstream technologies like smartwatches and smartbands that contribute to the growth of the so called QuantifiedSelf movement . Monitoring of physical, cognitive and physiological status by the means of wearable sensors may play a key role in setting up of a high personalised healthcare. Wearable sensors are already fashion and design devices, however, they have not yet reached full acceptance by society at large and, mainly, the healthcare community.

Case study example: Salivary diagnostics on paper microfluidic devices and their use as wearable sensors for glucose monitoring.

For more technology case studies - https://airtable.com/appLTZBZ0xy9kN0EX/tblc8oUUvC05jtlLg/viwScGL6kyRlgUQzO?blocks=hide



Example Sensors with application to Food.

5.3. Robotics

Robots have a huge potential to improve and help humans take over dangerous, repetitive or tedious tasks. Over the last couple of years robotics has started to make its way into almost every link in the food supply chain, from the field to the kitchen. Robotics solutions will tackle all the relevant key abilities needed by service robots in the market today for semi- or full autonomy in an environment collaborating with human workers.

Case study example: Robochef – world's first fully automated robotic kitchen that cooks 800+ recipes with zero manual effort powered by IoT, robotics and machine learning.

For more technology case studies - https://airtable.com/appLTZBZ0xy9kN0EX/tblc8oUUvC05jtlLg/viwScGL6kyRlgUQzO?blocks=hide

6. Information for the Open Call Tracks

A co-design workshop took place in Dublin bringing together experts in Food and Technologies (See Annex - the Co-design Workshop summary). A series of scenarios for the different tracks were developed which will feed into the Open Call (see Table 1).

Table 1: Scenario Mapping: What are the future potential scenarios for our food industry and food systems when we consider the 3 tracks of research and future technologies

	Challenges and opportunities in reducing carbon footprint in dietary behaviour	Role of Food in holistic human wellbeing	Rethinking the food chain in our environment
Artificial intelligence	An individual society with no awareness of CO2, robotic plants are used as indicators High CO2 – A.I is a logistic overlord that controls food distribution	People have expectations for personalized diets Machine learning develops shopping lists based on genetic and health profiles The applications we buy through recognize food composition and can track what we eat	A.I is Optimizing waste management by to assist in using complex food chains and environmental interactions maximise use of waste.
Robotics	Food system contribute to majority of CO2 emissions Robots (SWARM) act as distributers of distributions. In rural areas we have the 'last-mile' delivery	80% of the population are now obese. Robotic twins track and assists people in making healthier choices. Assistant robots help people to prepare and cook food safely	Climate change modifies the ecosystem Robots demonstrate the food chain interactions and display concepts of systems thinking and future food chains
Wearables	New meat replacements have made our diet and CO2 level worse. We were devices that read our biological levels such as metabolic health, the device advises and monitors what we cook	Individuals having poor metabolic health leading to them having a shorter lifespan. Wearable technology will advise individual to how and what t cook for healthier lifestyle	Climate change effects mutations in plants. Plant wearables are common to track their health and that of the ecosystem Exoskeletons are needed to access elements of the food systems

Draft text for each track is summarised below:

1: Challenges and opportunities in reducing carbon footprint in dietary behaviour
The population of the world is expected to rise to between 9.4 to 10.2 billion by 2050. With this increasing population comes an increasing demand for food. In order to provide enough nutritious food for future generations we must change our dietary habits and switch to more sustainable eating patterns.

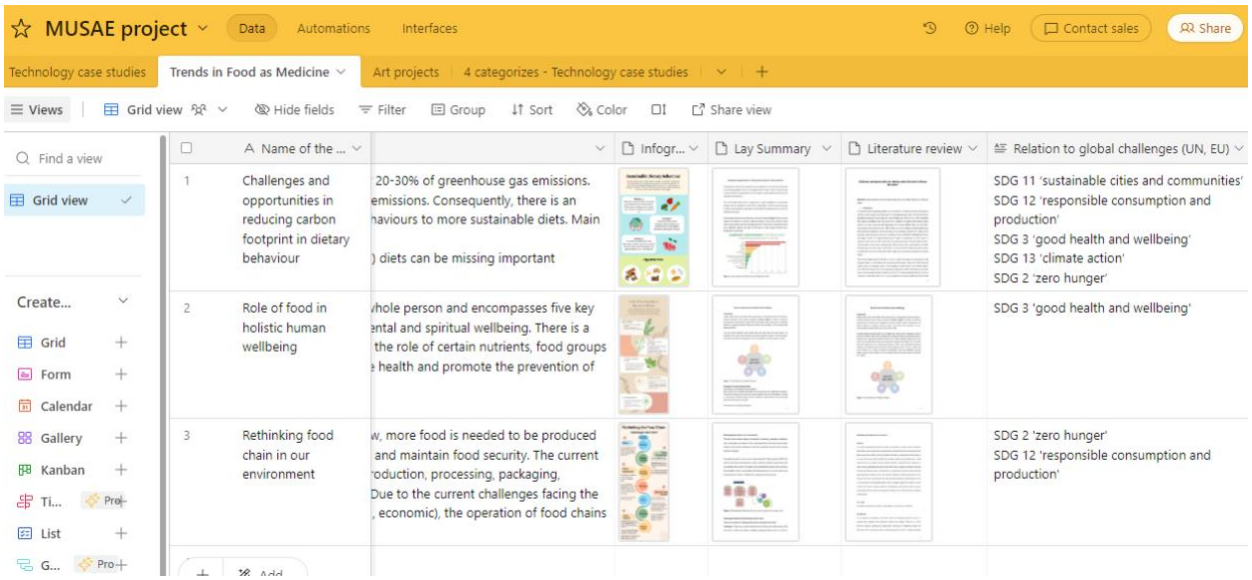
2: Role of Food in holistic human wellbeing

- Holistic health refers to the health of the whole person, encompassing five key dimensions - physical, emotional, social, mental, and spiritual wellbeing. There is a large and growing body of evidence which supports that the intake of certain nutrients, food groups, and dietary patterns to positively influence health and promote the prevention of non-communicable diseases. Development of strategies that enable individuals to change their dietary behaviour and to promote a great awareness of the link between diet and health are needed.

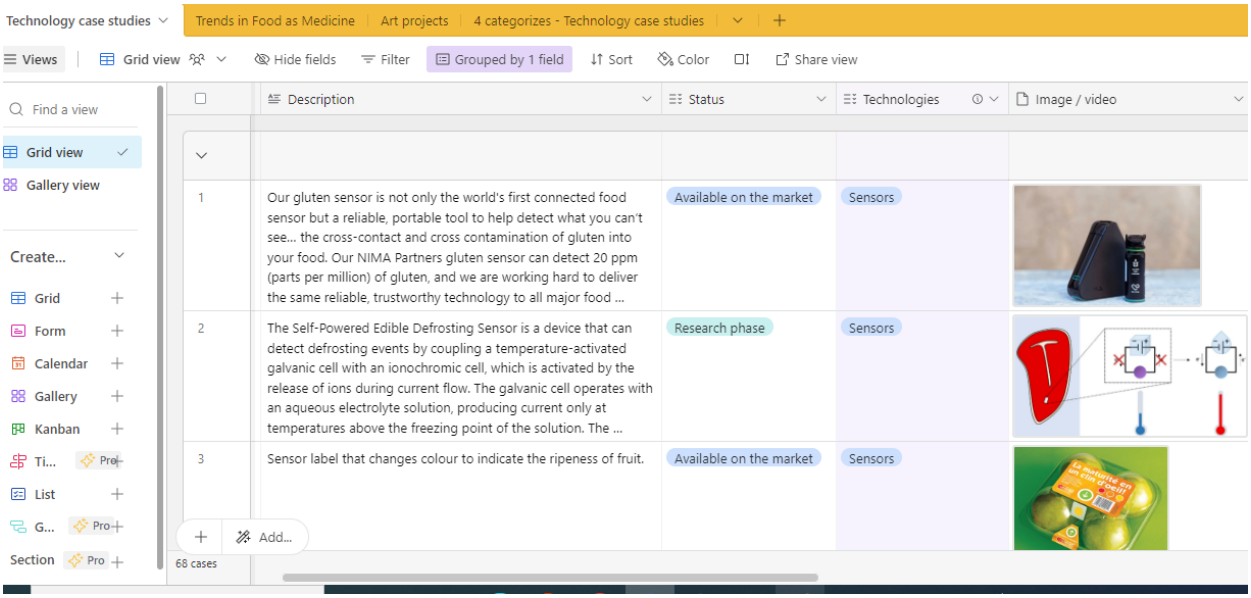
3: Rethinking the food chain in our environment
We need to reshape food supply chains to stay resilient during and beyond current environmental, political, and economic crises. Components of the food chain involve production, handling and storage, processing and packaging, distribution, retail, consumers, and waste.

7. Airtable screenshots

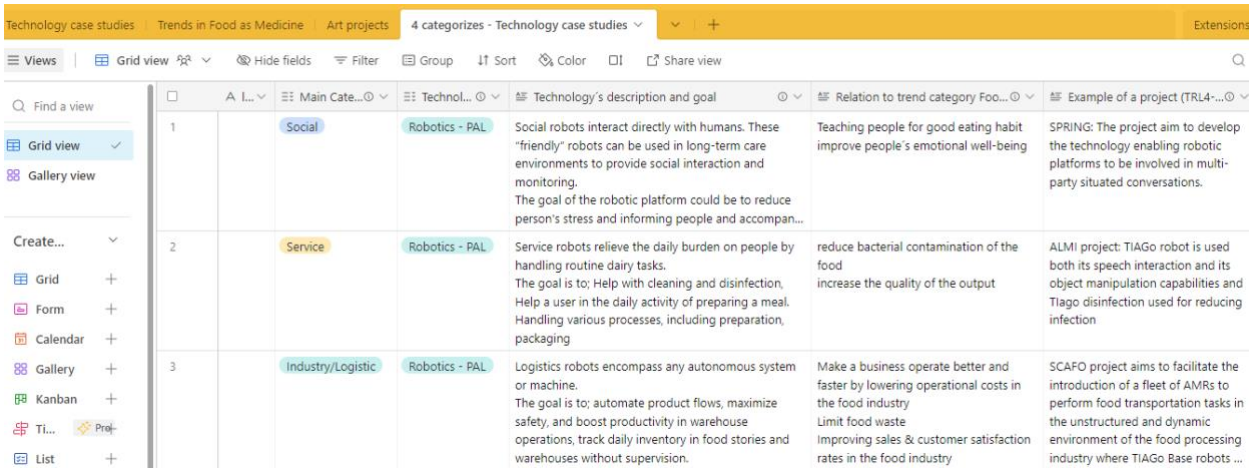
All the data collected in relation to this deliverable is collated in an easy to use and navigate airtable. Examples of the layout and data contained in the Airtable are given below.



Airtable 'Trends in medicine'



Airtable ‘Technology case studies’



Airtable ‘Technology case studies- categorised’

8. Annex

8.1. The co-design workshop summary

Musae
Co-Creation Workshop

Workshop Summary
14.02.2022

Topic of discussion:
"Food as Medicine"

PRESENTED BY
Shaun Ussher
Aisling Murray

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Opening exercise – The memory of food.

Participants gathered around the table, to close their eyes and relax. They were told to breathe slowly and deeply, like a meditation. Participants were then prompted to remember back into their past, to think of a food experience that was of important significance to them.

Participants were asked to think of the smells, sounds and the environments in which the memory takes places, they were asked to imagine what they could touch and feel, and consider who was there and what they were doing, lastly, they were asked to taste the food and remember how it made them feel.

Participants were asked to do this at 3 significant timepoints in their life, at childhood, when they became independent and lived away from home, and a time that is more recent.

Exercise 1 – Past, Present and Future of Food

Participants were broken into two groups of four. They were provided with colored post-it notes and asked to respond as a group to 4 prompts. Each prompt was delt with separately, participants had 3 minutes to write as any post-its as they could. Once completed they were grouped into categories and presented to the group.

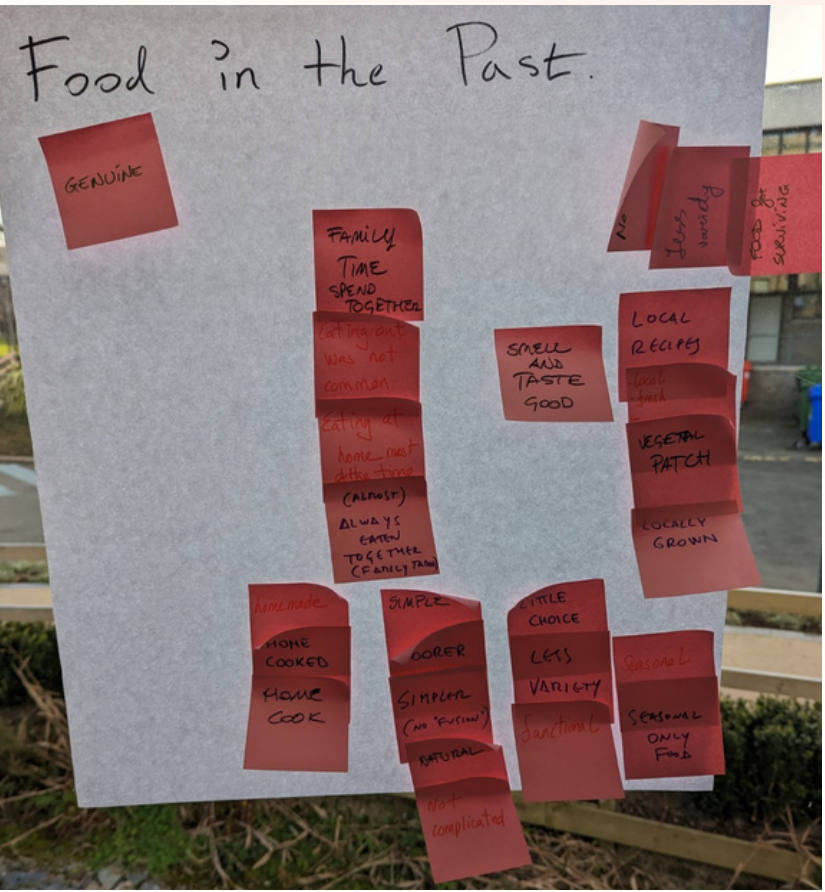
The prompts are shown below along with the resulting categories for each prompt, with some examples listed.

Past, Present and Future of Food

Prompt 1:
Food in the past was different than food today. What do you think of when you recall food from the past?

Results

1. Social Aspects: Food reminded participants of family and friends, most of the time food was eaten at home.
2. Homemade and simple: Food was always homemade, it was more natural due to simple ingredients and methods
3. Local: Food was more local, it was grown, farmed, and sourced locally, there were local recipes and expertise. The variety of food was less and dependent on the time of year, as natural food was more seasonal.
4. Necessary: Food in the past was for sustenance and survival; it was eaten as a necessity for health.



Past, Present and Future of Food

Prompt 2:
What are the positives about food in today's world?

Results

1. Fast & Convenient: Food is quicker today; it saves time, is more convenient, and more people eat out more frequently.
2. Slow: Food is also slower and treated as more of an exquisite experience
3. Variety and availability: There is a greater variety of food, and it more readily available giving people more choice of food type and quality
4. Cheap and Easy: Food is cheaper, easier to find and there are more options out there

Past, Present and Future of Food

Prompt 3:
What are the negatives about food in today's world?

Results

1. Security: There is a security scare of food resources in times of crisis (covid-19), with the raising cost of living we may not have access too particular foods.
2. Resource intense: Food farming, manufacturing and production are highly intensive process that uses a lot of natural resources, leading to humanitarian and environmental exploitation.
3. Waste: Due to the readiness of food, it is easy to waste food without thinking, leading to unsustainable living unnecessary waste and lack of diet from the poor-quality food intake.
4. Climate change: The above points all lead to the major issue of the food industry contribution to the climate crisis, the more extreme the climate crisis becomes the more pressure will be put on the food industry – a positive feedback loop emerges.

Past, Present and Future of Food

Prompt 4 :
What values do we need to take forward into the future world of food?

Results

1. Equitable distribution of food globally: Control on globalization, more sustainable transport, less environmental impact
2. Access of food for all: Social distribution, affordable food.
3. Education around food: Food for health reasons, reducing unsustainable consumerism
4. Developing a healthier society: Food as medicine
5. Food culture bringing people together: Reusing older traditions

Exercise 2 – User Mapping

Participants were asked to create a list using sticky notes of two types of stakeholders.

1. Who is affected by the issue?
2. Who has the power to affect the issue?

Participants were asked to divide these into two instances, those who are core stakeholders and those who act as inspiration. The results were as follows

Table 1: *User / Stakeholder Mapping: What audience should we be considering when we are thinking of Food as Medicine.*

Who is affected by the issues?		**Who has the power to affect the issue?**	
Core	**Inspiration**	**Core**	**Inspiration**
Elderly	**Teenagers**	**Food producers**	**Policy Makers**
Generation Z	**Industry**	**Product manufactures**	**Designers**
Museum Users	**Logistics providers**	**Food industry**	**Early adopters**
Doctors	**Producers**	**Educators**	**Environmentalists**
Plants	**Packaging manufacturers**	**Artists**	**Tech Developers**
Health Workers			
Patients			

Exercise 3 – Technology Mapping

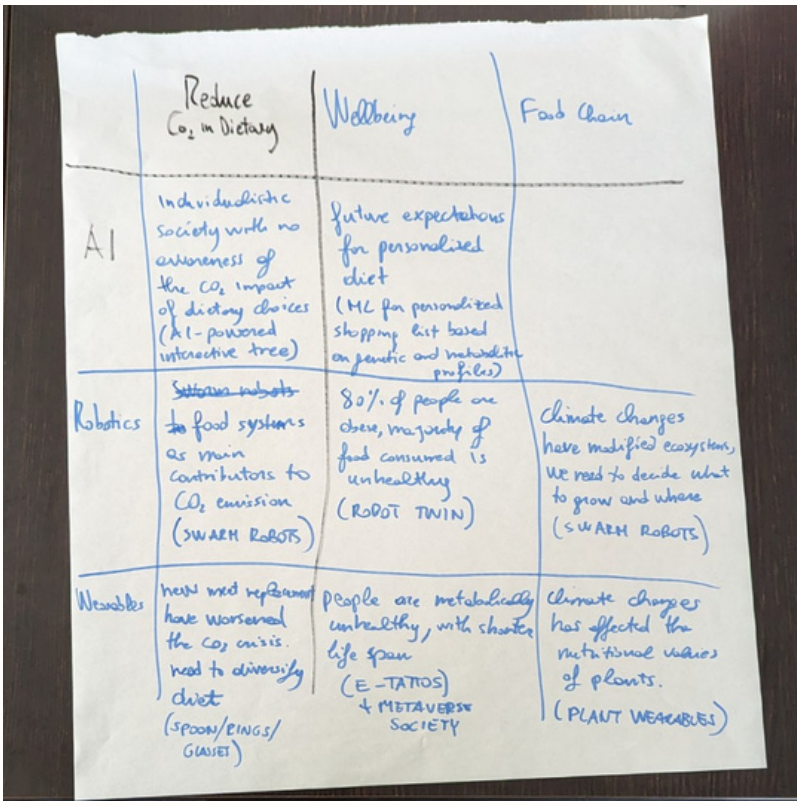
Participants were asked to map out the vast variety of technologies that could fall into the 3 categories of the project will place a focus on. A summary of the results are as follows:

Table 2: Technology Mapping: What technologies are available for use when we consider "Food as Medicine"

Artificial Intelligence	Robotics	Wearables
ML, DL, NLP, CV etc.	Robots	Exoskeletons
Ambient Intelligence	Manipulators	Automatic cleaning
Human Computer Interfaces	Humanoids	Haptics
Assistance – chatbots / buddies	SWARM	Sensor implants / E-tattoos
Smart Devices	Prosthetics	Skins / Second Skins
Intentions	Face sensors	VR / AR / ER
HRI / MMI	Mobile bases	Smart nose / breathing analyzer's / watchers

Exercise 4.a – Scenario Development

Participants were challenged to try and think like artist would. The purpose of this is to place themselves in the shoes of the artist, designer, research, or producer who could be working to develop this piece in the future. The aim of this exercise is to allow those participating to image what the future could like in, to understand the type of artists, technologies and themes that would appeal to them when launching the open call.



Participants were asked to imagine a future scenario in which on the 5 future challenges are solved. These challenges are related to the future values taken form exercise 1.

1. **Equitable distribution of food globally**
2. **Access of food for all**
3. **Education around food**
4. **Developing a healthier society**
5. **Food culture bringing people together**

Participants were asked to pick a core stakeholder from exercise 2, and a technology from exercise 3 and develop a future scenario in which one of the above challenges is solved for that specific stakeholder using that specific technology.

Examples 1: SWARM Bots

To reduce CO2 emission caused by unnecessary travelling and farming machinery, a safe environmentally friendly solution has been devised to plant food and distribute the produce.

SWARM bots are a compact solar powered Al robot, that use a model of interspecies interactions to identify the best plant species that should grow in specific parts of the surrounding environment. SWARM bots have maximized the use of land and biodiversity of the environments that they work in, this has led to a dramatic increase in sustainable production and distribution of food produce. Once the produce is farmed, they SWARM bots transport it directly to consumer reducing the emissions caused by traditional logistics companies.

Examples 2: Robot Twins

The robot twin lives in the meta verse and acts as mirror to your healthy or unhealthy self. The robot twin receives information of your food intake and exercise to establish an understanding of your overall health. Your twin can then encourage you to act healthier, either through a dramatic exaggeration of your unhealthy lifestyle and asking you to change, or by acting as a supportive co-inhabitant that can function as a nutritionist and personal trainer in the meta verse.

Exercise 4.b– Scenario Mapping

Lastly, participants were asked to observe what they have created and place these scenarios within a matrix of Research tracks against technologies they mapped previously to identify future scenarios.

The 3 tracks of research are:

Research Tracks

1. Reduce CO2 trough dietary behavior
2. The role of food in wellbeing
3. Rethinking food chains in our environment

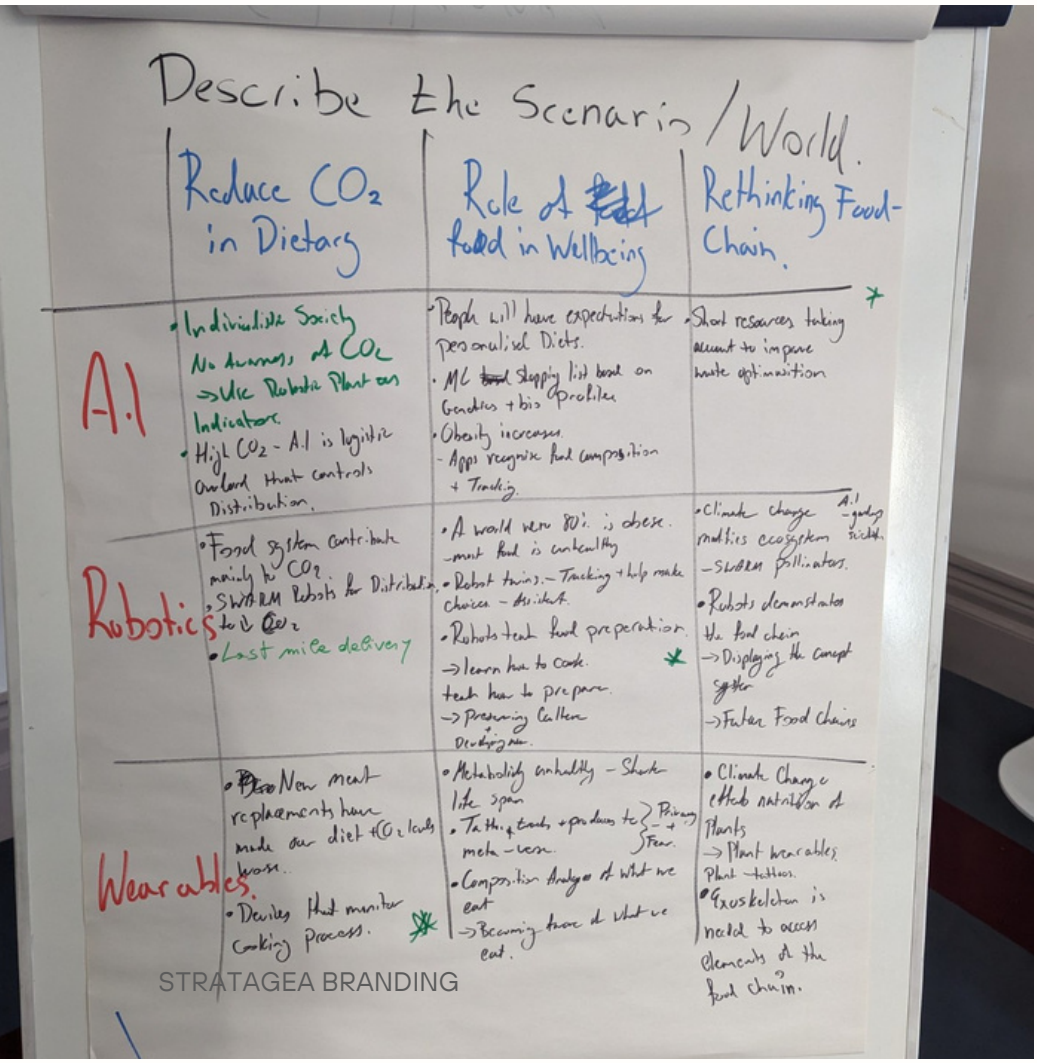


Table 3: *Scenario Mapping: What are the future potential scenarios for our food industry and food systems when we consider the 3 tracks of research and future technologies*

	Reduce CO2 trough dietary behavior	The role of food in wellbeing	Rethinking food chains in our environment
Artificial intelligence	**An individual society with no awareness of CO2, robotic plants are used as indicators High CO2 – A.I is a logistic overlord that controls food distribution**	**People have expectations for personalized diets. Machine learning develops shopping lists based on genetic and health profiles** **The applications we buy through recognize food composition and can track what we eat**	**A.I is Optimizing waste management by to assist in using complex food chains and environmental interactions maximise use of waste.**
Robotics	**Food system contribute to majority of CO2 emissions Robots (SWARM) act as distributers of distributions. In rural areas we have the 'last-mile' delivery**	**80% of the population are now obese. Robotic twins track and assists people in making healthier choices.** **Assistant robots help people to prepare and cook food safely**	**Climate change modifies the ecosystem. Robots demonstrate the food chain interactions and display concepts of systems thinking and future food chains**
Wearables	**New meat replacements have made our diet and CO2 level worse.** **We were devices that read our biological levels such as metabolic health, the device advises and monitors what we cook**	**Individuals having poor metabolic health leading to them having a shorter lifespan.** **Wearable technology will advise individual to how and what t cook for healthier lifestyle**	**Climate change effects mutations in plants. Plant wearables are common to track their health and that of the ecosystem. Exoskeletons are needed to access elements of the food systems**

Exercise 5 – Open Call

1. Provocation

- Open with an igniting question that to help spark ideas in the reader related to the future of food as medicine.

2. About Musae project

- Project summary: A short summary of the Musae project, its aims, and objectives.
- Call summary: Reason for open call and the aim of launching an open call

3. About Residencies

- Open Call One and Open Call Two: Make clear to readers that there will be two open calls, the purpose of each one. Focus on open call 1 for now, describe the key objectives and outputs on the call.
- Timelines: The timeline of open call one and open call two.
- Logistics: Describe how Open Call One will proceed and the partners that will be involved.

4. Experience required

- What experience we are looking for: For example "We are looking for artists with interests in _____ / experience with ____ is essential /experience with ___ is preferred / Applicants should be open to collaborating with ___ "
- What experience we have: "Residents will have the opportunity to work with ___"

5. The future of food as medicine

- Brief description of the 3 tracks of scientific enquiry
- Brief (one line) of the use of the 3 types of technology artists could work with.
- Example of future scenarios

6. Application

- Who? Who is the open call open to? (referring back to the experience)
- When? What is the timeline for the open call open dates? When does it close?
- How? Is there a link to the open call? What platform will you apply through? Do You need to pre-register?
- Webinars and future engagements: Will there be an online webinar to give potential participants information they need for applying?

Musae

Co-Creation Workshop Summary